



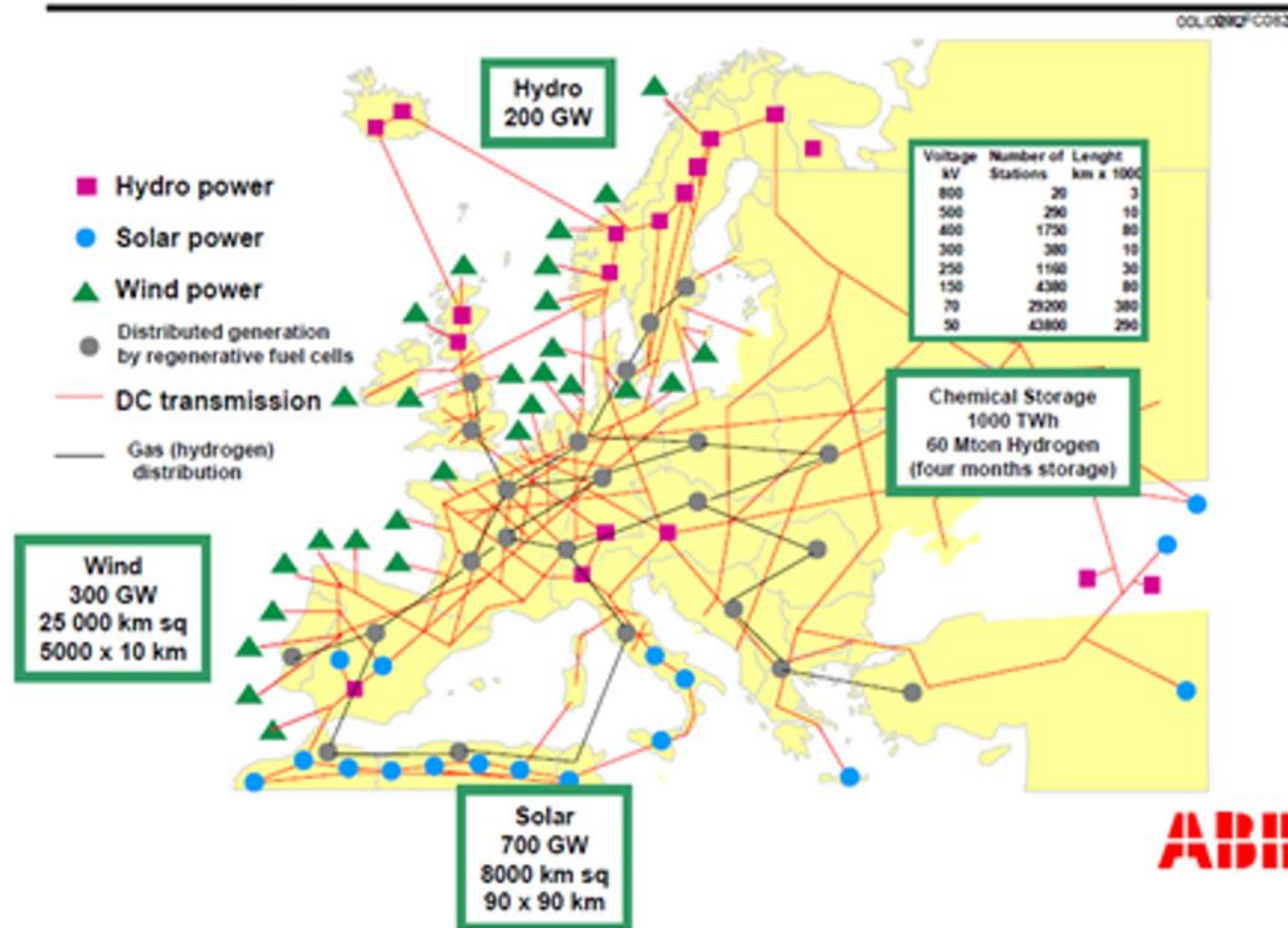
**EUROPEAN  
BATTERY  
ALLIANCE**

**EBA250**

**Power System in the Era of 100% Renewable Energy  
Challenges and Solutions  
REI webinar July 30, 2021  
Bo Normark; Industrial Strategy Executive EIT InnoEnergy**

## 100% Renewable Energy System, Hydro, Wind, Solar and Storage

### Europe 20XX



- Hydro
- Wind
- Solar
- Inter Connections
- Storage

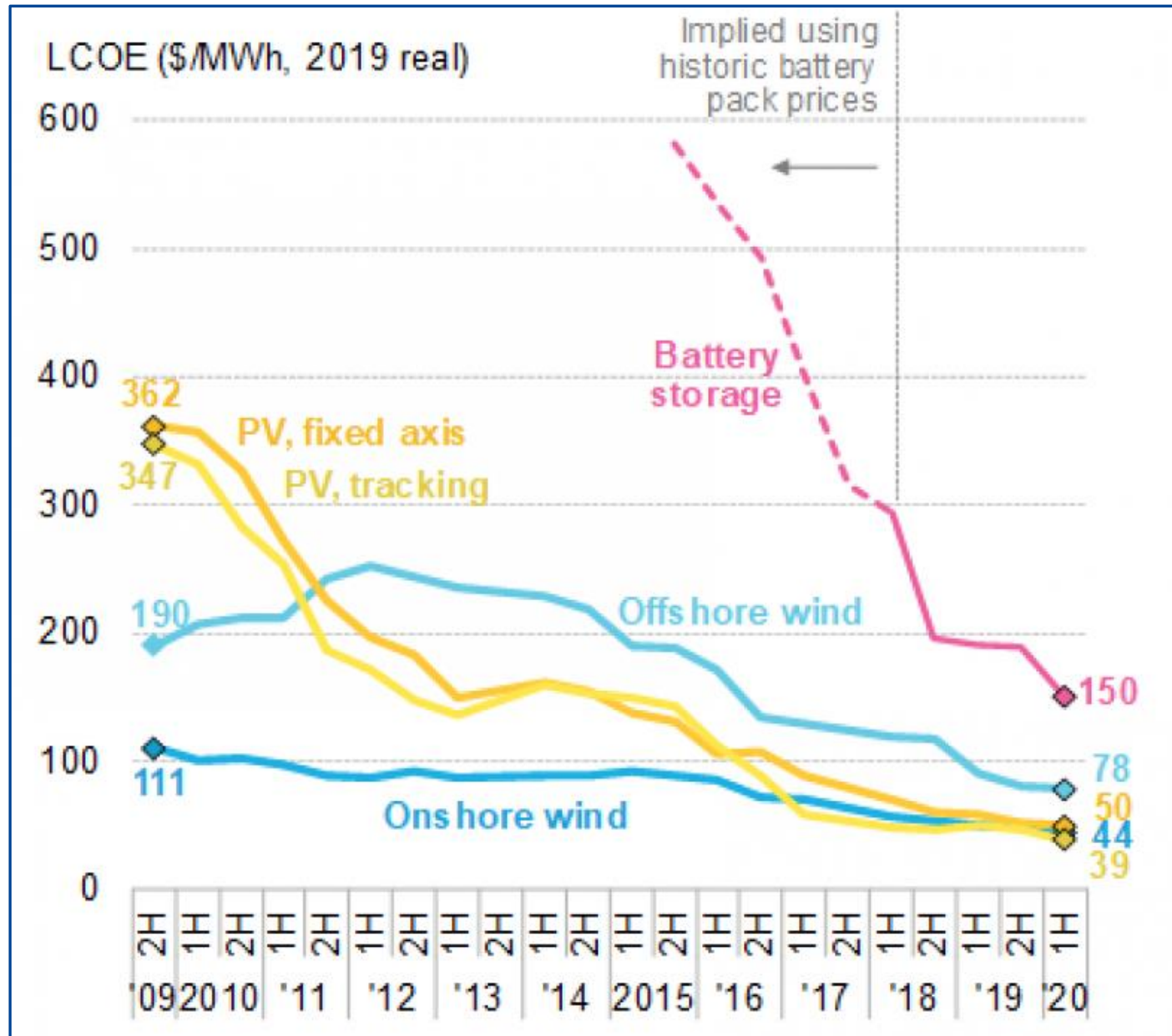


## Where are we today and 2025 ?

	Vision	Today	/	2025
■ Solar	700 GW	137 GW	/	280 GW
■ Hydro	200 GW	230 GW	/	230 GW
■ Wind	300 GW	220 GW	/	325GW
■ Storage	1000 TWh	200 TWh	/	220 TWh

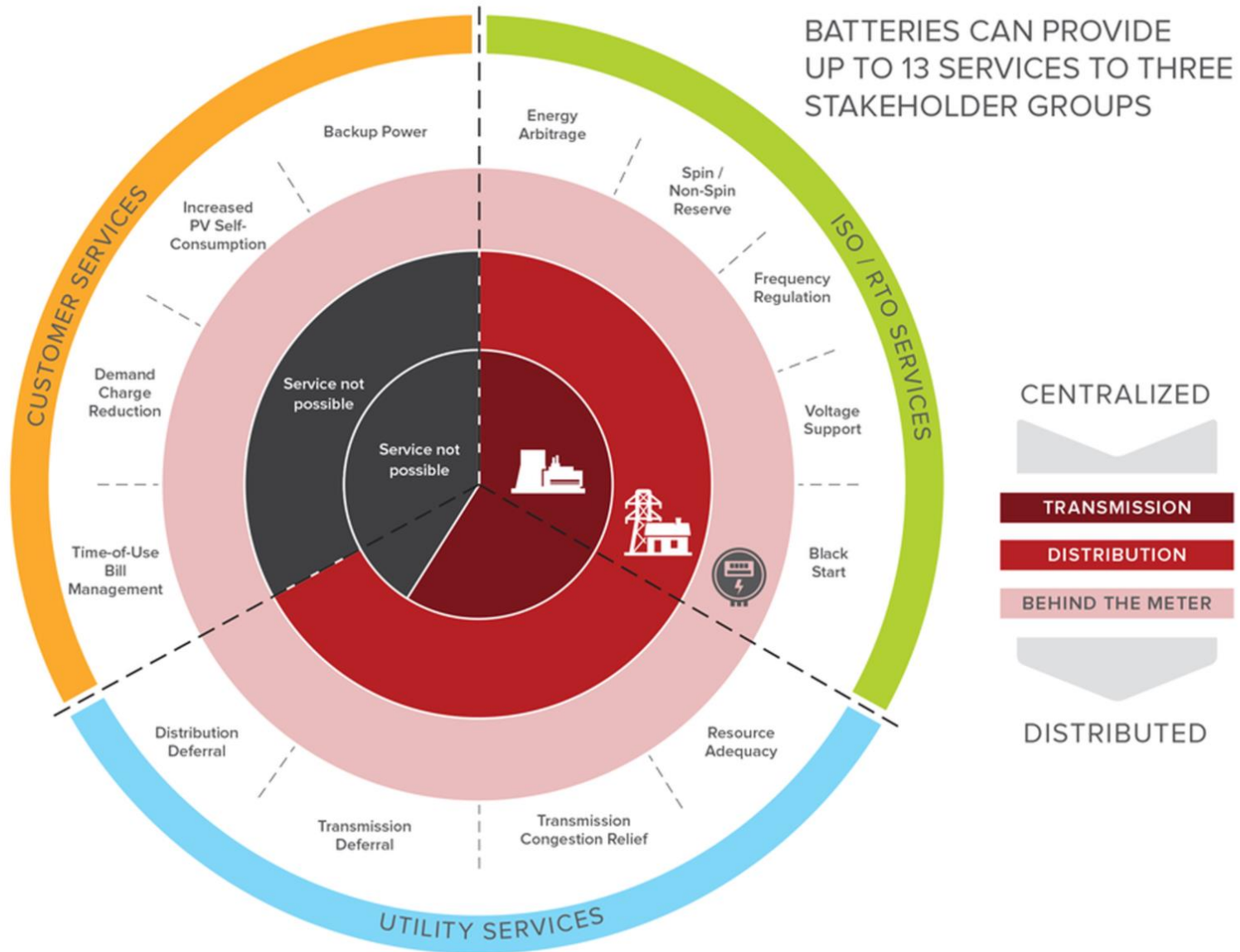
# Batteries in the Power System

# Cost development of key technologies

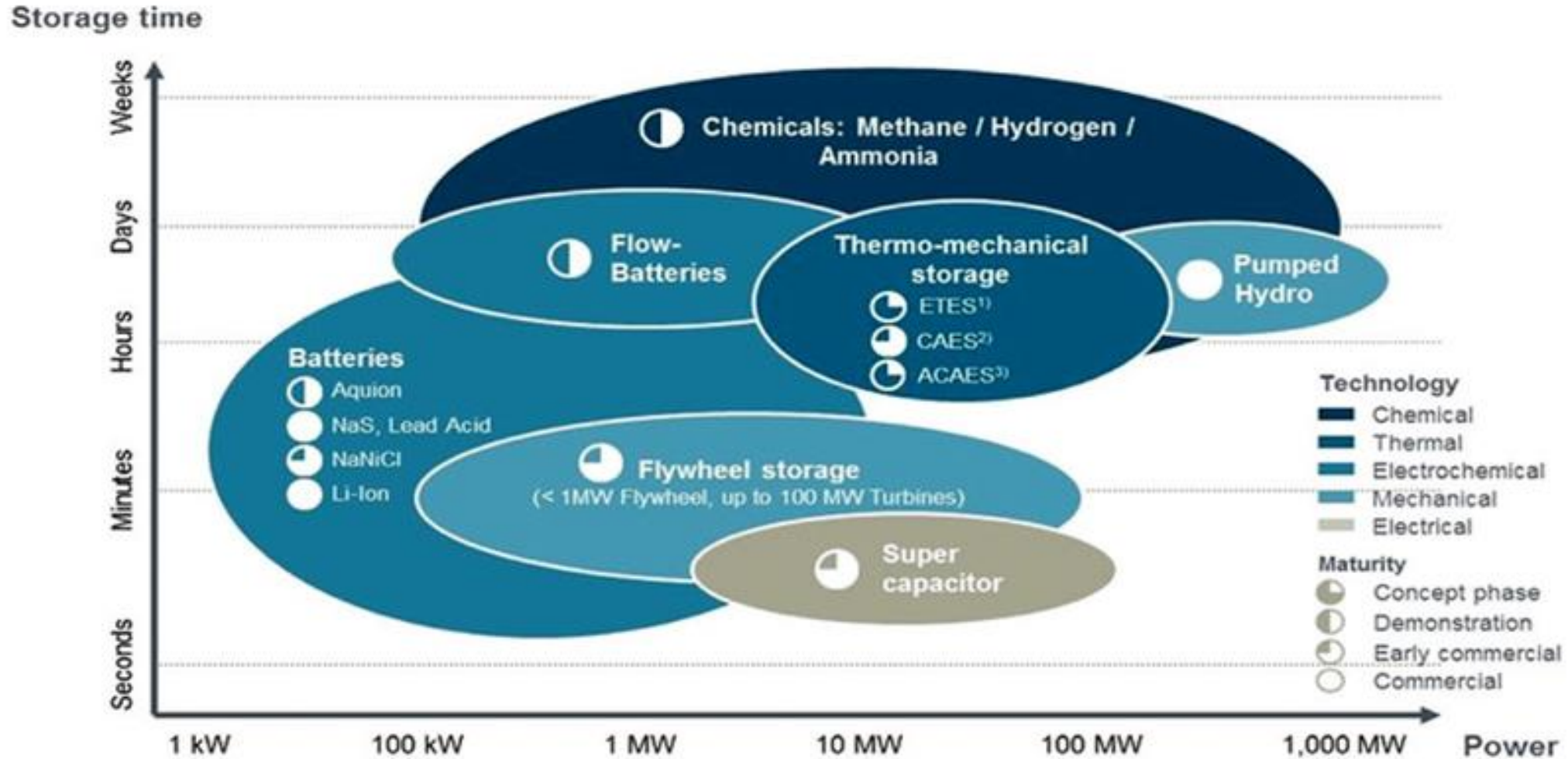


**Battery Storage  
fastest  
falling costs  
in Power System**

# Storage can provide multiple services



# Storage technologies

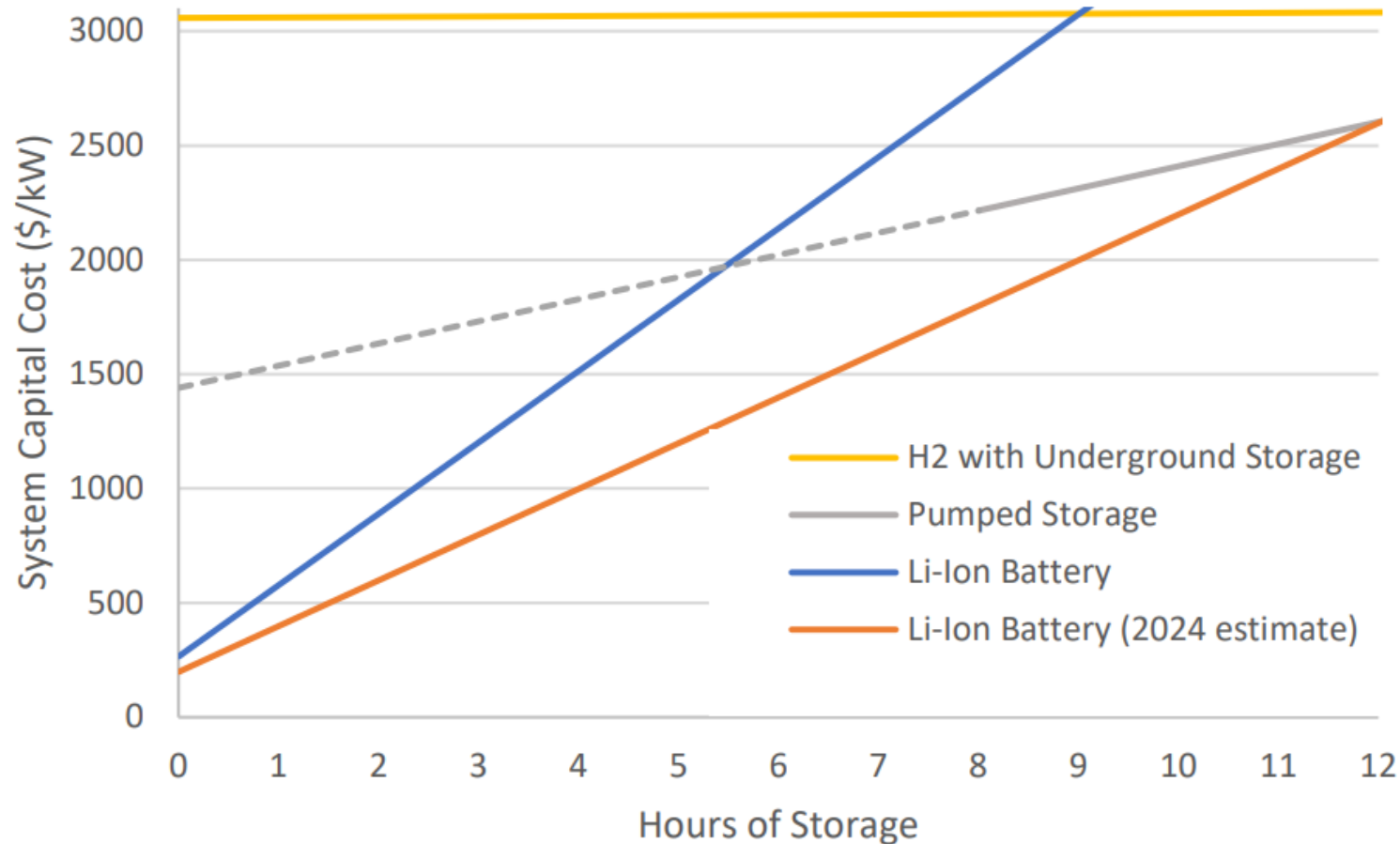


<sup>1)</sup>Electro-Thermal Energy Storage

<sup>2)</sup>Compressed Air Energy Storage

<sup>3)</sup>Adiabatic Compressed Air Energy Storage

## Battery costs are projected to continue to fall





# Peak Power in High-RES System

# Peak shaving, battery vs grid vacuum cleaner

Electric Power 700 W  
Vacuum Power 200 W  
Max Grid Power 700 W

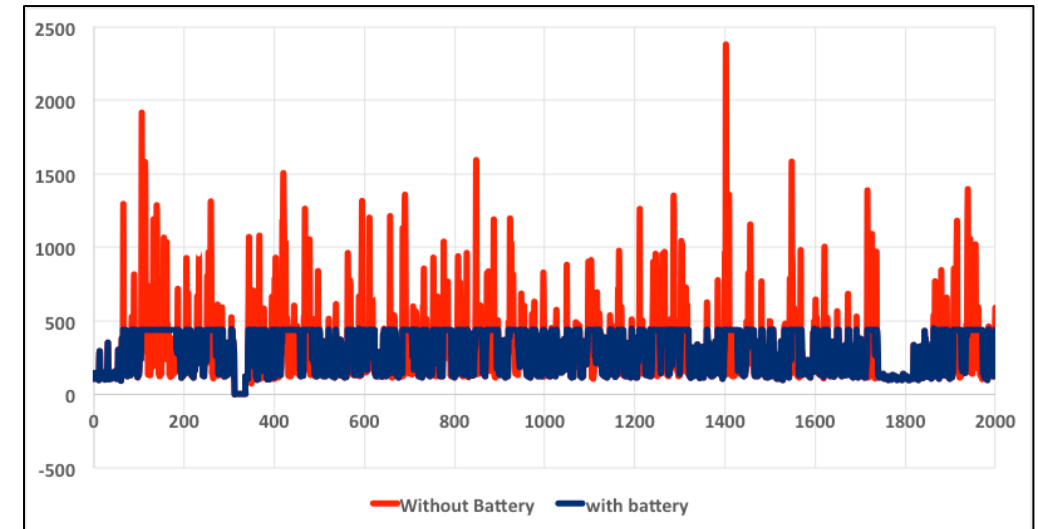
14 x

Electric Power 550 W  
Vacuum Power 200 W  
Max Grid Power 50 W



# Peak shaving with local battery

## An alternative to build more local grids



“  
A battery of around  
1 kWh per apartment is  
sufficient to reduce peak  
load by 40 per cent in the  
entire building.”



BRIEF

## **PG&E to replace 3 gas plants with world's biggest battery projects**

Pacific Gas and Electric (PG&E) late last week requested approval from the California Public Utilities Commission (CPUC) for four energy storage projects totaling about 2,270 MWh.

# Interconnections in High-RES System



## Plan for 2030



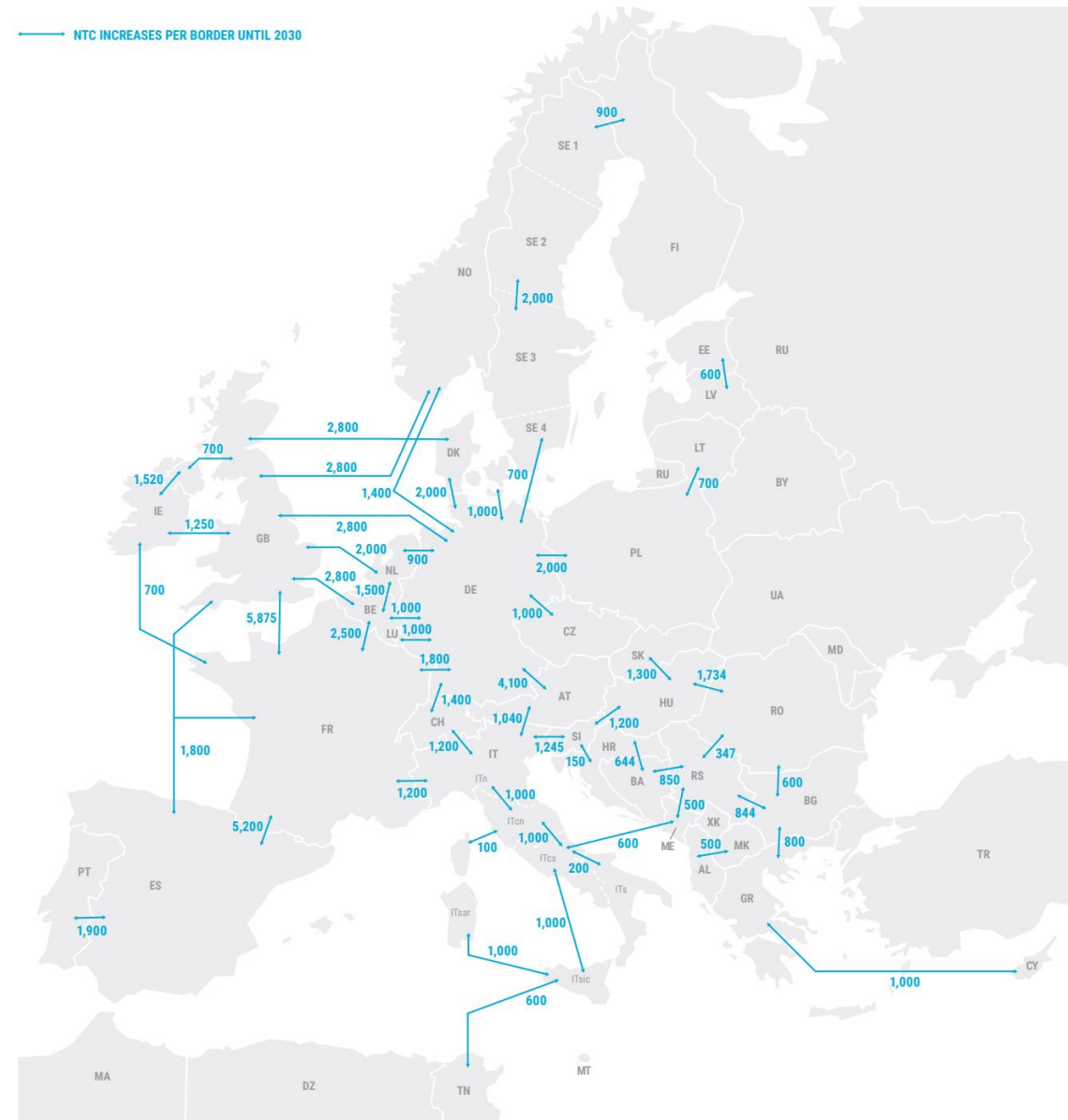
The TYNDP 2020 assessed **154** transmission projects, of which 97 cross-border projects representing close to **90 GW** of additional cross-border transmission capacity. Overall, the TYNDP 2020 portfolio represents **46,000 km** of lines or cables.



**26** storage projects, representing **485 GWh** of storage capacity. That's 6 more storage projects than in the TYNDP 2018, with for the first time a TYNDP pilot cross-sector (transport) project.



Collectively, TYNDP 2020 projects generate an increase in socio-economic welfare by **7.3 to 13.2 billion euro per year**, depending on the scenario considered.



**Germany’s grid could use gigawatt-scale ESS as alternative to ‘billions in infrastructure spending’**

**The net booster should make it possible to transport more power with existing lines and thus to dispense with some new routes.**

## **France’s ‘virtual power line’ takes shape**

Nidec has deployed a 12 MW/24MWh storage system for French grid operator RTE. The battery – part of a 72 MWh project to prevent grid congestion in peak demand periods – is in an area with abundant renewables, including wind.

<https://www.pv-magazine.com/2020/10/07/frances-virtual-power-line-takes-shape/>

<https://www.energy-storage.news/news/germanys-grid-could-use-gigawatt-scale-ess-as-alternative-to-billions-in-in>



# System Services in High-RES System

## What is a 'synchronous system'?

A synchronous system is a power grid where electricity is generated at a single synchronised AC frequency. Ireland and Northern Ireland form such a system – all of the conventional generators on the island run in synchronism, producing electricity at 50Hz. Synchronous systems can operate in relatively small regions, such as Ireland and Northern Ireland, or span vast areas, such as Continental Europe.

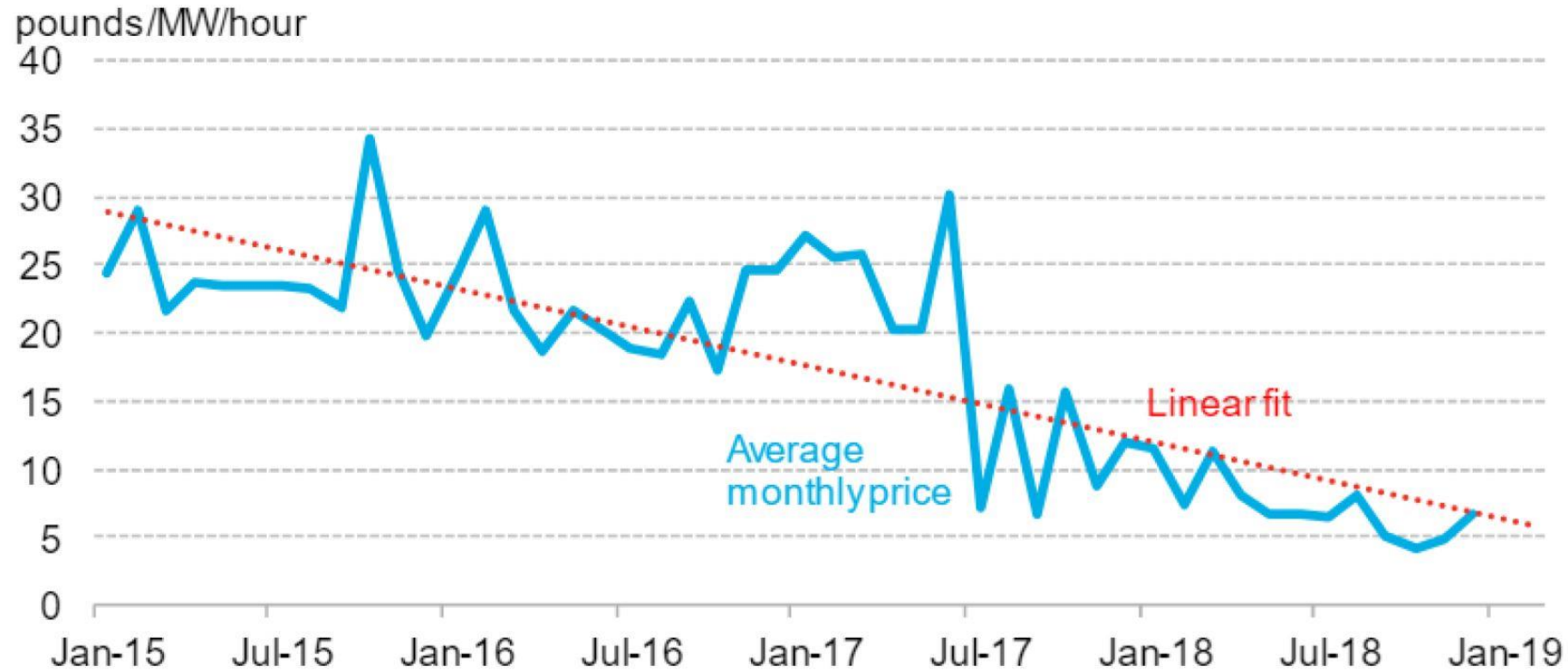
## Penetration of Non-Synchronous Renewables IN EACH EUROPEAN SYNCHRONOUS SYSTEM 2010-2020



Source: The National Renewable Energy Action Plans (NREAP 2010)

## Batteries are delivering FFR since 2015

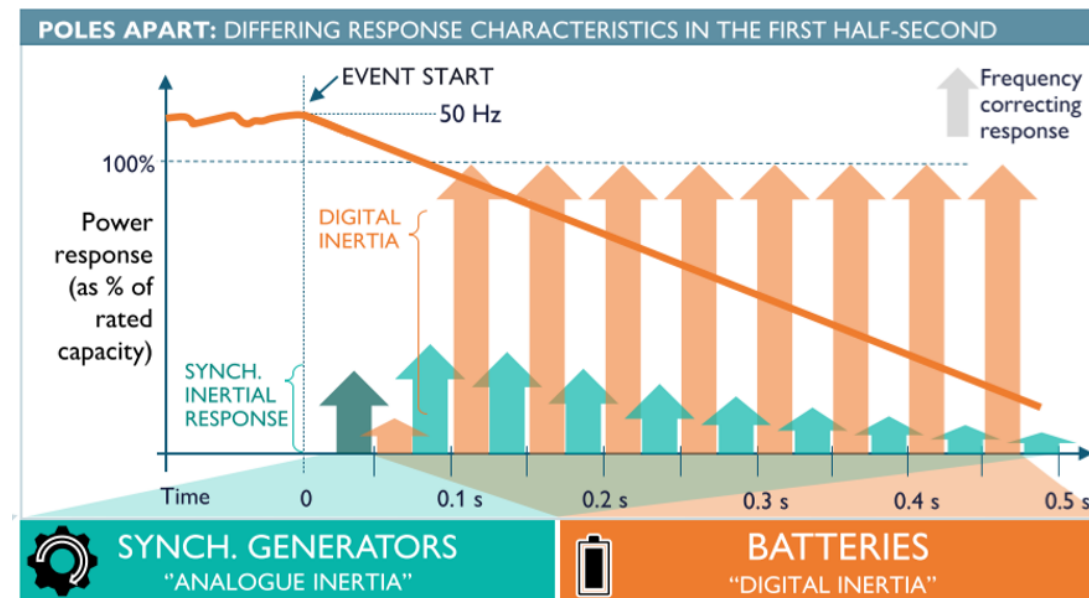
Figure 65: U.K. average monthly Firm Frequency Response (FFR) prices



Source: BloombergNEF, National Grid

BATTERIES CAN PROVIDE FAST AND EFFECTIVE SYNTHETIC INERTIAL RESPONSE WITHOUT DISPLACING RENEWABLES. THIS IS DIGITAL INERTIA.

## 'Digital inertia': Energy storage can stabilise grid with 1/10 the capacity of thermal generation



<https://www.pv-magazine.com/2020/12/14/italian-grid-operator-awards-250-mw-of-storage-in-pilot-auction/>

## Italian grid operator awards 250 MW of storage in pilot auction

Terna's first auction for reserve storage capacity was largely oversubscribed, with over 1,327 MW of submitted projects. Overall, 23 projects were assigned to 17 operators.

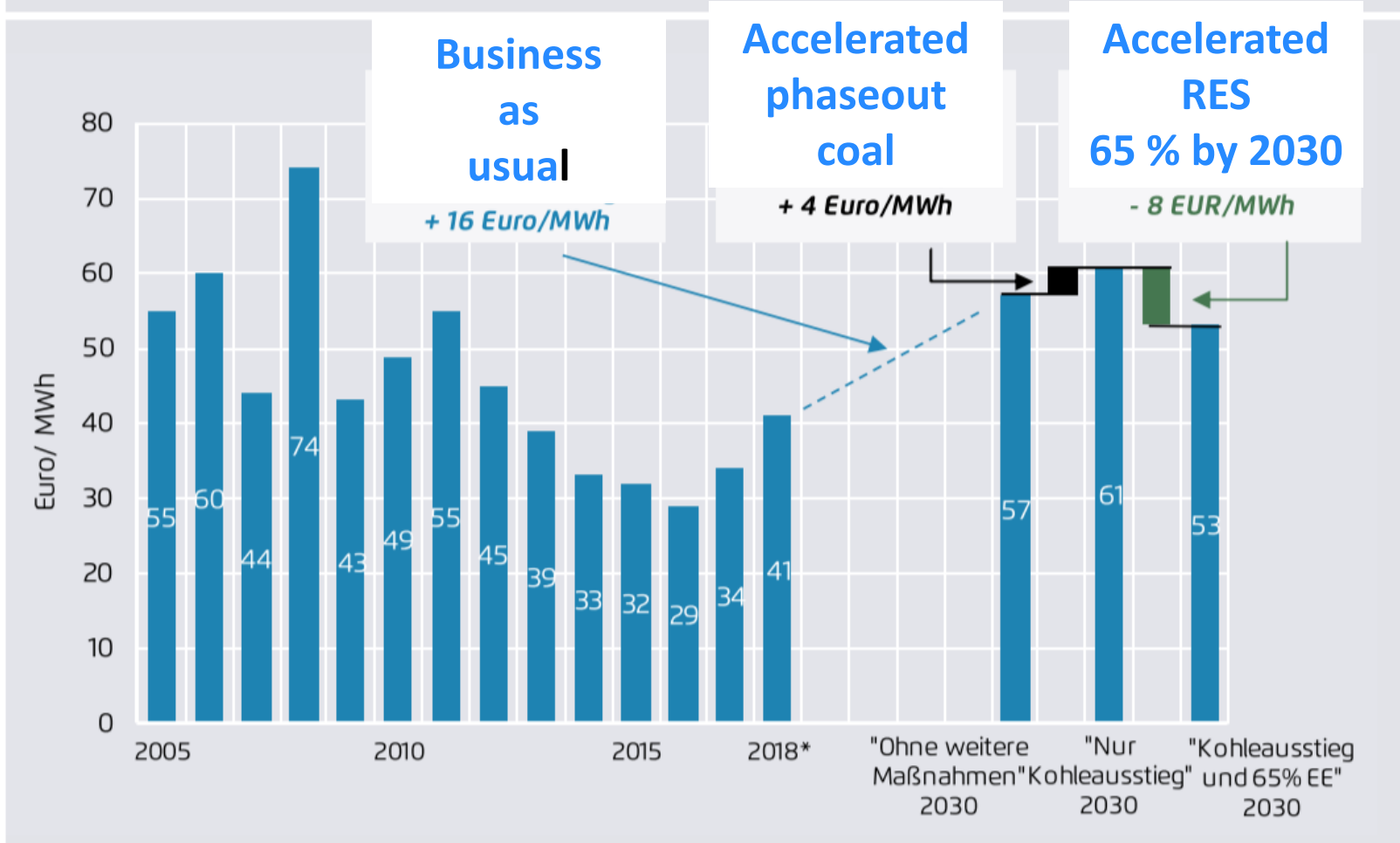
**DECEMBER 14, 2020** **EMILIANO BELLINI**

Italy's grid operator, Terna, has awarded around 250 MW of capacity in its energy storage auction, held last week. The auction is part of the company's Fast Reserve pilot project, dedicated to the participation of large scale batteries in the dispatching services market.

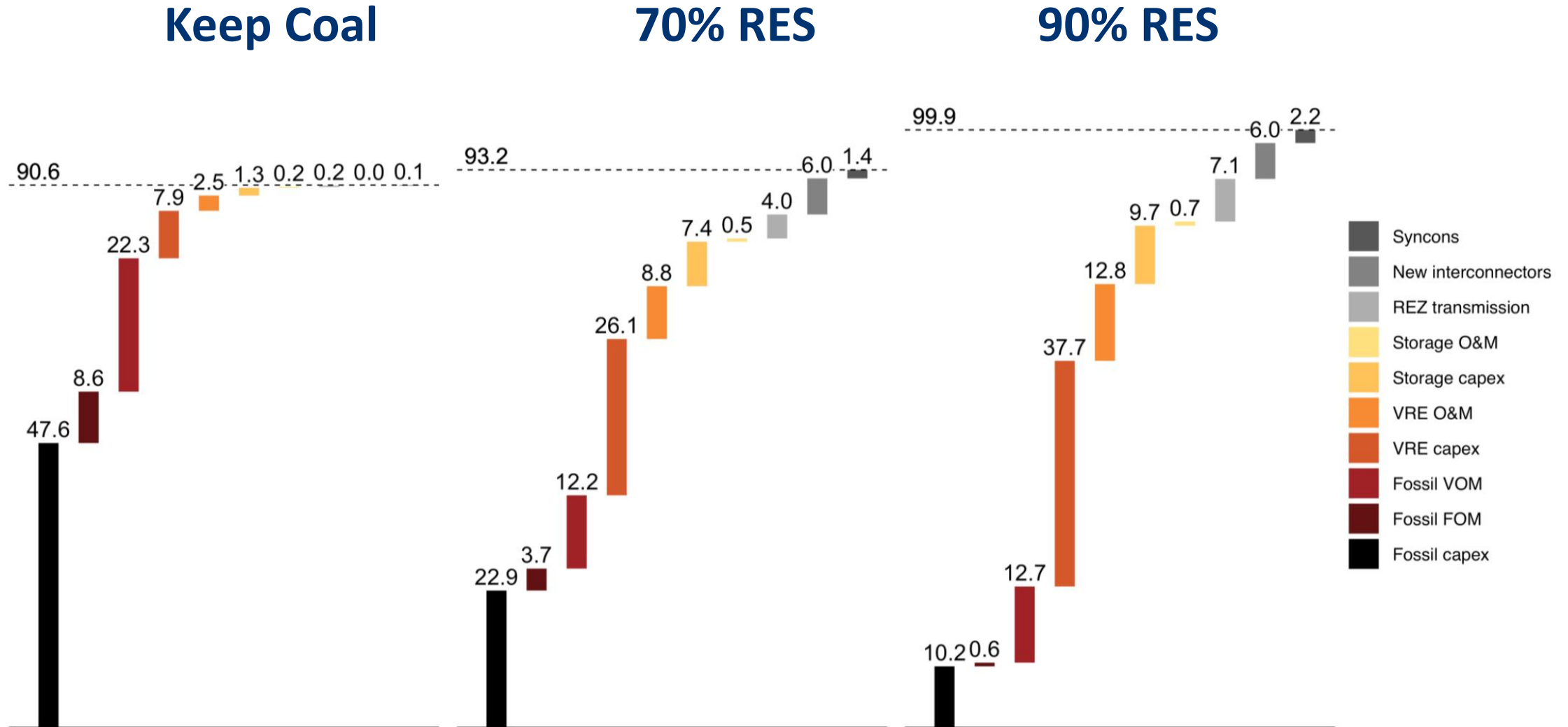
# Cost comparisons

# Cost projections three scenarios, Germany

Abbildung 6: Entwicklung der Börsenstrompreise (day-ahead) 2005 bis 2018\* und 2030



# 2040 Cost projections three scenarios, Australia



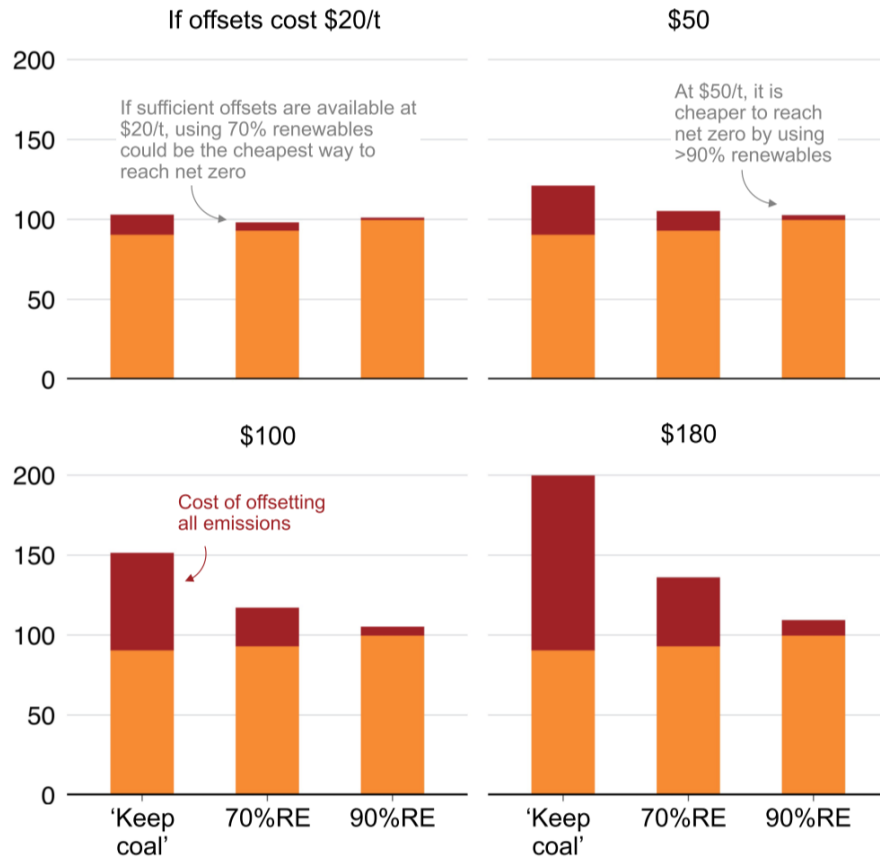


# There is a major "but" when comparing costs

## A carbon price of only 20 \$/ton makes the 90% RES lowest cost alternative

Figure 3.3: The price of offsets will determine the cheapest way to achieve net zero in the NEM

System unit cost (\$/MWh), including the cost to offset any emissions

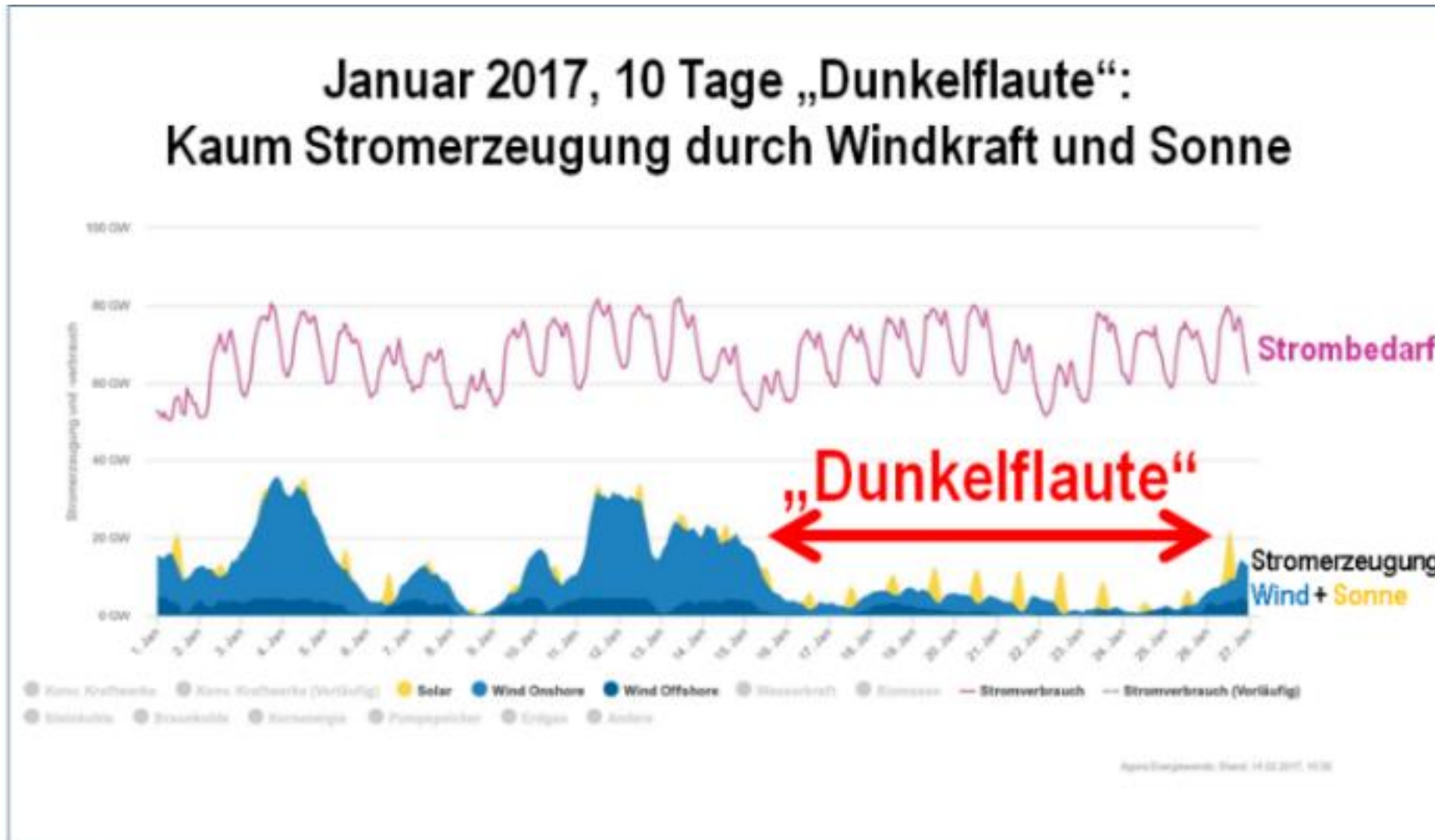


- A global carbon tax likely
- EU will introduce "Carbon Border Tax" for all imports before 2030

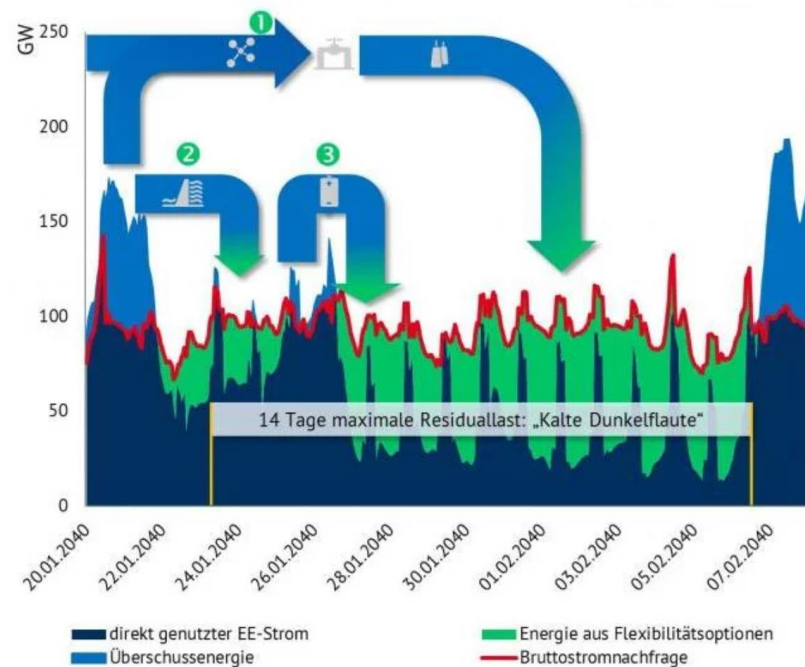
# The “Dunkelflaute” challenge

# The "Dunkelflaute" Challenge

## Januar 2017, 10 Tage „Dunkelflaute“: Kaum Stromerzeugung durch Windkraft und Sonne



## Der kalten Dunkelflaute mit Flexibilitätsoptionen begegnen



Schematische Darstellung der Flexibilitätsoptionen, die in einer Dunkelflaute eine sichere Stromversorgung ermöglichen. (Grafik: Energy Brainpool)

- 1 Langfristflexibilität:** Ein Elektrolyseur erzeugt Speichergas für das Gasnetz und Gaskraftwerke erzeugen klimaneutralen Strom in der kalten Dunkelflaute
- 2 Mittelfristflexibilität:** Zum Beispiel Pumpspeicher können über wenige Tage Überschüsse ausgleichen.
- 3 Kurzfristflexibilität:** Zum Beispiel Batteriespeicher gleichen Stromangebot und -nachfrage über Stunden hinweg aus

## Solutions:

- Long (2 weeks) Hydrogen
- Middle (1-2 days) Pump Storage
- Short (hours) Batteries

# Case Sweden



## Doubling of electricity consumption until 2045 and

- Electrification of the entire transport sector
- Continue electrification of heating system
- Expand IT system with server halls
- Build an entirely new battery industry
- Rebuild a fossil free steel industry
- Rebuild a fossil free cement industry

## H2 Green Steel

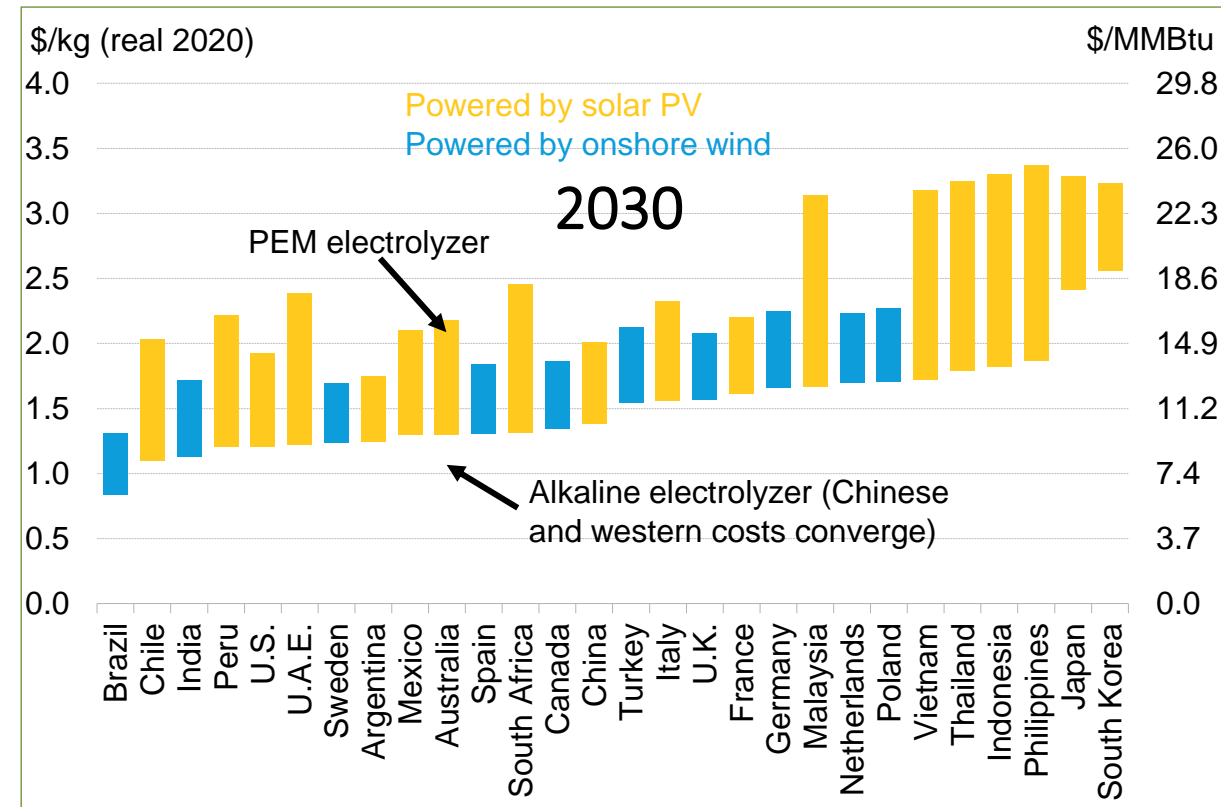
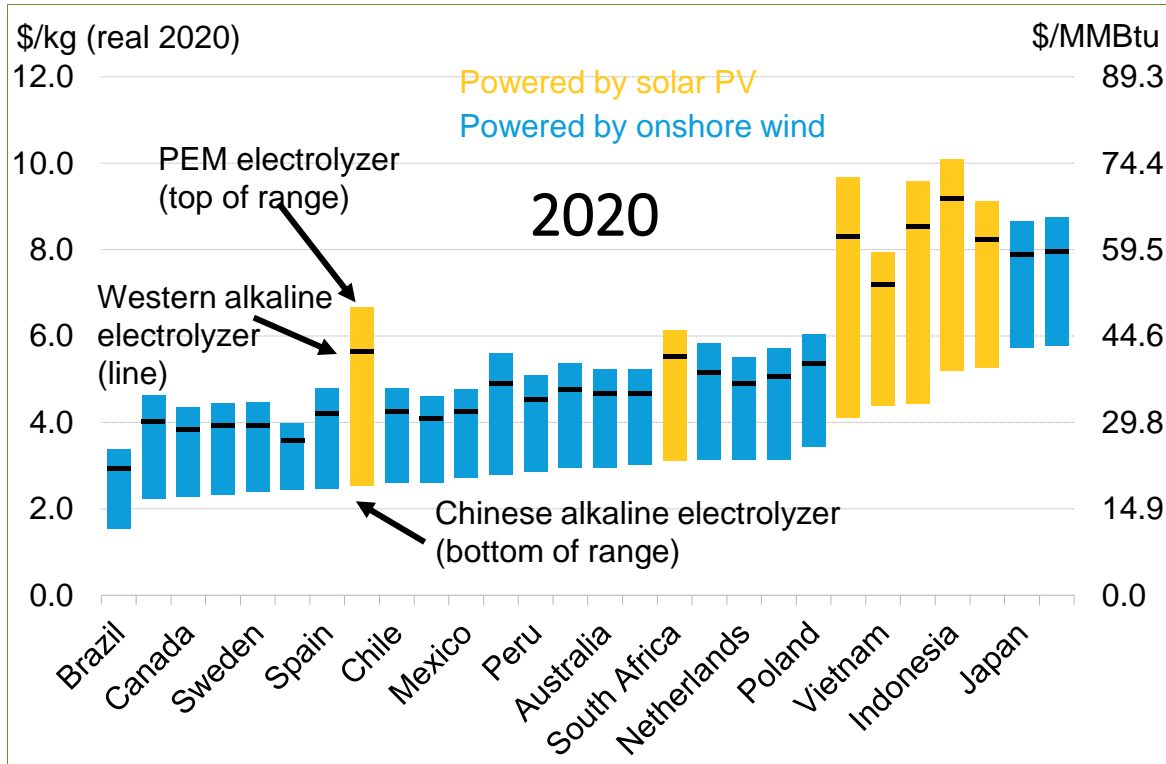
- Location Northern Sweden
- Capacity 5 million tons
- Electricity demand gross 1500 MW
- Energy storage gives flex power 800 MW
- In service 2024 - 2028



**Largest flexibility resource in the Nordic Power System**

# Rationale for Green Steel, Green Hydrogen price

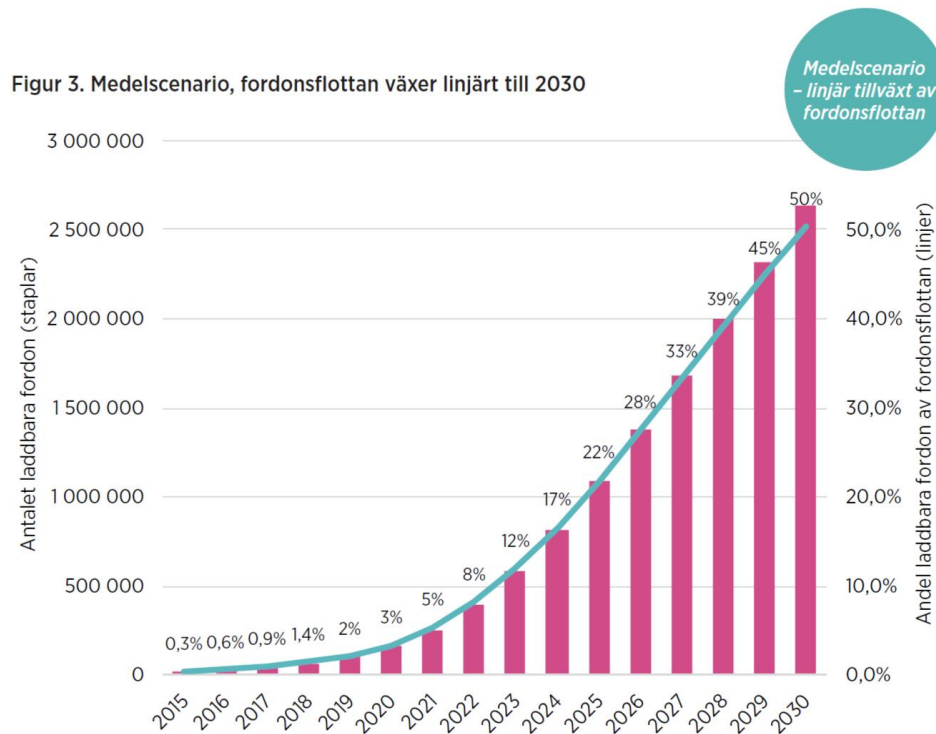
- Sweden has lowest price in Europe for Green Hydrogen
- Green Hydrogen is competitive in many markets by 2030



Källa: BNEF 2021



Figur 3. Medelscenario, fordonsflottan växer linjärt till 2030



Källa: SCB och egen bearbetning.

Anm.: Staplarna avser antalet laddbara fordon i trafik (vänster axel).

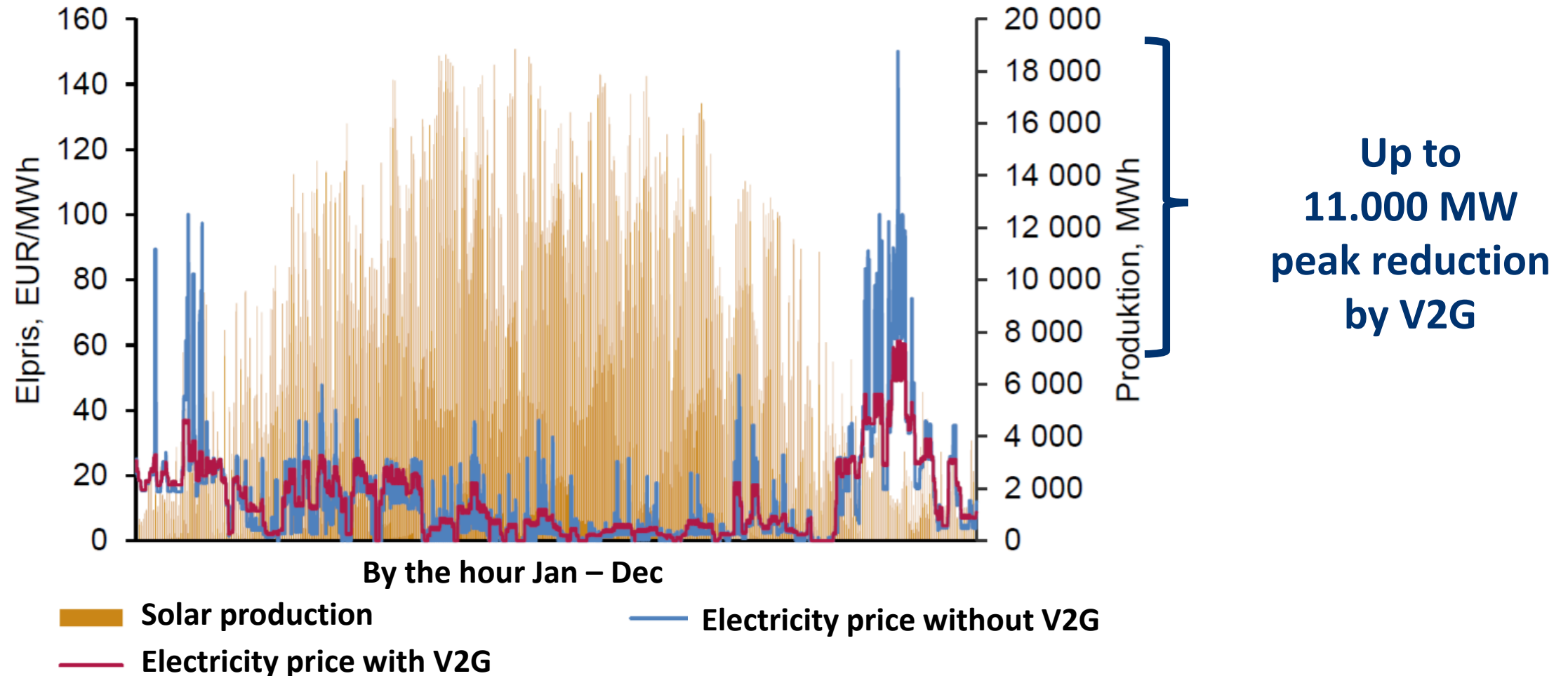
Anm.: Linjen avser andelen laddbara fordon av fordonsflottan (höger axel).

Anm.: För åren 2015-2019 redovisas faktiska utfall.

**Projekted 2.5 million BEV:s on Swedish roads by 2030 representing \*):**

- +/- 25.000 MW flexible power
- 50.000 MWh storage

## Simulation 2045, 100 % RES system; V2G key element in power system



# Sweden, 100 % renewable power system

## Flex resources with hydrogen, batteries and V2G enabling 100 % RES system

Scenario 4; Electrification base Renewable Generation (EF); TWh

	2025	2035	2045
Solar	3	11	18
Wind	49	103	211
Thermal	11	10	9
Nuclear	51	47	0
Hydro	68	67	66
Production Total	182	238	304
Consumption Total	147	217	302
Export	35	21	2
Flex resource Hydrogen	0	34	84
Flex resource Batteries + V2G *	0	13	42

\* Based on 15 % BEV by 2035 and 50 % BEV by 2045

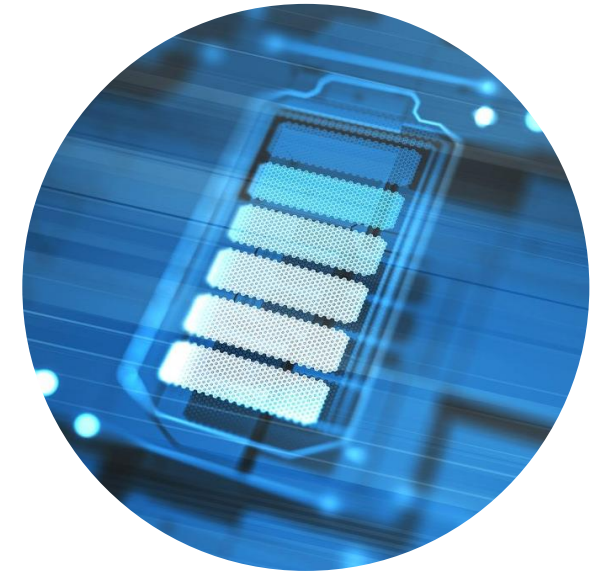


- **100 % Renewable Energy System realistic scenario**
- **Key elements:**
  - **Overbuilding renewable production to serve new industries**
  - **Interconnections**
  - **Demand response**
  - **Storage**
  - **Zero emission despatchable generation mainly Green Hydrogen**
- **Sector coupling Power/Transport/Industry essential**

EIT InnoEnergy is the innovation engine for sustainable energy across Europe supported by the European Institute of Innovation and Technology.

EIT InnoEnergy's role in the European Battery Alliance is to provide background data, collect and formulate key questions, recommendations and actions.

EIT InnoEnergy also support the establishment of a European Battery eco-system by promoting a meeting place for key players along the entire value with our EBA250 Workshops.



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