



Integrating Supply and Demand: Smart Systems; Storage

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Eamonn Boland, Manager, Baringa Partners
eamonn.boland@baringa.com

Reputation built on results

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Monetising the value of storage in GB

- How is the energy system changing, what are the revenues available to storage, what is their value and how are they accessed?

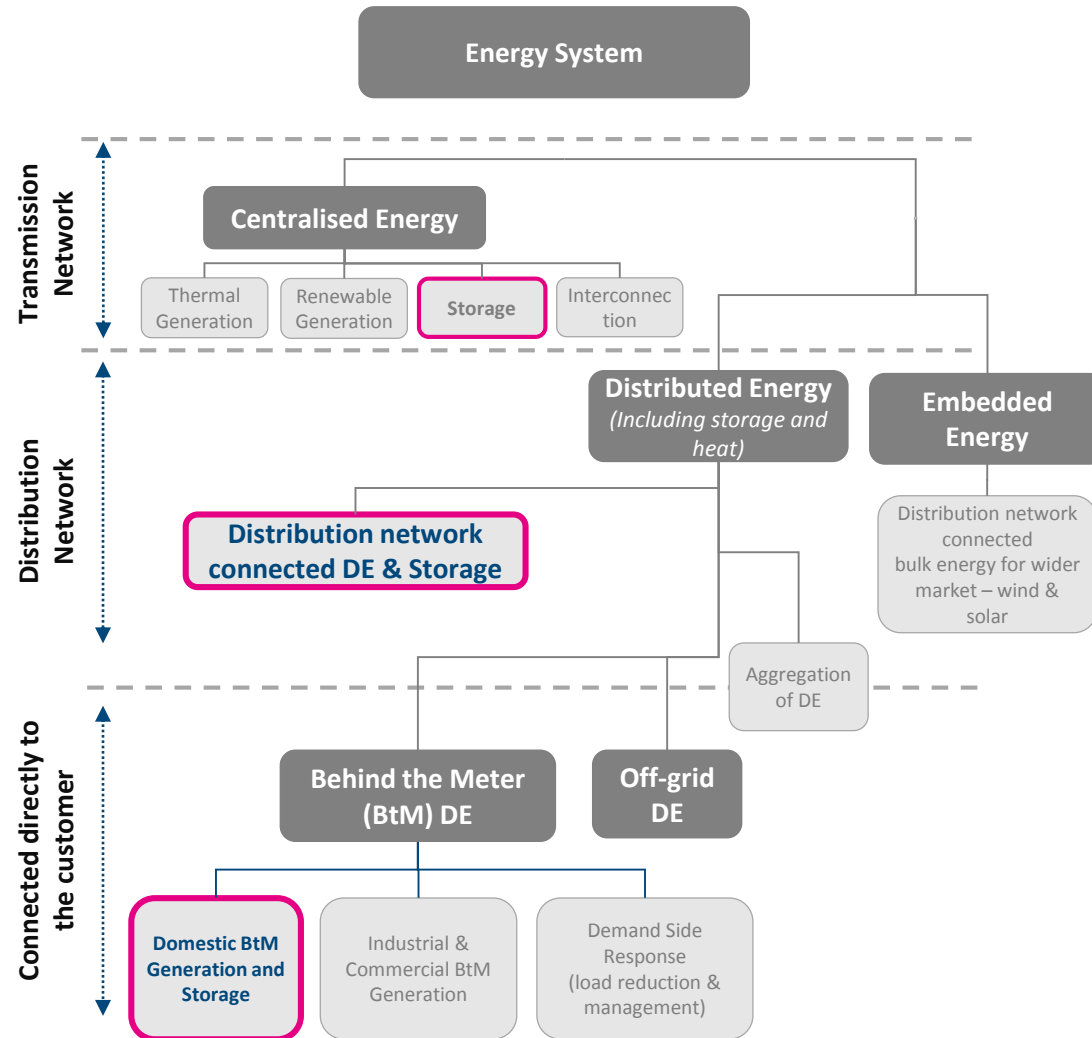
How might battery storage be deployed at scale in GB

- As battery costs reduce, which markets and applications will become economically and technically viable for storage?

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The changing GB Electricity System?

As the GB electricity system changes to one with increasing volumes of generation connected to low voltage distribution network, there will be opportunities for batteries to be deployed across the energy network

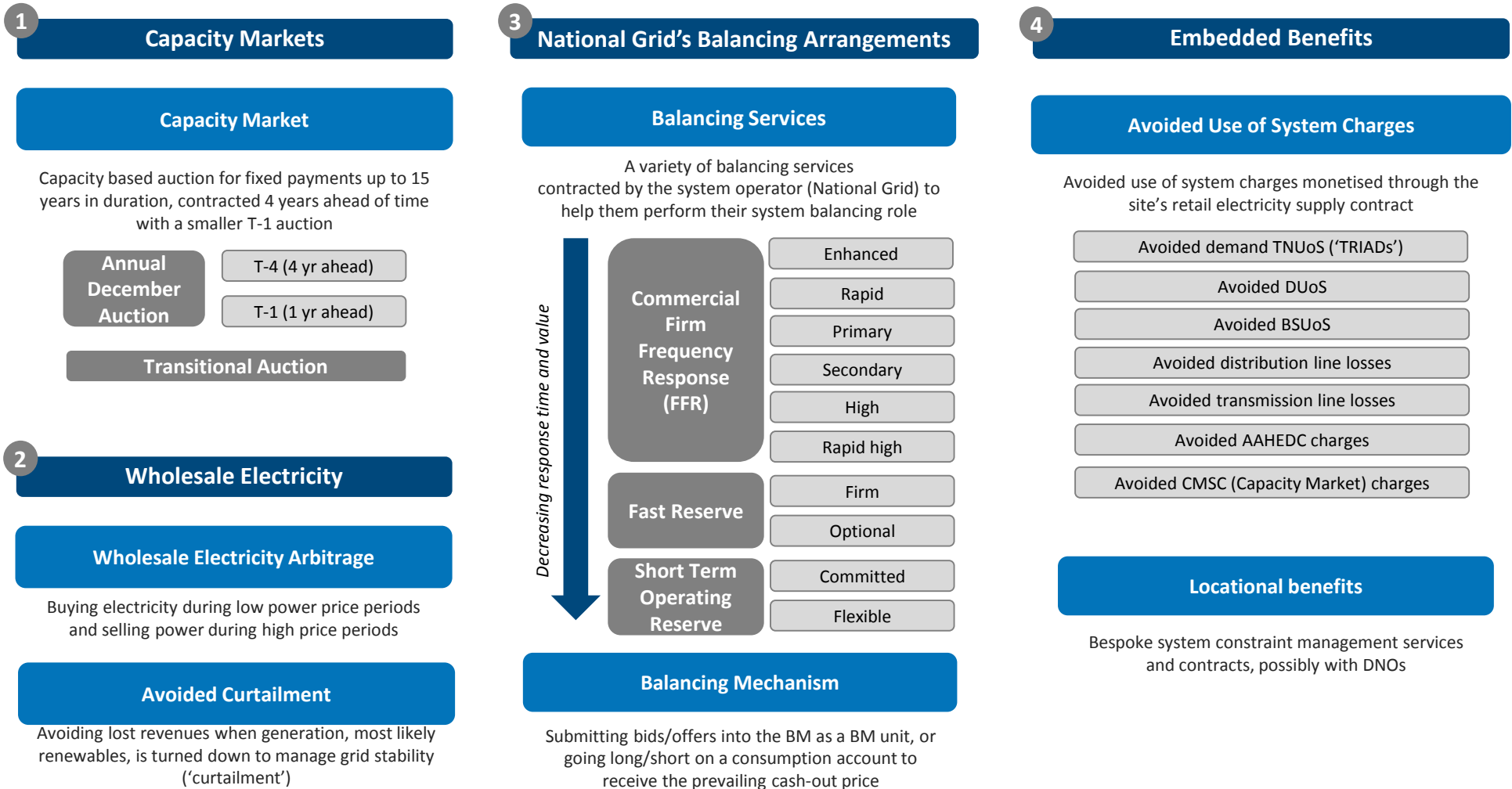


Storage in a disaggregated energy system

- ▶ As the energy system becomes more disaggregated, storage will be deployed at different scales across the energy value chain using multiple different technology types
- ▶ Pumped storage hydro, electrochemical storage, flywheels, CAES, fuel cells, all have different response time, scale and cost characteristics that make them more or less suited to different applications
- ▶ The flexibility of storage allows it to provide a broad spectrum of services, each of which offers different value making them more or less attractive

How does storage monetise its flexibility value?

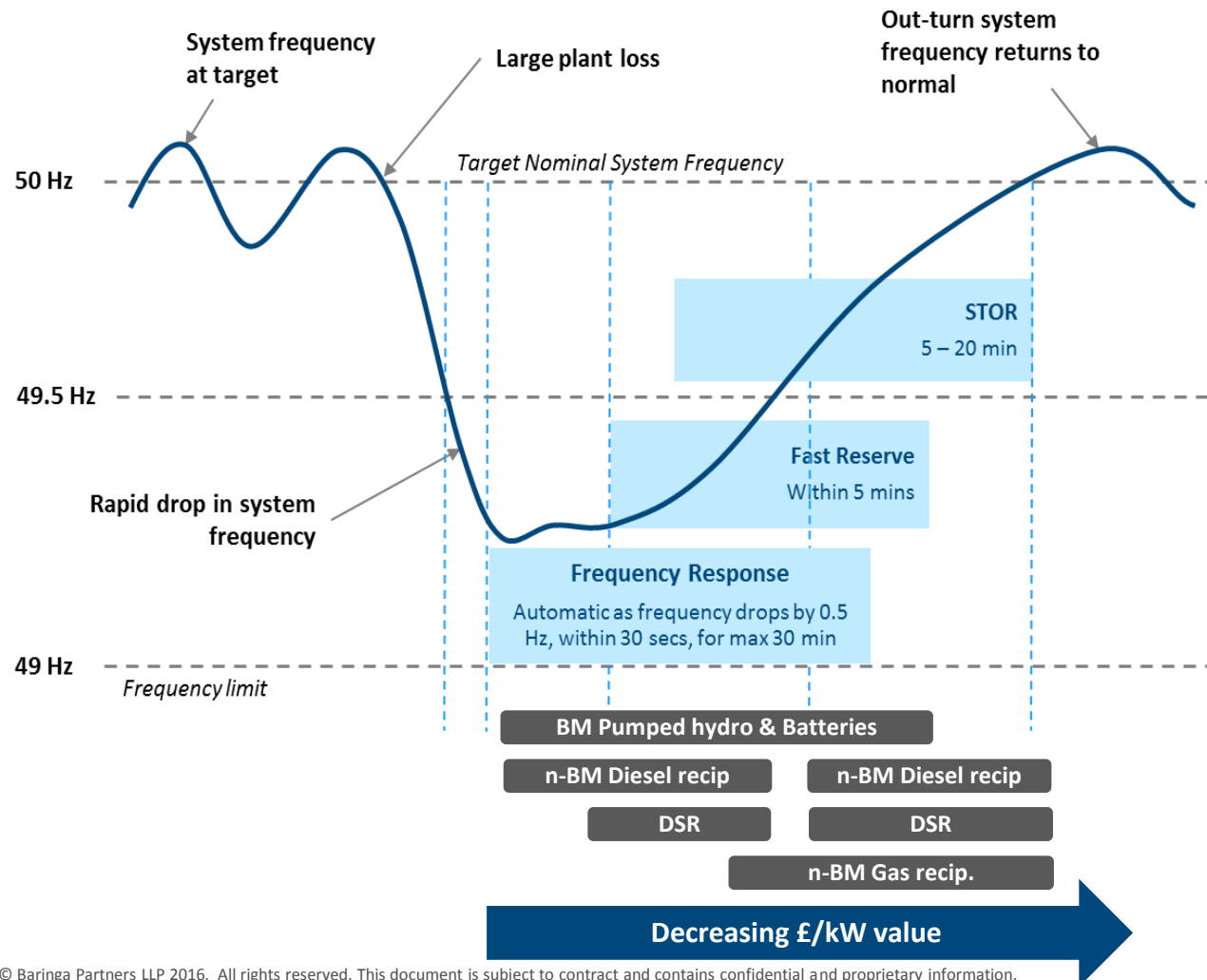
The revenue streams available to storage can be broadly categorised as Capacity payments, Wholesale Electricity, Balancing Arrangements and Embedded Benefits



Balancing Services - Illustrative imbalance event

National Grid dispatch a series of balancing services through an imbalance event, paying a premium for services with the quickest response time

Illustrative System Energy Imbalance Event



- ▶ National Grid requires this spectrum of Balancing Services to increase resilience across different types of imbalance event, but also to alter between differing products as the system is brought back to equilibrium
- ▶ There is a price premium paid for rapid response services that National Grid may not want to use for the full imbalance period, switching to cheaper but lower response time products that it can utilise for longer as the system equilibrium is reached
- ▶ There is an incentive scheme in place for National Grid to dispatch Balancing Services in an economically efficient manner

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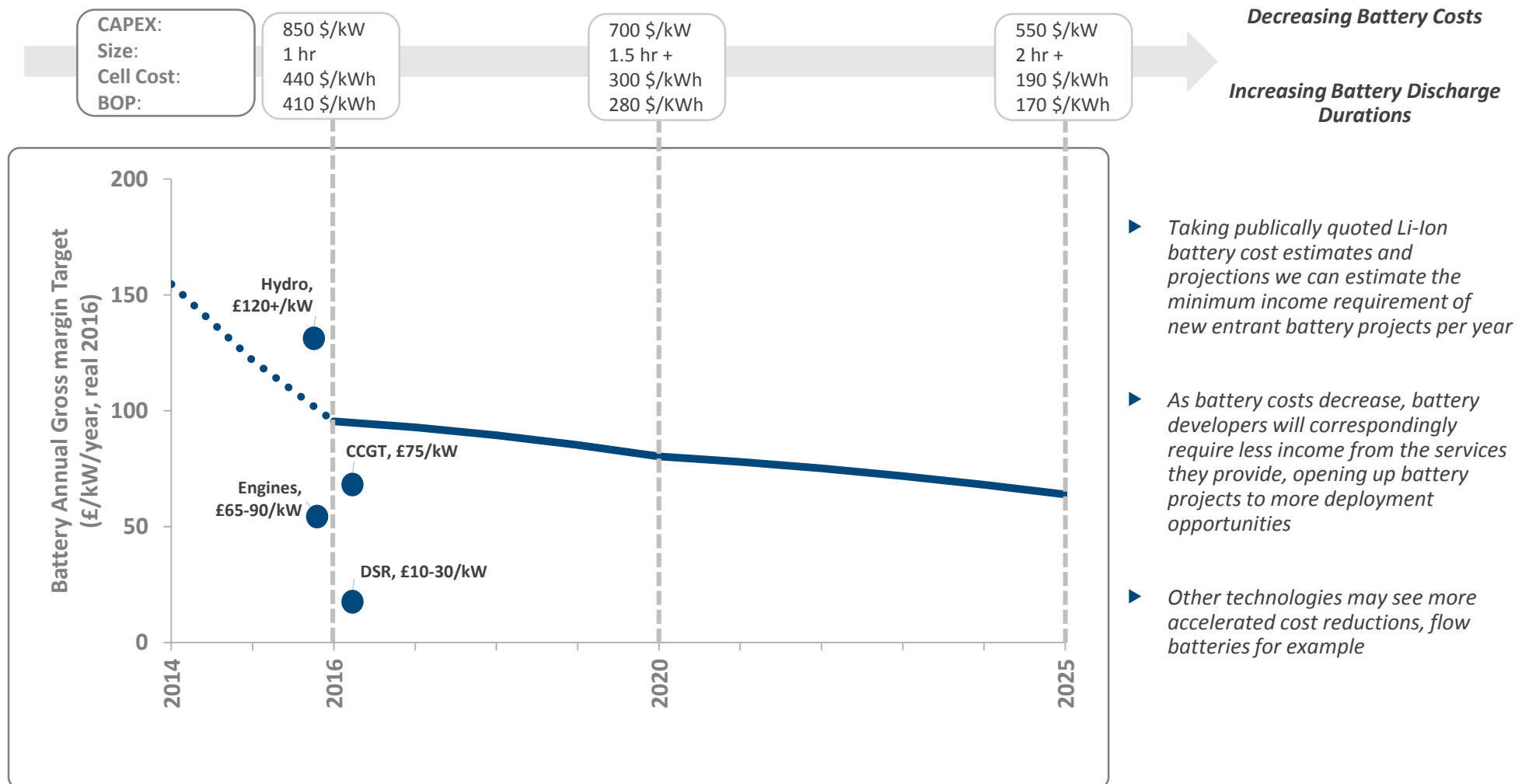
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Decreasing Battery Costs will Broaden the Role of Storage



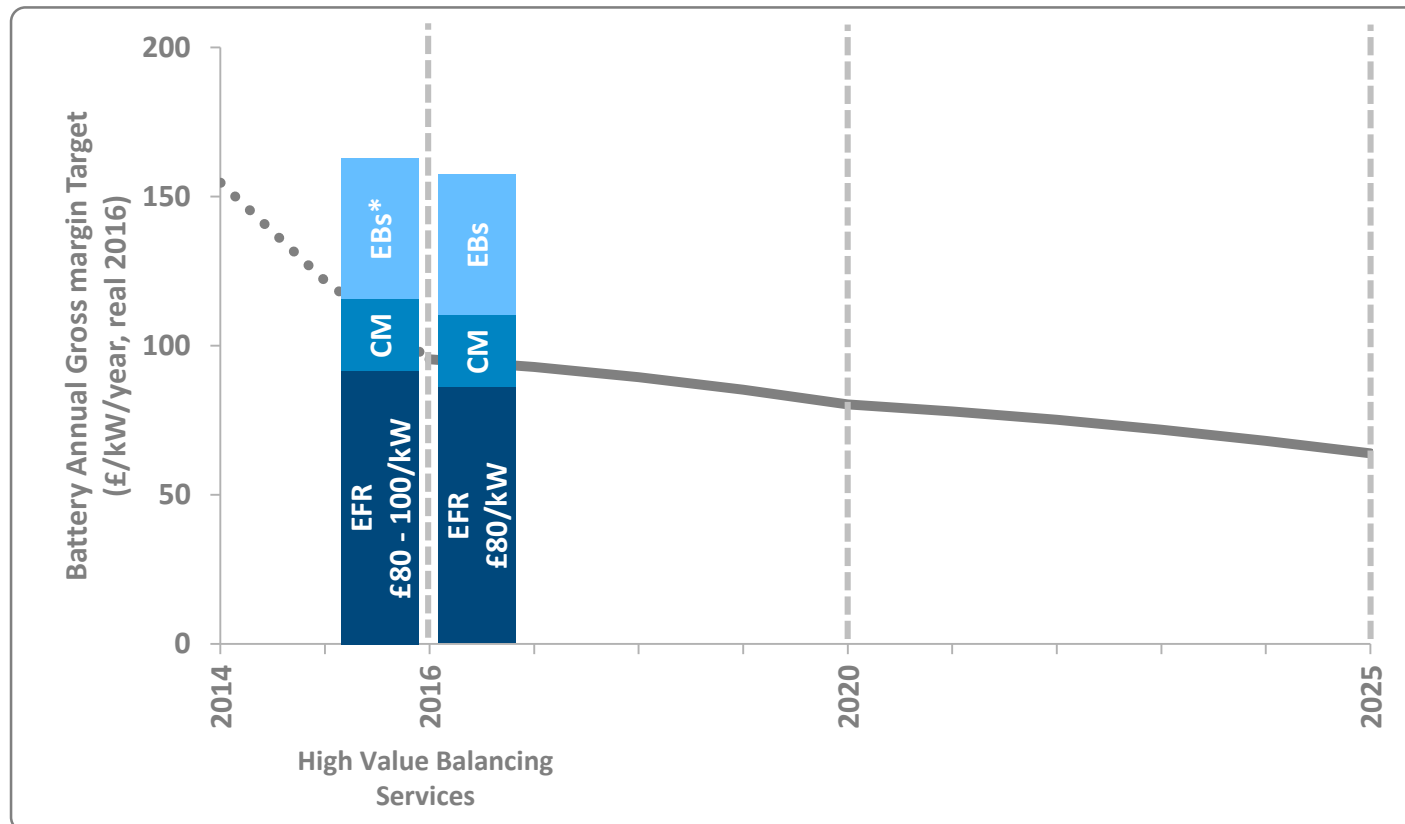
Electrochemical battery costs have decreased dramatically in the past 3 years, in part driven by advances in EV technologies, with this decrease expected to continue



Battery Deployment

Today, in all but niche and demonstration projects, batteries can only be deployed at scale in the high value, rapid response Balancing Services

- ▶ National Grid's recent Enhanced Frequency Response tender procured 200 MW of battery storage clearing at a weighted price of £9.4/MW/hr, or £82/kW/year. This illustrates the rapid maturity of the electrochemical battery market
- ▶ Other Balancing Services offer similar value today, but the shorter tenor of these services make them less attractive



Key Considerations

Tenor of Balancing Services

Longevity of Embedded Benefits

Eligibility of Capacity Market & EFR

Technology Risk

Stranding Risk

Other Applications Today

DNO grid support services

High curtailment avoidance

Demonstrations Projects

Virtual Power Plant

Battery Deployment in the Medium Term

As battery costs decrease, discharge durations will increase and battery developers will increasingly deploy batteries for wholesale arbitrage and co-location opportunities

- ▶ Wholesale electricity arbitrage is the most intuitive service for storage, but it does not make commercial sense today, and when it does it will carry considerable merchant risk
- ▶ Co-location with renewables and demand offers exciting opportunities for novel business models to manage imbalance exposure, shift load, avoid use of system charges and aggregate multiple assets into virtual portfolios

Key Considerations

Cannibalisation of Wholesale Arbitrage Revenues

Commercial Models of Co-Location with Renewables and Demand

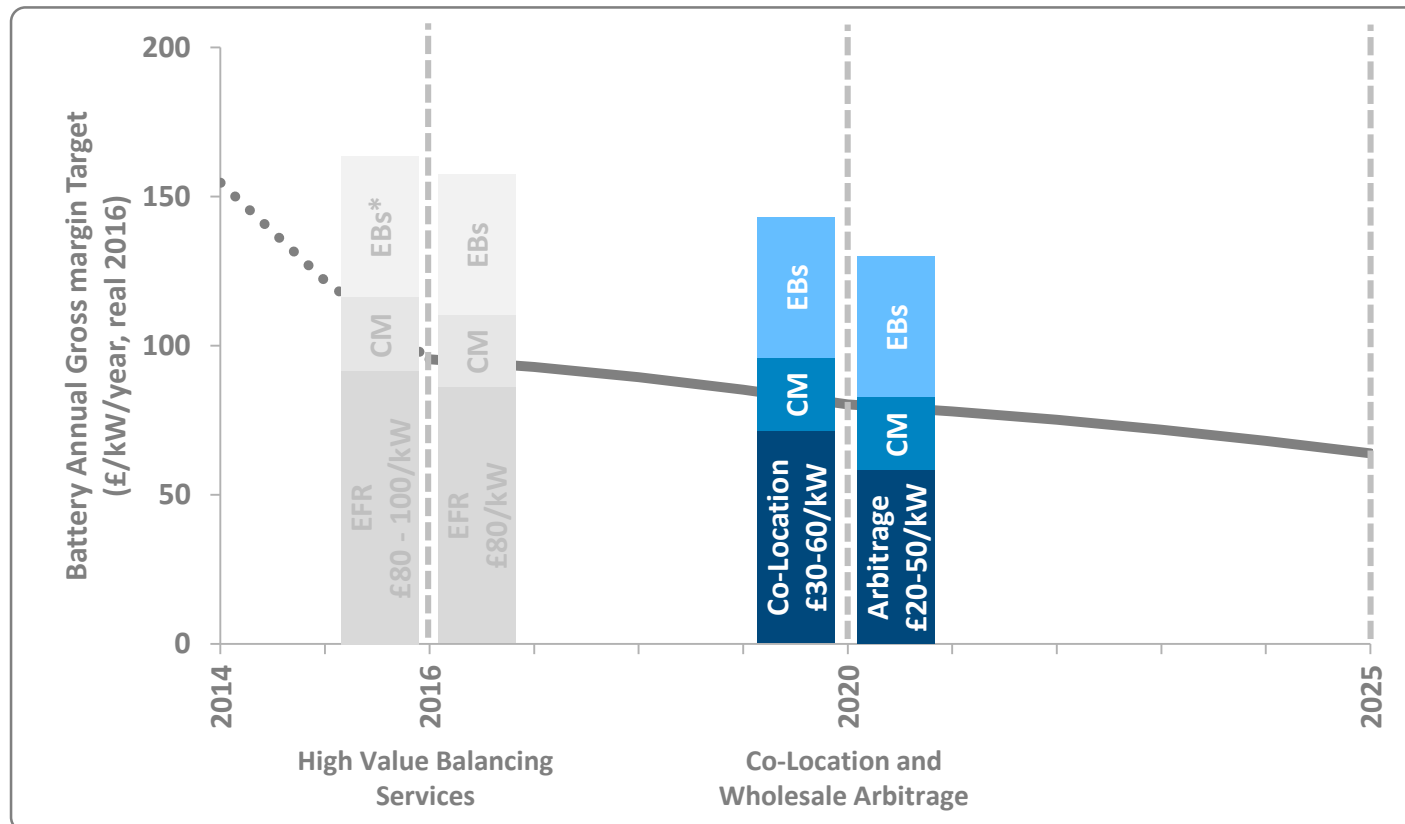
Merchant Risk

Other Medium Term Applications

Co-location includes: renewables, wind and solar, industrial sites, domestic sites and thermal generation

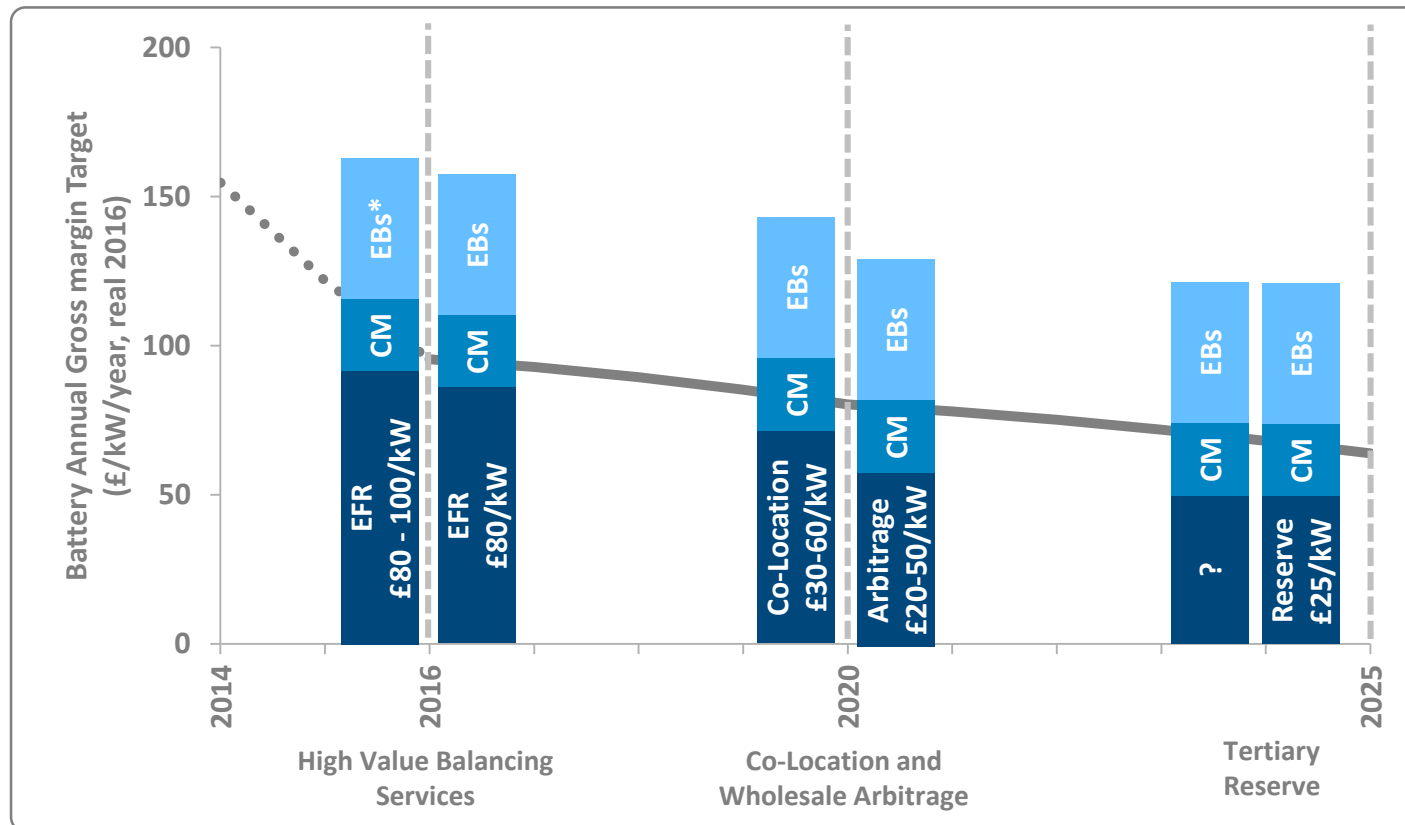
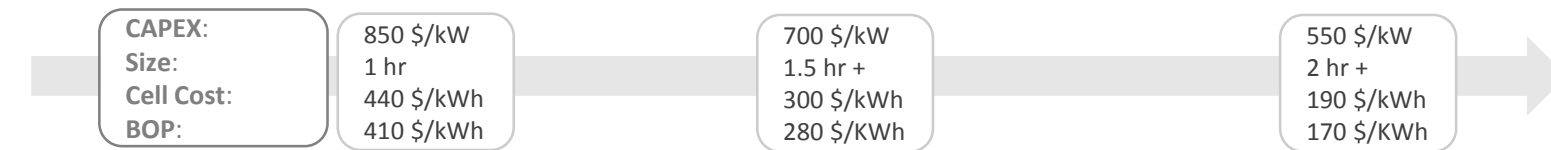
Virtual Power Plant

Imbalance Management



Battery Deployment in the Long Term

In the long term, batteries will integrate into multiple facets of the energy system with markets responding and adjusting to create a more holistic and responsive energy system



- ▶ The addressable market size for batteries will increase as the markets it can access increase
- ▶ Today, the market size is limited to the volume that can access Balancing Services Markets, which is relatively small (the Frequency Response Market is ~ 1.8 GW in total)
- ▶ In the medium term, co-location and wholesale arbitrage opportunities will be limited by the cannibalisation in these markets, the availability of sites, and capital's appetite for increased merchant risk
- ▶ As batteries are deployed, they will serve to cannibalise their core revenue streams until such time as equilibrium is reached. This creates a stranding risk for early generation batteries

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Introduction to Baringa



- ▶ Baringa Partners LLP is a market-leading consulting company with a focus on energy, commodities and financial services
- ▶ Founded in the UK in 2000 – Baringa Partners has a market turnover of approximately €135m, with more than 450 professionals. Our German branch office has been opened in 2011 to increase support of our clients in central and eastern Europe
- ▶ Baringa Partners has a strong track record working with numerous companies in the international commodities trading markets – our capabilities and experiences extend across Oil, Gas, Power, Coal, Carbon and Soft Commodities; our clients comprise Oil Majors, Utilities, Investment Banks, Exchanges and Investment Funds
- ▶ Baringa is recognised both in the UK and internationally for its unique culture, which has been acknowledged by a number of awards and accolades and continues to reaffirm Baringa's status as a leading people-centred organisation.



A selection of our recent and relevant experience

We have worked with governments, regulators, system operators, investors, developers and utilities to understand the new world of distributed energy (DE)

