

INTEGRATING WIND INTO THE ENERGY SYSTEM

Getting more wind in the grid at lower cost



NEW TURBINE DESIGNS

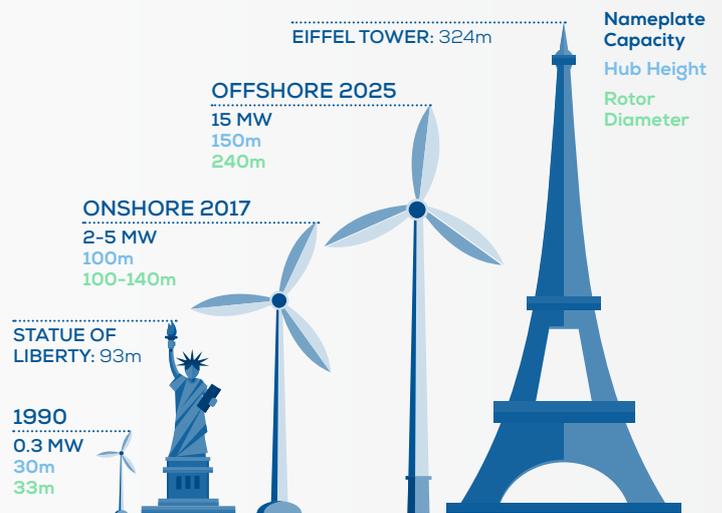
ARE MORE SYSTEM-FRIENDLY, LEADING TO HIGHER CAPACITY FACTORS AND SMOOTHER OUTPUTS

- Larger blades and higher towers
- Low wind speeds
- Lower energy density (Generator to rotor ratio W/m^2)

The network capacity is better utilised, leading to lower network costs

Forecast errors are reduced, leading to lower balancing costs

Power production is more evenly distributed, leading to higher market value



MARKET DESIGN AND SYSTEM OPERATORS' COOPERATION

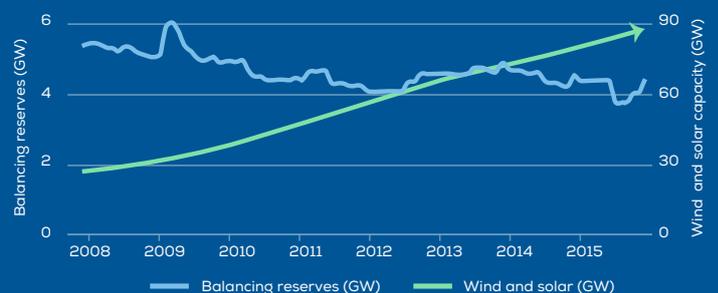
LEADS TO LOWER BALANCING RESERVES COSTS, EVEN WITH HIGHER SHARE OF RENEWABLES

- > Intraday market
- > Share of reserves among TSOs
- > New market participants
- > TSOs crossborder coordination



Since 2008, balancing reserves in Germany decreased by 20%, and their costs by 70% while wind and solar capacity tripled.

The German balancing paradox



RENEWABLES COMPLEMENT EACH OTHER

DAILY, MONTHLY AND SEASONALLY

Winter months are characterised by high wind resources while summer months present lower value. Solar PV resources have opposite attributes and thus are complementary.

WINTER MONTHS



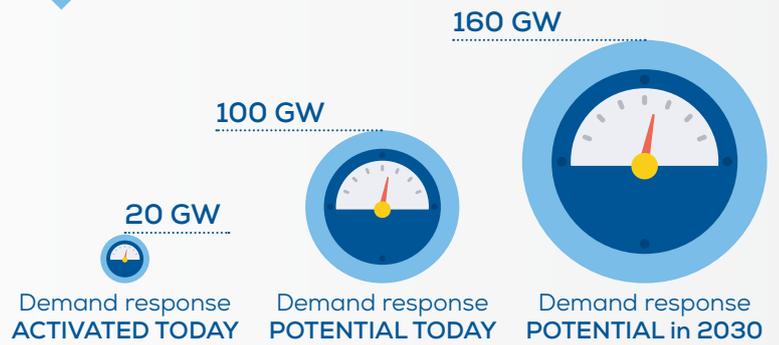
SUMMER MONTHS



DEMAND MANAGEMENT OFFERS GREAT FLEXIBILITY POTENTIAL

ALTHOUGH A COMPETITIVE SOLUTION, TODAY IT REMAINS LARGELY UNDER-UTILISED

Source: European Commission



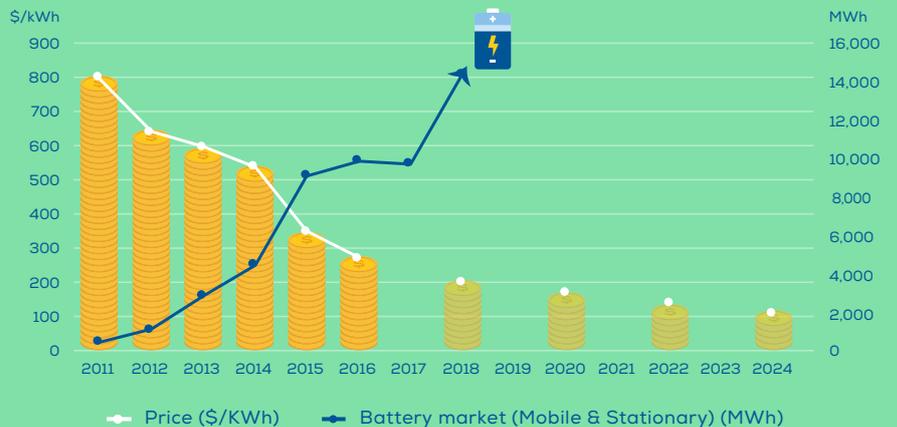
COMPETITIVE STORAGE SOLUTIONS

PROVIDE A LARGE RANGE OF FLEXIBILITY OPTIONS FOR INTEGRATING WIND POWER

Demand for batteries is booming. And battery storage costs are decreasing rapidly. This will enable the uptake of electro-mobility and the use of storage in colocation with wind farms, solar plants or as stand-alone grid components.

Sources: Prices: BNEF; Market growth: WindEurope based on various sources (Delta E&E, Mc Kinsey, press statements)

As demand for batteries is going up, storage costs are going down



WIND SHARE OF DEMAND IN 2017

