Integrating Supply and Demand: Smart Systems; Storage


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Reputation built on results
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?
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.

*DE includes storage and heat*
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.

1. **Capacity Markets**
   - **Capacity Market**
     - Capacity based auction for fixed payments up to 15 years in duration, contracted 4 years ahead of time with a smaller T-1 auction
     - **Annual December Auction**
     - T-4 (4 yr ahead)
     - T-1 (1 yr ahead)

2. **Wholesale Electricity**
   - **Wholesale Electricity Arbitrage**
     - Buying electricity during low power price periods and selling power during high price periods
   - **Avoided Curtailment**
     - Avoiding lost revenues when generation, most likely renewables, is turned down to manage grid stability (‘curtailment’)

3. **National Grid’s Balancing Arrangements**
   - **Balancing Services**
     - A variety of balancing services contracted by the system operator (National Grid) to help them perform their system balancing role
     - **Commercial Firm Frequency Response (FFR)**
     - Enhanced
     - Rapid
     - Firm
     - Optional
     - Committed
     - Flexible
   - **Fast Reserve**
     - High
     - Rapid high
   - **Short Term Operating Reserve**
     - Committed
     - Flexible

4. **Embedded Benefits**
   - **Avoided Use of System Charges**
     - Avoided use of system charges monetised through the site’s retail electricity supply contract
     - Avoided demand TNUoS (‘TRIADs’)
     - Avoided DUoS
     - Avoided BSUoS
     - Avoided distribution line losses
     - Avoided transmission line losses
     - Avoided AAHEDC charges
     - Avoided CMSC (Capacity Market) charges
   - **Locational benefits**
     - Bespoke system constraint management services and contracts, possibly with DNOs

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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

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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Illustrative System Energy Imbalance Event

- System frequency at target
- Large plant loss
- Out-turn system frequency returns to normal
- Target Nominal System Frequency
- Frequency Response
  - Automatic as frequency drops by 0.5 Hz, within 30 secs, for max 30 min
  - Fast Reserve
    - Within 5 mins
  - STOR
    - 5 – 20 min

Decreasing £/kW value

BM Pumped hydro & Batteries
n-BM Diesel recip
n-BM Diesel recip
DSR
DSR
n-BM Gas recip.
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  • As battery costs reduce, which markets and applications will become economically and technically viable for storage?
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.

- Taking publically quoted Li-Ion battery cost estimates and projections we can estimate the minimum income requirement of new entrant battery projects per year.
- As battery costs decrease, battery developers will correspondingly require less income from the services they provide, opening up battery projects to more deployment opportunities.
- Other technologies may see more accelerated cost reductions, flow batteries for example.
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

* Embedded Benefits, including TRIADs, which are subject to regulatory review
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

*Embedded Benefits*
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.

[Diagram showing battery deployment and market targets over time.]

- CAPEX: 850 $/kW 1 hr
- Cell Cost: 440 $/kWh
- BOP: 410 $/kWh
- Gross margin Target (GBP/kW/year, real 2016): 700 $/kW 1.5 hr + 300 $/kWh 280 $/KWh
- Size: 550 $/kW 2 hr + 190 $/KWh 170 $/KWh
Agenda

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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)