Building flexibility markets for a net zero electricity system

How can we explicitly recognise and value carbon within our flexibility markets?

Regen position paper

THE ELECTRICITY STORAGE NETWORK

regen transforming energy

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Building flexibility markets for a net zero electricity system

Zero carbon flexibility is essential for a net zero electricity system. Flexibility services from high carbon sources have been an important transition technology as the electricity system has shifted to high levels of variable renewable generation. However, we now need to send the right signals through flexibility markets to drive down the carbon intensity of flexibility services and put us on a pathway to zero carbon.

The necessary data to assess carbon intensity of flexibility markets is not available. Ensuring that there is transparency of the carbon intensity of all procured flexibility services and markets is a key first step.

Going forward, flexibility markets must explicitly value carbon. A carbon price is unlikely on its own to be an effective way of sending the right signals through flexibility markets. Policy makers and regulators must, therefore, now consider market mechanisms that value carbon inherently.

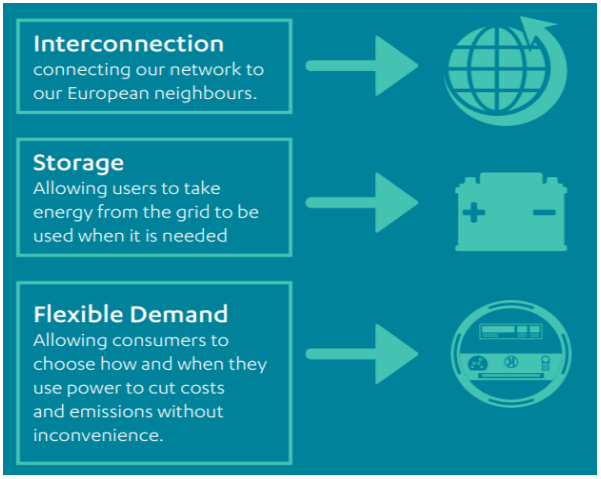
RECOMMENDATIONS:

1. Ofgem should mandate that National Grid ESO and Distribution Network Operators publicly report on the carbon intensity of flexibility services and markets
2. The Department for Business, Energy and Industrial Strategy should lead a work programme on options for putting zero carbon at the heart of smart flexibility markets

Flexibility

Achieving the UK's target of net zero by 2050 will require an electricity system that can support increased penetration of non-dispatchable renewables and increased demand. Smart, flexible technologies will be vital to providing flexibility to respond rapidly to system imbalance.

Flexibility has historically been provided by gas peaking and diesel plant. However, low carbon sources of flexibility are available; interconnection, storage and demand turn up/down are all able to help address imbalances. Smart, automated systems are also increasing in sophistication and can be used to control the system to improve responsiveness. Renewable generation has the potential to provide flexibility in some circumstances, for example, a solar PV plant could provide grid services, from spinning reserve to frequency response, according to a study by the National Renewable Energy Laboratory.[1]



Smart Power report, National Infrastructure Commission

1 www.nrel.gov/docs/fy16osti/65368.pdf

The UK government recognises the importance of flexibility in the power system and has a clear plan in place for improving the UK's capacity to transition to a smart, flexible grid. The Smart Systems and Flexibility Plan, released in 2017, sets out a roadmap for improving flexible technologies and providing routes to market for such services, including calling for local flexibility markets which have now been set up by all Distribution Network Operators (DNO). Ofgem's recent Decarbonisation Action Plan also sets out actions to support flexibility, including how markets take into account carbon intensity.

BEIS and Ofgem have listened to industry feedback and are currently conducting a programme of work to investigate the feasibility of measuring and valuing carbon in flexibility markets, as part of their update to the Smart Systems and Flexibility Plan. There is currently an open opportunity to inform and influence this work.

Current market structure

National Grid Electricity System Operator (ESO) runs several markets that incentivise flexible assets to provide response and reserve services to the system. At a local level, DNOs are setting up local flexibility markets as they shift to becoming Distribution System Operators (DSOs). There is ambition and opportunity to use low carbon technologies to provide these services, however, markets are not currently achieving low carbon outcomes, typically supporting fossil fuel generation.

The current market model dictates technology neutrality. Auctions for various services administered by National Grid ESO and the DNOs are based on a set of initial technical requirements for that service, but then decided almost solely on a price basis. In reality, a wide range of external factors influence which technologies win contracts.

A lack of transparency in these flexibility markets means that it is currently very difficult to assess their carbon impact. The Capacity Market and local flexibility markets are recent examples of auctions that have favoured high carbon generators.

In considering the carbon impacts of flexibility markets we need to consider both the direct emissions of the market as it runs, and the indirect emissions of the assets that such markets support.

There is a clear appetite in the energy industry to improve flexibility markets in a way that values carbon more directly. This aspiration can be seen, for example, in a recent workshop run by BEIS which clearly showed broad agreement amongst 70+ industry experts that the current market structure does not work for renewables and the approach to carbon valuation needs to change. Regen has also encountered similar views in our work with DNOs and their customers, in particular, a consultation conducted for Western Power Distribution which demonstrated that customers agreed that decarbonisation should be at the heart of DNO priorities.[2]

This paper is intended to highlight that flexibility markets are currently propping up high carbon generators, call for greater transparency on the carbon impacts of these markets, and spark debate on the potential solutions.

2 www.regen.co.uk/wp-content/uploads/WPD-DNO-DSO-community-consultation-report-designed.pdf

Why is change necessary?

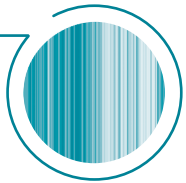
There has been a rapid increase in the number of low carbon sources of flexibility in UK flexibility markets, in particular storage and demand side response. However, low carbon technologies have struggled to compete with incumbent fossil-fuel generators across a number of markets, citing issues such as merit order dispatch in the control room, barriers for smaller participants, and the inability to compete on cost.

The Capacity Market has low de-rated values for renewables and storage (3% for solar PV and 40% for a 2-hour battery, compared to 95% for gas OCGT plants). The significant administrative burden of applying for contracts in the Capacity Market often negates any financial benefit. Renewables did win contracts in the latest 2020 Capacity Market auction, but the majority were large companies with existing Capacity Market contracts. The table on the next page illustrates the significant differences in prices across technologies.

Capacity Market de-rating factors and 2020 T-4 auction clearing price

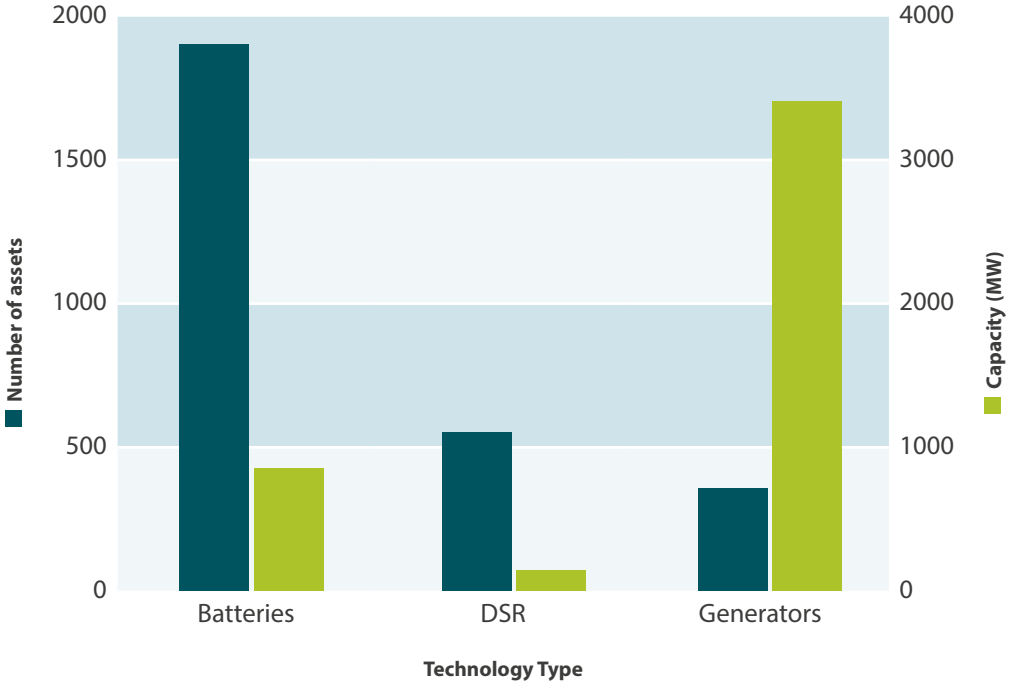
Technology Type	De-rating factors T-4 (%)	Indicative price in 2020 T-4 auction (clearing price £15.97/MW)
Open Cycle Gas Turbine (OCGT)	94.98	£15.17 /MW
Reciprocating engines	94.98	£15.17 /MW
Combined Cycle Gas Turbine (CCGT)	90.00	£14.37 /MW
Coal	85.81	£13.70 /MW
Storage (2 hour duration)	41.04	£6.55 /MW
Storage (1 hour duration)	20.43	£3.26 /MW
Offshore wind	10.55	£1.68 /MW
Onshore wind	7.42	£1.18 /MW
Solar PV	3.22	£0.51 /MW

3 Source for de-rating factors: EMR Capacity Market Guidance
www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/Auction%20Guidelines%202020_T-1_T-3_T-4.pdf



DNOs have been procuring local flexibility services since 2018 as an alternative to network solutions. The aim of these markets is to facilitate net zero by reducing the costs of network constraints and by providing a route to engaging a wider range of customers.

Local flexibility contracts are typically low value and short term. These contracts favour existing distributed energy resources with spare capacity, which tend to be gas or diesel. Local flexibility contracts are unlikely, on their own, to enable investment in new flexibility solutions such as storage. DNOs are required to take a technology neutral approach to auctions which precludes them from requiring low carbon solutions.



Capacity and number of assets by technology type registered on Piclo Flex by 12th June 2019 (excluding speculative assets).[3]

The chart above from Piclo, the platform now used by all DNOs to host flexibility tenders, shows that 77% of technologies registered on the platform are generators, which Piclo state are most likely to be powered by gas or diesel.[4]

4 https://piclo.energy/publications/Piclo+Flex+-+Flexibility+and+Visibility.pdf

Transparency and carbon reporting

If the sector is to fully and properly assess how to increase participation of low carbon technologies to provide flexibility, we must be able to analyse and understand the carbon emissions of the types of assets winning contracts, as well as the overall carbon intensity of a market as it runs.

Currently, National Grid ESO publish a forecast of carbon intensity of the UK grid – nationally and regionally[5]. This uses historical data and weather data to predict the carbon intensity of the grid, 96 hours ahead. It is an advanced tool and an excellent means of assessing the carbon intensity of the grid. However, there is limited available data which allows us to scrutinise the carbon intensity of particular grid services procured through markets.

5 https://carbonintensity.org.uk

Direct vs indirect emissions

The services that provide flexibility are called upon at very different rates. For example, frequency response services are regularly called upon, whereas the Capacity Market has never been used as a service to respond to a system stress event. Measuring direct emissions and intensity of services, while valuable and necessary, will therefore not reveal the degree to which flexibility services incentivise indirect emissions by maintaining or supporting the business case for fossil fuel generation.

Any data and reporting that ESO and DNOs release must be accompanied by (but not necessarily carried out by ESO and DNOs) thorough analysis of the carbon intensity of a service and also the extent to which services are propping up the business case for fossil fuels.

There are several ways in which National Grid ESO and DNOs can report on carbon emissions:

1. DNOs and ESO could report on carbon emissions of the generation they procure through markets – this could be included in scope 3 emissions as part of official carbon reporting. This may not be specific enough for us to monitor particular markets
2. Data released from auctions could have technologies and their carbon intensity specified. This would only tell us the carbon intensity of the generation procured, not the market itself as it runs
3. DNOs and ESO could provide specific reports on carbon intensity of each of their markets including balancing mechanism and local flexibility provision – this should be done on a regular (e.g. annual) basis

RECOMMENDATION:

Ofgem should mandate that National Grid ESO and Distribution Network Operators publicly report on the carbon intensity of flexibility services and markets

Building zero carbon flexibility markets

Carbon pricing

Carbon in the UK is valued through the EU Emissions Trading Scheme (ETS) – emitters pay a price for the carbon they emit using this scheme and can trade permits. The UK also has a Carbon Price Support scheme which sets a minimum 'floor' that emitters must pay – this was in response to the EU ETS price falling significantly after the 2008 recession.

The widely held view, particularly by economists, is that carbon is best valued through a functioning carbon price or a carbon tax. Changes to the way the system operates, as the generation mix decarbonises, will affect the influence the carbon price has on wholesale price. A 2019 paper from Pöyry for the Energy Systems Catapult[6] points to increased uncertainty in the carbon price over the next 10-15 years, suggesting that short term carbon price increases may support carbon reduction, but in the longer term, carbon pricing alone will not be able to drive decarbonisation.

However, even a high carbon price is unlikely to be effective in flexibility markets, particularly where assets are building a business model around market volatility. Many flex services are also an opportunity for smaller assets to participate – a bonus for low carbon technologies, but also for fossil-fuel generators who are not exposed to carbon pricing.

6 https://es.catapult.org.uk/reports/towards-a-new-framework-for-electricity-markets

Environmental permitting

Environmental permits for medium combustion plant are another means of reducing high emitting plant that participates in flexibility services. These permits set an emissions limit for pollutants for any combustion generator that is not operating as emergency back-up – this includes all flexibility services. This policy is intended to reduce the number of high-emitting generators, particularly diesel, that participate in balancing services, however a recent report from the Power Responsive group has indicated that it has not caused the expected decrease in contracts for diesel generators in the STOR market.[7]

Questions remain over the efficacy of these permits to reduce high emitting generation, particularly around abatement technologies, and to what extent they are being used to allow generators to continue running. Loopholes may also exist that allow generators to continue to participate in flex services, for example those that operate under 500 hours/year. As carbon is not an emission covered by this permit, it may not be effective in limiting gas-fuelled generators from participating in flexibility services.

7 http://powerresponsive.com/wp-content/uploads/2020/04/Power-Responsive-Annual-Report-2019.pdf

Market mechanisms to value renewable and low carbon technologies

There have been several different mechanisms suggested in literature and there are some currently in place across the world. Which option is suitable for different UK markets will need to be thoroughly debated by the industry, and by setting out several of those mechanisms here, we hope to spark that debate.

Option 1: Emissions limit

The Capacity Market has recently had an emissions limit imposed, following an EU ruling. The UK has implemented the limit of 550g CO2/kWh. France implemented a limit of 200g CO2/kWh and the last round of auctions saw storage take two thirds of the capacity available[8]. Would other UK markets benefit from a similar principle?

8 https://www.pv-magazine.com/2020/02/28/storage-prevails-in-frances-capacity-auction

Option 2: Two-stage auction

In his 2018 paper, the Cost of Energy Review, Dieter Helm sets out an auction method that would use a two-stage approach to ensure carbon targets are met[9]. In the first stage, bids are taken as normal and assessed at the end of the round to see if the carbon target is met. If not, a second stage is undertaken and repeated until the bids meet the required carbon target. Helm bases this on an equivalent firm power auction, so this may not be appropriate for all markets.

Option 3: Scored or multi-criteria auction

As an alternative to the two-stage auction, Helm proposes that a single-stage auction could be scored, with bids being assessed on multiple criteria, including carbon. This is an approach used in several countries and has allowed authorities to put a variety of requirements onto bidders, including social obligations, economic benefits and local support[10] – something Regen has called for to support renewable and community participation in local flexibility markets.[11]

9 Page 116, www.gov.uk/government/publications/cost-of-energy-independent-review

10 E.g. South Africa, France, China and Uganda (page 145 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA_Renewable_Energy_Auctions_A_Guide_to_Design_2015.pdf)

11 www.regen.co.uk/smart-flexible-and-clean-or-costly-dumb-and-dirty

Option 4: De-rating

In a similar approach to scoring, in the Capacity Market, technologies are assigned a de-rating factor based on the technical criteria required to provide the service required in a stress event – e.g. duration is a key criterion in this de-rating calculation. De-rating could apply to other auctions, with carbon being a key criterion. Indeed, carbon could be a factor in the Capacity Market de-rating calculation.

Option 5: Clean Peak Standard

The state of Massachusetts in the US has implemented a Clean Peak Standard.[12]
The programme rewards renewables, storage and DSR that are outputting or turning down during defined peak periods, across the year. Assets that are eligible receive certificates which they sell to suppliers who have an annual minimum obligation. The programme is intended to incentivise the use of storage, although it has faced some criticism for its potential to reward storage that is simply shifting high carbon generation.

12 www.mass.gov/doc/drafts-cps-reg-summary-presentation/download

Option 6: Carbon intensity standard

The Energy Systems Catapult has put forward a carbon intensity standard[13] – this would obligate consumers, producers and suppliers in the energy sector to meet a minimum standard of carbon intensity. Credits for those that exceed the standard could then be traded. Although Frontier Economics, the paper's authors, admit that this would be less efficient than a carbon price, it is possible to implement in the energy sector alone, without dependency on broader carbon price developments.

13 https://es.catapult.org.uk/reports/rethinking-decarbonisation-incentives-setting-standards-for-carbon-intensity/

Not all of the above mechanisms will be suitable for the needs of the UK market and there are advantages and disadvantages to all. However, given the appetite and need for change, a more open debate must take place to determine what mechanisms are necessary to facilitate renewable and storage participation in electricity markets.

RECOMMENDATION:

The Department for Business, Energy and Industrial Strategy should provide research and open up thorough industry debate on the options for putting zero carbon at the heart of flexibility markets

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