Distributed Generation Owner/Operator Forum

Osborne Clarke, Bristol





building a low carbon economy in south west England

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Smart Energy Marketplace

28 March 2017

Sandy Park, Exeter

The biggest smart energy and generation show in the south west

Exhibit, conference, talks, electric vehicles showcase and more

www.regensw.co.uk/smart-energy-marketplace-2017

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Agenda

Chair: Merlin Hyman, CEO, Regen SW

13.30 **Arrival, registration and buffet lunch**

14.00 **Welcome and introductions from the chair**

14.10 **Review of progress on actions to address outages**
Generator portal and point of contact
Longer term visibility of outages
Reducing outage impact – including 'just in time' approaches

Led by Sean Sullivan, control room manager, WPD

15.30 **Opportunities for a consortium approach to outages**

15.50 **Discussion on operational modes of energy storage and grid impacts**
Johnny Gowdy, director, Regen

16.30 **Networking and close**

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DNO Outage Flow Chart DRAFT – January 2017

Process Notes

DNO to ensure site name, site address, Owner and O&M contact details are correct.

Constraint type (full or partial) must be included

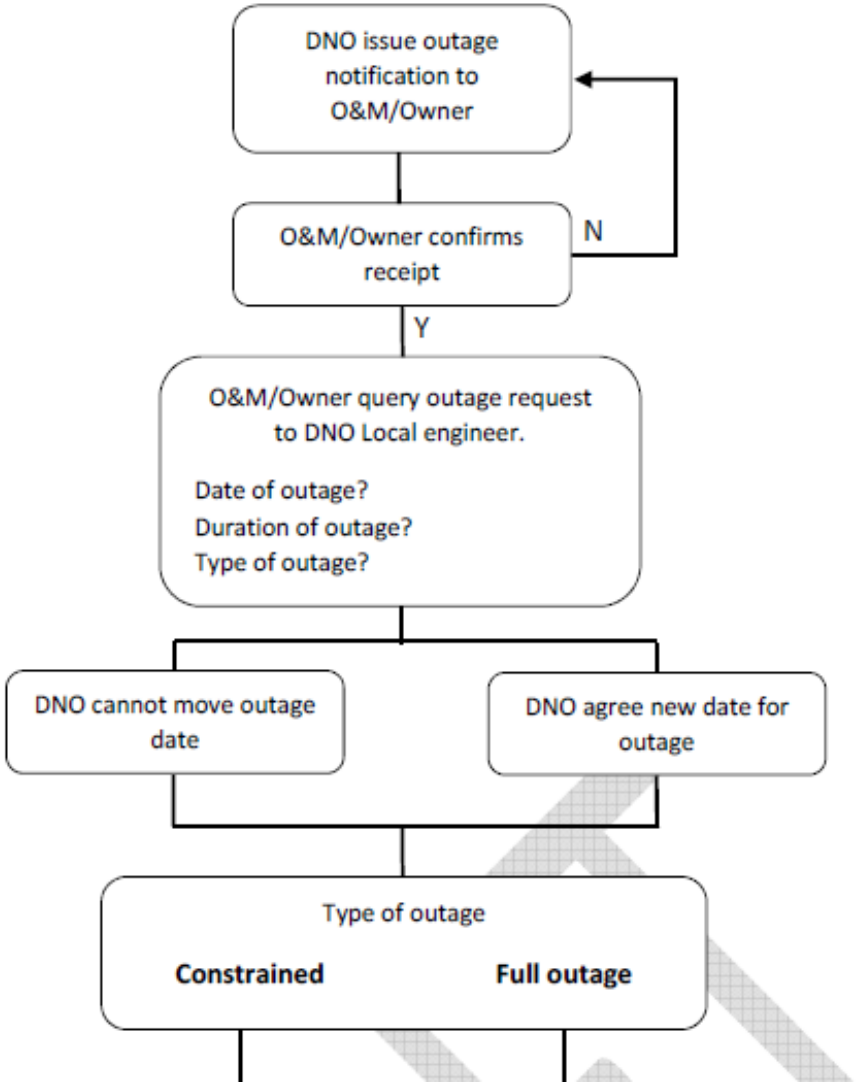
11kV or 33kV?

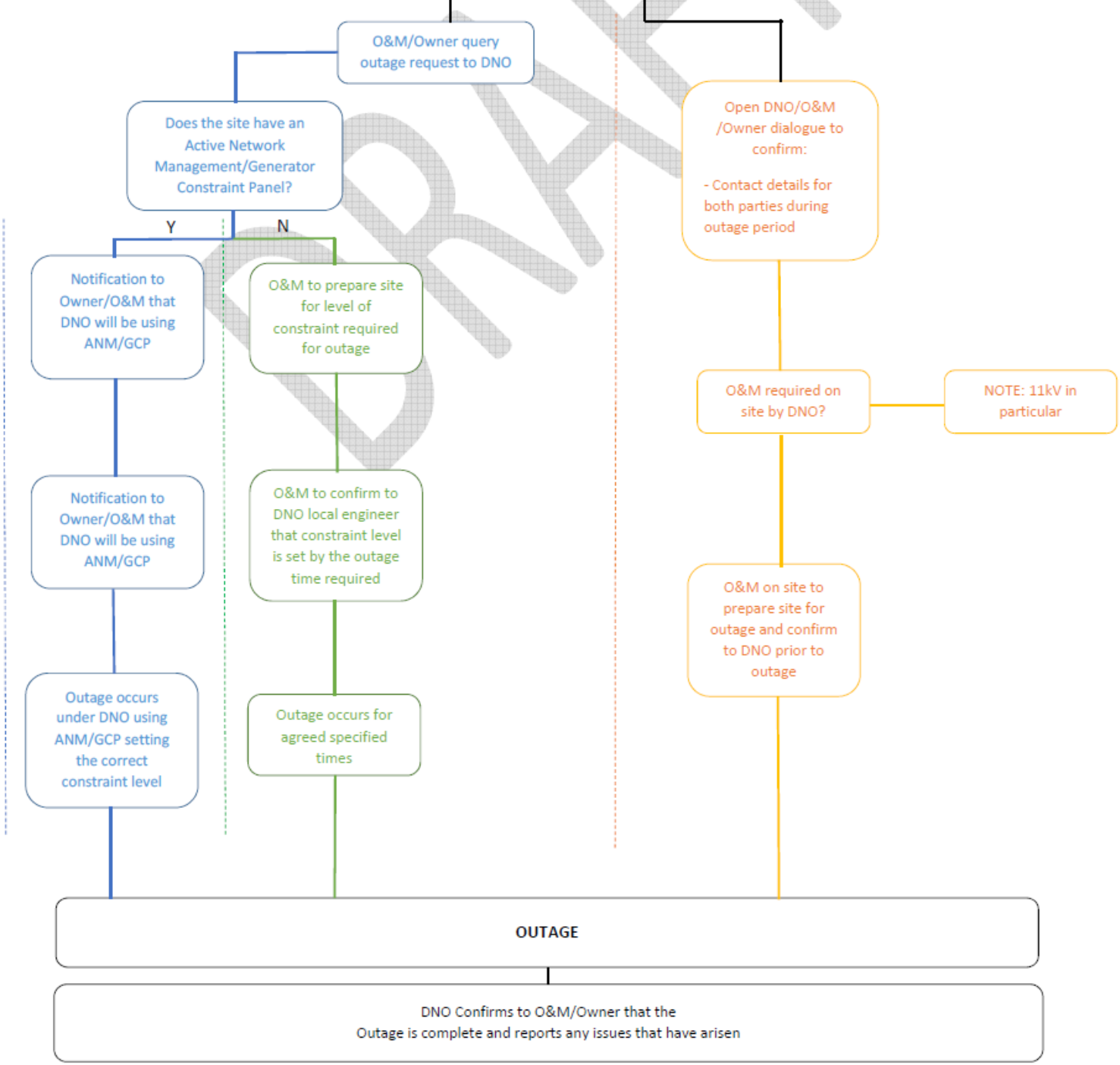
DNO local engineer details must be included

Details of the Constraint value not to be exceeded rather than the capacity in the Connection Agreement

DNO to highlight whether any other sites are affected in the same outage and provide Owners details.

Has DNO considered the Outage in terms of time of year i.e. loss of revenue?




O&M/Owner query outage request to DNO
Does the site have an Active Network Management/Generator Constraint Panel?
Y
N
Notification to Owner/O&M that DNO will be using ANM/GCP
O&M to prepare site for level of constraint required for outage
Notification to Owner/O&M that DNO will be using ANM/GCP
O&M to confirm to DNO local engineer that constraint level is set by the outage time required
Outage occurs under DNO using ANM/GCP setting the correct constraint level
Outage occurs for agreed specified times
Open DNO/O&M /Owner dialogue to confirm:
- Contact details for both parties during outage period
O&M required on site by DNO?
NOTE: 11kV in particular
O&M on site to prepare site for outage and confirm to DNO prior to outage
OUTAGE
DNO Confirms to O&M/Owner that the
Outage is complete and reports any issues that have arisen

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WPD Generation Owner/Operator Forum

Energy storage growth, operations and grid impacts

January 2017

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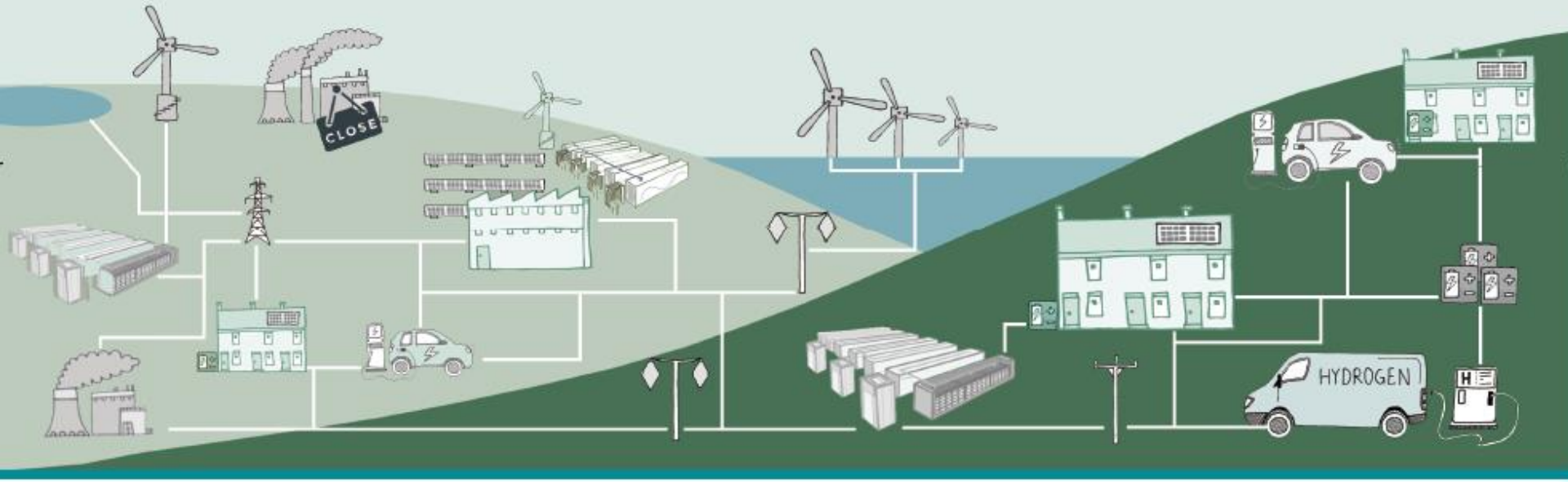
Pathways to Parity - Market insight series

Energy Storage - Towards a commercial model



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Solving the Rubik's Cube

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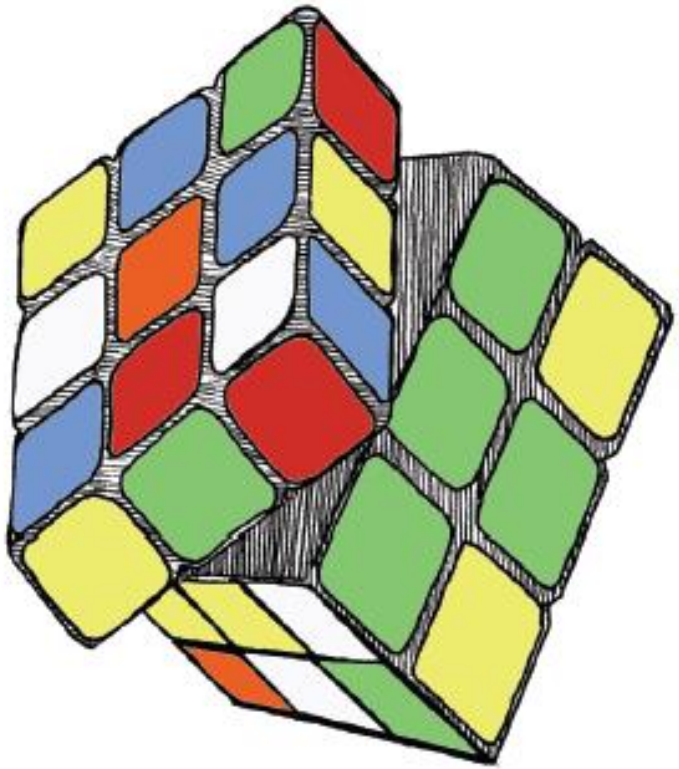
Route to market

Policy/regulation

Costs/finance



Technology

Timescales

Revenue Streams

Energy system structural changes

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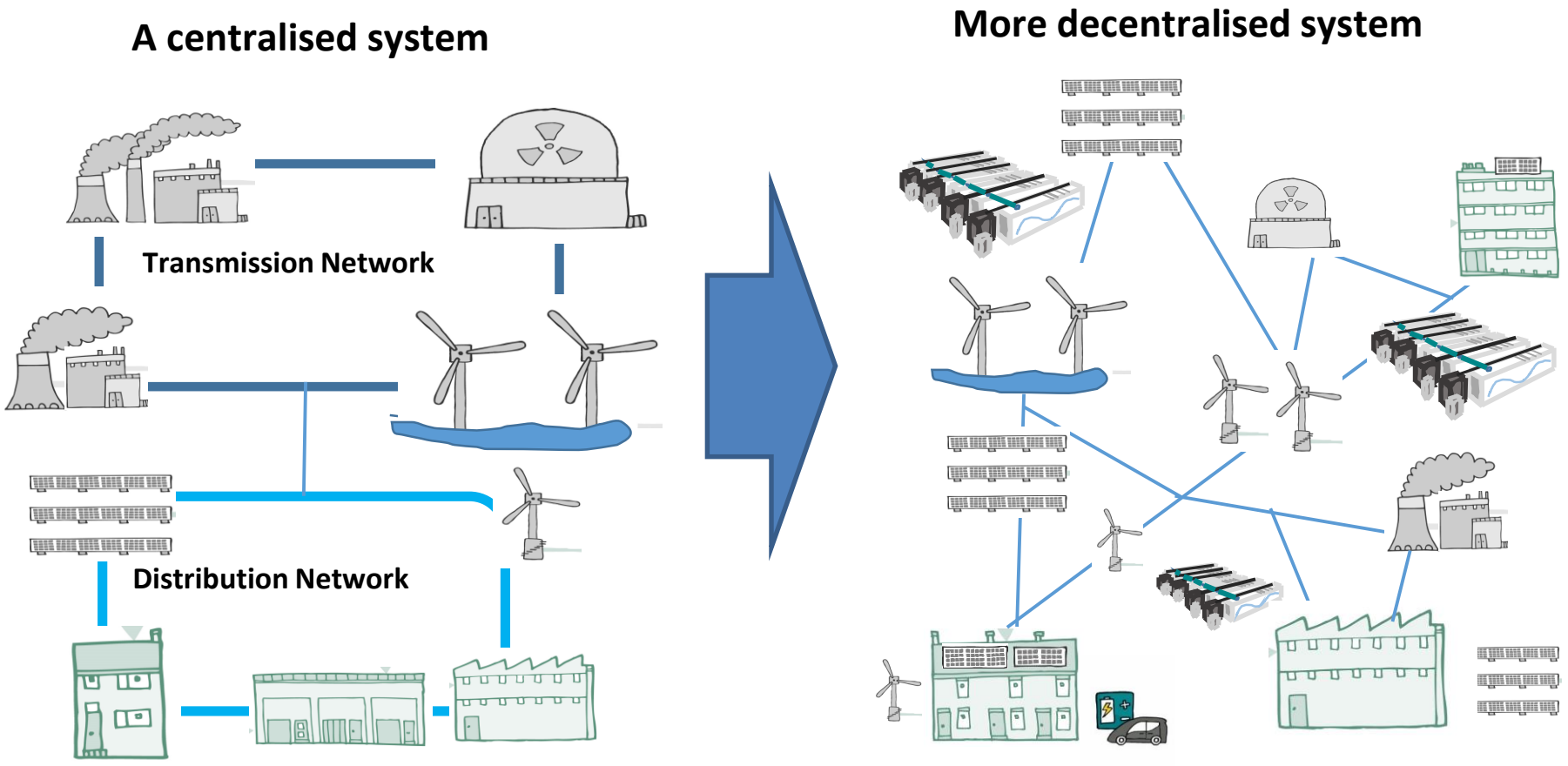


"Our engineers say that 2015 was the last year we operated the system in the way it has operated for the past 50," he says. "The way we are operating now is fundamentally different." John Pettigrew Chief Exec. National Grid

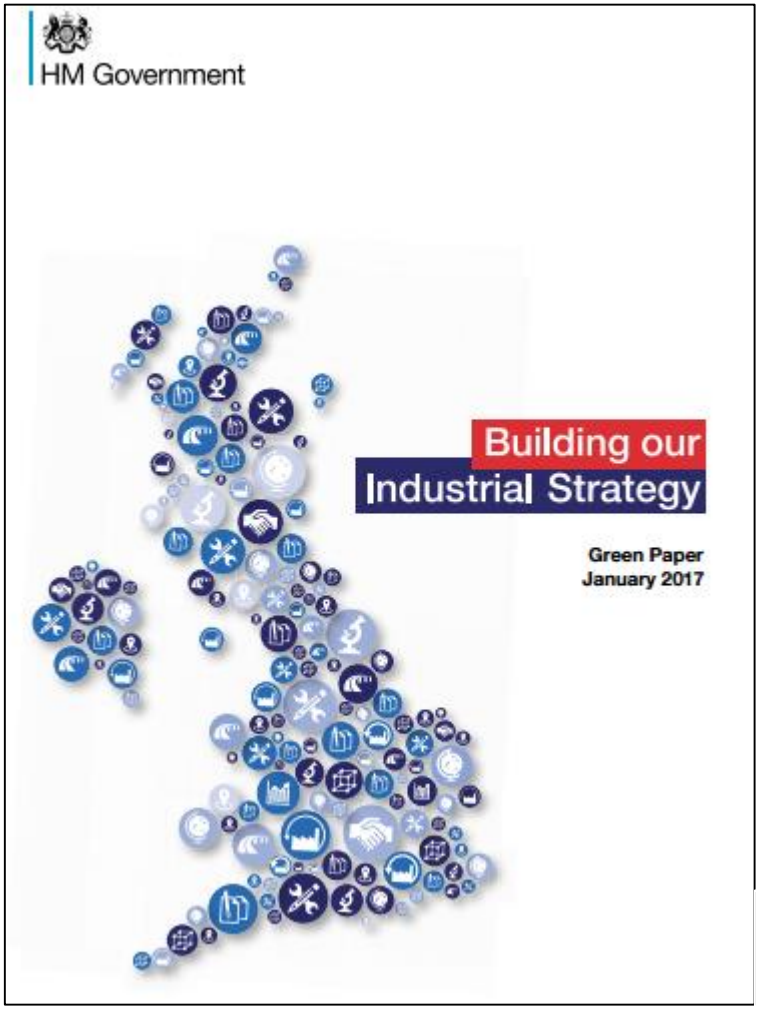
Radical new approach

"The energy sector is undergoing a **fundamental, structural change**. We are **moving away from the linear 'one-way' flow** of electricity from large generators, through transmission and distribution networks, to passive consumers.

Instead we are now moving to a system where generation is **distributed and more variable**, where **consumers** can better monitor and manage their energy use, and where **new technologies and business models** are emerging."

Quote above from OFGEM Sept 2015 "Making the electricity system more flexible and delivering the benefits for consumers- position paper"

UK Industrial Strategy

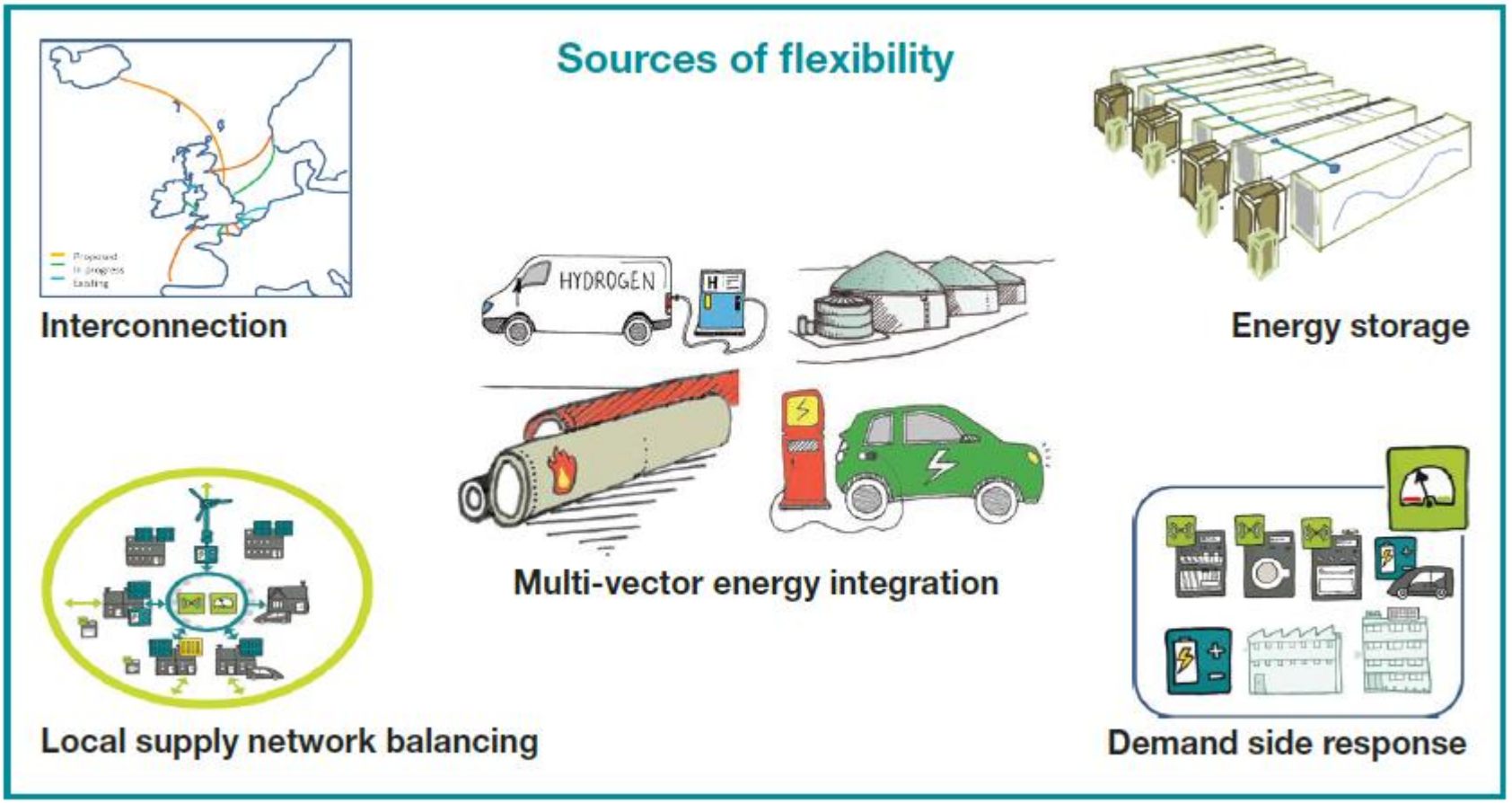


"Given the UK's underlying strengths in science and energy technology, we want to be a global leader in battery technology"

"Battery technology is of huge importance to a range of new technologies, including the automotive sector, smart energy systems and consumer electronics"

"Government has also asked Sir Mark Walport, the Government's Chief Scientific Adviser, to consider the case for a new research institution as a focal point for work on battery technology, energy storage and grid technology."

Value of flexibility



"Three innovations will help us deliver greater flexibility – interconnection, storage, and demand flexibility – which have the potential to displace part of the need for new generating capacity, save money for businesses and domestic consumers and help the UK meet its climate reduction targets. The saving could be as large as £8 billion a year by 2030".

Lord Andrew Adonis, Chair, The National Infrastructure Commission[10]

The role of energy storage

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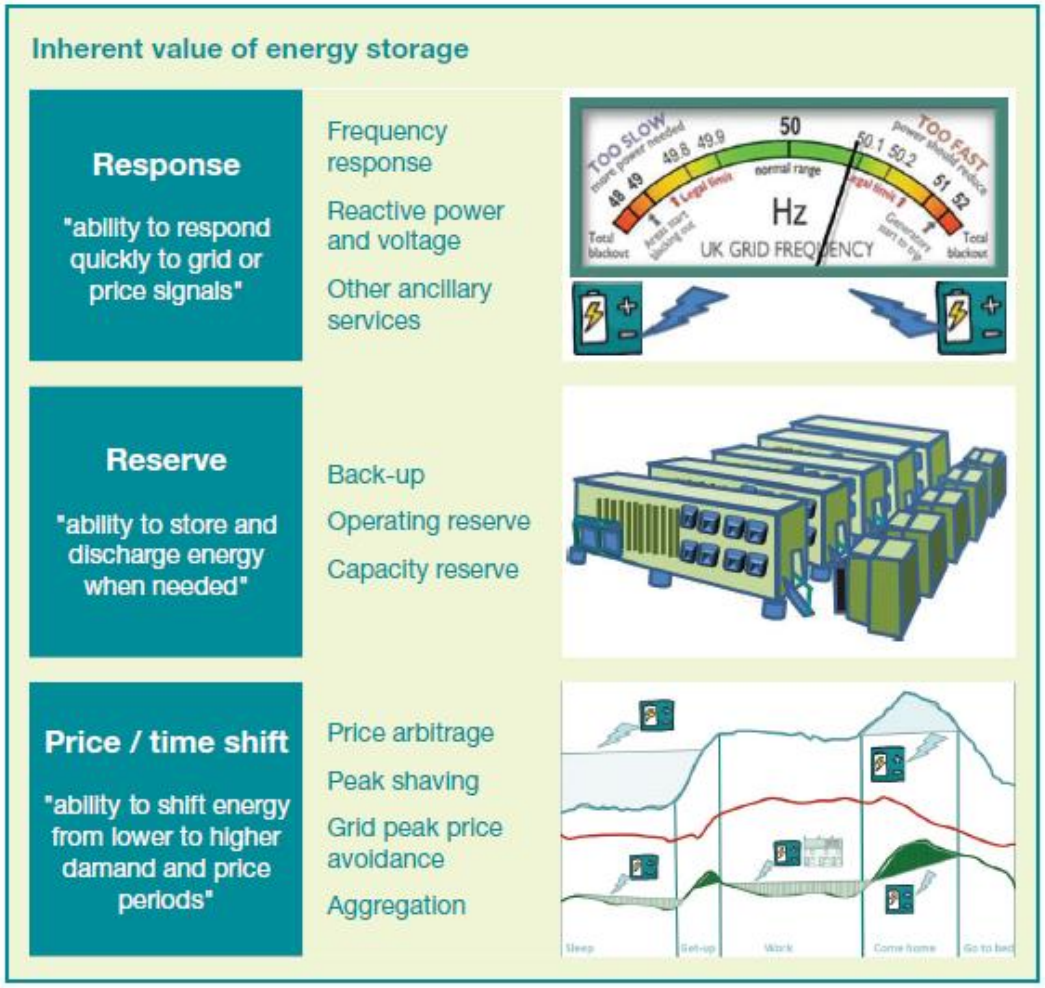
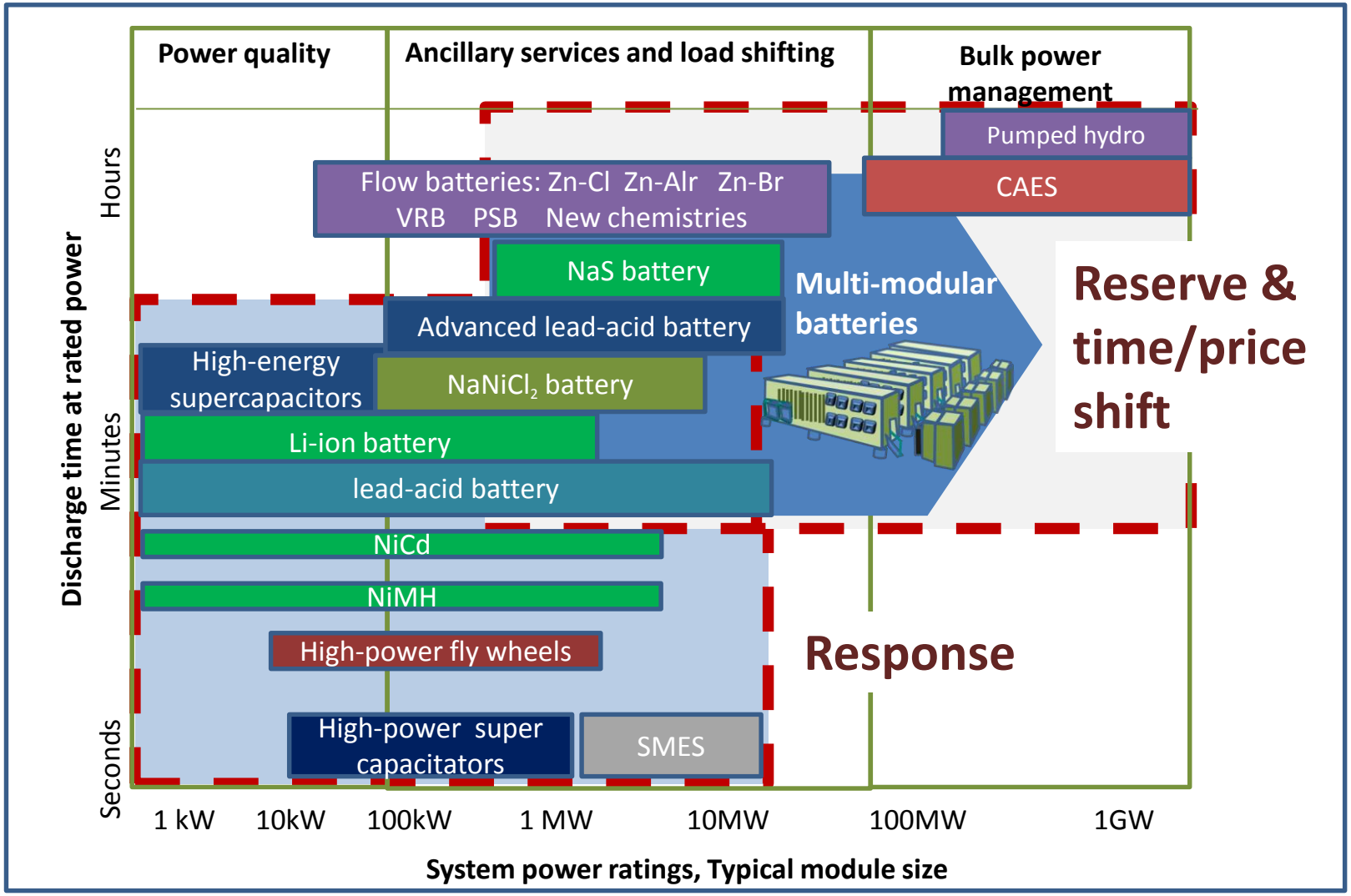


Response: The ability to respond quickly (milliseconds – minutes) to grid, frequency and/or price signals. Potential applications include the provision of ancillary network services such as frequency response and voltage support.

Reserve: The fundamental property of energy storage that enables the storage of energy to be used at a time when it is required. From a simple back-up capability for use as an alternative source of energy, to large scale capacity reserve and Short Term Operating Reserve.

Price and time shift: The capability to shift energy from lower to higher price/cost periods. A more sophisticated application of both reserve and response functions, allowing energy users and suppliers to take advantage of price variance (price arbitrage), avoid peak transmission and distribution costs and/or to recover energy that would be lost due to grid or other constraints.

Energy storage technologies



Potential revenue streams

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	Major revenue stream	Route to market	Relative value	Market size*	Location options
Response	**Enhanced Frequency Response**	Tender (Auxiliary service)	High	200-700 MW	
Response	**Firm Frequency Response (generation or demand reduction)**	Tender (Auxiliary service)	High	2000-3000 MW	
Response	**Frequency Control by Demand Management (FCDM)**	Tender (Auxiliary service)	Med/high	??	
Reserve	**Fast Reserve**	Tender (Balancing service)	Med/high	250-600 MW	
Reserve	**Consumer backup power**	Contract	Variable	??	
Reserve	**Short Term Operating Reserve (generation or demand reduction)**	Tender (Balancing service)	Med	2-4 GW	
Reserve	**Capacity Market**	Tender - Capacity Auction	Med	GWs	
Time/price shift	**Transmission cost avoidance**	Market mechanism/cost avoidance	Med/high	GWs	
Time/price shift	**Distribution cost avoidance**	Market mechanism/cost avoidance	Med/high	GWs	
Time/price shift	**Generator "Own Use" (Domestic and non-domestic)**	Market via price/cost avoidance	Low	GWs	
Time/price shift	**Generator grid curtailment**	Market via price & subsidy revenue gain/reinforcement avoidance	Low/mid	GWs	
Time/price shift	**Price arbitrage (& peak shaving)**	Market via price variance/trade	Low	GWs	

Transmission grid connected

Distribution grid connected

Potential demand side response or behind the meter

Co-location with renewables benefits

Table adapted from a number of sources including National Grid Future Energy Scenarios 2016

Current and emerging business models

Response service	**Response service** - providing higher value frequency response services to the grid networks, such as EFR, FFR, Voltage support.
Reserve service	**Reserve service** – Larger scale storage – eg hydro, CAES providing short and medium term capacity reserve through STOR, Fast Reserve and Capacity markets
High energy user "behind the meter"	**High energy "prosumer" -** "behind the meter" located with an industrial/commercial energy user (and generator), primarily to avoid peak energy costs, transmission and distribution costs
Domestic and community "own use" with PV	**Own Use** – Domestic, community or small commercial to maximise "own use " of generated electricity – mainly PV
Generation co-location	**Co-location** – Co-located with variable energy generation in order to a) price/time shift and/or b) Peak shave to avoid grid curtailment/reinforcement cost
Energy trader	**Energy trader** – Energy supply company, intermediary or generator using storage as a means of arbitrage between low and high price periods using aggregation and new market platforms

Business model variations

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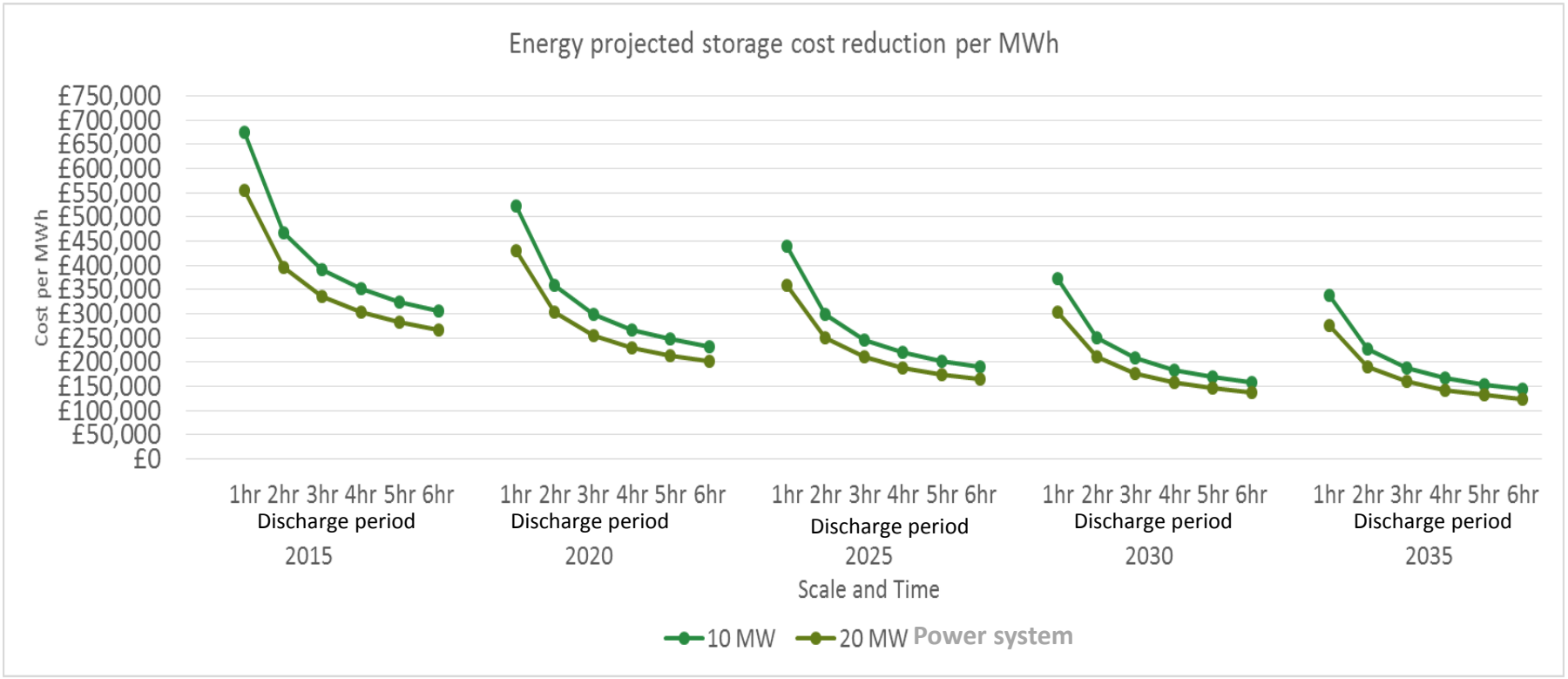
Response service	EFR and/or FFR	Combined with Embedded benefits (mainly TRIAD)	Combined with Capacity Market
Response service	STOR Peak Generation	Potentially combines with peak network charge avoidance and arbritage	
High energy user "behind the meter"	With generation maximise own consumption	Peak Demand reduction appears as DSR	Sized for export for embedded benefits TRIAD and DNuOS
Domestic and community "own use" with PV	"Simple" maximise own consumption	Price sensitive Time of Use / variable Export Tariff	Peer-to-peer, virtual or private wire – micro grid
Generation co-location	Generation Time/price transfer	With grid curtailment	Winter use CM stress and Embedded
Energy trader	Arbitrage Time/price transfer	Aggregation	Market platform trader

Rapidly falling storage costs



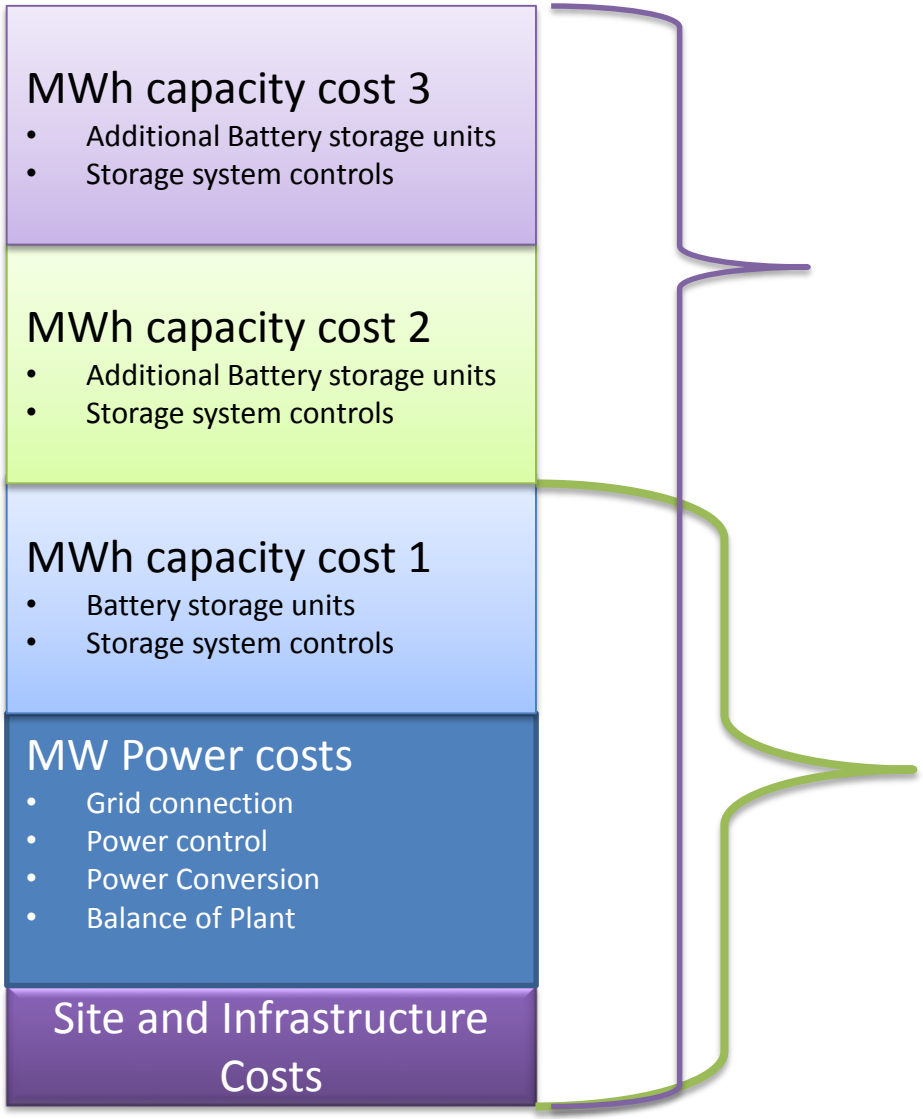
System cost economies of scale

3 hr discharge
30 MWh

2 hr discharge
20 MWh

1 hour discharge
10 MWh

Power Output
10 MW



Price/time shift & Reserve Services system 10MW/30MWh
Higher capital cost but lower cost per MWh if targeting reserve and price/time shift revenue streams

Response Services System 10MW/10MWh
Lower capital cost system if targeting high value Response Services based on delivery of MW power e.g. EFR

Potential “waves” of deployment

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Wave 1

Response Services – driven by EFR and FFR markets

First “behind the meter” high energy users

Plus domestic “early adopters”

Today

Wave 2

“Behind the meter” industrial - DSR

RE co-location - especially for new PV

Some standalone sites

Domestic and community storage with PV

Tomorrow

Wave 3

Aggregation and marketplace models

RE co-location

Domestic and community storage becomes standard

The day after!

Storage projects bidding into EFR and CM auctions

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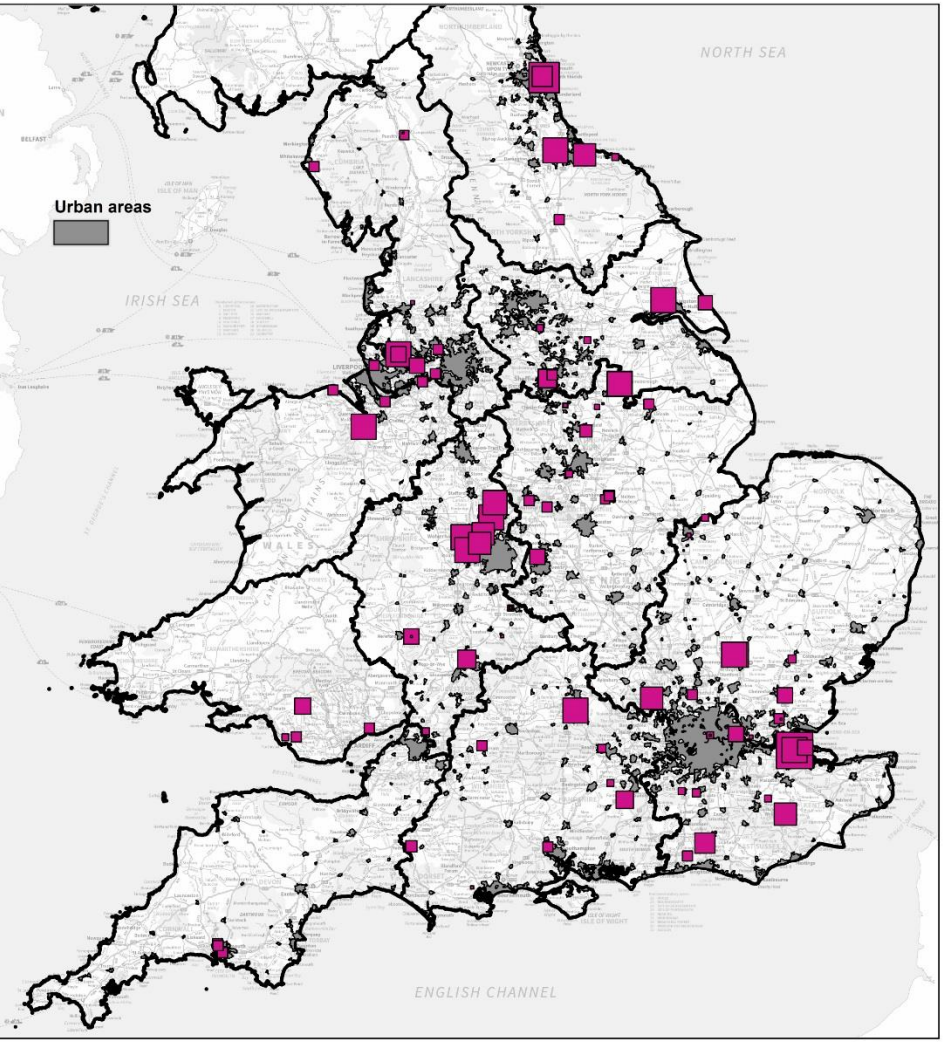
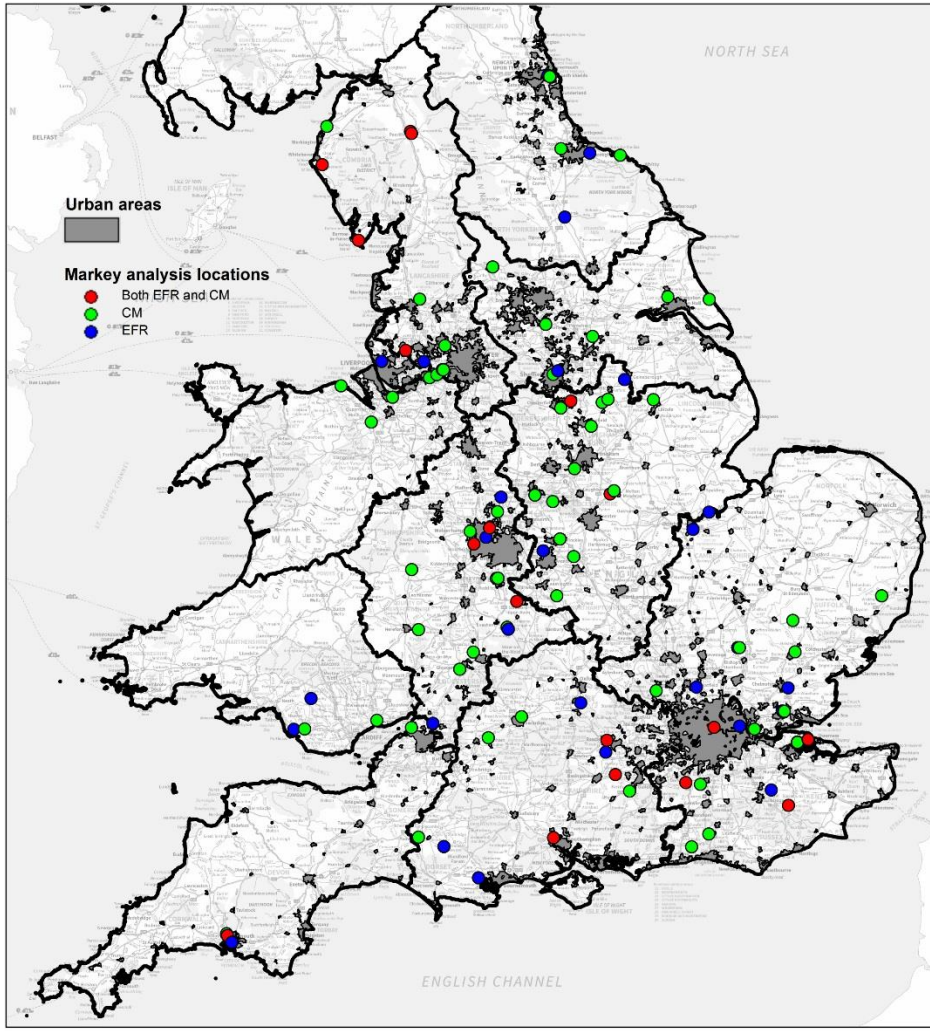
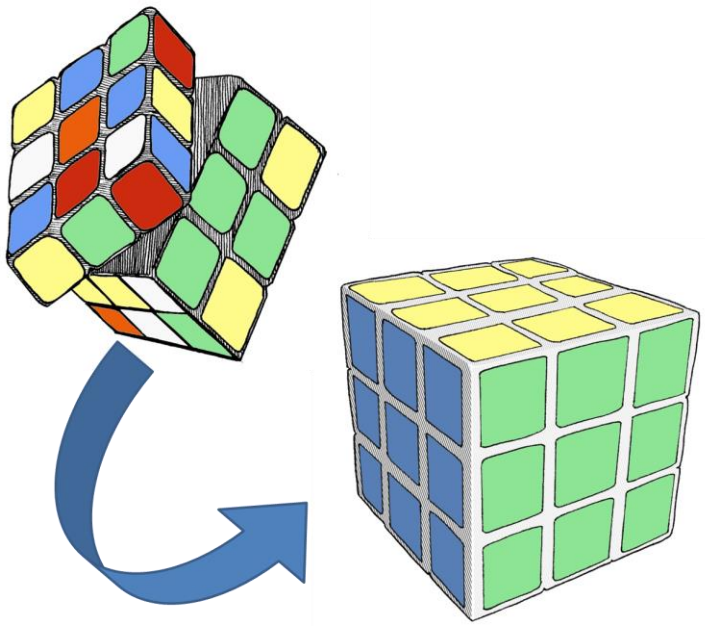




Potential Storage Market Scale

Business model	GB market scenario growth scenario by 2030*		
	High Growth Scenario	Slower and no growth Scenario	Possible upside very high growth scenario
Response service	2 GW	0.5 - 1 GW	2 - 3 GW
	2 GWh	0.5 - 1 GWh	4 - 5 GWh
Reserve Services*	3-4 GW	2-3 GW	4 GW
C&I high energy user & behind the meter	2.5 - 4 GW	0.6 - 1.2 GW	5 GW
	10 - 16 GWh	2.5 - 5 GWh	20 GWh
Domestic and community own use with PV***	1.5 - 2 GW	0.37 - 0.75 GW	3 GW
	6 - 8 GWh	1.2 - 3 GWh	12 GWh
Generation co-location	2 GW	0.5 - 1GW	4 GW
	6 - 8 GWh	2-4 GWh	16 GWh
Total GB market	10 - 12 GW	4 - 5 GW	15 GW**
	24 - 44 GWh	6 - 13 GWh	50 GWh

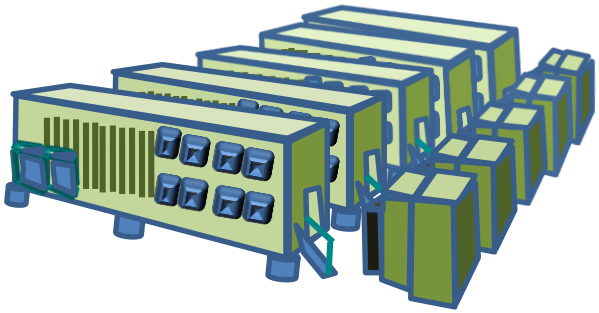
Regulatory challenges

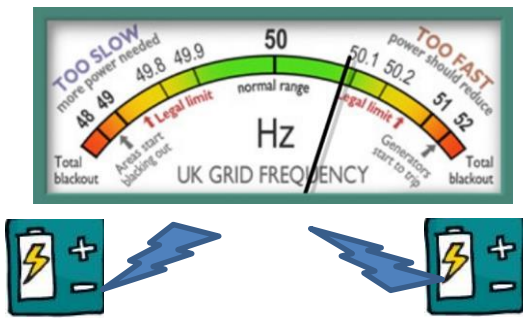


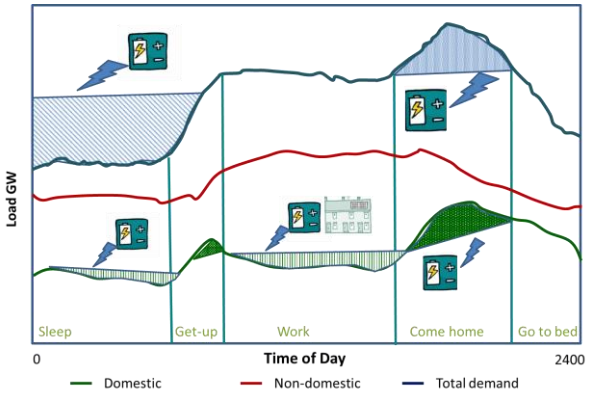
Definition	1. Clarity on the role and definition of storage, including the potential for a new licence definition
Grid charging methodology	2. Ensure that the forthcoming reform of network charging takes an holistic view and ensures a level playing field for energy storage technologies, demand side response and other form of system flexibility
Smart technology	3. Accelerate roll-out of smart meters and the uptake of Time of Use Tariffs to enable more consumers to take advantage of price arbitrage opportunities
End user levies	4. Elimination of instances of double charging (demand and generation) for end user levies and other network charges
Network services regulations	5. Measures to ensure that energy storage can fully access network service revenues – for example distribution network (DNUoS) banded tariff credits 6. Provide clarity on the scale and timing of the commissioning of future balancing and auxiliary services and adapt service specification to encourage competition from energy storage solutions 7. Ensuring that the transition towards a Distribution System Operator model supports the development of local network balancing using energy storage and other flexibility services 8. Ensuring a coherent and consistent approach to the procurement of network services (National Grid and DNO/DSO services) allowing services to be appropriately bundled to create longer term revenue streams

Big Question

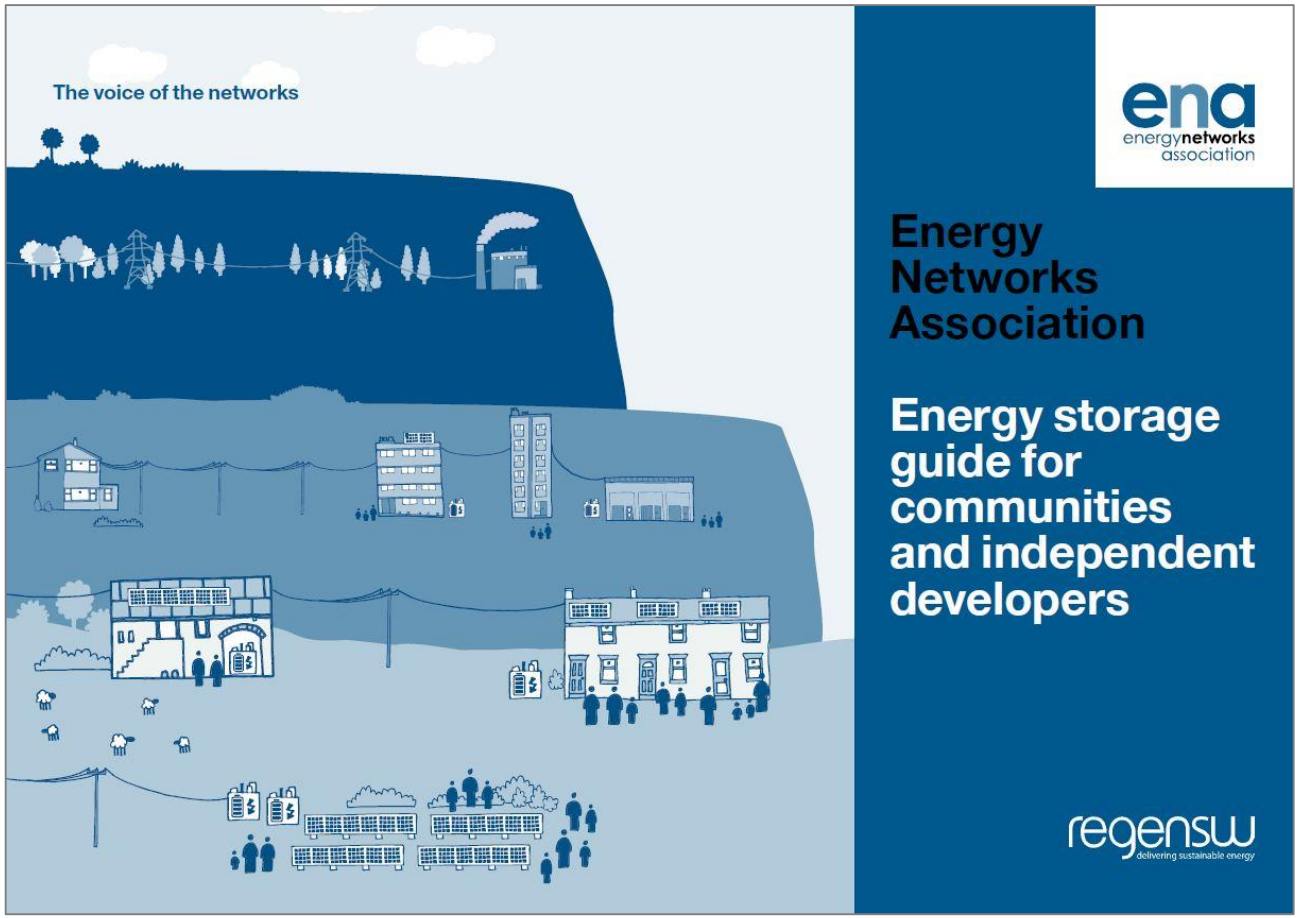
In practice – how will energy storage interface with the grid??







ENA storage guide



- Introduction to area of energy storage and ways to connect to the network
- For community energy groups and smaller independent developers
- Publication - due very soon

Discussion

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Enhanced Frequency Response (EFR)	Firm Frequency Response (FFR)	Fast Reserve	Short Term Operating Reserve	Capacity Market
Similar to FFR but a faster response service to provide sub-second frequency response services. Service specifically targeted at battery storage providers with a high response capability. National grid tender for 200 MW announced in August 2016 that 8 EFR bidders had been awarded 4 year contracts using battery storage. Further tenders are expected. No aggregation. Pre-tender speculation suggested rates of between £20 and £40 per MW per hour of service. Auction outcome was however lower at an average of £9.40 per MW per hour with a range from £7-£11.97	Service to maintain overall grid frequency within a tolerance range of 50Hz. Service may be dynamic (constantly responsive) or static (trigger response). Service is tendered on a monthly basis and rates vary depending on service level, of which there are several. Short term tenders – 1-23 months although most > 6 months. Suitable for battery applications, response within 10 sec (primary) or 30 sec (secondary) and sustained for up to 30 mins. 10 MW minimum but can be aggregated. Potential also for Demand Response - FCDM.	Fastest reserve service, 2 minute response to unexpected demand increase or loss of generation. Service utilisation for a up to 15 min (or as specified) unit but generally <5 minutes Contract duration 1-23 month (can be up to 10 years) but typically < 6 months. Morning and evening availability. Minimum capacity 50 MW but aggregation is possible through an integrator. Relatively small market and few current providers. Complex payments for availability, positional, nomination and utilisation. Potential for Demand Response.	Short term and a slower reserve service. 3 MW minimum but typically 10-15MW. Ramp up within 20 mins desirable to win contract, typically asked to maintain energy output for a minimum of 2 hours and a recovery within 20 hours. 3 seasonal auctions, seasonal & daily time periods. Payments for availability £/MW/hr and utilisation £/MWh. Prices and revenues have been falling suggested increased competition. Revenue is uncertain depending on availability and utilisation. Competitive threat from diesel generators. Potential for Demand Response	The Capacity Market instrument to secure existing, and incentivise, new capacity to maintain capacity margins. In return for capacity payment revenue, generators must be available to deliver energy at times of peak demand or system stress. Annual auction tender for future years capacity. Duration varies – longer for new capacity. Intended for larger capacity but energy storage could deliver. UK 2015 T4 tender for 2019/20 lower than expected at only £18 per KW. Rules and penalties for non-delivery have been increased. Competitive threat from diesel generators.
Relative value –high	Relative value - High	Relative value – Med/high	Relative value - Med	Relative value – Med
Based on 2016 EFR auction outcome: annual Revenue £60-£105k per MW per year	Varies according to service. Rough estimate £40-150k per MW per year depending on service and hours tendered.	Difficult to estimate for a storage provider new entrant. Very rough revenue estimate £50-70k per MW per year based on analysis of National Grid 2015/16 market data.	Combined annual potential revenues circa £20-35k per MW per annum (assuming availability). Based on 2014/15 and 2015/16 total STOR expenditure Ref National Grid Service Reports	£20-35k per MW per year, possibly higher, depending auction* outcomes. *UK 2016 T4 (Dec) tender price is expected to be higher than 2015,

Transmission cost avoidance	Distribution cost avoidance	Generator "own use" (domestic and non-domestic)	Generator Grid Curtailment	Price arbitrage (& peak shaving)
The cost of UK transmission network is charged to generators and demand users via a number of mechanisms. Demand based charges (73% of total charges) are mainly recovered through the Transmission Network Use of System (TNUoS) & Balancing Services Use of System (BSUoS). Both are based on peak time demand – for TNUoS this is calculated using the "TRIAD" peak demand periods. There is a value in using storage to reduce net demand during the peak time & TRIAD periods to avoid these charges. Revenue could come in the form of payments from energy off-takers ("Embedded Benefits") or	The cost of running the distribution network is recovered from generators and demand users. Energy storage and distributed generators can therefore offset demand earning a credit from DNO's, or offsetting high energy users costs. For intermittent generation the credit is a flat rate, for non-intermittent the credit is time banded and are highest during the peak demand period "Red Zone" (4-7pm daily) and in the winter period "Super Red Zone". The value is greatest if connected at the Low Voltage network and varies (greatly) by region.	Located alongside variable generation such as PV and wind, energy storage could be used to store energy during peak generation periods and deliver energy during periods of user demand. Value for the energy user comes from maximising their own use of generated electricity, avoiding the peak price for electricity during high demand periods. An example would be charging batteries linked to solar PV during the day, and time shifting the energy to the early evening peak when costs are highest. This will be facilitated by the roll-out of smart meters and "time of use" tariffs (TouT).	Energy storage could be used to store, and time shift energy which would otherwise be "lost" due to grid curtailment. This opportunity has grown due to the increase in constraints in the distribution network especially in high renewable energy regions and the increase in constrained grid connection offers. An alternative value would be avoidance of grid reinforcement. This could potentially be combined with an "own use" high energy user or as a standalone application co-located with an energy generator.	Although co-location alongside energy generation and a high energy users would deliver greater value, it is also possible that energy storage could be used simply to exploit price variance in the energy market. Storing energy during low price periods for delivery during peak price periods. Wholesale price variance in the UK ranges from <£20 MWh during low demand periods to £80 MWh plus during the peak. Extremes of negative pricing and very high spot prices have also become more common.
Relative value – Med/high	Relative value - High	Relative value – Low	Relative value - Low	Relative value – Low
Potentially a good revenue stream especially if the TRIAD periods are successfully targeted.* Together TNUoS, BSUoS and transmission loss embedded benefits or cost savings could be worth £40-50k per MW per year.	Potentially attractive. depending on location and how energy storage is treated by DNO's*. Potentially £40-80k per MW per year in the south west of England.	Low relative value because a relatively high storage capacity is required to store variable generation and capture revenue from daily price variance between wholesale and retail tariff.	Combined with own use would deliver higher value but a relatively high storage capacity (and therefore capital cost) is needed to meaningfully time shift generation.	The challenge for energy storage is the capital investment required to store significant energy capacity to effectively price arbitrage.
*Note: The mechanism to recover transmission costs is expected to be overhauled and the future of TRIADs is uncertain – see "Paying for our grid"	*Note: at the moment energy storage is defined as "intermittent" generation and therefore does not qualify for the highest level of peak banded credits.			