



CURRENT AND FUTURE STORAGE APPLICATIONS

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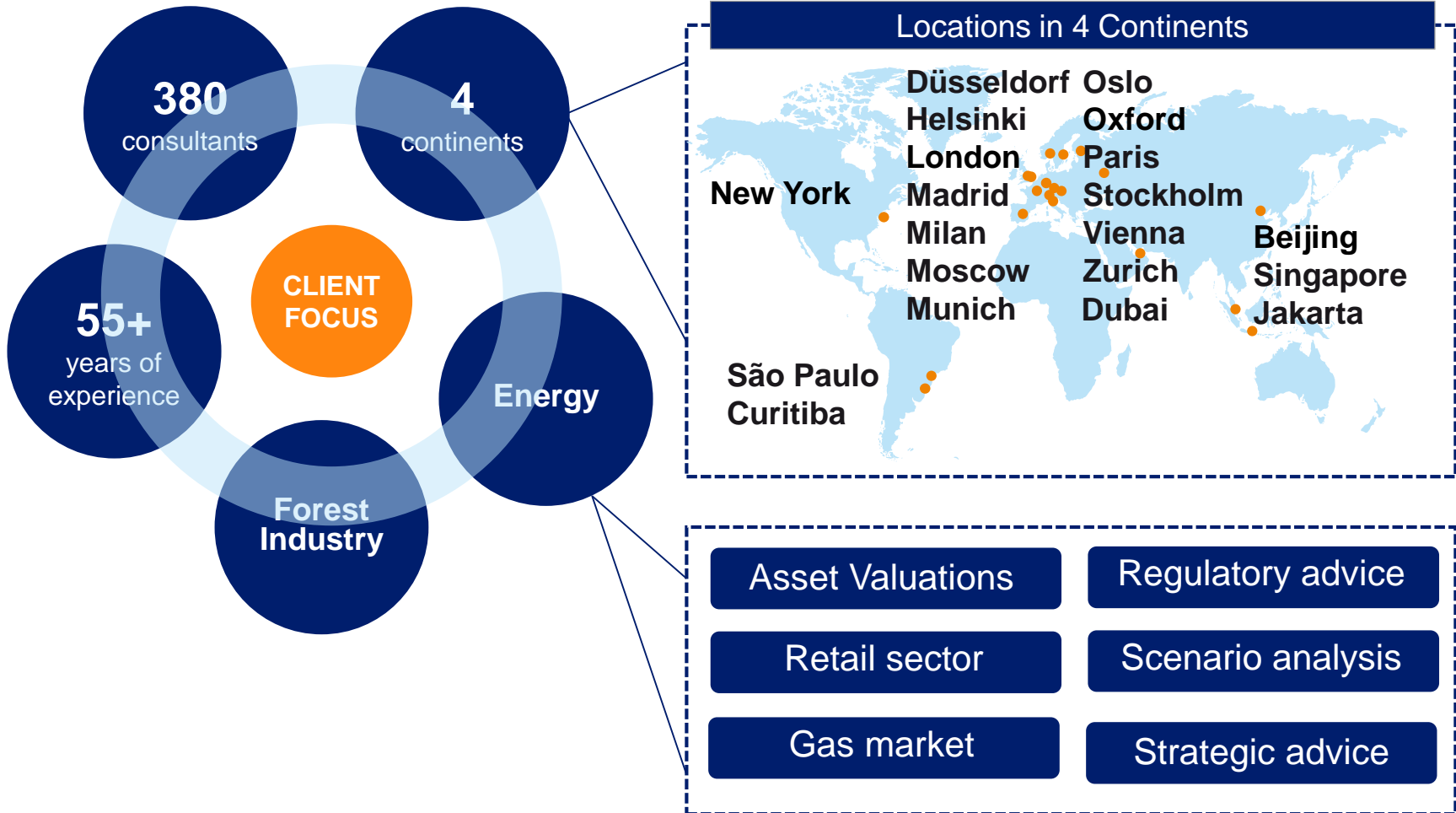


Before we begin...

“I never make predictions, and I never will.”

Paul “Gazza” Gascoigne

PÖYRY MANAGEMENT CONSULTING



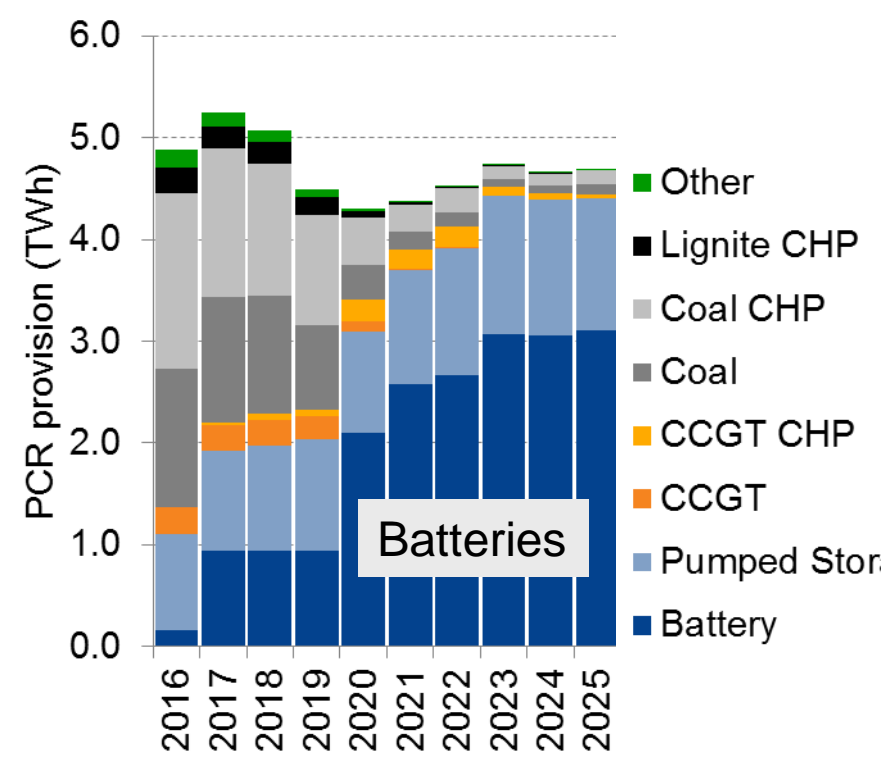
WHAT ARE THE CURRENT AND FUTURE STORAGE APPLICATIONS?



RESERVE MARKETS

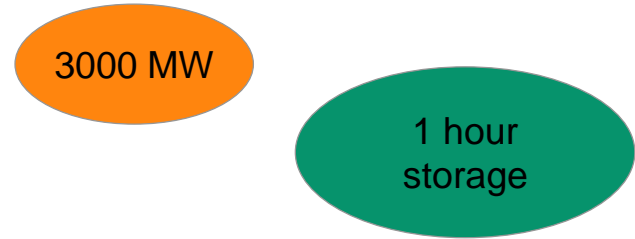
New battery entry is flooding the primary markets, due to their small size.
Secondary markets are bigger but much lower value

Germany Primary provision

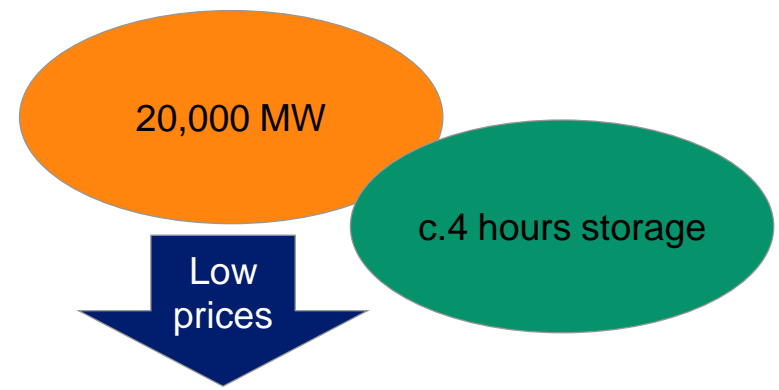


Source: Pöyry analysis using BID3

FCR (primary) requirements



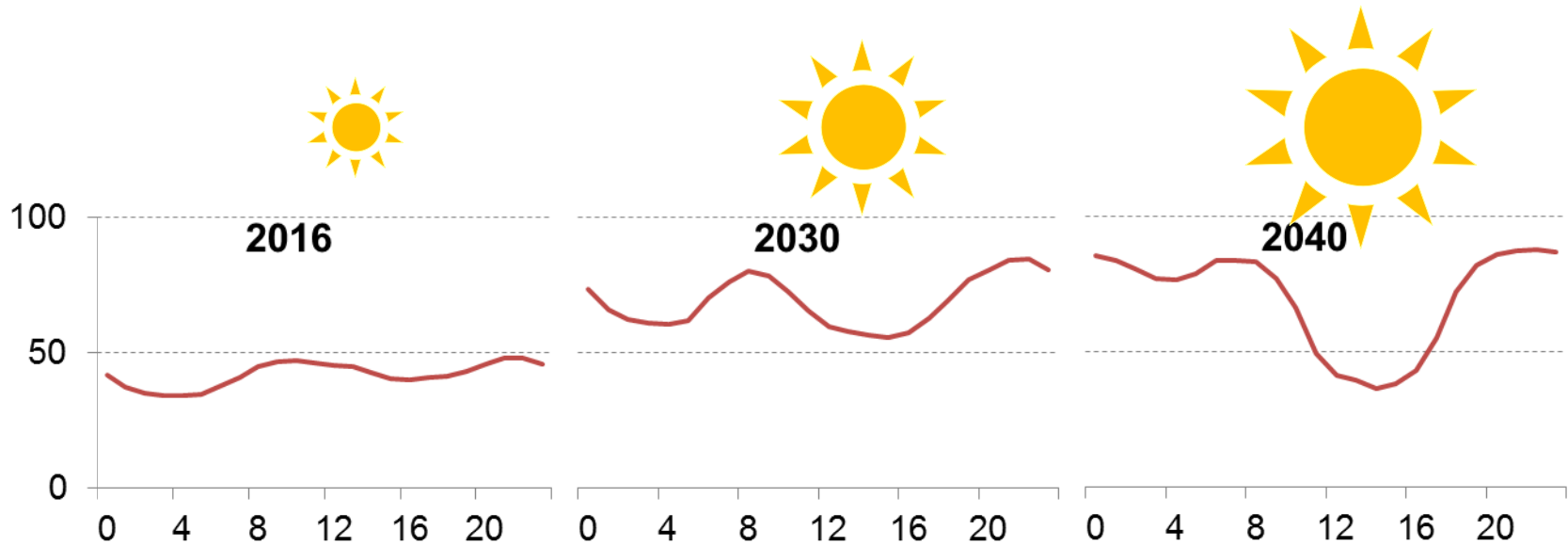
FRR (secondary) requirements



WHOLESALE MARKETS

Falling battery costs plus rising RES deployment helps battery build

Within-day price variation (summer), Spain

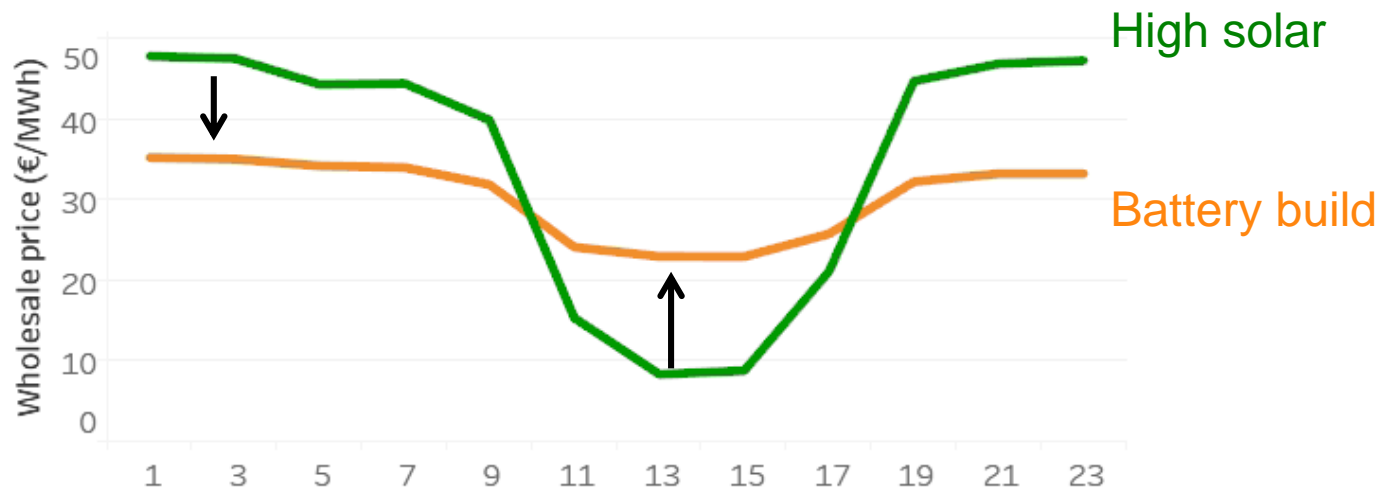


Source: Pöyry analysis using BID3

GROWING SOLAR DOES NOT MEAN HUGELY PROFITABLE BATTERY INVESTMENTS

Li-ion cannibalises its own revenue stream...and in turn caps price volatility

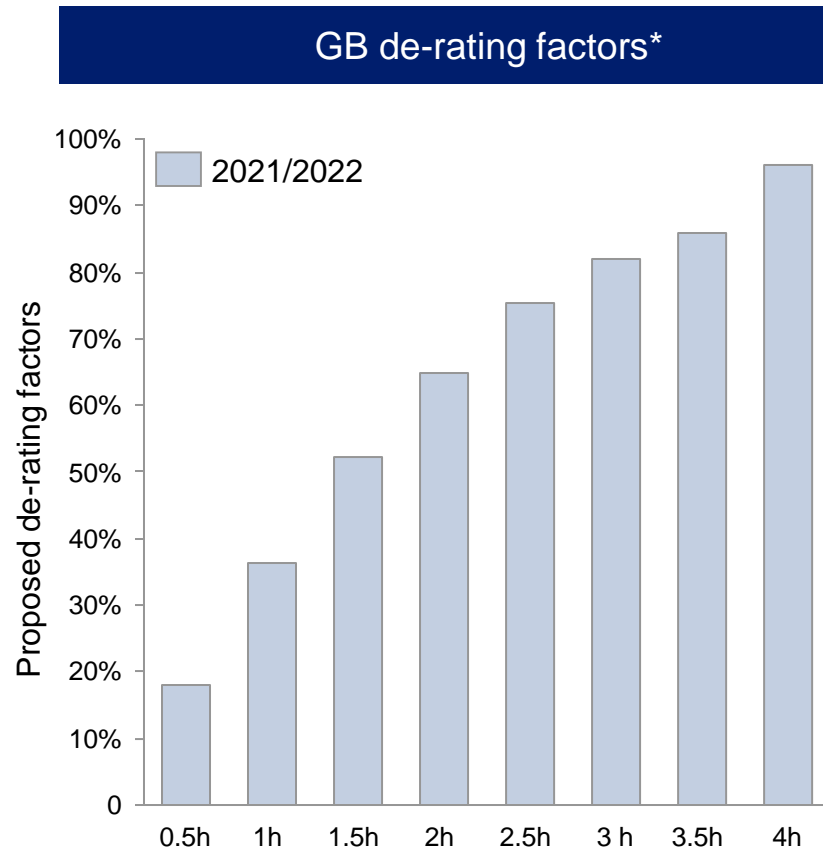
Hourly power price profile, France, summer 2040



Source: Pöyry analysis using BID3

CAPACITY MARKETS PROVIDE IMPORTANT REVENUE STREAMS

However, de-rating of batteries acts to limit their usefulness



*CM De-Rating Factors Proposed for Duration-Limited Storage Class in the 2018/19 T-1 and the 2021/22 T-4 Auctions

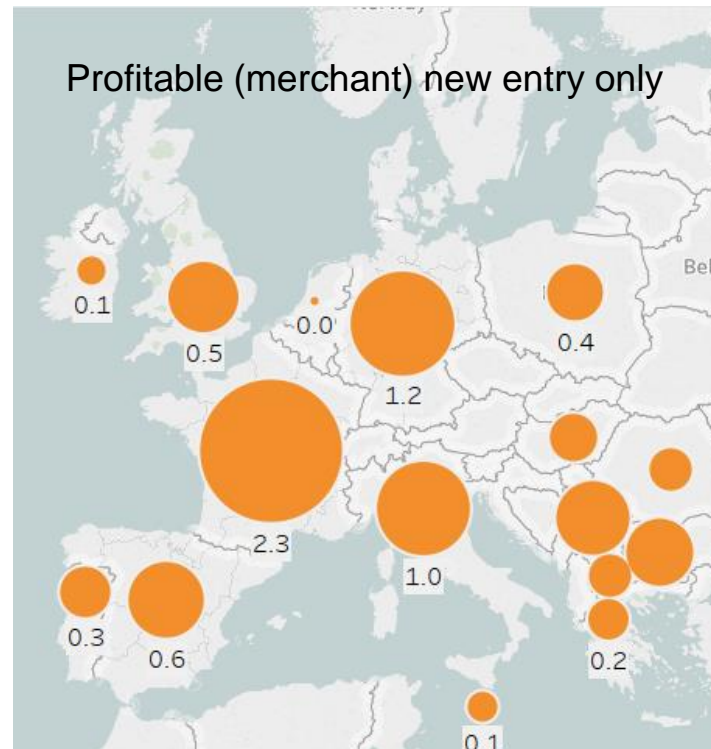
WHOLESALE MARKET MERCHANT BATTERIES

Combination of wholesale markets plus capacity markets gives merchant deployment in the 2030s: but still relatively limited

- Falling battery costs
- Rising solar
- Tightening capacity margins
- Revenue from capacity prices
- Additional revenues
 - Balancing market strategies (NIV chasing etc.)



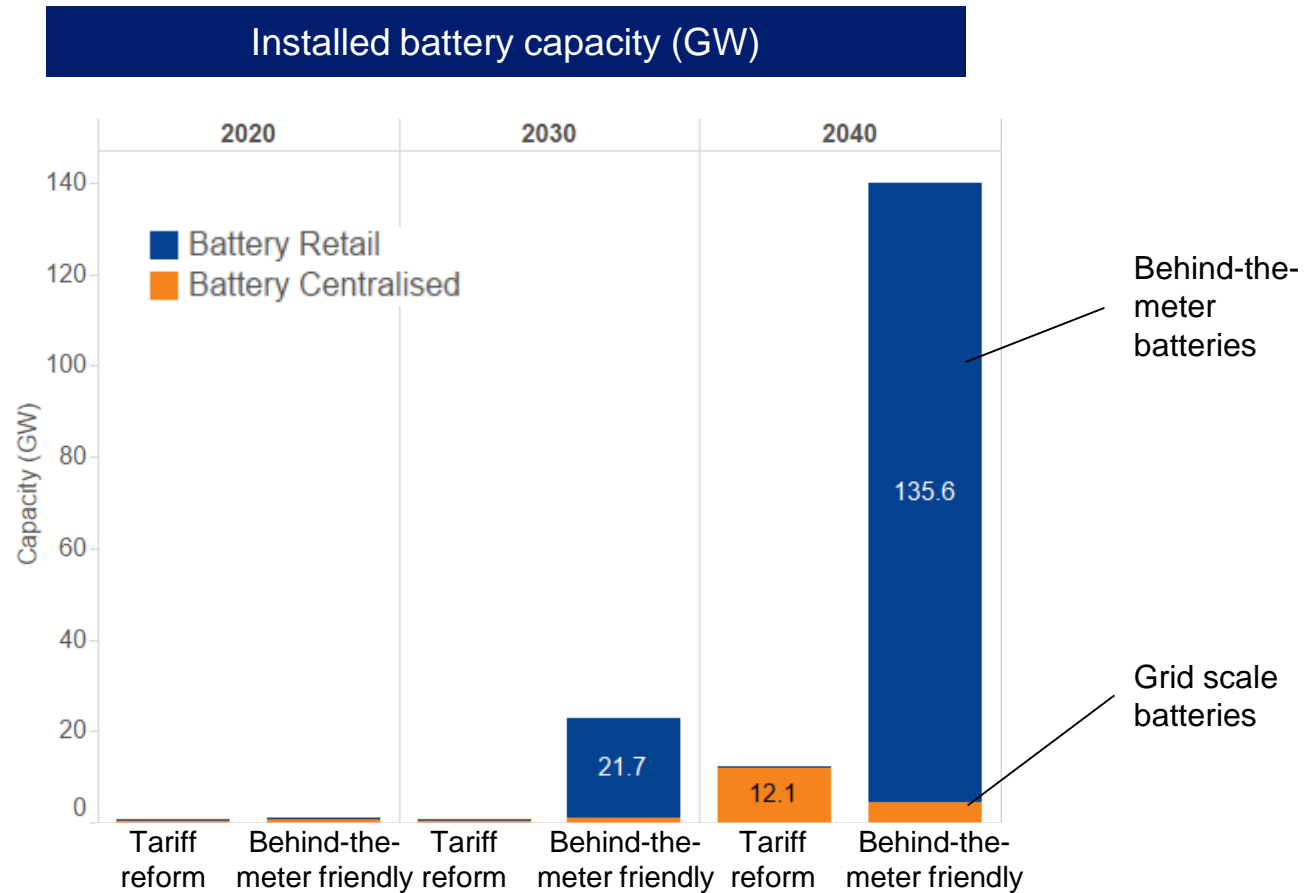
Installed battery capacity in 2030s (MW)



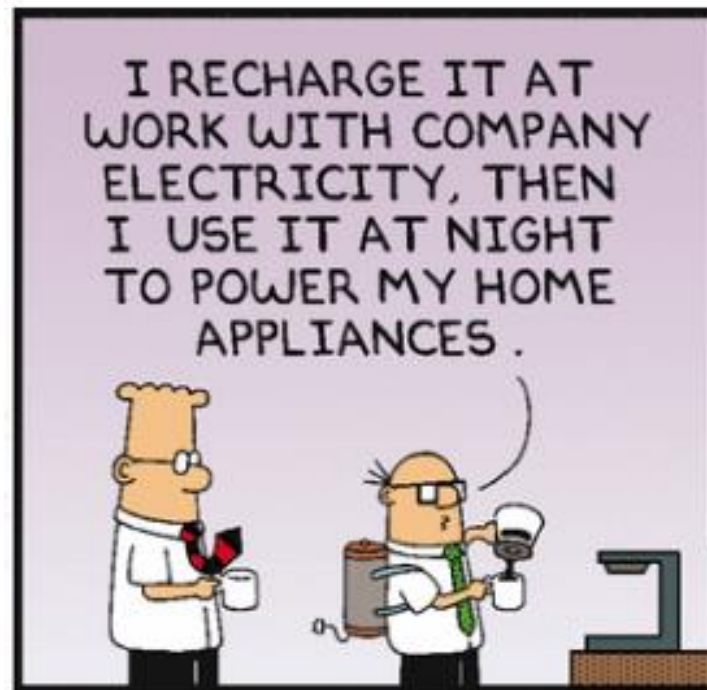
Source: Pöyry analysis using BID3

BEHIND-THE-METER DEPLOYMENT

Poyry modelling for C+W Europe gives the potential for large deployments – but it depends hugely on the retail tariff structure



Source: Pöyry analysis using BID3



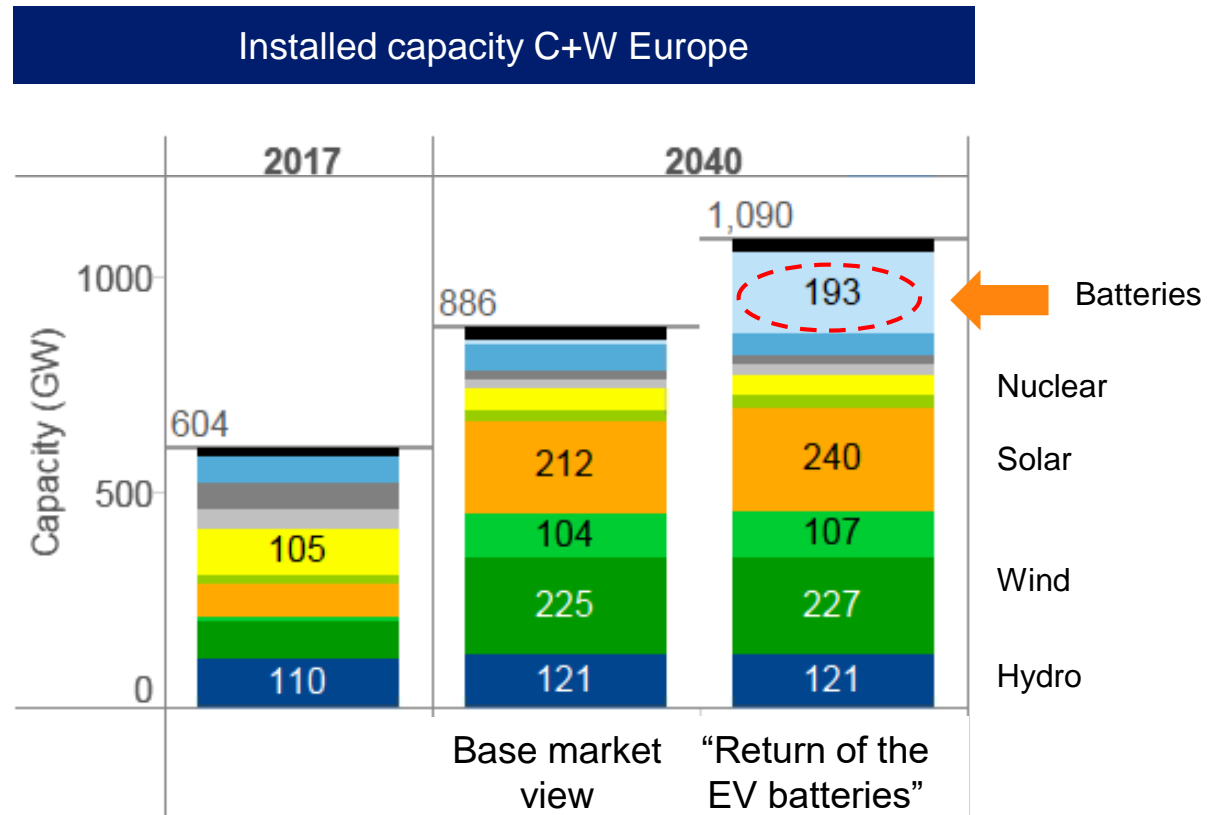
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THE THREAT OF CHEAP FLEXIBILITY

What happens if large numbers of EV batteries re-enter the electricity market?

Assumptions:

- 50% of EV batteries are recycled as centralised storage 10 years after purchase
- Batteries have 70% of their original MWh
- Recycled as 8h batteries

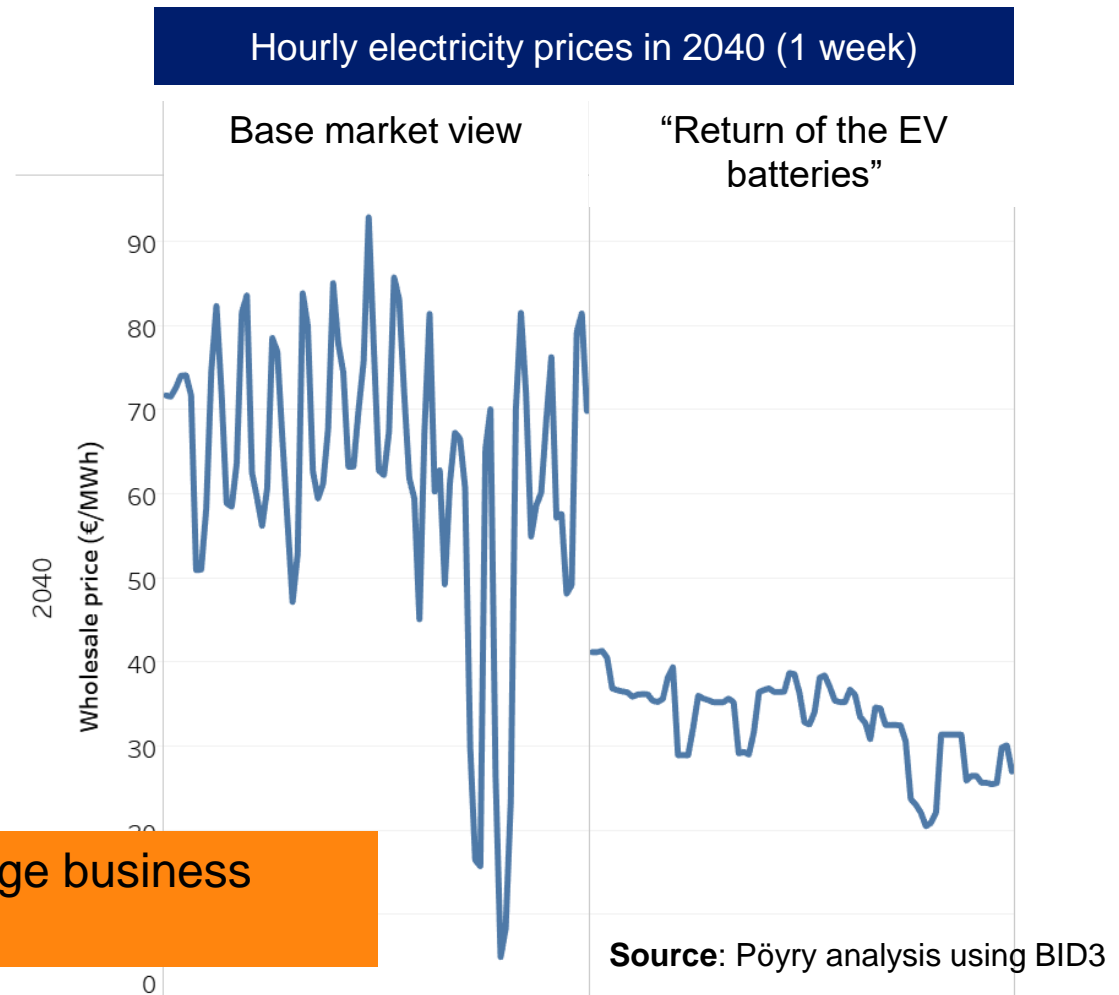


Source: Pöyry analysis using BID3

OTHER SOURCE OF FLEXIBILITY MAY SWAMP BATTERIES

Impact of recycled batteries flattens market prices and kills returns

- This example shows impact of 193GW of EV batteries
- Flexible charging of EVs has the same impact:
 - Flatten market prices and “drive batteries out of business”



The biggest threat to storage business models is ‘free flexibility’

FINAL THOUGHTS

Ancillary services

- FCR (primary reserve) is perfect for batteries
 - Challenge is limited market size (3GW) plus lots of new entry
- FRR (secondary) is a much bigger market (20GW)
 - Greater hours of storage plus lower prices make entry difficult for batteries
 - Other storage technologies can compete

Wholesale markets

- Falling battery costs plus rising solar means increasing wholesale arbitrage revenues
- Capacity markets appear juicy
 - But uncertain (and potentially brutal) de-rating factors are a risk

Behind-the-meter

- Behind-the-meter deployment relies on hourly time of use tariffs plus free-riding on retail tariffs (avoiding network or policy support costs)
 - A change to retail tariffs rapidly kills economics

Expect to see large scale battery deployment in the electricity sector.
But the biggest threat comes from other courses of flexibility – especially those that are ‘free’

Kenneth Arrow, Nobel Laureate economist, recalling the response he and colleagues received during the Second World War when they demonstrated that the military's long-term weather forecasts were useless

“The Commanding General is well aware the long-term weather forecasts are no good. However, he needs them for planning purposes”



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