



Energy Storage in the United Kingdom

Guidelines to do business in the e-storage sector

Energy market

Market designs, energy prices & capacity mechanisms

Energy Regulator

Ofgem - <https://www.ofgem.gov.uk/> - is responsible for regulating the gas and electricity markets. Its role is to protect the interests of consumers, regulate competition between providers, and monitor social and environmental issues within the industry. It primarily focuses on the following areas:

- Making gas and electricity markets work effectively by promoting competition in generation and supply
- Ensuring companies in the sector fulfil their legal and licence obligations
- Regulating the revenues of monopoly businesses, e.g. network companies, and
- Ensuring social and environmental responsibilities on energy companies are met



The regulator is tasked with assessing market power, preventing predatory pricing, assessing the effects of inter-company agreements on competition, and ensuring compliance with legal requirements.

Electricity Licensing and Code Compliance

TABLE 1: ELECTRICITY LICENSING AND CODE COMPLIANCE

	Interconnector License	Transmission License	Distribution License	Generation License	Supply License
Balancing and Settlement Code (BSC): Reporting and financial requirements for trading and balancing	X			X	X
Connection Use of System Code (CUSC): Charging framework for usage of the transmission system				X	X
Distribution Connection Use of System Agreement (DCUSA): Charging framework for usage of the distribution system					X
Grid Code: Engineering and connection requirements for the transmission system		X	X	X	X
Distribution Code: Engineering and connection requirements for the distribution system		X	X	X	X
Master Registration Agreement (MRA): mechanisms for customer transfer			X		X
Smart Energy Code (SEC): terms of provision for smart metering					X

License Exemptions

- **Small-scale electricity generators:** typically below 100MW in England and Wales, 30MW in South Scotland and 10MW in North Scotland can connect to the distribution system without gaining a license. Historically this was not a concern with large-scale centralised power stations, but is becoming an issue given the roll-out of small-scale renewable assets and new technologies such as battery storage now accounting for 40% of electricity generating capacity.
- **Aggregators:** who by definition aggregate smaller-scale assets to provide services to National Grid in the electricity market
- **Financial gas traders:** who avoid having much of the requirements under the UNC applied to them as they have no physical market position

The electricity system operator (SO)

— The electricity system operator (SO) for GB is **National Grid**. This entity is a separate function to the National Grid electricity and gas network businesses. The purpose of National Grid as SO is to ensure security and safety of the GB transmission system. They do this through real-time management of the transmission grid to ensure supply and demand are kept within engineering tolerances. The main measurement tool being the frequency on this system, for this process is maintained by the SO at 50Hz per second with a +/- 0.2%.Hz limit.

- The SO can call upon parties (such as generators) to provide it with services required to maintain the balance between supply and demand. It does this through contracts (known as balancing services) or via the Balancing Mechanism, which is where parties choose to (or must, depending on the type of party) offer balancing services to the SO for a price. The costs of balancing the system are passed back to generators and suppliers. Market trading for electricity ends one hour before delivery, so final responsibility for flows on and off the transmission system is solely down to the SO.

Elexon

— Elexon - <https://www.elexon.co.uk/> - is the Balancing and Settlement Code Company (BSCCo) and is responsible for implementing and managing the balancing and settlement arrangements for GB. It does this using the Balancing Settlement Code (BSC), which outlines the rules and governance for the balancing mechanism and the associated imbalance settlement charges that arise. All licensed electricity companies who operate in the market place must adhere to this code. Elexon is a wholly owned subsidiary of National Grid, but it is independently financed and has its own independent Board of Directors.

Market design

All gas and electricity trades in GB are **forwards trades**, as suppliers and generators/producers look to trade their position before expected delivery. Licensed parties in the market, i.e. those with generation or supply/shipper licenses, must comply with rules under:

- The Balancing and Settlement Code (BSC) for electricity
- The Uniform Network Code (UNC) for gas

The rules stipulate that:

- For electricity, wholesale contracted volume notifications can now be made just before delivery,
 - For gas, shippers can continue to nominate wholesale contracted volumes during the gas day (5am to 5pm) until 3am.
- The reason for this submission and end to trading is the need for the central SO, National Grid in both cases, to take over from the market and manage the networks for safety and security of supply purposes.

Balancing tools for the SO

Balancing tools for the SO Under licensing rules, the SO cannot own or operate its own generation or supply. Therefore, National Grid calls on market players to assist with balancing the electricity and gas system. It does this through several tools:

- For electricity, large generators have to offer support, at their chosen price, to National Grid each half-hour through the Balancing Mechanism service. The costs of this are used to derive charges for those suppliers and generator in “imbalance”
- The electricity SO also procures balancing services ahead of time to ensure all possibilities of shortage and surplus are covered for. This includes contracts to ensure 1.3GW of capacity is always left on the system to cover the largest possible trip, usually Sizewell B nuclear power station in Suffolk
- For gas, the SO uses the on-the-day commodity (OTC) market to buy or sell gas within the trading day when necessary to balance the system.

Balancing services contracts

Balancing services contracts, sometimes called “ancillary contracts” or “ancillary services” in the industry, are becoming a more widely used means for the electricity SO to balance the system. These contracts are offered to market participants (generators and consumers) that can provide specific types of balancing services.

These can be broken down by the response time required to offer a service (e.g. sub-second as is the case with battery storage), duration of service that can be offered (e.g. maintaining output for minutes or hours), and reserve to cover the unexpected loss of generation. As the electricity generation mix has evolved, the need for balancing services has increased as the SO has to manage a system that is increasingly made up of intermittent generation (e.g. wind and solar) and changing demand.

As a result National Grid is continuing to open up balancing services markets to smaller, distribution-connected and “behind the meter” participants. It does this through competitive auction tenders and bilateral agreements with specific parties. As new services have come online and technologies improve battery storage, Demand Side Response (DSR) and small-scale gas engines have entered the market to provide services.

Trading electricity and gas

Wholesale markets for electricity and gas broadly align in their aims of linking energy production to consumption. The markets are both physical and financial. The physical wholesale electricity and gas markets cover contracts which eventually see delivery from producer to consumer. Financial markets exist where contracts for future delivery are traded multiple times before this delivery in the expectation of financial gain or a reduction in risk exposure.

Financial trading is critical to both markets as all trades are for future delivery. With multiple trading on contracts, buyers and sellers can better assess the “true” value of the commodity as there is greater trust in the price through liquidity of trades. Liquidity refers to the ease of buying or selling a commodity in the market. The higher this is, the more competitive a market is deemed to be.

For electricity liquidity is relatively low, churn of traded volumes against delivered volumes is only around 3. Gas churn is closer to 20 times, and as a result gas trades tend to be contracted further into the future as there is more confidence in the price

Trading electricity and gas

— **Forwards and futures markets:** for buying and selling large volumes in advance, typically a trade could be for an annual amount, an upcoming summer or winter period or for some years ahead. For example a supplier might sign new contracts with customers for a 1 year fixed deal, and look to lock-in price for that coming year to reduce exposure to price change. These contracts are designed to manage price risk, but they can also be used by the counter-parties to speculate on future prices. Trading parties often use the “forward curve” as an assessment of future prices and when is best to buy and sell.

— **Spot and prompt exchanges:** There are several power exchanges where traders can anonymously buy spot (on the day) or prompt (the next day(s) contracts. These trades usually cover short time frames and have to be bought closer to delivery as real-time conditions arise, for instance a plant outage or a change in weather conditions.

Daily and within-day prices changes will ultimately see different prices taken in the market by different parties. Those who hedge for longer into the future may benefit if prices rise closer to delivery, but can also be locked into higher prices if market conditions change and prices reduce closer to delivery

Power and gas price drivers

- Wholesale power prices are heavily influenced by oil, coal, carbon and gas prices. As gas-fired power stations continue to make up the majority of the GB generation mix, the price of gas has the most notable influence on power prices. Furthermore, as many gas contracts are linked to the price of oil, oil prices can indirectly impact power prices through the gas market. While coal-fired power output has been declining rapidly, it still exercises some influence over the power market, while the cost of emitting carbon is also incorporated into the price of power.
- Renewables output tends to have a downwards impact on wholesale prices, mostly because they have very little operational costs with no fuel inputs (wind and solar being of course free). Despite having a downwards impact on prices, they can increase volatility due to their intermittent nature. If there is a sudden decline in renewables output due to weather variations, wholesale prices can spike upwards as more expensive forms of generation are called on to meet demand over a relatively short time scale. The relative differences between demand and generator availability continues to impact prices. Times of high demand and low availability experience the highest prices, while periods of low demand and high availability see the lowest prices. Finally, interconnected markets are having a rising impact on GB's wholesale power market. Over the next decade, prices and events in Europe are set to more frequently impact on the GB market, particularly as the number of interconnectors with the continent is planned to increase sharply

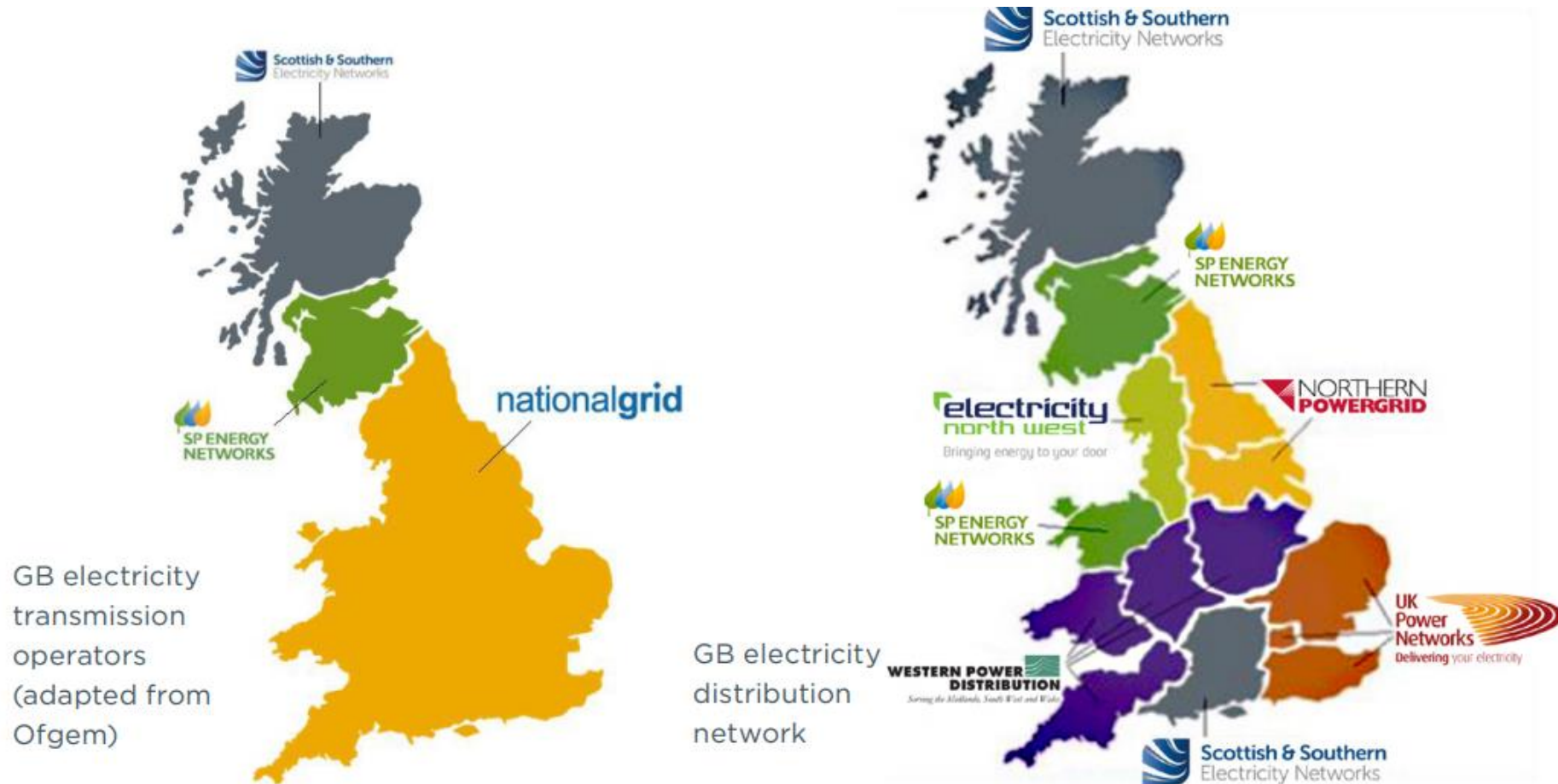
Grid Aspects

TSO's & DSO's

Electricity Networks

- The electricity networks are used to transport electricity from generators to end users. The system is made up of transmission and distribution networks. It is worth noting that these assets are wholly privatised and as natural monopolies are regulated in how they can charge for their services.
- The transmission networks transport high voltage electricity from power stations to the distribution networks. In England and Wales, the transmission network operates at 275kV and 400kV voltages, and in Scotland, the transmission system additionally operates at 132kV. In England and Wales, the 132kV lines are part of the distribution network. This generates geographical differences in connections for some generators and consumers. Typically, in England and Wales any consumer of generator above 100MW will connect at the transmission level. For South Scotland this falls to above 20-30MW and for Northern Scotland most sites above 5MW are connected on the transmission level. The reason for this discrepancy is due to the need for greater management of the constrained Scottish areas

Transmission Operators and Distribution Networks



GB electricity transmission operators (adapted from Ofgem)

GB electricity distribution network

Subsidies and Support

UK government has created a range of schemes to incentivise low-carbon electricity and heat deployment and also initiatives to ensure energy security. Some of the key schemes:

- **Large scale low carbon**

Renewables Obligation (RO) – The RO came into effect in 2002 in England, Wales and Scotland, followed by Northern Ireland in 2005. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources. Renewables Obligation Certificates (ROCs) are issued to operators of accredited renewable generating stations for the eligible renewable electricity they generate. Generators can trade ROCs with other parties. ROCs are ultimately used by suppliers to demonstrate that they have met their obligation.

Contracts for Difference (CfD) – Replacing the RO is the CfD scheme. Prospective projects are categorised as “established” or “less established” and then bid into an auction to win a contract. CfDs require generators to sell energy into the broader energy market as usual but, to reduce exposure to changing electricity prices, CfDs provide a variable top-up from the market price to a pre-agreed “strike price”

Subsidies and Support

UK government has created a range of schemes to incentivise low-carbon electricity and heat deployment and also initiatives to ensure energy security. Some of the key schemes:

- **Small scale low carbon**

Feed-in Tariffs (FiTs) – FiTs are designed to incentivise uptake of smaller renewables installations (sub-5MW), like a solar panel on a domestic roof. FiT payments are made quarterly (at least) for the electricity an installation has generated and exported. Payments are made based on the generation meter reading submitted to an energy supplier.

Renewable Heat Incentive (RHI) – Opened in 2014, the RHI is a government financial incentive to promote the use of renewable heat. People who join the scheme and stick to its rules receive quarterly payments for seven years for the amount of clean, green renewable heat it's estimated their system produces. The scheme is operated for both homes and businesses

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- **Low carbon cost controls**

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Energy Security – Capacity Market

The capacity market is intended to ensure security of electricity supply by providing a payment for reliable sources of capacity, alongside their electricity revenues, to ensure they deliver energy when needed. This is intended to encourage the investment needed to replace older power stations and provide backup for more intermittent and inflexible low carbon generation sources.

Potential capacity market participants can bid for contracts in auctions held every four years (so called T-4) ahead of the delivery date. Supplementary auctions are held a year ahead of delivery date (so called T-1). Longer term agreements (15 years) are available for new plant. During the delivery year, capacity providers will receive monthly payments for their agreed obligation at the auction clearing price. Providers are expected to be available to respond with their agreed generation volumes or load reductions when called on by National Grid at times of system stress. The auction process is technology neutral and open to all generators and DSR providers not currently gaining subsidy i.e. both existing and new generators. So far, auctions so far have seen variability in prices and in the providers coming forward. The success of gas and coal stations at auctions has received criticism on the grounds of decarbonisation aims and the subsidy of old plant. A number of smaller players have seen success in recent auctions including new build small scale gas engines, battery storage project and DSR providers. Many of these parties have used the 15-year contracts available as a basis for investment.

Policy focus

The current government's policy focus for energy is encapsulated in its recent Clean Growth Strategy. This aims to ensure the UK is leading the world in cutting carbon emissions to combat climate change at the lowest possible cost, while also driving economic growth.

Commitments in the strategy include:

- Support of around £3.6 billion of investment to upgrade the energy efficiency of around 1 million homes — Up to £557 million for further Contract for Difference auctions
- Investment in low carbon heating by reforming the Renewable Heat Incentive, spending £4.5 billion to support innovative low carbon heat technologies in homes and businesses between 2016 and 2021, and
- Development of a package of measures to support businesses to improve their energy productivity, by at least 20% by 2030

Emerging trends and the future

Whilst legislation and regulation are always evolving, the profound changes the Great Britain's (GB) energy market is undergoing with the changing generation mix, influx of new suppliers and rising consumer bills, has resulted in the current pace of an unprecedented change. Ongoing large scale changes to the industry include:

- A proposal for a price cap for domestic customers from 2018
- Next-day switching working programme to be implemented by 2020
- A network charging Significant Code Review⁵ (SCR) raised by Ofgem to look at the appropriateness of current charging arrangements in the context of embedded generation and technology changes
- A review of the supplier hub framework for customer charging

Market Entry

Market Entry

For detailed information on entering the UK Energy Trading Markets

- Becoming a Generator
- Becoming a Supplier
- Becoming a Non Physical Trader
- Etc.

Visit:

<https://www.elexon.co.uk/reference/market-entry/>

Becoming a Generator

Becoming a Supplier

Becoming a Non Physical Trader

[Becoming an Interconnector User](#)

Becoming an Interconnector Administrator or
Interconnector Error Administrator

Becoming an Energy Contract Volume Notification
Agent

Becoming a Metered Volume Reallocation Notification
Agent

Becoming a Virtual Lead Party

Becoming an Asset Metering Virtual Lead Party

Becoming a LDSO or IDNO

Energy Storage Sector

Emerging trends and the future – Storage Licensing

With increasing efficiency and reducing costs in the global battery storage market, many battery projects have entered the GB electricity market.

This has been through direct grid connection, behind the meter developments at larger business and so called co-location, mainly on existing renewables sites. However, many batteries have faced the problem of definition within the regulatory framework as they can be seen as both a generator and consumer of power over different timescales. This has caused concerns as under the current system batteries could potentially face consumer levies and network charges whilst simultaneously being paid them. As a result of this, Ofgem has now introduced a **new storage license to the electricity market**. This is effectively a subset of the generation license. This defines electricity storage, removes levies for storage and maintains exemption from wider licensing. The move is expected to ease storage integration onto the system, with over 5GW currently in the network connections queue alone

UK POLICIES AND MARKET MECHANISMS

The UK has implemented a number of policies, which although not aimed specifically at energy storage, have implications for the sector. These come predominantly from the nationally legislated target to reduce greenhouse-gas emissions by 80% by 2050 compared to 1990 levels (House of Commons Library 2019):

- **The Capacity Market is part of the Governments Electricity Market Reform (EMR)** and is designed to maintain security of supply and offers electricity capacity providers (including new and existing power plants, and electricity storage systems) a monthly revenue for providing electricity at times when required (usually when the system is under stress) (DECC, 2014). In 2016, 500 MW of non-PHS (battery) storage was successful in the T-4 auction. Since then the CM auction price has come down, and storage has been subject to ‘de-rating’ based on the duration over which capacity could be provided, which effectively reduced its ability to compete (NGET, 2017).
- **Contracts for Difference (CfD)**, also part of the EMR is an incentive for low-carbon generators (most recent CfD’s exclude onshore wind and solar PV) where a strike price is agreed per unit of electricity generated, if the market price for electricity is less than this strike price then the difference is made up by the UK Government. Energy storage can be used in conjunction with low-carbon generators benefiting from CfD’s and the rules for doing so were clarified in a Government response to a CfD consultation in 2017 (BEIS, 2017b).
- **Feed-in Tariffs (FiTs)** provide a generation and an export tariff to eligible small-scale (<5MW) low-carbon generators, as with the CfD’s energy storage can be used in conjunction with FiTs. FiTs closed to new applicants from April 2019, however it has been replaced by a ‘Smart Export Guarantee’ which provides an export tariff to small scale low-carbon generators (BEIS 2019b). A number of firms are marketing home PV + storage systems.
- For electric vehicles, the UK government compensate up to 35% of the cost of an electric car, up to a maximum of £3,000 depending on the model. There are also grants available towards the cost of electric vehicle charge-points both at home and at the workplace as well as for local authorities.

Regulations aimed specifically at energy storage

- A revision to the charges placed on storage facilities, for which consumers and generators are charged for using both the transmission and distribution networks through Use of System and Balancing Services Use of System charges. However because energy storage consumes and generates it has been effectively double-charged. This does not take into account the benefits of storage to the network in providing a balancing service rather than contributing to the congestion of the network; therefore through OFGEM's Targeted Charging Review these charges have been revised so that energy storage facilities only pay the generation charges (Ofgem, 2017).
- A regulatory definition of energy storage: the government intends to amend the Electricity Act to include a specific definition of energy storage as a subset of the generation asset class. Providing a regulatory definition of energy storage will not only confirm that it should be treated as a generating asset, but will also help to cement energy storage as an integral part of the electricity system (Ofgem, 2020).
- A clarification of the rules around co-locating energy storage with renewable energy. It can be beneficial to co-locate energy storage with renewable energy, however many renewable energy schemes receive subsidies either from FiTs or CfDs (or their predecessor Renewables Obligations). The Government and OFGEM have subsequently published guidelines around co-location to clarify the process and ensure that only renewable generation is rewarded by the subsidy schemes (Ofgem, 2020b).

Best Practice & Business Support

Energy Systems Catapult

- Energy Systems Catapult provides technical, commercial and policy expertise to drive innovation across the whole energy system.
- independent and technology-agnostic delivering thought leadership, collaborative R&D and commercial commissioning.
- Providing a range of capabilities, tools and labs – from world class Net Zero modelling and cutting-edge systems engineering – through to digital and data science and real-world innovation trials that drive start-ups to success.
- Supporting energy companies and networks, industrial sites and commercial businesses to navigate to Net Zero.
- Supporting government, local authorities and innovators to create the new policies, markets, business models and technologies we need to deliver Net Zero.



Faraday Institution

- Established in September 2017 as the UK's independent institute for electrochemical energy storage research, skills development, market analysis, and early-stage commercialisation. It brings together research scientists and industry partners on projects with commercial potential that will reduce battery cost, weight, and volume; improve performance and reliability, and develop whole-life strategies including recycling and reuse.



**POWERING BRITAIN'S
BATTERY REVOLUTION**

UK Battery Industrialisation Centre

- The £130 million UK Battery Industrialisation Centre (UKBIC) is a pioneering concept in the race to develop battery technology for the transition to a greener future. The unique facility provides the missing link between battery technology, which has proved promising at laboratory or prototype scale, and successful mass production. Based in Coventry, the publicly-funded battery product development facility welcomes manufacturers, entrepreneurs, researchers and educators, and can be accessed by any organisation with existing or new battery technology – if that technology will bring green jobs and prosperity to the UK.



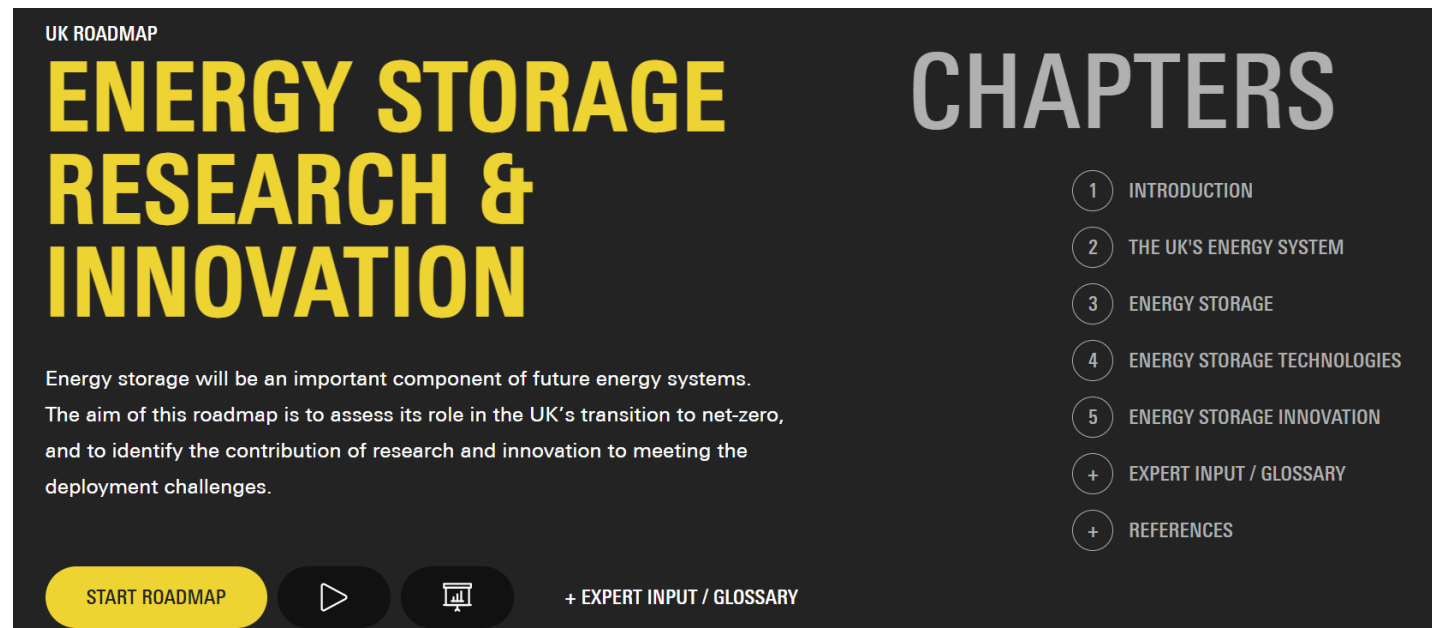
WP-Cambridge Materials Innovation Centre

- The WP-Cambridge Materials Innovation Centre (WP-CAMMIC) will be based at Cambridge's Department of Materials Science & Metallurgy (DMSM), supported by £7.2 million from the WP Investment Company (WPIC), a South Korean investment group.
- The funding will support the acquisition of state-of-the-art equipment, funding for PhD students and postdoctoral researchers to carry out research in lithium-based energy storage technologies. The Centre will also focus on sustainable manufacturing and the circular economy, including recycling to develop battery materials with enhanced properties.



Supergen – UK Energy Storage Roadmap

- <https://ukesr.supergenstorage.org/>
- The Supergen Energy Storage Network+ is an integrated, forward-looking platform that supports, nurtures the expertise of the energy storage community, disseminating it through academia, industry, and policy, at a particularly important time when decisions on future funding and research strategy are still being resolved.



UK ROADMAP

ENERGY STORAGE RESEARCH & INNOVATION

Energy storage will be an important component of future energy systems. The aim of this roadmap is to assess its role in the UK's transition to net-zero, and to identify the contribution of research and innovation to meeting the deployment challenges.

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START ROADMAP

+ EXPERT INPUT / GLOSSARY

Interreg North-West Europe STEPS

European Regional Development Fund

THANK YOU!