



Energy storage: market update & opportunities for domestic & community scale storage

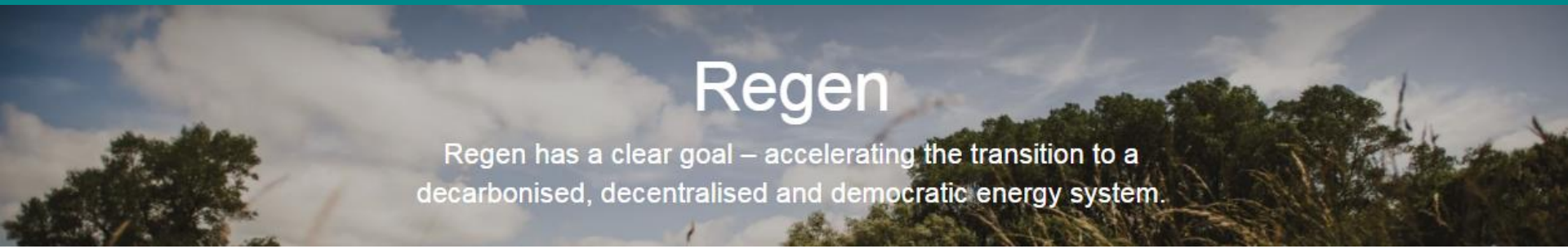
Ray Arrell – Senior Project Manager

UNIVERSITY OF EXETER

ecoe exeter community energy

regen transforming energy

Who are Regen?



Financial modelling

Financial and economic modelling to assess opportunities and aid decision making

Advisory services

Bespoke consultancy and support services from strategy to delivery

Data analysis

Market and technology analysis backed by full GIS capability

Future energy scenarios

Applying real-life industry knowledge to understand future energy systems

member

RENEWABLE DEPLOYMENT

DECARBONISATION AND ENERGY STRATEGY

GRID AND NETWORK MANAGEMENT

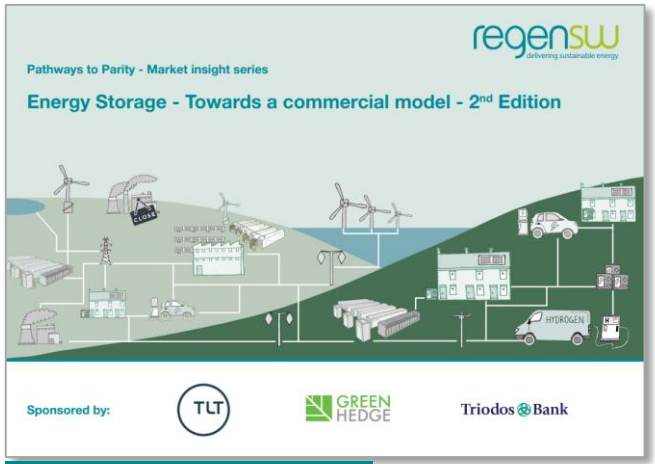
SMART ENERGY AND STORAGE

COMMUNITY ENERGY

BUILDING AND ENERGY MANAGEMENT

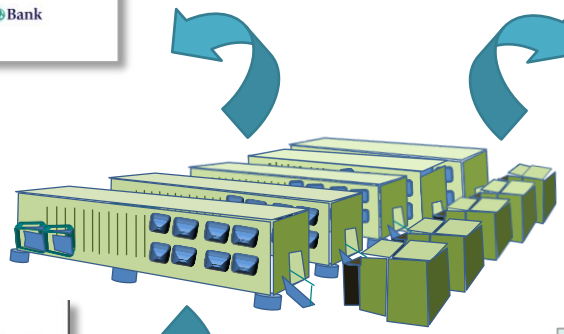
HEAT

Regen's recent work on storage

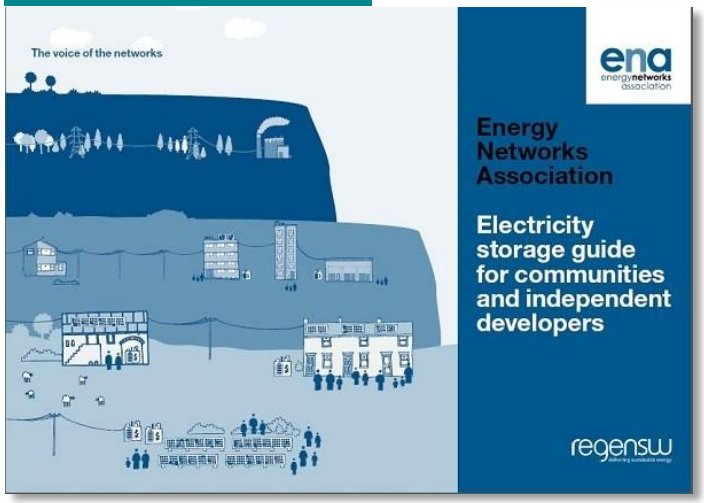


November 2016

March - July 2017

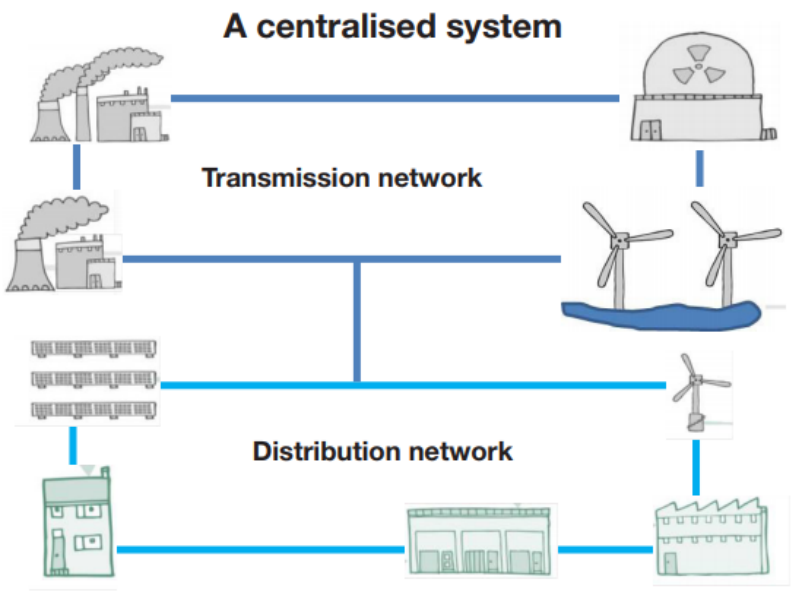


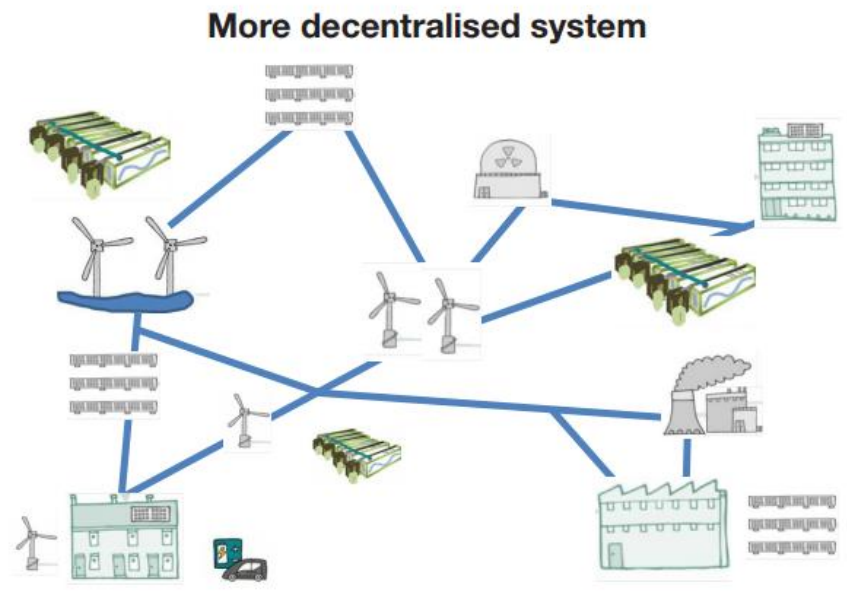
February 2017

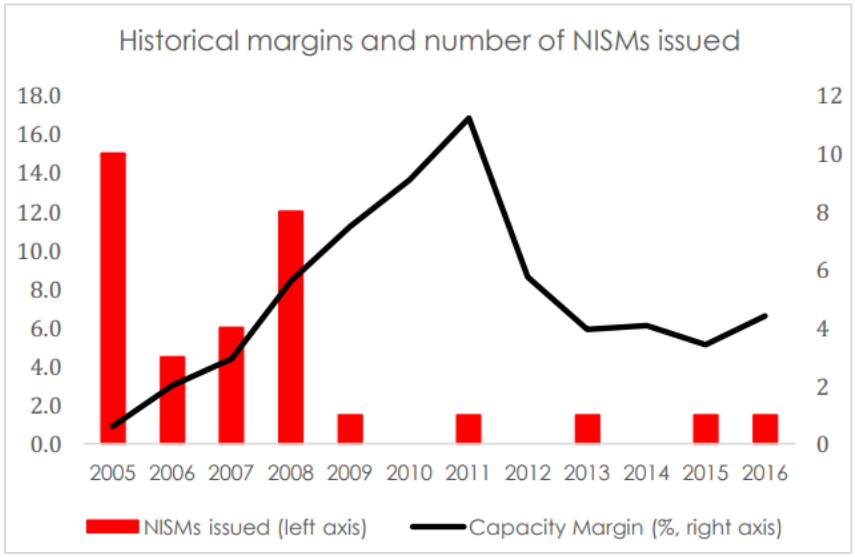


November 2017

A rapidly changing energy system



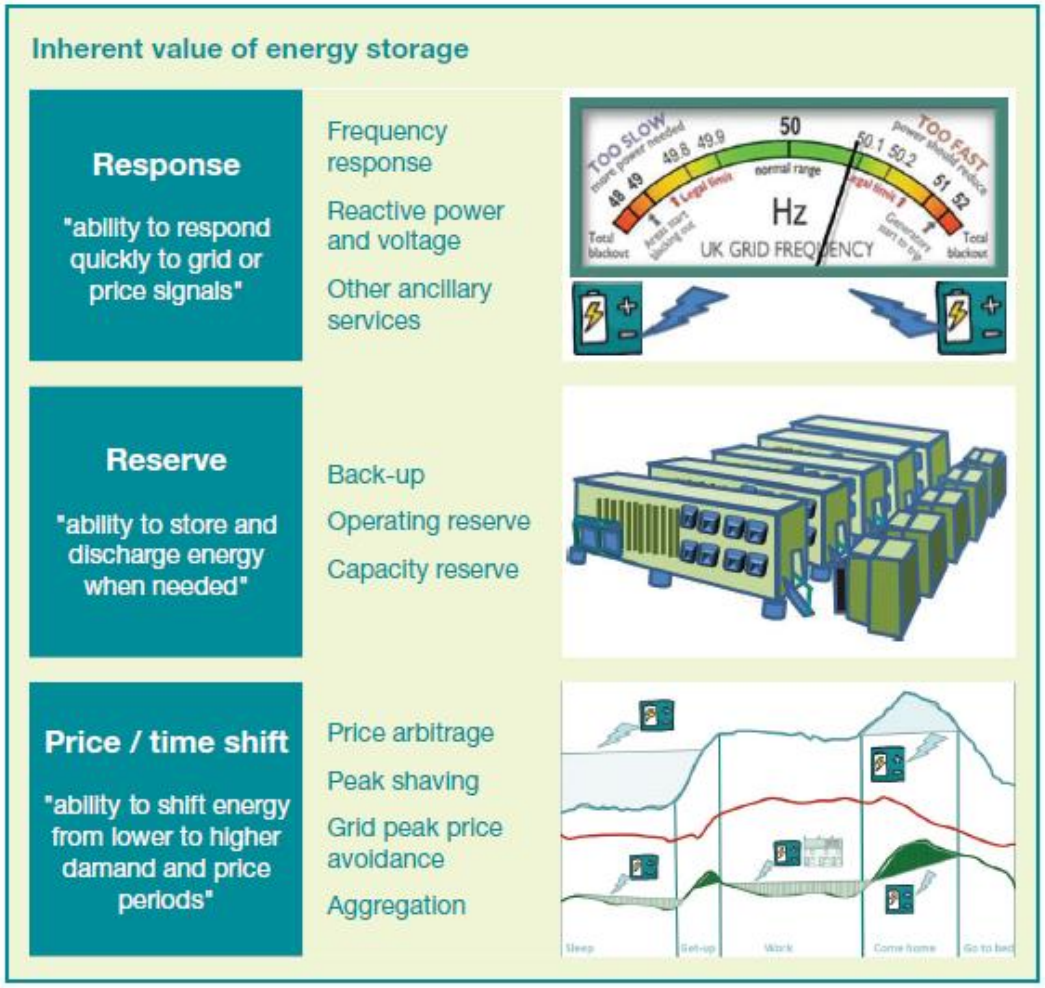




> ***"...embedded generation has come to dominate the peak power flows on the distribution networks."***
>
> Nigel Turvey, Network Strategy & Innovation Manager, Western Power Distribution
> [DSO Strategy Launch Event 14/09/17]

Source & credit: Energy & Climate Intelligence Unit (ECIU)
http://eciu.net/assets/ECIU_Overpowered.pdf

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.

Scales of storage assets

Domestic storage
Typical scale: 1 kWh – 30 kWh

A number of home scale/wall mount battery storage products are available, with some element of modular connection. Costs per kWh are high at the domestic scale, not benefitting from economy of scale. Prime drivers for the domestic storage market are to enable those with domestic scale generation (almost entirely rooftop PV) to increase the self-use of generation, time-shifting daytime PV generation with early evening household consumption. The potential for a home battery to be used in the case of a power cut is also of value to a domestic customer.

Key operating modes:
Maximising self use of onsite generation
Mains back-up / UPS services

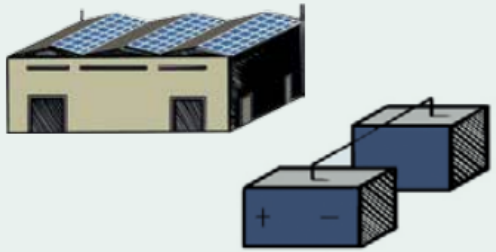
Commercial and Industrial (C&I) storage
Typical scale: 30 kWh – 1 MWh

Behind the meter storage on C&I sites is potentially suited to medium scale storage assets that align with the peak or average demand of operational load on site.

These may give rise to storage products that are designed specifically to be installed within industrial sites, using potentially similar containerisation to gridscale projects.

C&I storage assets will be optimised to enable the avoidance of peak network charges and maximising self use of generation if present on site.

Key operating modes:
Network peak charge avoider
Cost sensitive self-use of onsite generation
Mains backup / UPS services

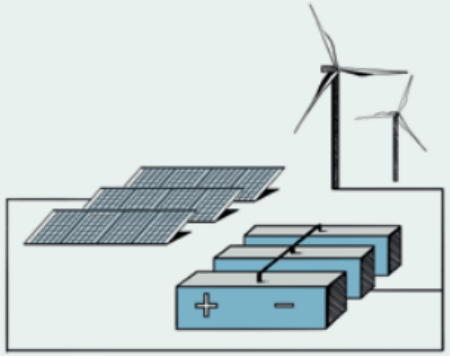


Grid scale storage
Typical scale: 1 MWh+

Standalone or grid scale storage assets are much larger in scale, potentially as multiple containerised storage units located and connected together.

This scale of asset could be targeting dedicated response and/or reserve services, or interacting with co-located standalone generation capacity, to enable additional revenue streams or bypass constrained connection capacity.

Key operating modes:
Network auxiliary services
Balancing services
Generation time and price shifting
Price arbitrage



Storage business models

1. Response service	*Providing higher value ancillary services to transmission and distribution network operators, including frequency response and voltage support (EFR, FFR, 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 (D&C) 'own-use'	*Utilising storage with rooftop PV generation to maximise "own use" energy and avoid higher retail prices. Potentially aggregated to maximise own use across a local network and linked to Time of Use (ToUT) tariffs*
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.*

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

Potential Waves of Deployment

Wave 1

Response Services – driven by EFR and FFR markets

First "behind the meter" high energy users

Plus domestic "early adopters"

0.5GW installed in next 2 years?

Wave 2

Co-location & "Behind the meter"

RE co-location - especially for new PV

Industrial installations

Some standalone sites

Domestic and community storage

Wave 3

Aggregation and marketplace models

RE co-location

Domestic and community storage becomes standard

New projects coming online

Inside Parc y Cymoedd, Vattenfall's EFR project and first UK battery

E.On first to announce completion of EFR battery storage project

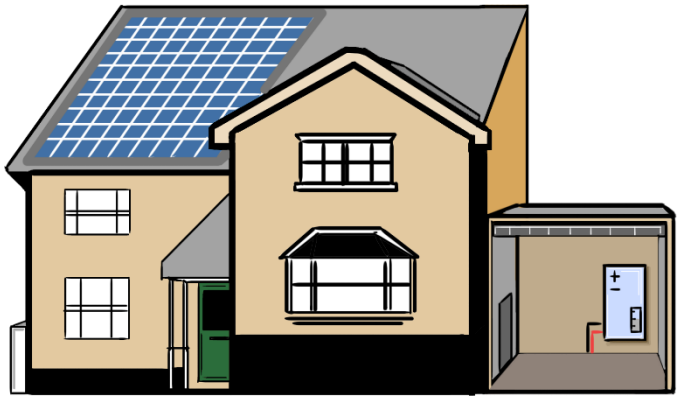
By David Pratt 9 Oct 2017, 15:11

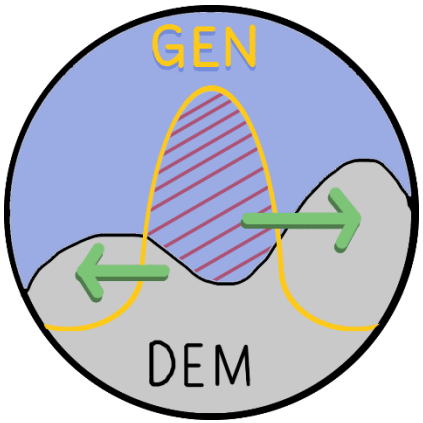
UK aggregator Kiwi Power completes 4.8MWh battery in South Wales

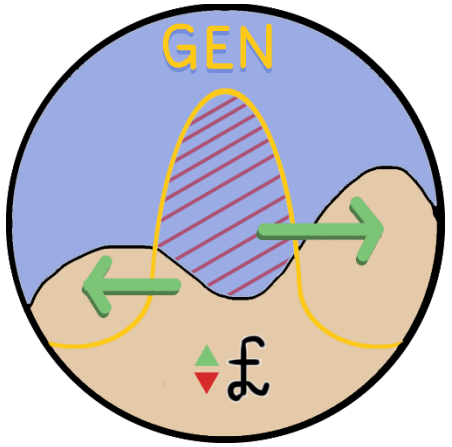
VLC Energy completes 50MW EFR battery portfolio

NES's 50 MW UK energy storage project operational

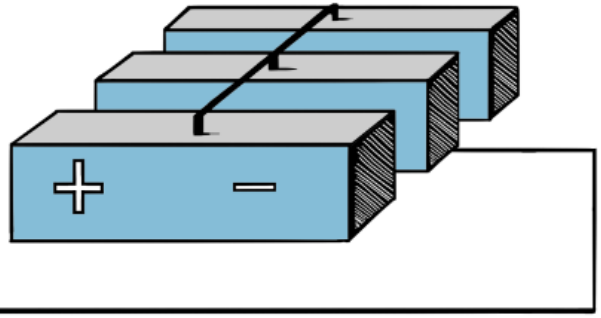
D&C storage – core benefits







- Improving domestic ‘self-use’ of PV
- Enhancing the sale of community owned generation



National balancing services market

- Potential to access balancing services through aggregators

power responsive

Flexitricity

AMERESCO Green • Clean • Sustainable

REstore

limejump

KiWiPOWER demand management

ENDECO TECHNOLOGIES Unlocking New Revenue

Actility

open energi smart revenue generation

STOR GENERATION LTD

Energy Pool Smart energy management

origamienergy shapingenergywithtechnology

ukpowerreserve SUPPORTING A RENEWABLE FUTURE

PEARLSTONE ENERGY

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EDF ENERGY RENEWABLES

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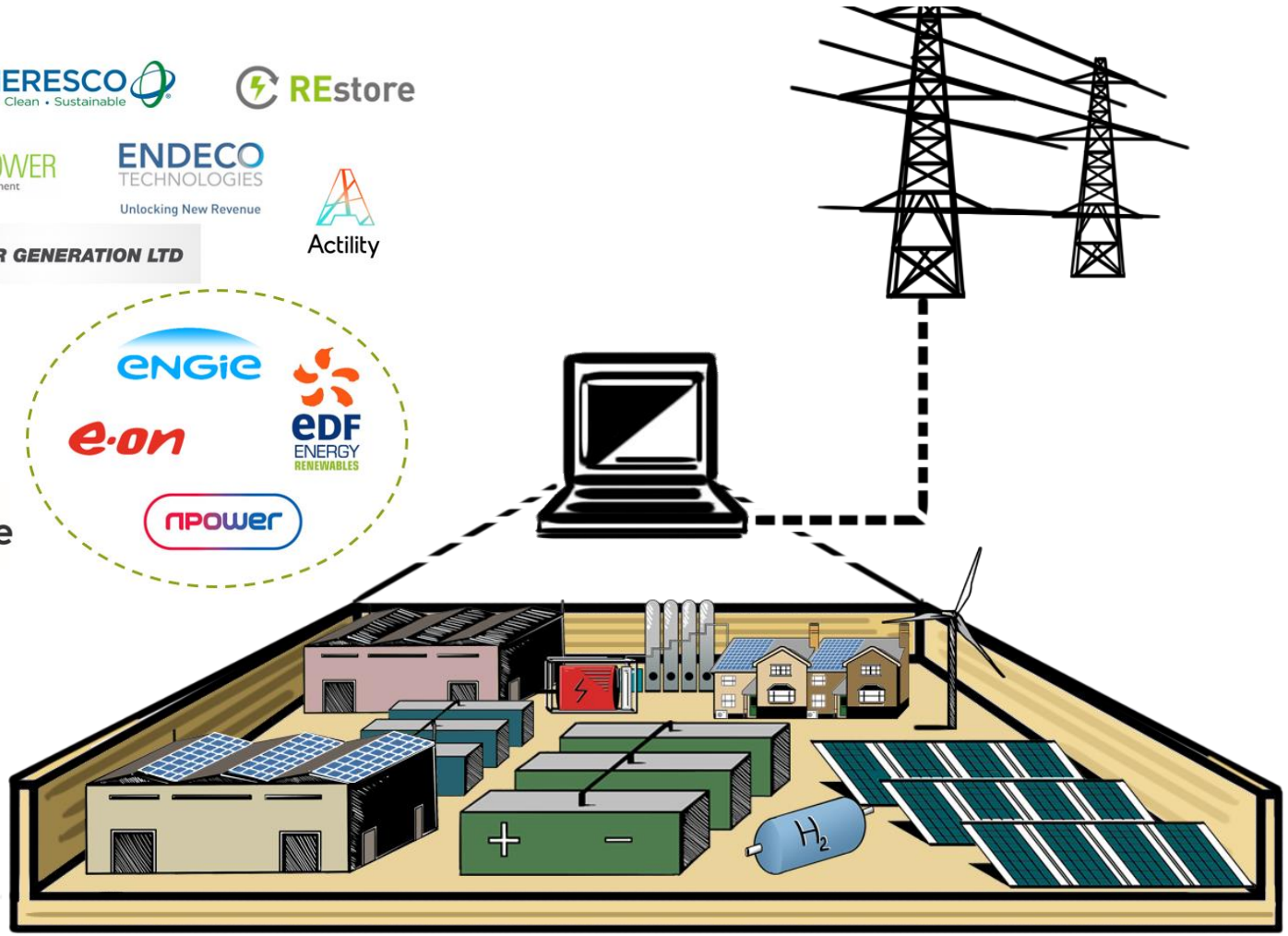

Domestic Storage Aggregation
PETE Project

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UNIVERSITY OF OXFORD

eden project

POWERVAULT

Mixergy®
Sensing, storing and sustaining energy

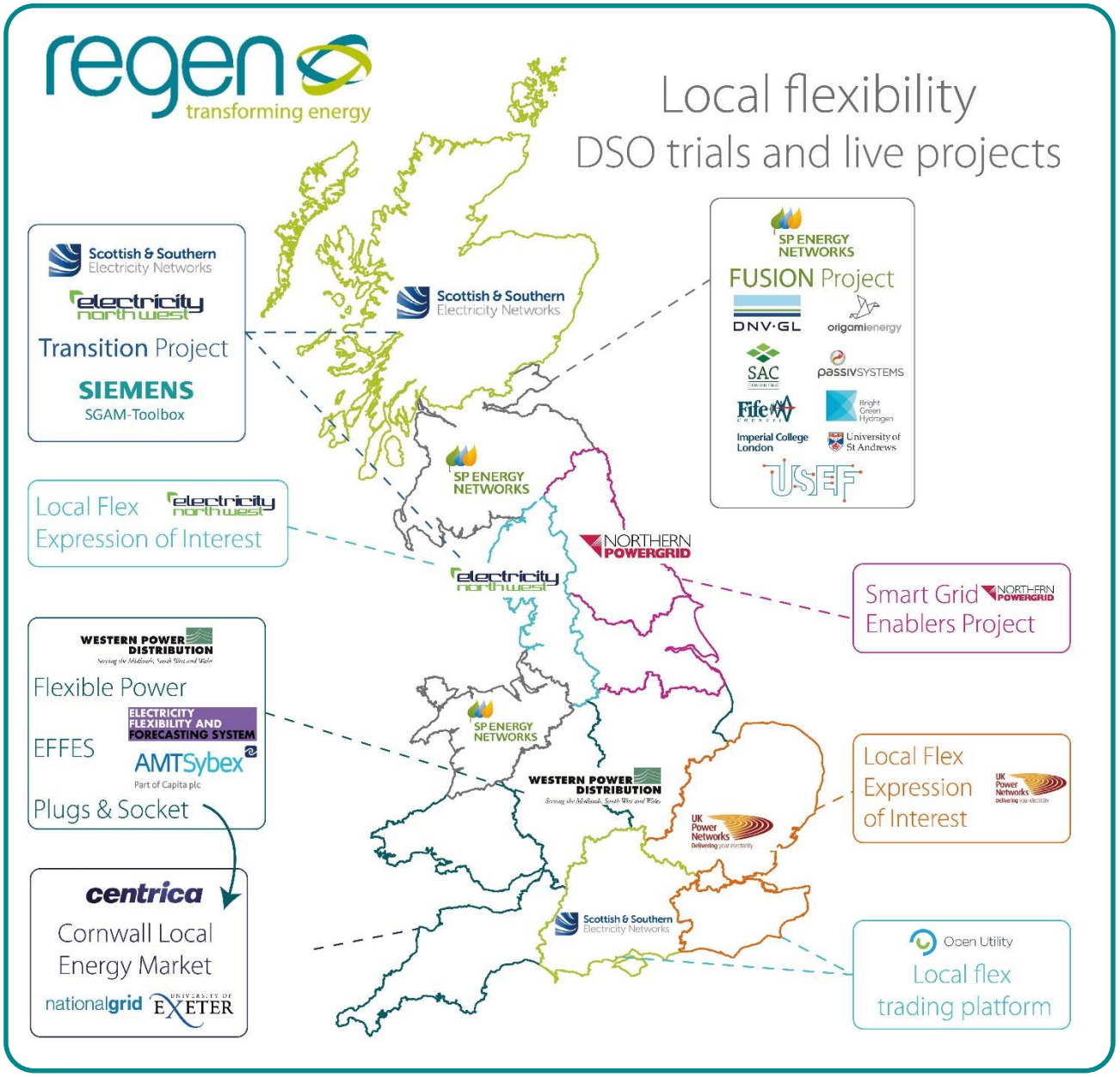
upside

Discounted Prices

Powervault product	Charger/ Inverter	Lifetime/ Warranty	Price	RRP	Discount
Lithium-ion 4kWh ($LiFePO_4$)	1.2kW/ 1.6kVA	11-13 years / **10 year warranty**	£2,899	~~£4,799~~	**40%**
Second Life Lithium-ion 4kWh ($LiMn_2O_4$)		5-7 years / **5 year warranty**	£1,899	~~£3,799~~	**50%**

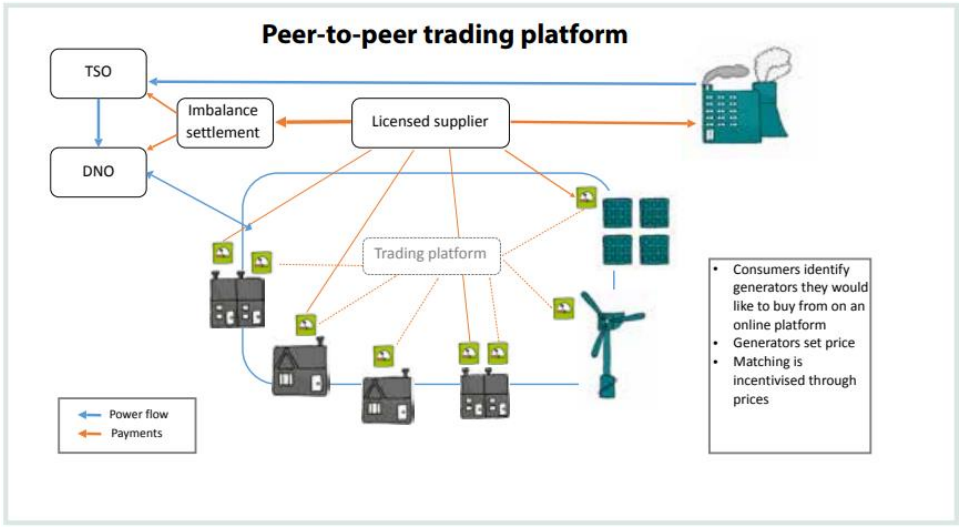
All prices displayed include the cost of installation, delivery, and VAT.

Future opportunity – local flexibility

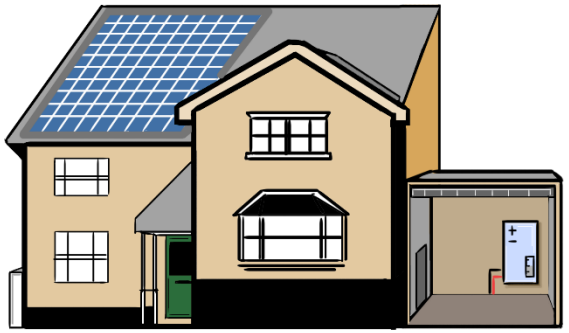


- Specific locations /substations
- Neutral markets
- Lower entry thresholds
- Aggregation permitted
- USEF based on European trial of smart domestic appliances

Evolving local supply options



- Energy clubs
- Local generation tariffs
- Peer-to-peer trading
- Microgrids
- Local energy markets
- Local ESCO



Solar battery ‘ready reckoner’ - PEC

Friends Provident Foundation

Interreg North-West Europe Climate Active Neighbourhoods

Plymouth Energy COMMunity

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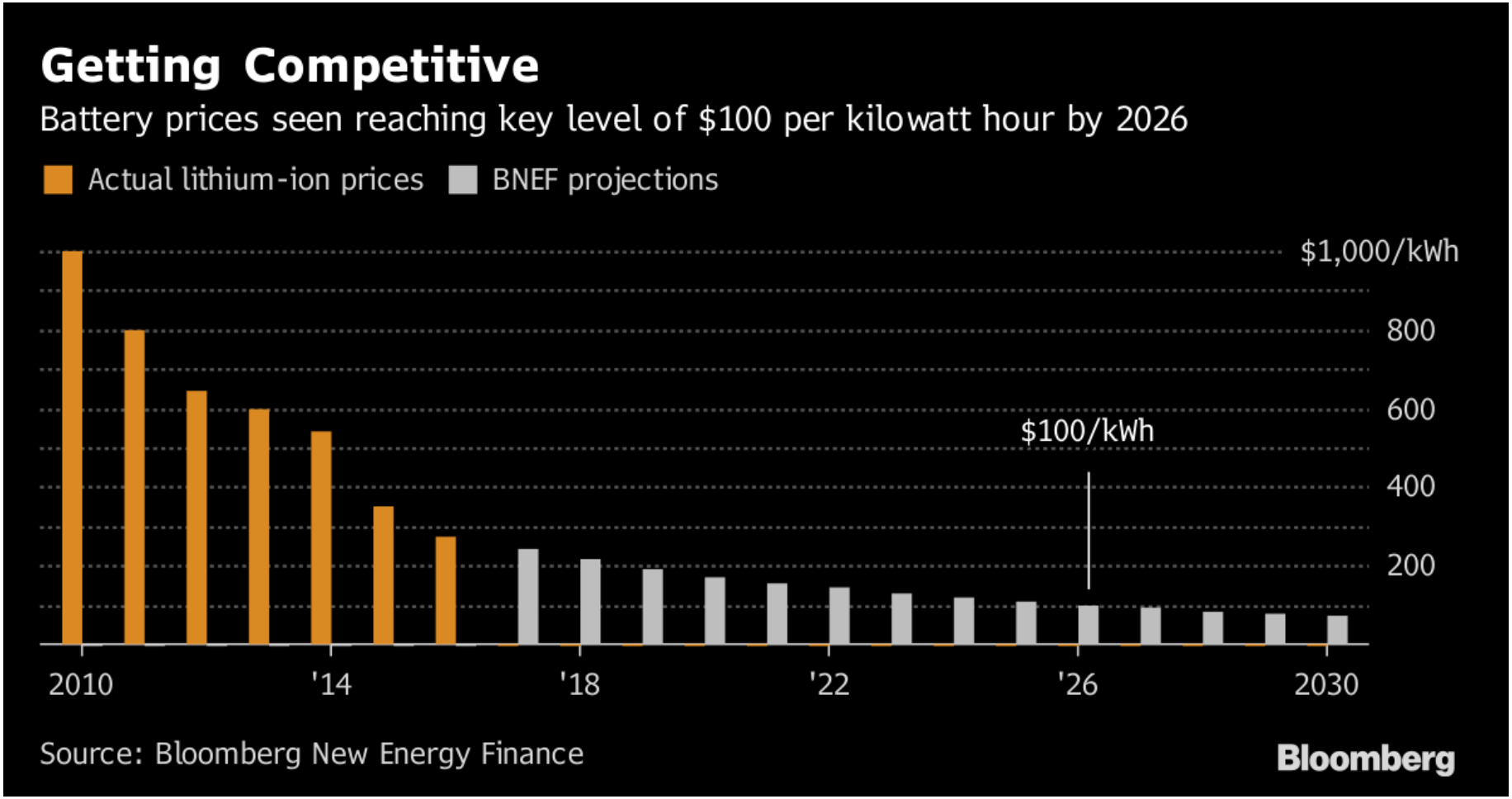
Onsite solar PV: battery storage ready reckoner for import avoidance

- 30 PEC PV installations on Schools
- Development of solar + battery ready reckoner

Key lessons from the project

1. Collecting good energy consumption data is key to understanding a site’s demand profile and creating robust financial models. This may require a year of paid for metering collection services. Community energy groups can use PEC’s Ready Reckoner tool to make a high-level assessment before investing in metering.
2. Storage doesn’t look viable for most community energy installations - yet.

Battery prices expecting to fall



Domestic storage product providers