


Talks session

Storage – the commercial business case

Smart Energy Marketplace – 28 March 2017

Ray Arrell, Senior project manager, Regen

regen
transforming energy

This session

Ray Arrell – Senior project manager, Regen

Summarising Regen's evolving thinking on of the role of storage, business models for deployment and generic 'operating modes' for storage assets.

Impact of recent Ofgem Targeted Charge Review and the removal of 'double charging'

Tim Marsters – Commercial director, Green Hedge

Talking about Green Hedge's experience in storage sector

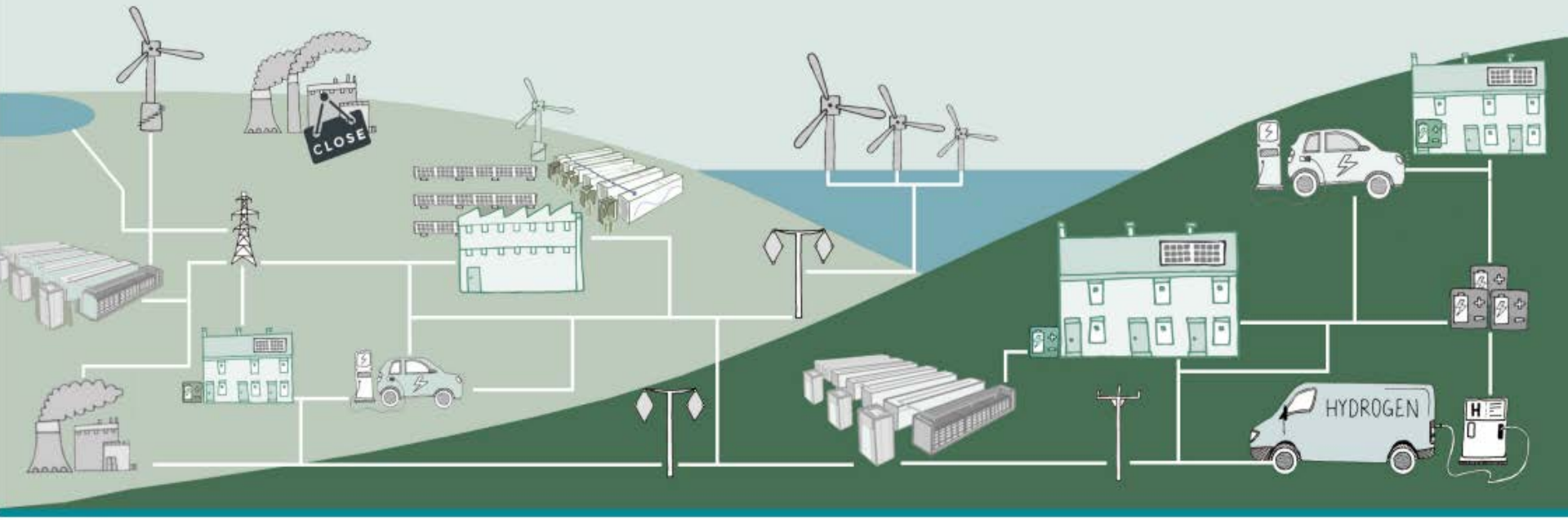
The storage opportunities Green Hedge are pursuing, including their grid scale 'Energy Barns' and behind-the-meter storage systems

Questions

regensw
delivering sustainable energy

Pathways to Parity - Market insight series

Energy Storage - Towards a commercial model - 2nd Edition



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TLT

GREEN HEDGE

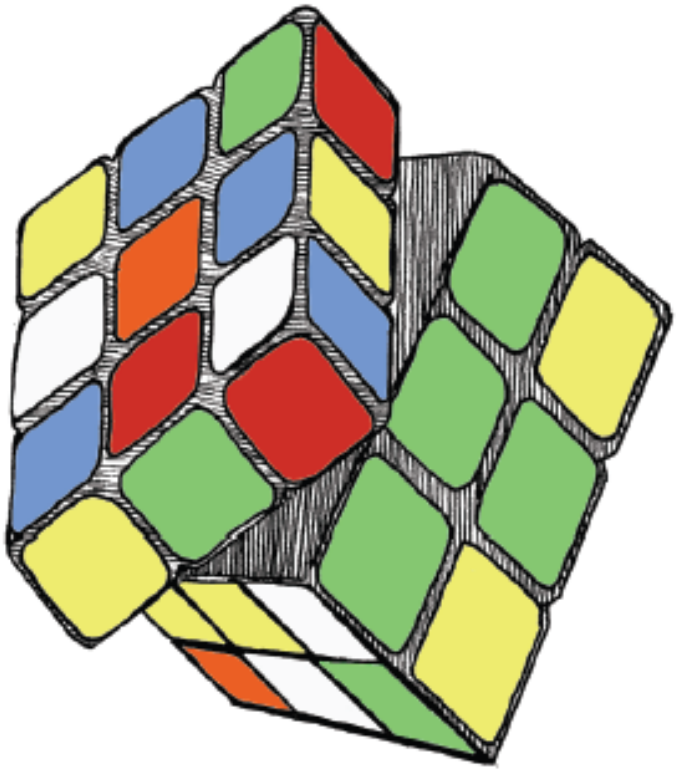
Triodos Bank

Solving the Rubik's Cube

Route to market

Policy/regulation

Costs/finance

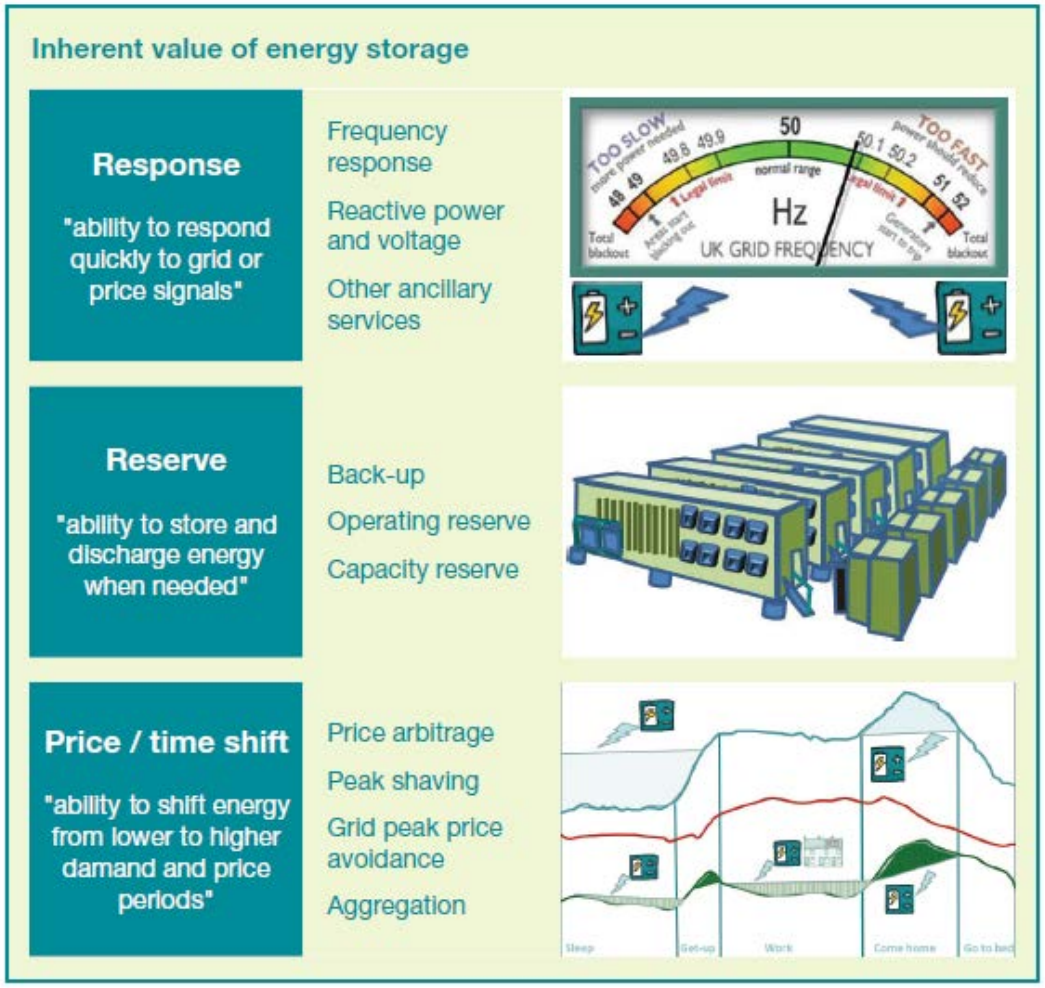


Technology

Timescales

Revenue Streams

The role of energy storage



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.

Potential scale of the storage market

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

* includes existing 2.7 GW of storage – mainly pumped hydro reserve services

** A very high growth scenario for all business models would probably imply some degree of revenue cannibalisation between business models and is therefore less likely by 2030.

*** Would include EV vehicle-to-house storage discharge although this has not been modelled separately

Modelling storage – key definitions

"Business models" or **"storage asset classes"**

A set of commercially driven models that define the class or type and primary function of storage projects that will be developed. The business model can be a key determinant for project size, ratio of power to capacity and potentially even project location.

"Revenue streams"

Individual sources of value (cost savings, benefits or revenue) that can be accessed using energy storage. Revenue stream – singly or in combination(stacking) will form the basis of business models.

"Operating modes" and **"Daily operating mode profiles"**

A generic or typical mode of operation – profile of storage charge/discharge over a period of time.

"Input profiles"

A set of variables profiles used to refine and set the given conditions that may apply to a storage system. *Examples being:* ***onsite generation*** *from a given co-located generation asset,* ***on-site demand consumption*** *from an industrial premises or a* ***daily wholesale/retail price profile****.*

Business models / project classes

1. Response service	*Providing higher value ancillary services to transmission and distribution network operators, including frequency response and voltage support for network balancing (i.e. FFR, EFR, ERPS)*
2. Reserve service	*Specifically aiming to provide short/medium term reserve capacity for network balancing, such as the Capacity Market, Short Term Operating Reserve (STOR) and Fast Reserve*
3. C&I high energy 'prosumers'	*Located with a higher energy user (with or without on-site generation) to avoid peak energy costs, and peak transmission and distribution charges while providing energy continuity*
4. Domestic and community 'own-use'	*Domestic, community or small commercial scale storage designed to maximise own use of generated electricity and avoid peak electricity costs – i.e. with rooftop PV*
5. Generation co-location	*Storage co-located with variable energy generation in order to a) price/time shift or b) peak shave to avoid grid curtailment or reinforcement costs*
6. Energy trader	*The business model that references the potential for energy supply companies, local supply markets and/or generators using storage as a means of arbitrage between low and high price periods - likely aggregated - and peak shaving.*

Revenue streams

1) Income Streams

power responsive
nationalgrid

Views from National Grid:

- *Need to streamline the programmes*
- *Interest in community scale assets being involved*
- *Demand Turn-up could become more significant*

	Scheme	Minimum size*	Notice period	Duration	Regularity**	Value***	Contract
FREQUENCY RESPONSE SERVICES	**Static Firm Frequency Response (FFR)**	10 MW	30 sec	Max 30 min Typically 5 min	10-30	££	Monthly electronic tender
	Dynamic FFR	10 MW	2 sec	Max 30 min Typically 3-4 min	Daily	£££	Monthly electronic tender
	FFR Bridging	< 10 MW	30 sec	30 min	10-30	££	Bilateral contract of 12-24 months to transition in to the FFR market (either Static or Dynamic).
	Frequency Control by Demand Management (FCDM)	3 MW	2 sec	30 min	~10	££	Bilateral contracts for 1-2 yrs. Week ahead notification of daily load able to shed
	Enhanced Frequency Response (EFR)	1 - 50 MW	1 sec Dynamic	Max 15 min Typically 3-4 min		£££	New product – trial tender
RESERVE SERVICES	**Short Term Operating Reserve (STOR)**	3 MW	20 min	2-4 hrs Typically <20 min	Able to deliver 3x per week	£	3 tenders p.a. 'Committed' or 'Flexible' service
	STOR Runway	< 3 MW	20 min	2-4 hrs Typically <20 min	Able to deliver 3x per week	£	Bilateral contract
	Fast Reserve	50 MW	2 min, reaching 50MW in 4 min	15 min		£	Monthly tender
	Demand Turn Up	1 MW	10 min, sometimes requested day-ahead	Min 30 min		£	New product – trial tender

Source: National Grid

+ Capacity Market Auctions

Revenue streams

2) Cost Avoidance

Avoiding network charges

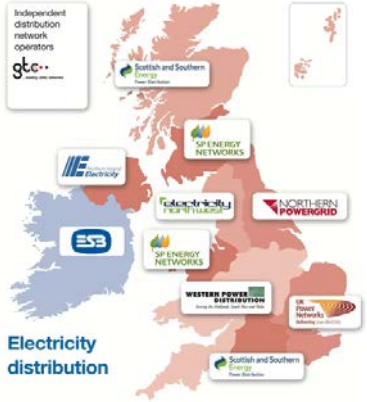
Transmission + Distribution

Maximising use of generation

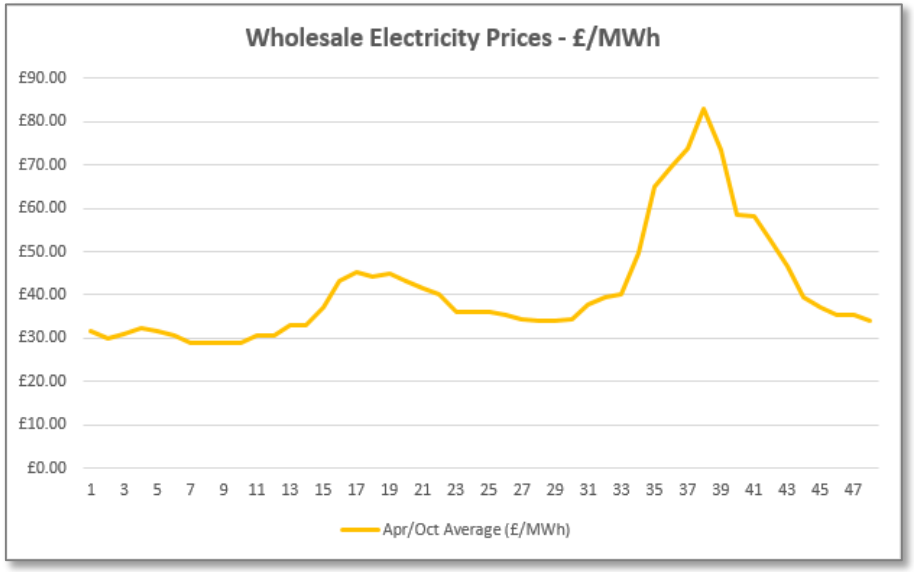
Price arbitrage – 'charge low, discharge high'

Avoidance of grid export constraints

nationalgrid



Source: National grid



Data source: Elexon

Which revenues for which assets?

	Main Revenue Streams	Target Incentive Programmes / Benefits
1. Response service	*Frequency & voltage programmes*	*Enhanced Frequency Response (EFR)* *Firm Frequency Response (FFR)* *Enhanced Reactive Power Services (ERPS)*
2. Reserve service	*Capacity & reserve contracts*	*Short Term Operating Reserve (STOR)* *Fast Reserve* *Capacity Market*
3. C&I high energy behind the meter 'prosumers'	*Network charges & capacity contracts*	*Transmission peak charges (Triads)* *Distribution peak charges (DUoS red band)* *Demand Turn-up*
4. Domestic and community 'own-use'	*Optimising self-usage of on site generation*	*Future Time of Use Tariffs (ToUTs)?* *Community scale aggregation into FFR/STOR?*
5. Generation co-location	*Time & Price Shift*	*Avoiding export restrictions (Time-Shift)* *Diverting generation into high price zones* *Capacity Market*

Power ←→ Energy

	Power to Energy Ratios (MW : MWh)	
1. Response service	*1 : 1*	*Rapid, short duration response* *Need for high power output rather than bulk energy storage capacity*
2. Reserve service	*1 : 3*	*Reserve services require longer duration* *Need for higher energy capacity, rather than instantaneous power*
3. C&I high energy behind the meter 'prosumers'	*1 : 3-4*	*Prime driver of high energy use storage is to avoid high cost periods* *Need to discharge for longer periods, to avoid costs and leverage more than one benefit*
4. Domestic and community 'own-use'	*1 : 1-3*	*Partially related to domestic/smaller scale products available and fixed vs variable costs. So a 1-1½ ratio initially, with technology developments as well as the domestic/community user's needs, may mean this expands over time.*
5. Generation co-location	*1 : 3-3½*	*High storage capacity is more important than a high power output, as prime operation is to smooth generation to export during high prices (price shift) or to peak shave to avoid export constraints (time shift).* *May also depend on the generation technology co-located with.*

Generic storage operating modes

Operating Mode	Summary Definition
i) Network Auxiliary services only	*Operating under direct contracted response services such as frequency, Voltage / Reactive Power. This mode is for battery systems that are dedicated to being available for these response programmes 24hrs a day*
ii) Network Auxiliary services + Network Peak	*As above, but carving out a small window of operation (2-4hrs) to discharge in peak network charge + commodity price periods.*
iii) Reserve service standby only	*Operating mode reflecting operation under balancing service contracts, effectively operating to be available for STOR, Fast Reserve, CM etc. - idle operation awaiting triggers/alerts*
iv) Reserve service + Network Peak	*Operating under ba… to discharge during …*
v) Network Peak Charge Avoider Only	*A mode of operatio… battery system has … Battery charging is …*
vi) Cost Sensitive Self-consumption	*A mode where a de… during high commodity/delivery charge periods. This could currently be a C&I user with generation, subject to cost sensitivity or smaller users with Time of use Tariffs*
vii) Max Self-Use	*A mode where the maximisation of self-usage is not sensitive to high/low price thresholds (i.e. domestic solar with a flat electricity import tariff). Charging when solar is generating, discharge when energy is needed.*
viii) Generation Peak Shaving	*Mode of operation where storage is co-located with a stand alone generation, diverting proportion of generation into storage, so as to bypass grid export limitations. Likely to also discharge during network peak.*
ix) Generation Time & Price Shift	*Mode as above, but whereby there is no grid export limitation restriction and the co-located storage is simply shifting the time of some exported volume into more beneficial times - i.e. evening network peak*

Still in development:

Different co-location technologies (PV, wind, hydro, AD)

Operating modes that incorporate *Demand Turn-Up*

Modelling of frequency (static/dynamic) + voltage

Business models vs operating modes

Business Models	Operating Modes								
	i) Network Auxiliary services only	*ii) Network Auxiliary Services + Network Peak*	*iii) Balancing Service standby only*	*iv) Balancing Service + Network Peak*	*v) Network Peak Charge Avoider Only*	*vi) Cost Sensitive Self Consumption*	*vii) Maximise Self-Use*	*viii) Generation Peak Shaving*	*ix) Generation Time & Price Shift*
1. Response service	✓	✓							
2. Reserve service			✓	✓					
3. C&I high energy user behind the meter		✓		✓	✓	✓	✓		
4. Domestic and community						✓	✓		
5. Co-Location				✓				✓	✓

Modes likely to change due to seasonal variation

But… it could all change!

A SMART, FLEXIBLE ENERGY SYSTEM

A call for evidence

ofgem

Department for Business, Energy & Industrial Strategy

Launched 10 Nov 2016
Expired 12 Jan 2017
BEIS analysing feedback
"Results in spring 2017"

Minded to decision and draft Impact Assessment of industry's proposals (CMP264 and CMP265) to change electricity transmission charging arrangements for Embedded Generators

Consultation

ofgem

Significant changes to benefits for embedded generation
c.90% cuts to 'Triad credits'

Targeted Charging Review: a consultation

ofgem

A much wider, holistic look into network charging, incl. 'double charging' for storage
Consultation closes 5th May

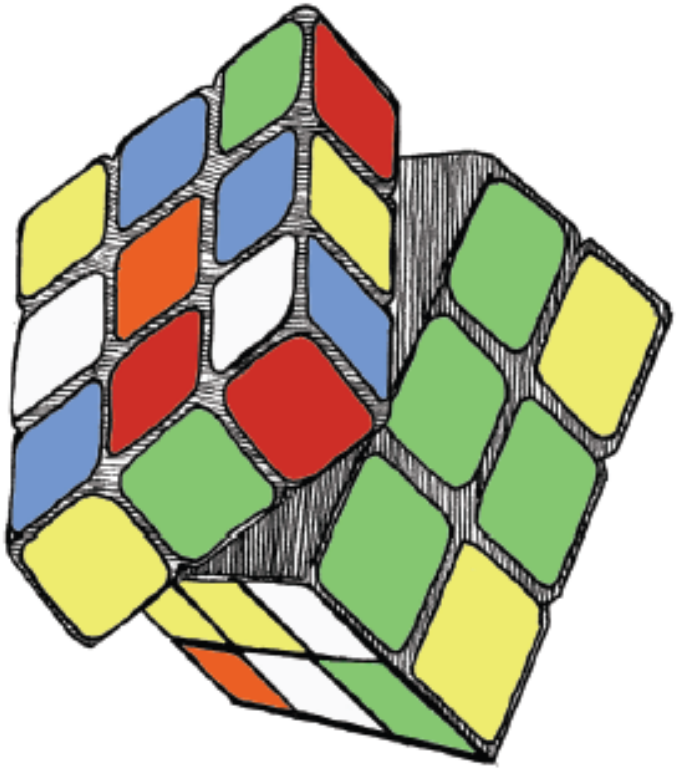
Summing up…

There is significant interest in storage across the energy sector
Progress is happening, but there are still a lot of moving parts…

Route to market

Policy/regulation

Costs/finance



Technology

Timescales

Revenue Streams

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SET-UP

Interreg Europe

SET-UP aims at improving energy performance of the partner regions with enhanced policies on smart grids, addressing three main challenges of empowering consumers, developing economic models and securing funding sources.

www.interregeurope.eu/set-up

Low-carbon economy

€ 1.35 M ERDF

Apr 2016 Mar 2021

European Union
European Regional Development Fund

Questions

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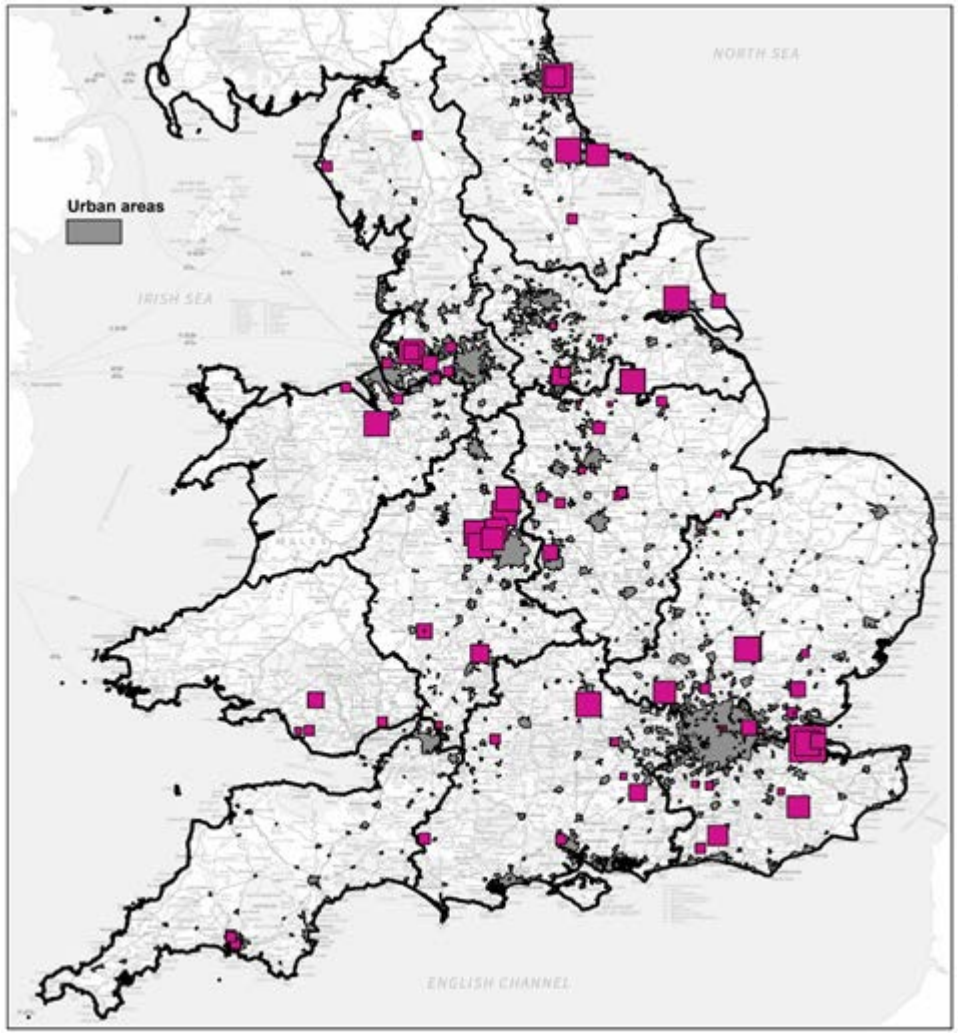
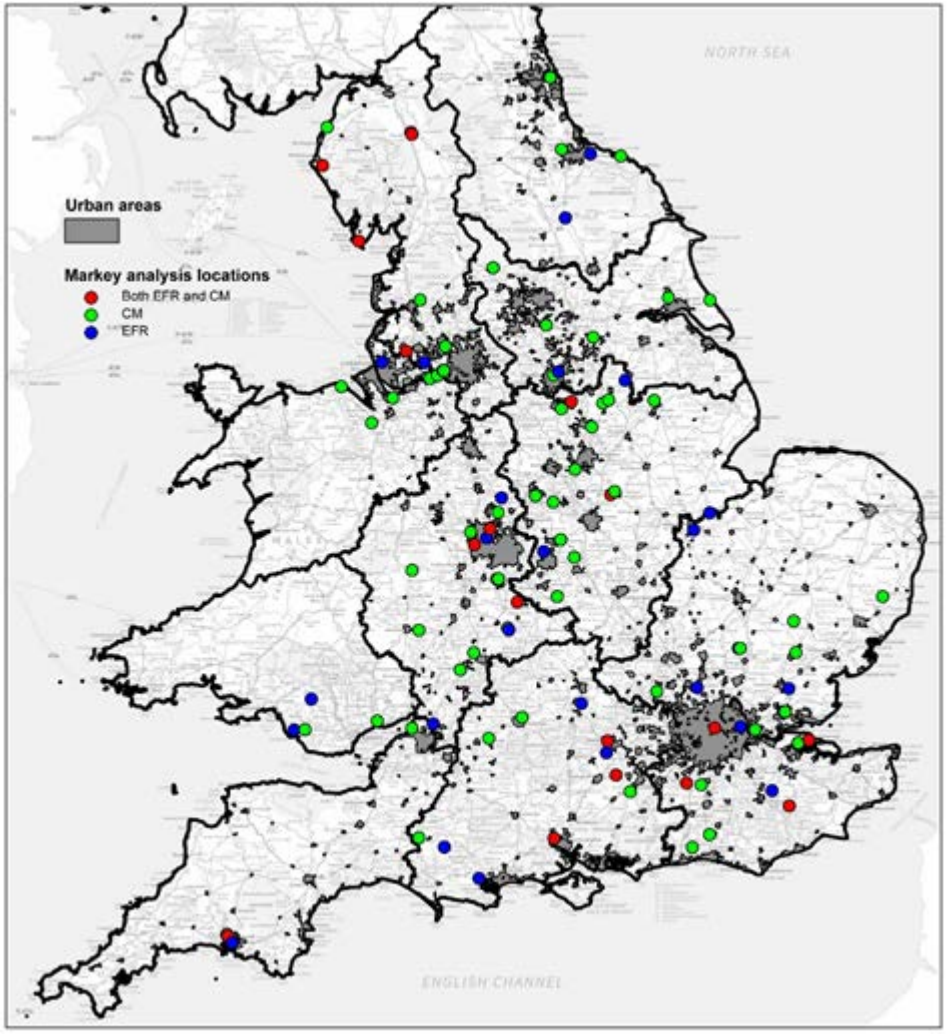
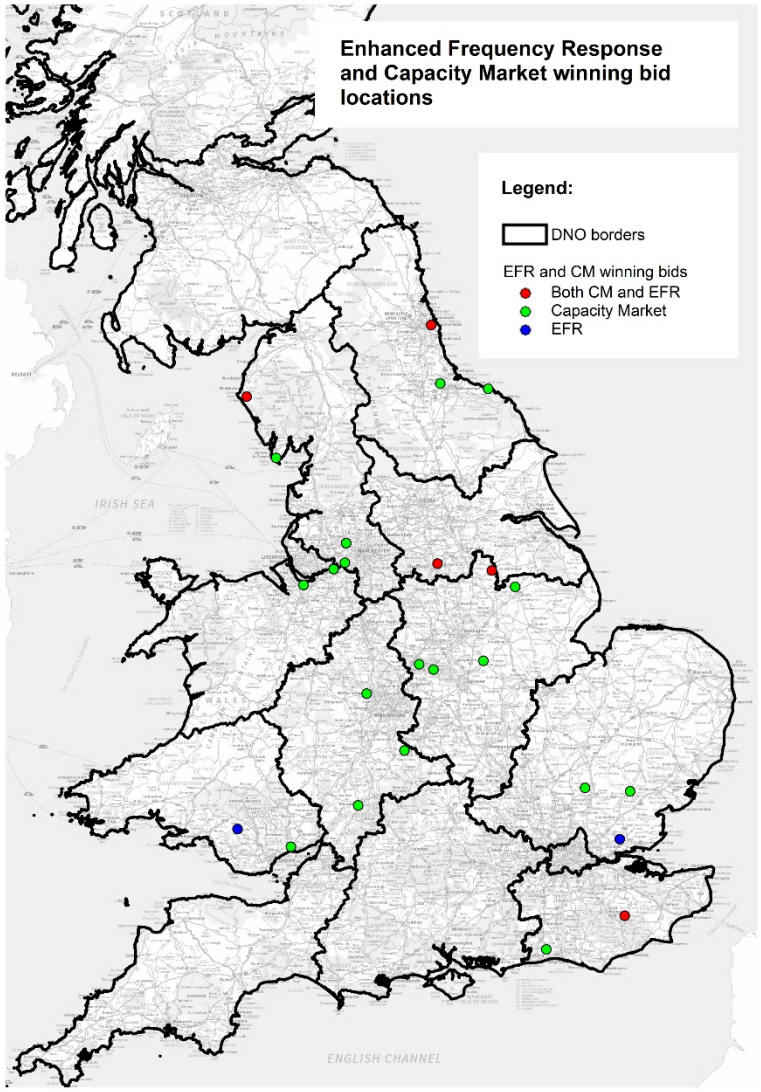
Storage projects bidding into CM & EFR





2016 EFR and T4 Capacity Market auction Winners - new build battery storage

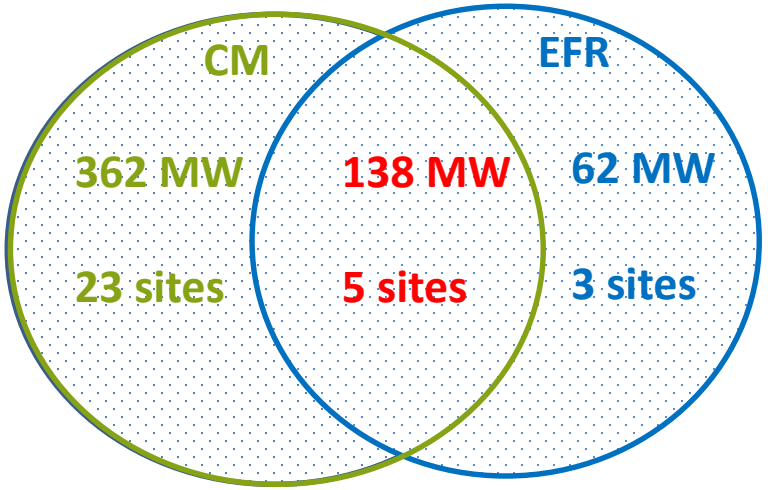


Capacity Market

500 MW
28 Sites

Enhanced Frequency Response

200 GW
8 sites



Total EFR and CM Winners
562 MW
31 Sites

* National Grid reports a lower figure @ 62 sites which could well be right