EUROPEAN ENERGY FORUM
Online Briefing Session

Energy security: an electricity system perspective

Session 2 - Keeping the electricity system secured in the long term: what's needed?

In cooperation with the EEF Associate Members

EASE European Association for Storage of Energy

SolarPower Europe

Wind EUROPE

Chatham House Rule

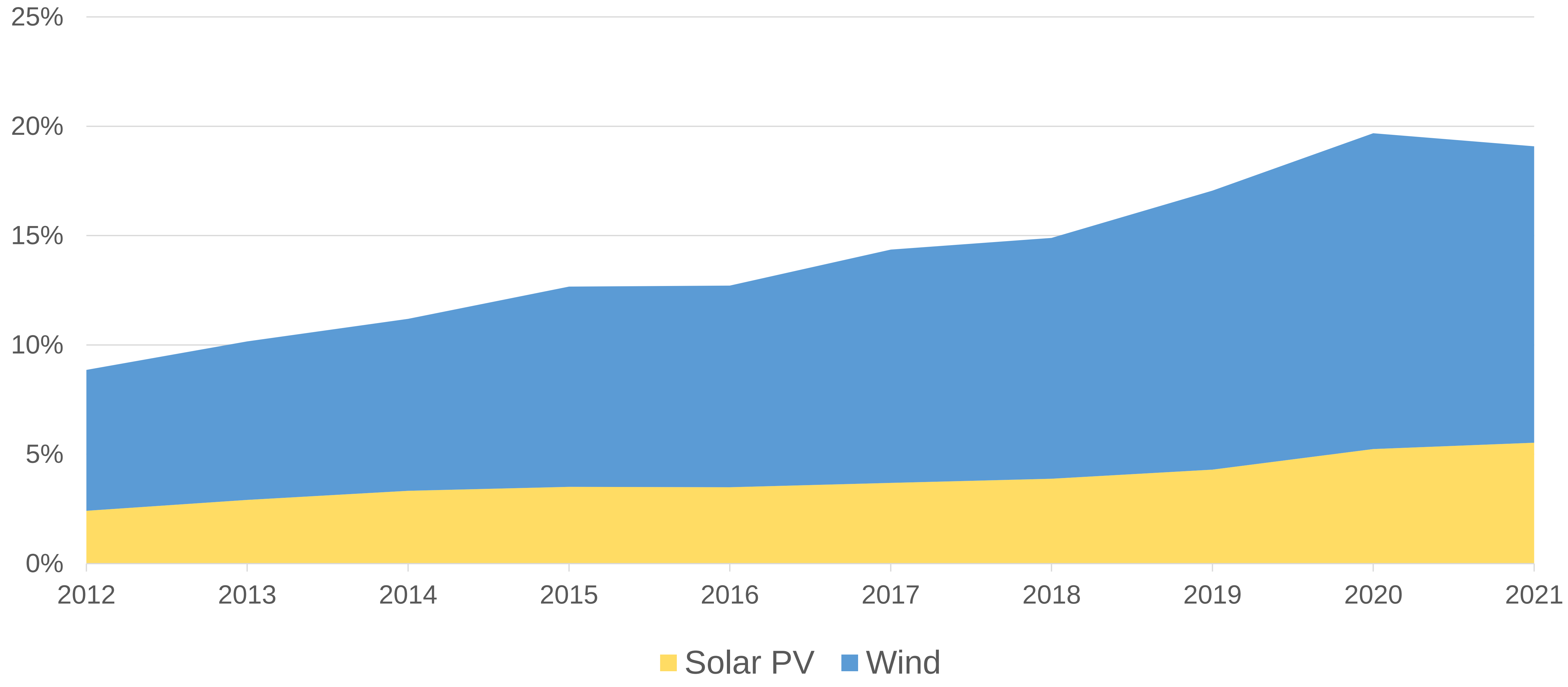
@EEF_EnergyForum #EEF_BriefingSession

Variable RES generation – current and future trends

Presented by ***Raffaele Rossi****, Head of Market Intelligence, SolarPower Europe*

Variable renewable energy production increases

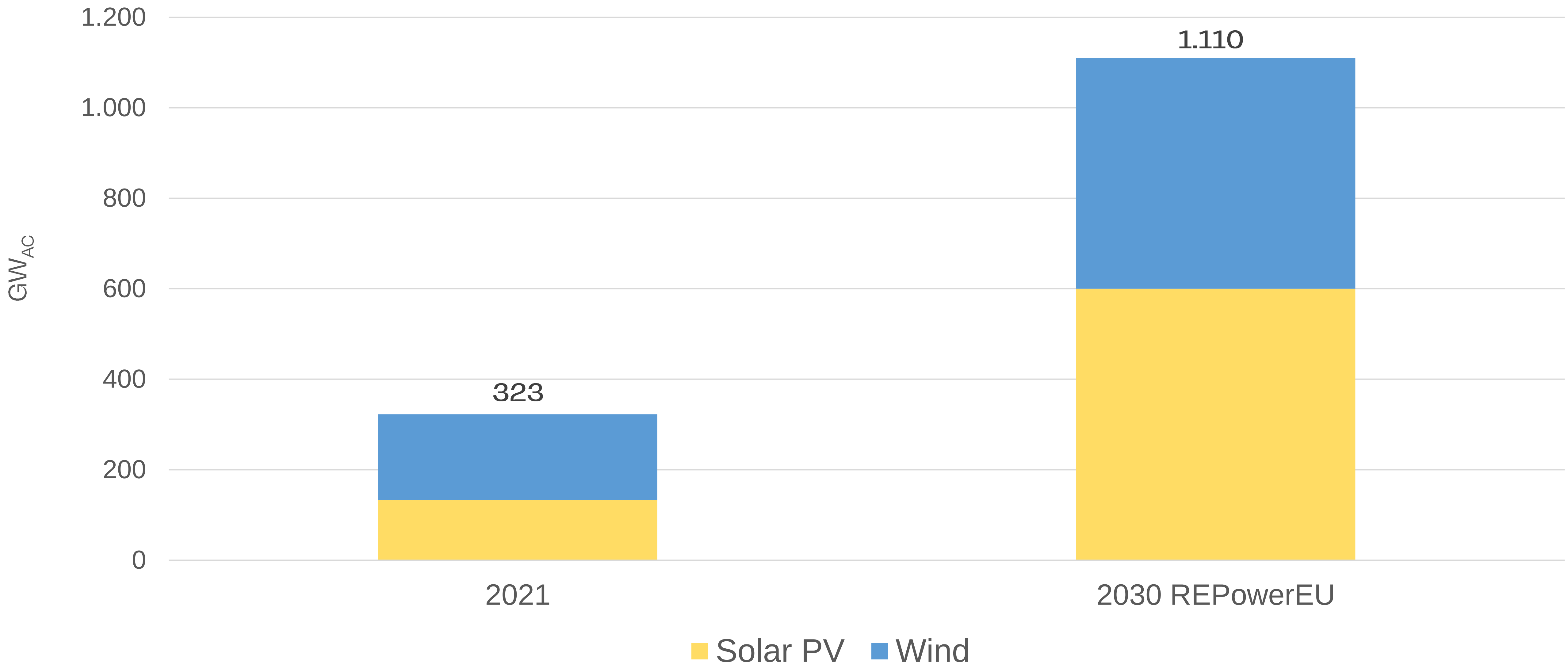
EU-27 solar PV and wind electricity generation share, 2012-2021



VRES generation from wind and solar PV has already grown from less than 9% in 2012 to **almost 20% in 2021**, but these technologies are expected grow much faster in the future.

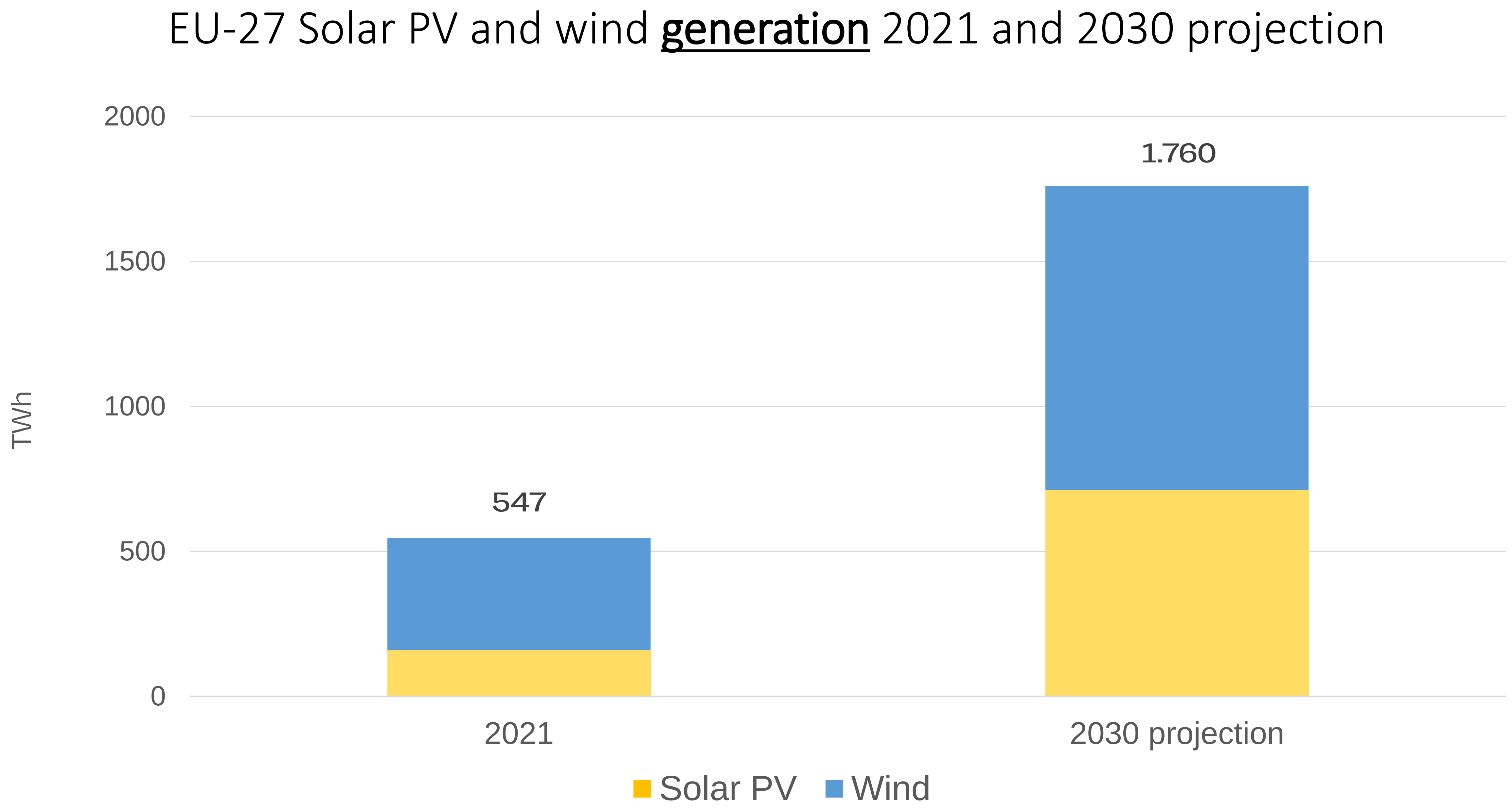
REPowerEU targets anticipate massive expansion in VRES generation

EU-27 solar PV and wind installed capacity 2021 and 2030 REPowerEU target



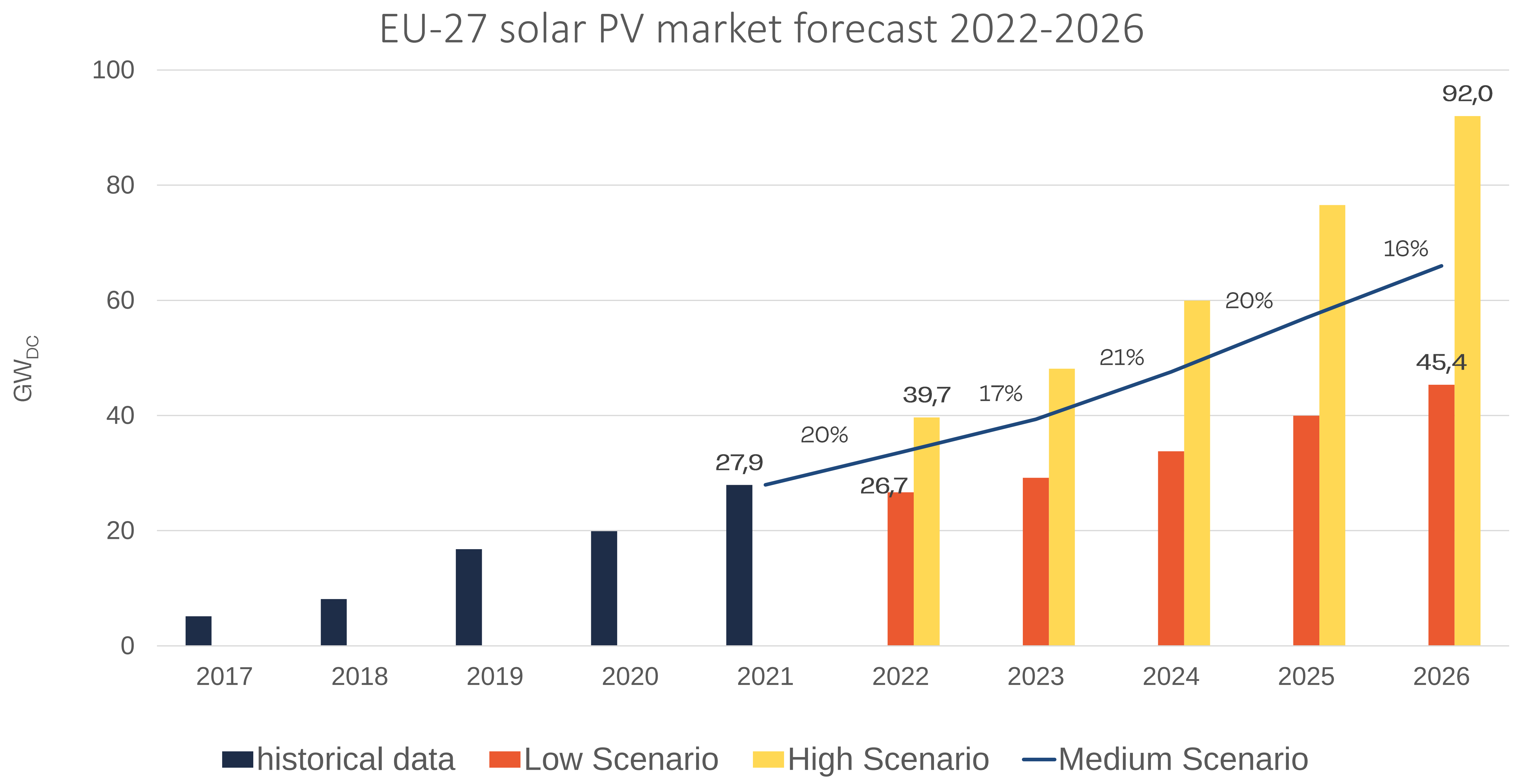
In 2021, solar and wind installed capacity in the EU-27 stood at 134 and 189 GW_{AC} respectively. Under the REPowerEU strategy, solar and wind capacity is set to increase to **600 and 510 GW_{AC} respectively**.

Projected VRES electricity generation in accordance with REPowerEU



Even with very conservative assumptions on projected generation based on today's capacity factors, VRES **electricity from wind and solar is expected to more than triple by 2030** compared to 2021. RES are expected to make up **64-67% of EU electricity generation** with a 38-40% RES target for 2030.

Solar PV deployment is set to accelerate in the EU



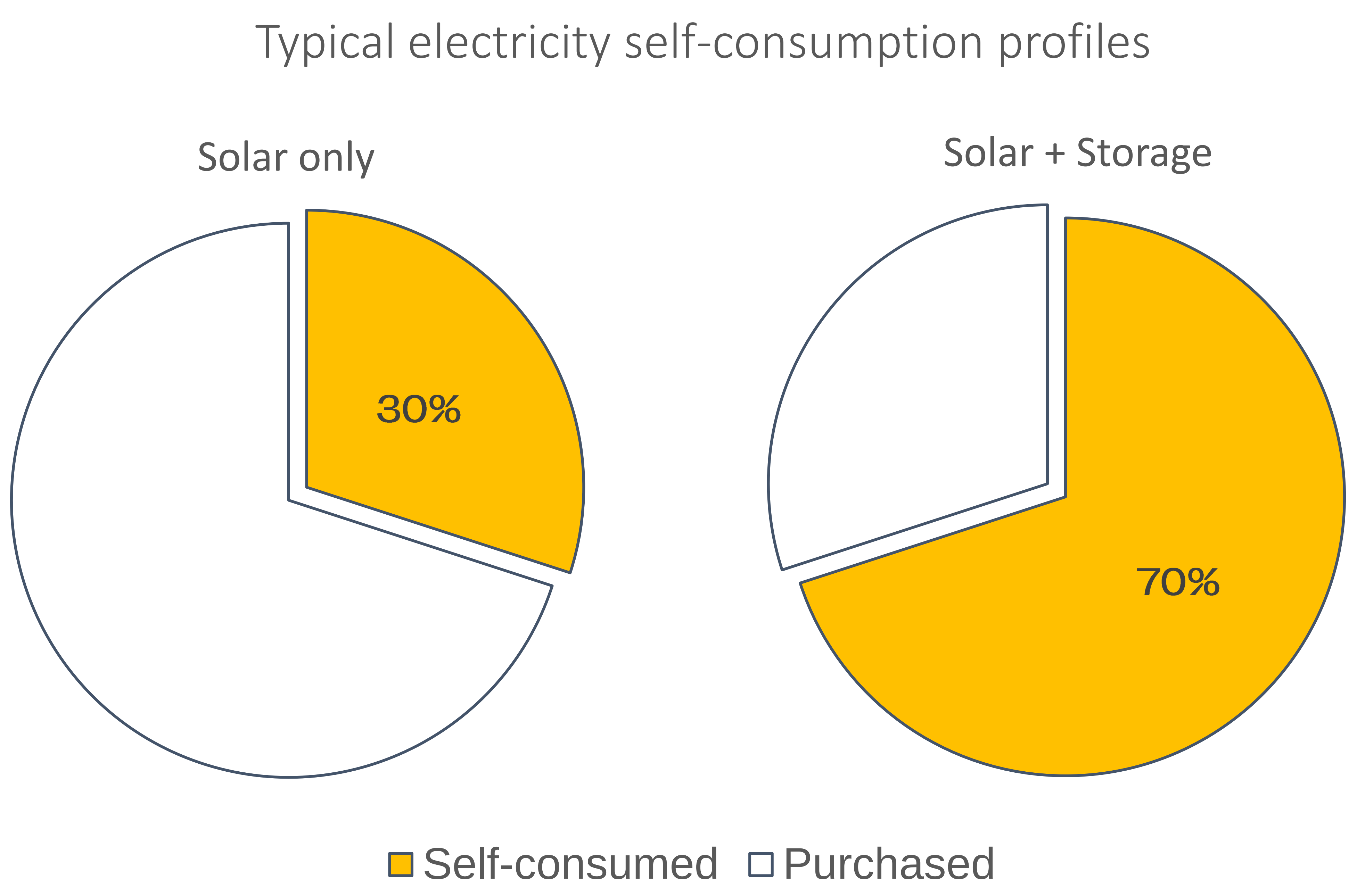
Solar had a record year 2022 with 40 GW_{DC} or more in line with SPE high scenario; 60+ GW_{DC} in 2026 are expected, but growth could be faster **up to 100 GW_{DC} by 2026**

Note that solar PV data is expressed in DC data, unlike the solar PV + wind target in REPowerEU. DC/AC conversion factor used is 1.25.

Co-located storage improves self-consumption

Rooftop solar works at its best when matched with battery storage:

1. A better **use of energy**
2. Less **stress on the grid**
3. Less exposure to **price volatility**
4. Lower **energy bills**



Electricity storage for system integration

Presented by ***Vasiliki Klonari****, Head of Energy System Integration, WindEurope*

Surplus and shortage of renewable power

Two main questions

- What happens at hours with **surplus** of renewables' production?
- What happens at hours with **shortage** of renewables' production?

In practice

In the electricity markets

Surplus of power production

1. The grid operator tries to balance demand and supply with the intra-day and balancing markets

+ imbalance costs €

Still surplus?

2. The grid operator notifies one or more generators to adjust their production

+ congestion management costs €

+ compensations to generators €

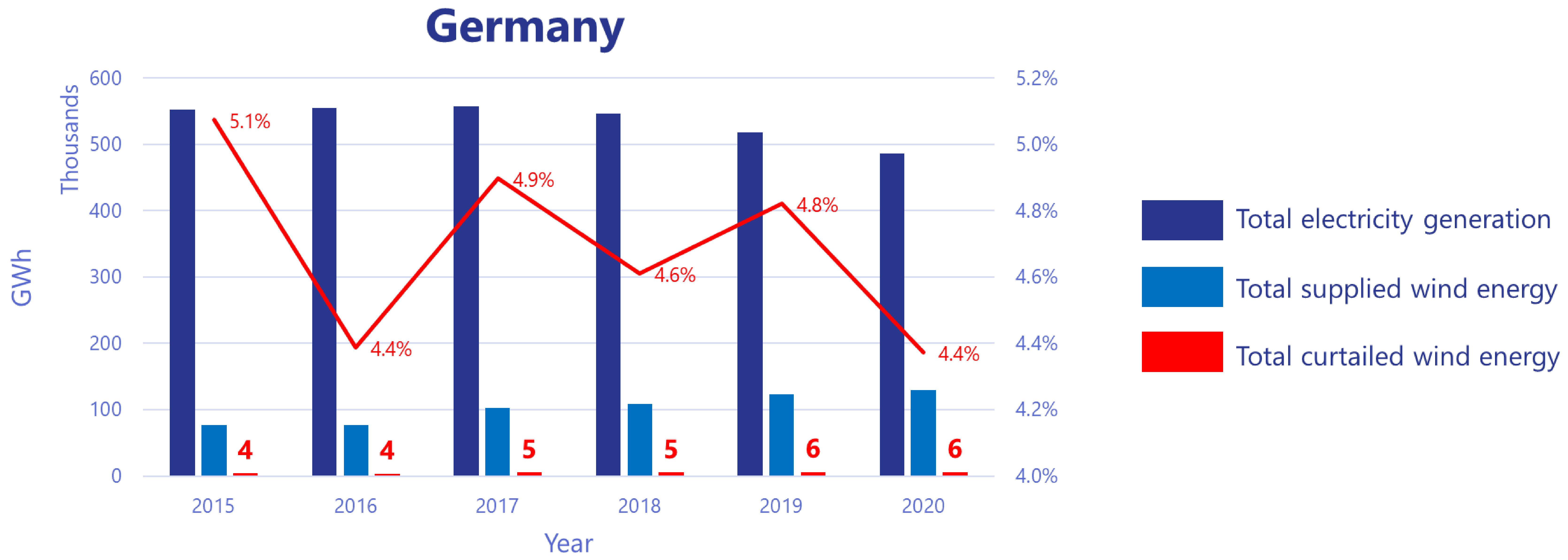
Still renewables' surplus?

3. The grid operator notifies renewable generators to cut off their production

+ compensations for curtailed energy €

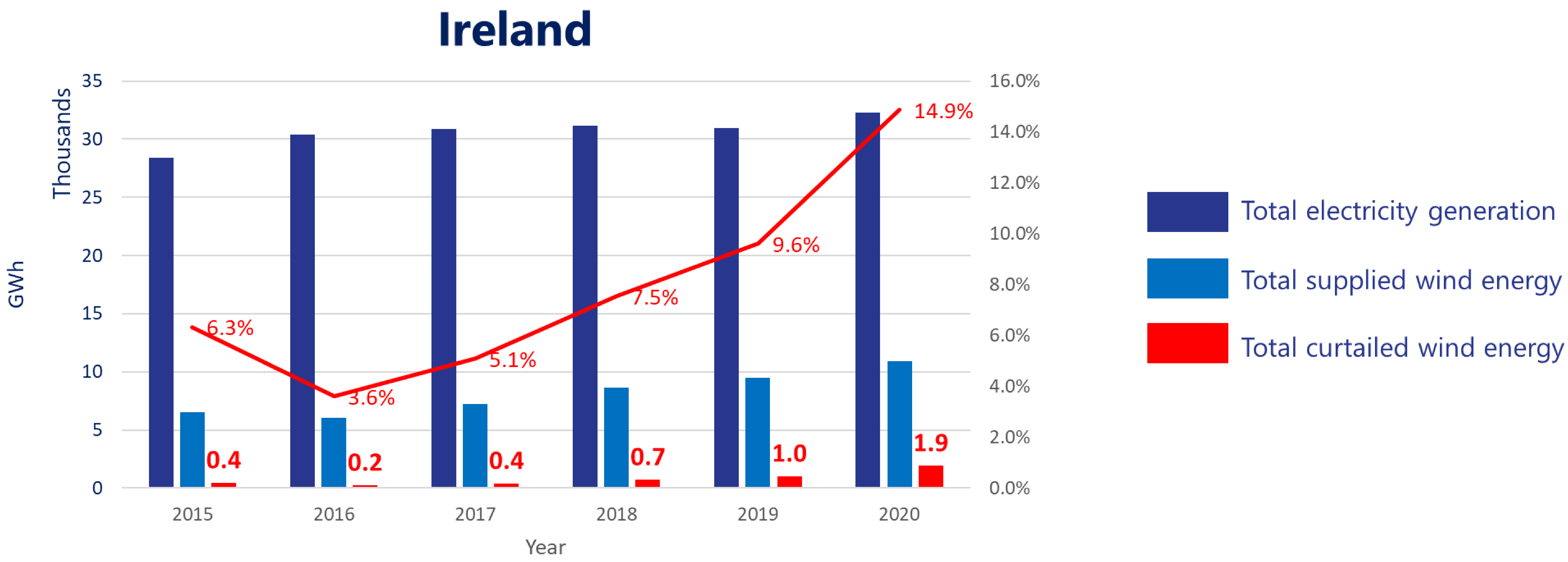
Total bill??

How much renewable energy is lost?



Source: Bundesnetzagentur

How much renewable energy is lost?



Source: EirGrid

Congestion management costs

- **Germany**: €1.3bn (2019) and €1.4bn (2020)
- **United Kingdom** (only for wind curtailment): £0.3bn (2020) and £0.5bn (2021)

Shortage of renewable production

1. Other inframarginal generation called upon. Demand response in some countries

   Still shortage?

2. Coal and gas generation need to cover the residual load

   Still renewables' surplus?

+ generation costs €

+ generation costs € €

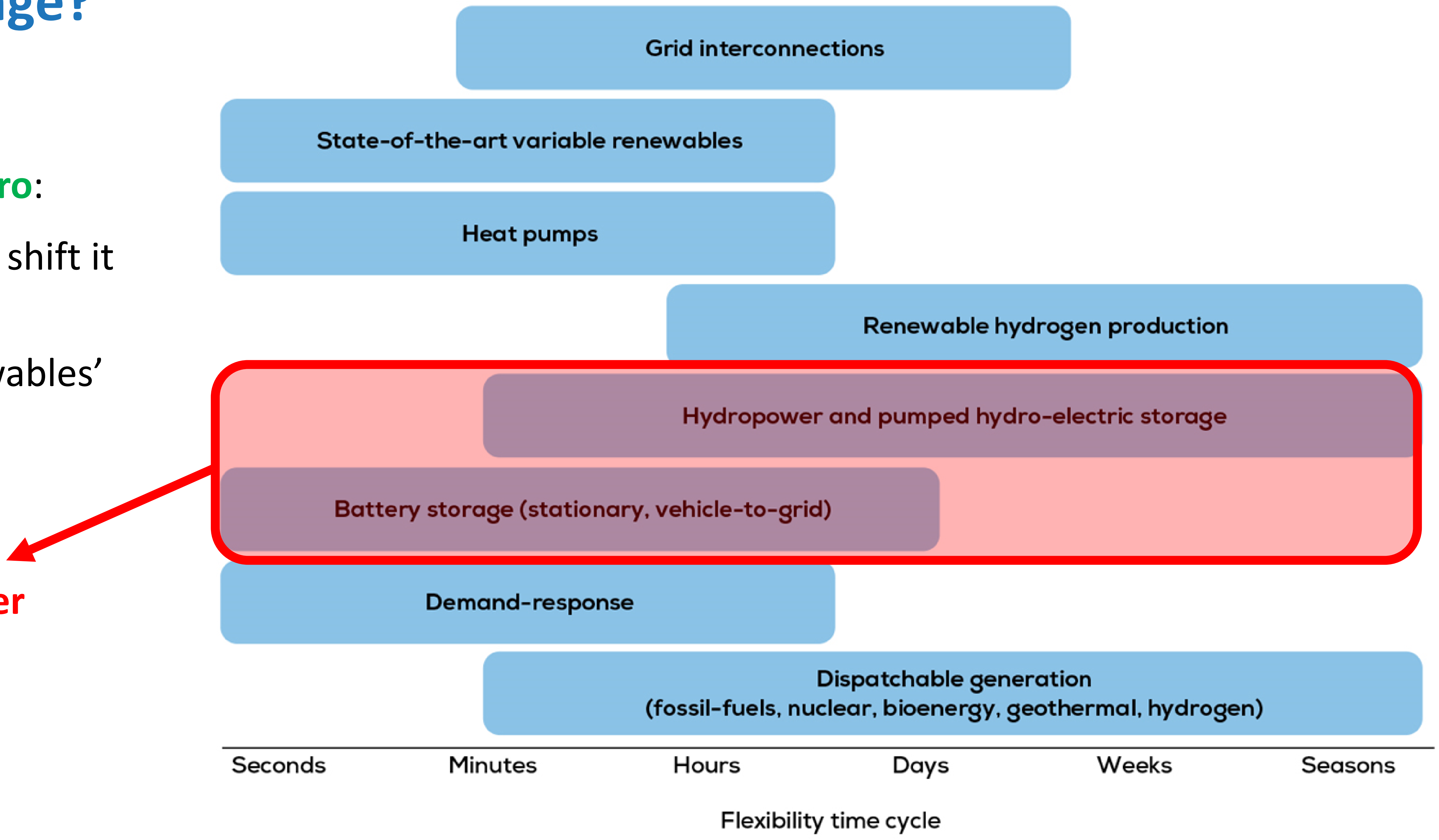
+ dependence on imported fuels

What can change?

Scale up flexible assets compatible with net-zero:

- to channel surplus or shift it to shortage hours
- to cover up for renewables' shortage

Energy storage can cover the entire time cycle



Source: ETIP Wind, WindEurope, Getting fit for 55 and set for 2050

Wind co-located with storage in Europe

26 projects

1.7GW wind/

0.37GW storage

Source: WindEurope

Country	Name of project	Plant type	Wind capacity (MW)	Solar capacity (MW)	Storage capacity (MW)
Denmark	Husahagi wind farm	Wind + Storage	11.7	-	2.4
Denmark	Vestas Lem Kær ESS	Wind + Storage	12	-	1.2
Finland	Viinamäki wind farm	Wind + Storage	21	-	6
France	Venteea Project	Wind + Storage	18	-	2
Germany	Regelkraftwerk Feldheim	Wind + Storage	72	-	10
Germany	Braderup ES Facility	Wind + Storage	18	-	2.3
Germany	Naturstromspeicher Gaildorf	Wind + Storage	13.6	-	16
Germany	Curslack wind farm	Wind + storage	12.6	-	0.7
Greece	Tilos	Wind + PV + Storage	0.8	0.4	2.8
Greece	Amari Pumped Hydro Hybrid	Wind + Storage	89.1	-	72
Greece	Naeras	Wind + storage	2.7	-	4.1
Ireland	Tullahennel	Wind + Storage	37	-	2.6
Ireland	Kilathmoy wind farm	Wind + Storage	23	-	11
Italy	Pietragalla	Wind + Storage	20	-	2
Netherlands	Princess Alexia	Wind + Storage	122	-	3.2
Netherlands	Haringvliet Zuid	Wind + PV + Storage	22	38	12
Portugal	Graciosa	Wind + PV + Storage	4.5	1	6
Portugal	Pego Municipality	Wind + PV + Storage	264	365	168
Scotland	Gigha community wind	Wind + Storage	0.675	-	0.105
Spain	Barasoain experimental	Wind + Storage	15	-	1
Spain	La Muela	Wind + PV + Storage	0.85	0.245	0.4
Spain	El Hierro Hydro-Wind	Wind + Storage	11.5	-	11
UK	Burbo Bank Storage	Wind + Storage	90	-	2
UK	Pen y Cymoedd Wind Energy	Wind + Storage	228	-	22
UK	Batwind- Statoil	Wind + Storage	30	-	1
UK	Whitelee wind farm	Wind + Storage	539	-	50

Energy Storage

*Presented by **Jacopo Tosoni**, Head of Policy, EASE*

What is energy storage?

Definition of Energy Storage in the CEP

Clean Energy Package definition of **'Energy Storage'** in the electricity system is defined as:

Deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier.

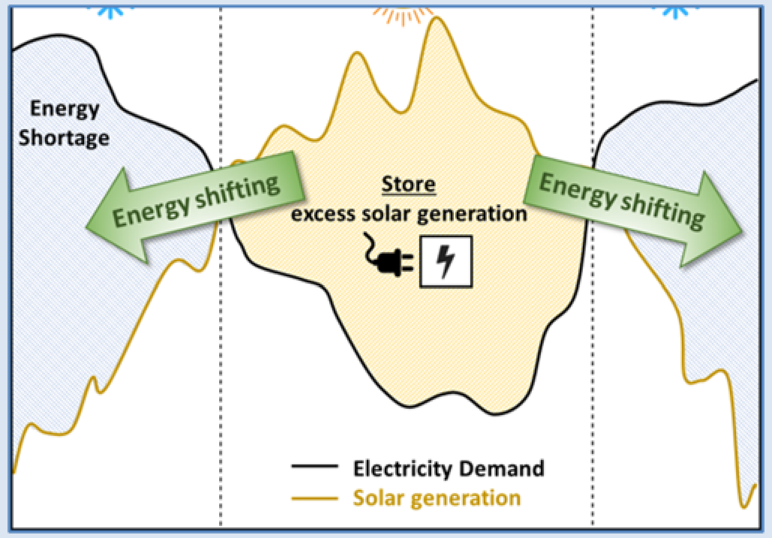
Power–to–X–to–Power	Power–to–X
e.g. Batteries, V2G, PHS, Electrolysers (P2G2P)	e.g. Electrolysers (P2G), TES (P2H), V1G

All solutions provide System Flexibility

Power–to–X–to–Power

bi–directional
Energy Shifting

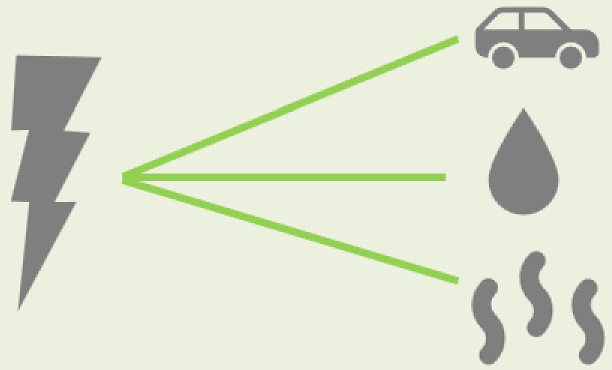
Shifting electricity by storing at times of surplus and releasing at times of deficit ("bidirectional")



Power–to–X

one–directional
flexibility

Electricity flows in one direction and is not given back to the system as electricity – it is converted into another energy carrier.



Where: V2G: vehicle-to-grid, V1G: smart charging, P2G2P: Power-to-gas-to-power, P2H2P: Power-to-heat-to-power, P2G: Power-to-gas, PHS: pumped-hydro storage, CAES: Compressed air energy storage, LAES: Liquid air energy storage

What is energy storage?

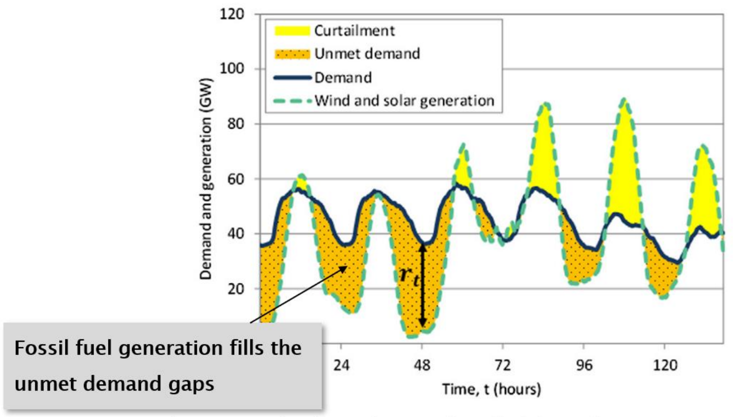
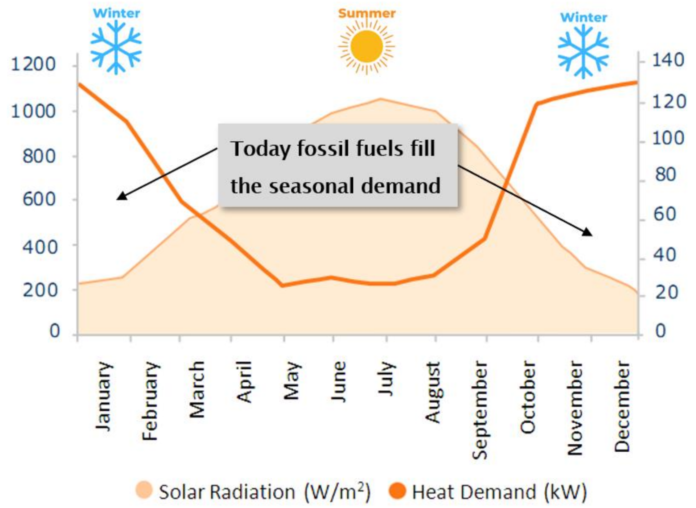


Fig. 2. Example of curtailment and residual demand in a power system.

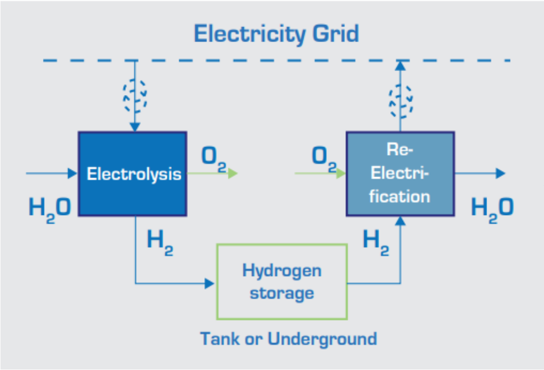


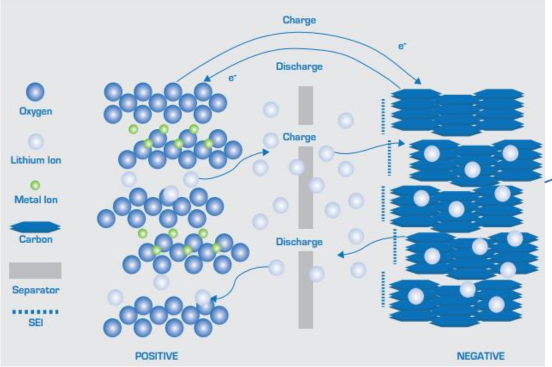
Source: https://www.icax.co.uk/Heat_Recycling.html

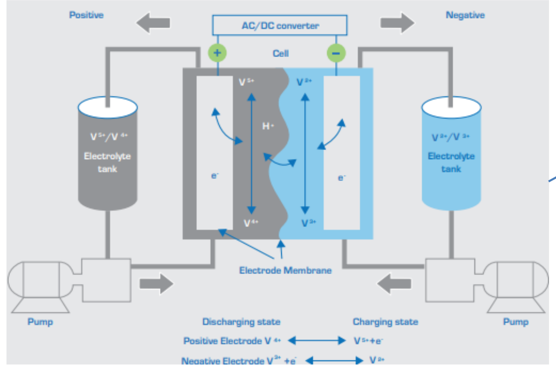
✓ Solution ✓ Partial solution

Flexibility duration	System Challange	Dispatchable generation	Grid reinforcement	Curtailment or feed-in management	Energy Storage – bidirectional flexibility (energy shifting)	Demand-side response/Energy Storage – unidirection flexibility
Intraday	Intermittent daily generation	✓ Solution		✓ Solution	✓ Solution	✓ Solution
	Reduced grid stability	✓ Solution			✓ Solution	✓ Partial solution
Multiday, multiweek	Multi-day imbalances	✓ Solution	✓ Partial solution	✓ Partial solution	✓ Solution	
	Grid congestion	✓ Partial solution	✓ Solution	✓ Solution	✓ Solution	
Seasonal duration	Seasonal unbalances	✓ Solution	✓ Solution		✓ Solution	
	Extreme weather events	✓ Solution			✓ Solution	
Cross-cutting	Curtailment costs minimisation				✓ Solution	✓ Partial solution
	Investment deferral				✓ Solution	✓ Partial solution
	Sector integration				✓ Solution	
	Citizen empowerment				✓ Solution	✓ Partial solution

What Solutions at our Disposal?







Chemical

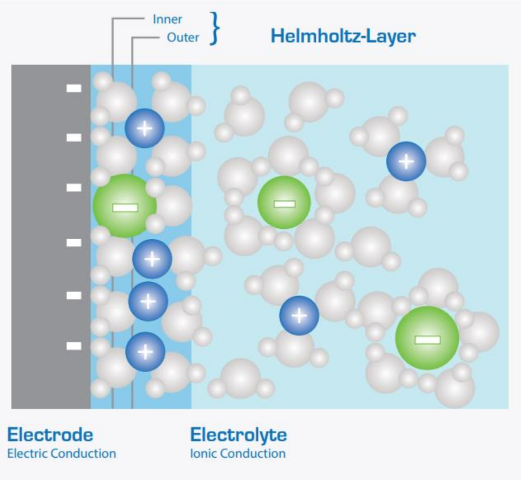
- Ammonia
- Drop-in Fuels
- Hydrogen
- Methanol
- Synthetic Fuels
- Synthetic Natural Gas

Electrochemical

- Classic Batteries
  - Lead Acid
  - Li-Ion
  - Li-Polymer
  - Li-S
  - Metal Air
  - Na-Ion
  - Na-$NiCl_2$
  - Na-S
  - Ni-Cd
  - Ni-MH
- Flow Batteries
  - Vanadium Red-Ox
  - Zn-Br
  - Zn-Fe
- Hybrid Supercapacitors
- Electrochemical Recuperator

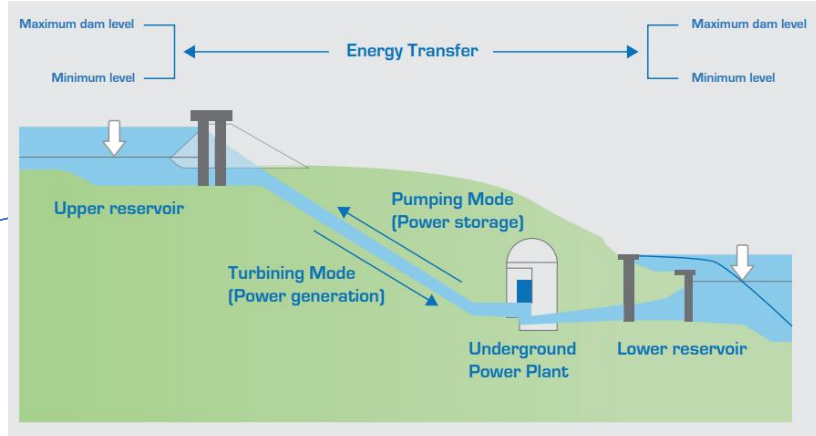
Electrical

- Supercapacitors
- Superconducting Magnetic Energy Storage (SMES)



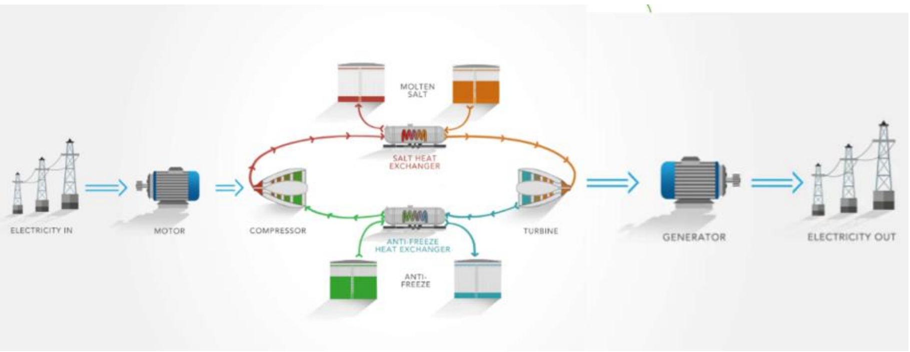
Mechanical

- Adiabatic Compressed Air
- Diabatic Compressed Air
- Liquid Air Energy Storage
- Flywheels
- Pumped Hydro



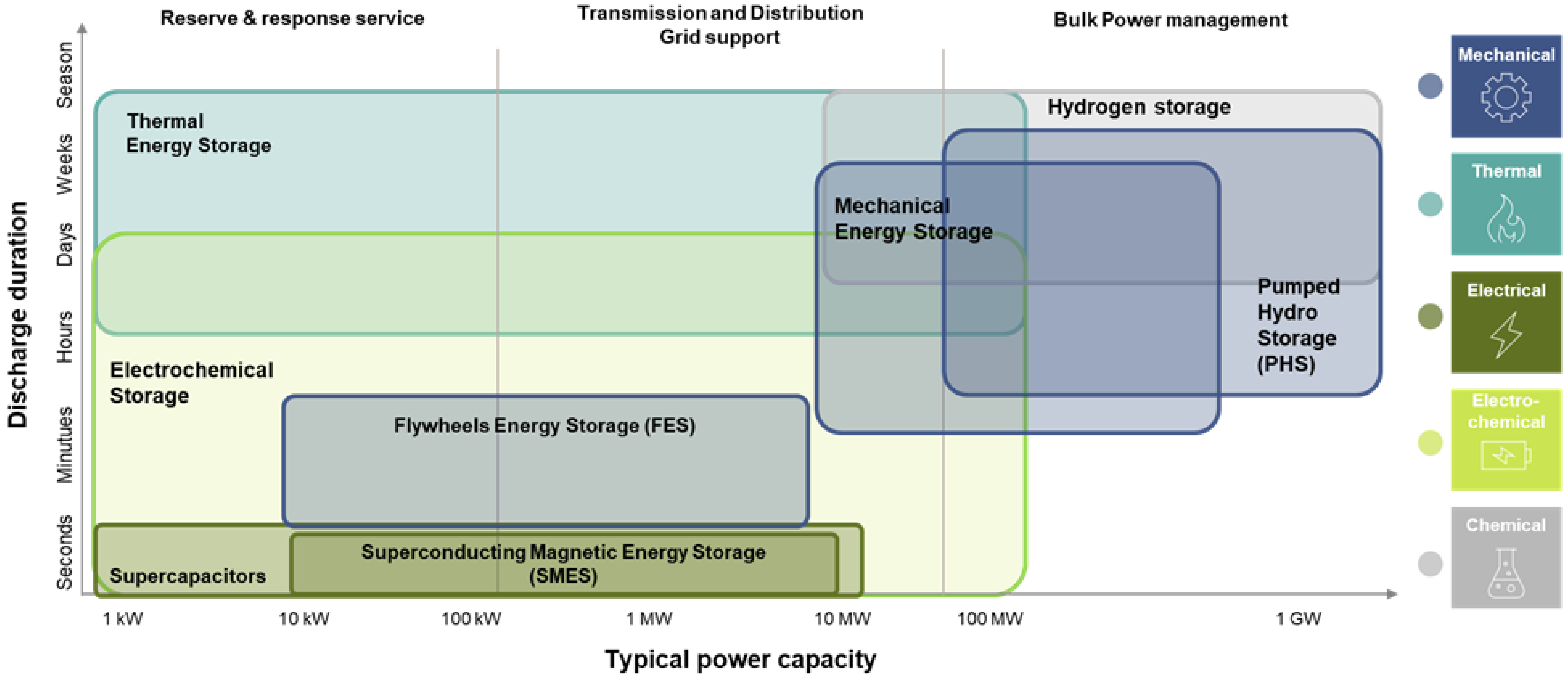
Thermal

- Latent Heat Storage
- Sensible Heat Storage
- Thermochemical Storage
- Ice Storage



Source: https://ease-storage.eu/energy-storage/technologies/

What Solutions at our Disposal?



Source: Global Data (2019), IRENA (2020), WEC (2020), BNEF (2020), EU (2020), HEATSTORE project (2021)

What Solutions at our Disposal?

Shorter storage duration (seconds)

Longer storage duration (season)

Energy storage form	Technology	Market readiness	Sector integration	Deployment
Electrical	Supercapasitors	Commercial	/	approx. 1%
Electrochemical	Classic batteries	Commercial	Electricity + Mobility	approx. 10%
	Aqueous electrolyte flow batteries	Pilot/commercial		
	Metal anode batteries	R&D/pilot		
	Hybrid flow battery, with liquid electrolyte and metal anode	Commercial		
Mechanical	Novel pumped hydro (PSH)	Commercial	Electricity + Gas	approx. 85%
	Gravity-based	Pilot/commercial		
	Compressed air (CAES)	Commercial		
	Liquid air (LAES)	Pilot (commercial announced)		
	Liquid CO_2	Pilot		
	Flywheel	Commercial		
Thermal	Novel pumped hydro (PSH)	Commercial	Electricity + Heating and Cooling	approx. 1%
	Sensible heat (eg, molten salts, rock material, concrete)	R&D/pilot		
	Latent heat (eg, aluminum alloy)	Commercial		
	Thermochemical heat (eg, zeolites, silica gel)	R&D		
	Ice storage	Commercial		
Chemical	Power-to-gas-(incl. hydrogen, syngas) -to-power	Commercial/pilot	Electricity + Gas	approx. 1%

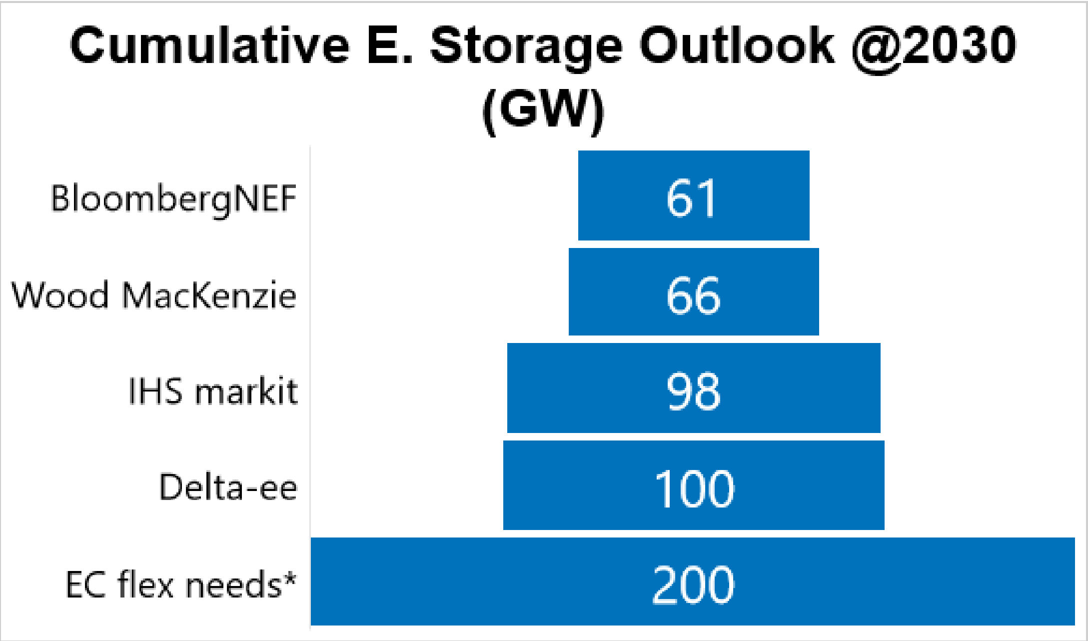
Longer duration technologies do not reach the market

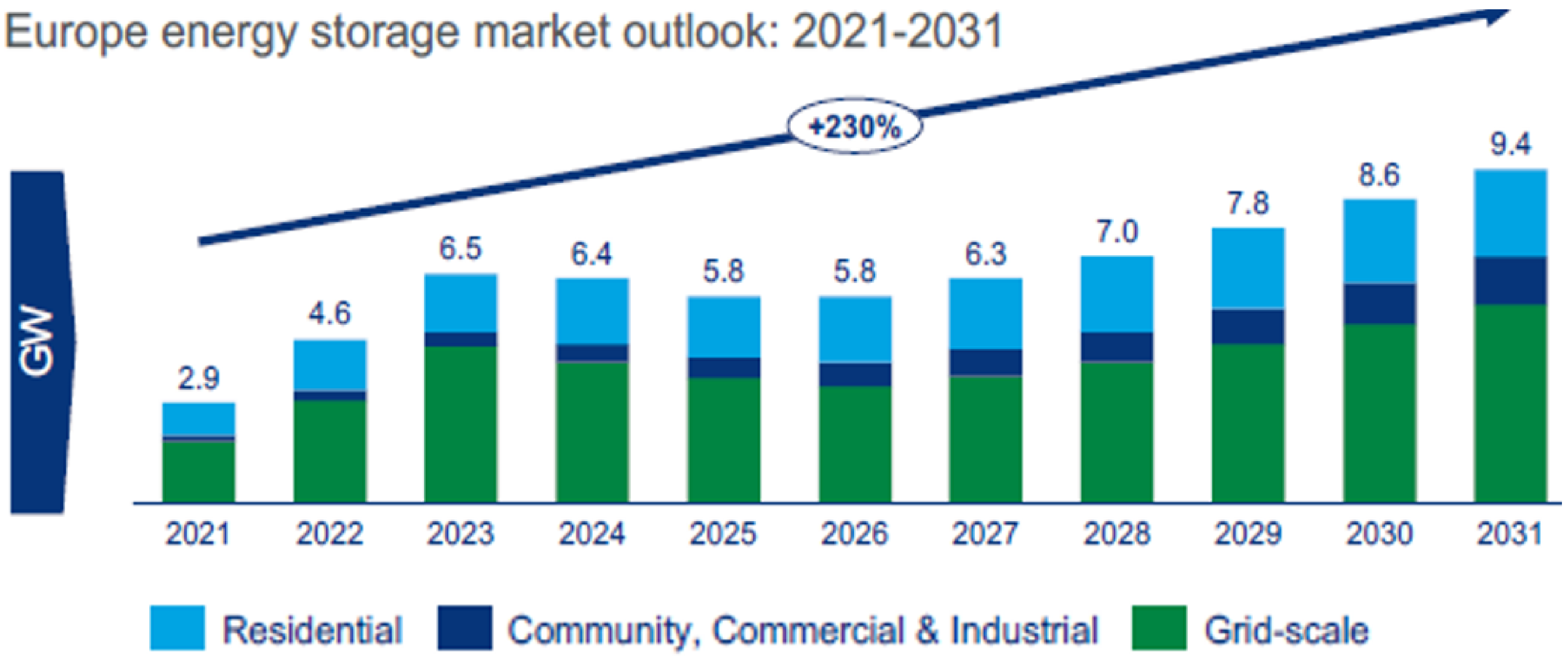
Energy Storage Capacity Today and Tomorrow

Presented by ***Raffaele Rossi****, Head of Market Intelligence, SolarPower Europe*
Jacopo Tosoni*, Head of Policy, EASE*

Energy Storage: a look to the Future

REPowerEU is pushing the demand for flexible power solutions



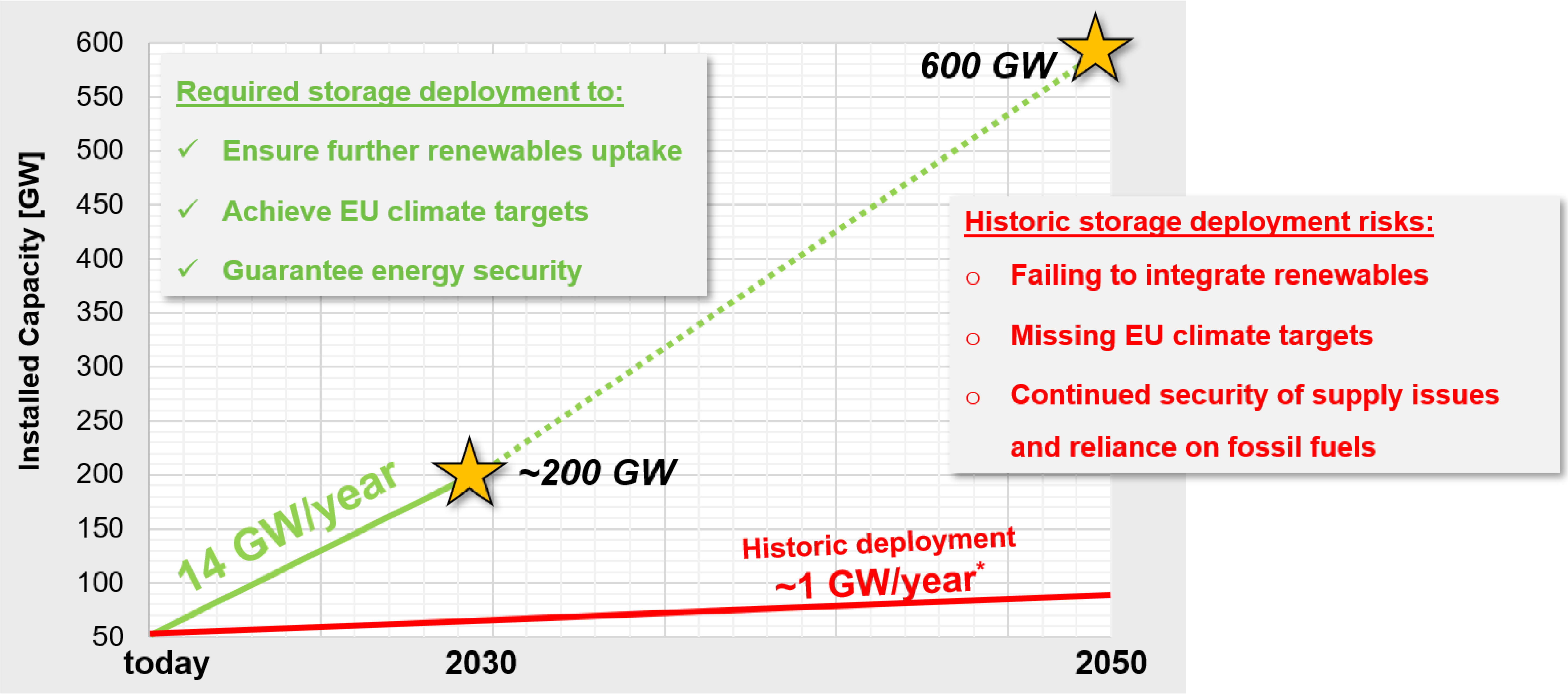


By **2030** there will be >**50GW of pumped hydro** and >**50GW of batteries**

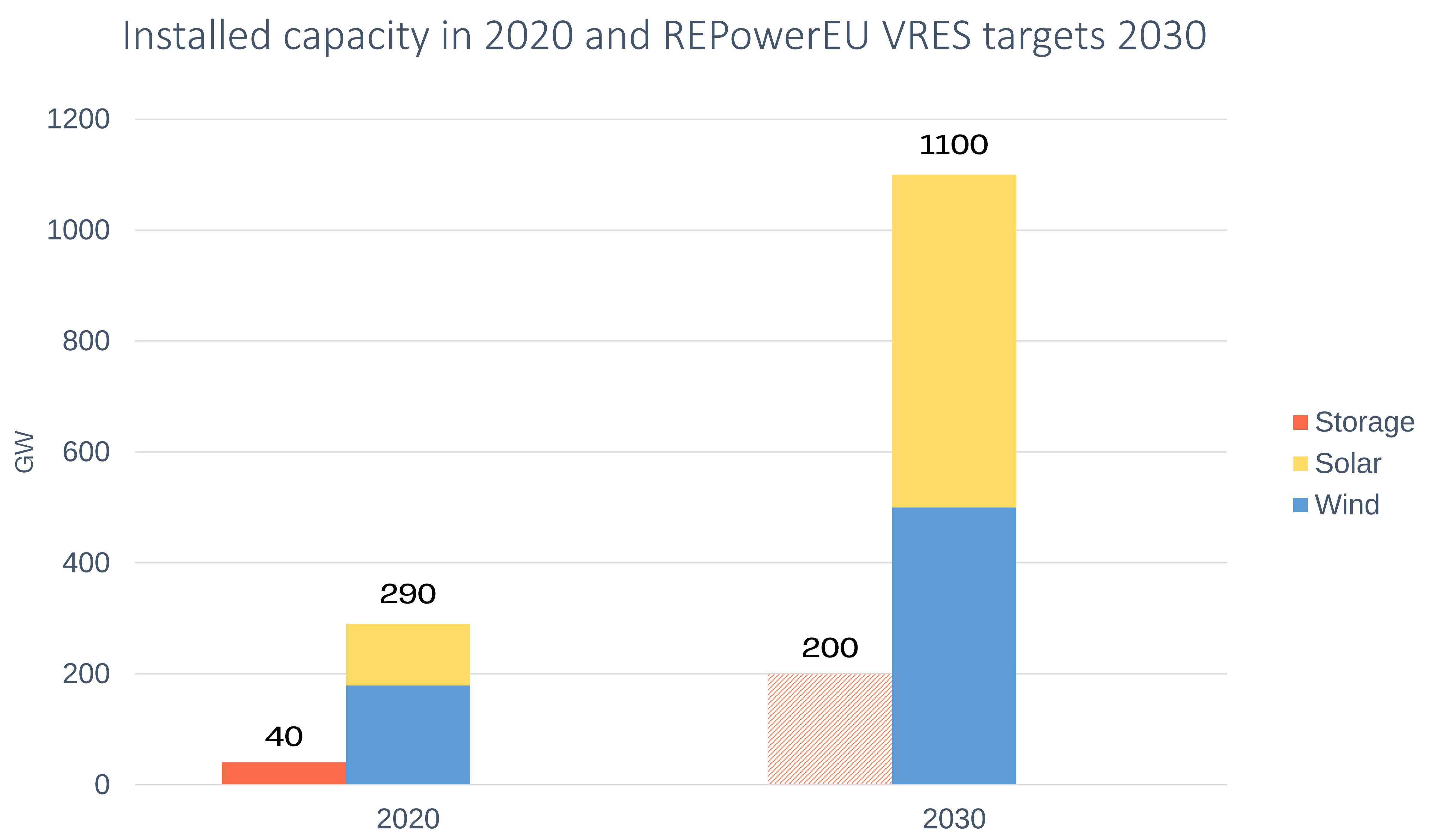
* EASE estimate using European Commission data @ June 2022
Sources:

- WMK "Global energy storage market outlook update: Q2 2022" – June 2022; WMK includes in the CCI application the Commercial and Industrial and Community ones.
- Bloomberg NEF "1H 2022 Energy Storage Market Outlook" – March 2022
- IHS Markit "GridConnected Energy Storage Market Tracker First half 2022" - August 2022. HIS foresees a stronger growth in Germany (+17 GW vs WMK and BNEF)
- Delta-ee "EUROPEAN MARKET MONITOR ON ENERGY STORAGE 6.0" – June 2022

Energy Storage: 2030 Needs



EU electricity storage target for 2030



storage capacity should be developed in parallel to variable renewables deployment as set out in REPowerEU targets