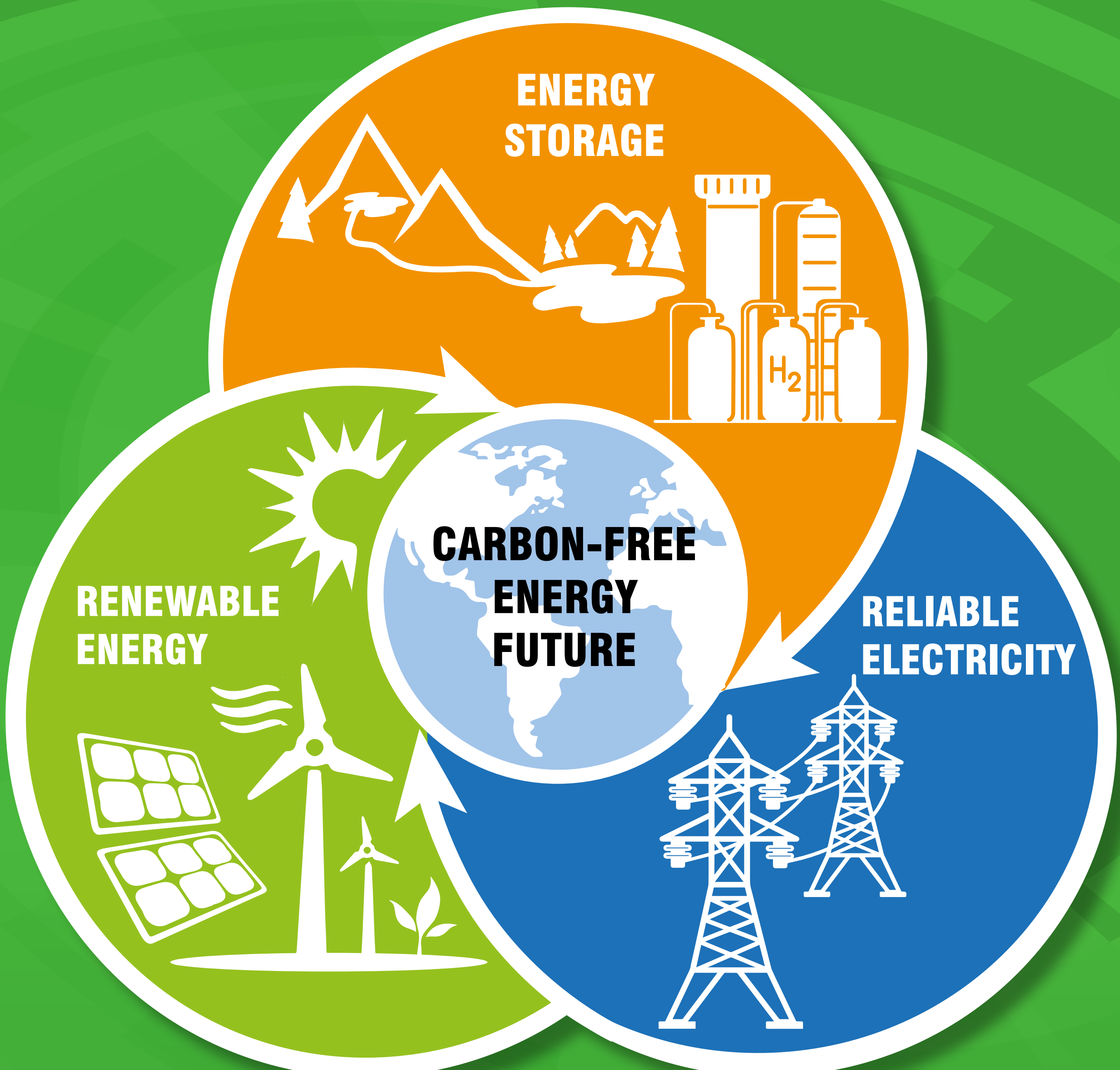
UNLOCKING INVESTMENT

in large-scale, long duration storage

Riverswan Energy Advisory

Strategy | Regulation | Investment



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Why is a new policy regime needed?

The rapid growth in renewable electricity generation expected for 2030 and beyond will require an accompanying major increase in flexible energy resources. The deployment of large-scale long-duration electricity storage will both enable the rapid deployment of renewable energy and avoid additional costs for new flexible gas plants and network infrastructure. Currently, the UK has only 4GW of large-scale, long-duration storage, all built several decades ago when the electricity sector was publicly owned.

Analysis from Imperial College and the Carbon Trust[1] has indicated that there is a benefit to customers totalling some £8 billion per annum available by 2030 through the development of a more flexible electricity system. Forecasts from Aurora suggest that 30GW of storage capacity will be needed by 2050[2]. The National Grid 2020 FES[3] predicts an increase from 4GW today to 14GW by 2030 and 40GW by 2050.

BEIS has already identified that there is a need to address policy and regulatory barriers to enable the development of large-scale, long-duration storage. Recent consultations have sought stakeholder views on this issue.

Bulk scale, longer duration storage projects such as pumped storage hydro, compressed air, thermal storage, and hydrogen have significant up-front capital costs. Individual project costs may range from hundreds of millions to billions, making it important that investors are able to have confidence that they will be able to earn returns on such large investments. Current market and regulatory arrangements do not provide the long-term price signals or revenue certainty that are needed to support investment in these technologies. Investors face significant risks, limiting the investment appetite.

Additionally, even if long-term price signals were available from the markets for these services, they would not be able to provide the degree of revenue certainty necessary for project financing investment structures, thereby ruling out a major source of potential investment finance.

Unless a policy change is made to address these issues, it is unlikely that private capital can be attracted to develop large-scale, long-duration storage, thereby both risking the achievement of NetZero targets and resulting in higher than necessary energy costs for consumers.

1 https://www.carbontrust.com/news-and-events/news/capturing-the-benefit-of-a-smart-flexible-energy-system

2 Aurora: The Road to 2050, 2019

3 https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents (Leading the Way scenario)

What are the funding model options?

Policies to address the investment barriers are needed, and there are a few potential options that may be considered. Assuming that private sector solutions to funding are being sought, the potential options for funding models may include:

No change – Merchant model

Under this approach, the storage project would base its investment case on future forecasts of a stack of potential revenue streams. These may include potential revenues from wholesale market trading, capacity mechanism contracts, from balancing and system ancillary services with the Electricity System Operator (ESO), and from bilateral contracts with other market participants.

This model relies on existing market arrangements and would not require policy change. It relies on investors gaining confidence in the future price signals and earning prospects of storage in a rapidly changing market.

But the various elements of the revenue stack are difficult to forecast and long-term contracts are either not available or are of limited scale. Potential funders of major capital projects find it challenging to gain confidence over different elements of a merchant revenue stack that are out of step with the longer funding, construction, and operational timescales of large-scale storage projects. Project finance is unlikely to be available.

Additionally, the ESO's direction of travel towards more liquid, real-time, technology neutral balancing and ancillary service markets means that larger scale storage faces being crowded out of these markets by less economic storage solutions such as batteries, or by unabated flexible gas plants.

The current merchant model presents a significant barrier to the development of large-scale, long duration energy storage projects.

Contracts for Difference (CFD) floor

Contracts for Difference (CFDs) were established in the UK to provide long-term revenue stability to low-carbon generators. They are long-term contracts between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC) which enable the generator to stabilise its revenues at a pre-agreed level (the Strike Price) in £/MWh for the duration of the contract. Under the CFD, payments flow from LCCC to the generator, and vice versa. CFD top-up payments above wholesale market prices are funded by electricity suppliers and ultimately by customers.

The advantages of low carbon CFD's are that they provide revenue certainty and enable investment funding at a lower cost of capital and therefore at a lower subsidy cost to consumers. Recent tender rounds have shown that some technologies have been able to secure CFDs at strike prices below the average expected wholesale price for electricity, and so over the course of a contract may pay back more than they receive in CFD top-up payments.

CFD's have demonstrated their effectiveness in attracting investment for low carbon generation and the regime is not yet designed for large scale storage. But if CFD's were used for large scale, long-duration storage then a Strike Price based solely on wholesale market prices would not capture the value of flexibility services e.g. demand response and other ancillary services that are provided by such storage capacity. If such storage projects were to bid a single Strike price of £/MWh of output, they would need to make assumptions about associated revenues from flexibility services, and revenues available from wholesale price arbitrage.
A significant merchant revenue risk remains.

An alternative approach could be to provide a storage plant with a CFD revenue floor price for asset availability, which would recover debt and fixed costs. This revenue floor could be established through a contestable process or as a bespoke decision for each project.

The storage plant would be incentivised to make its returns from trading in the wholesale and balancing markets and from providing ancillary services. If it did not, then subject to it meeting performance requirements (including completion of construction), the revenues would be topped up from energy suppliers and consumers. This approach would increase revenue certainty for investors and give them the incentive of retaining all potential upside returns.

A CFD floor model provides revenue certainty for debt and other fixed costs and should attract investment capital and the development of large-scale, long-duration storage investments.

Revenue cap and floor

This model would provide a guarantee (underwritten by energy consumers) of a revenue floor so that investors would be guaranteed a minimum revenue for an efficient project construction cost and cost of debt. Equity investors would have all their profits at risk which would also be capped at a reasonable rate of return.

The model is already proven for the development of interconnectors and has demonstrated that it can attract major investment capital. However, it has been developed for transmission infrastructure where the cap, floor, and efficient expenditure can be determined by Ofgem, and the associated payments/rebates can be applied through transmission network charges.

The advantage of this model for investors is that their cost of construction, debt and fixed costs are guaranteed by the floor. Consumers also benefit because returns are limited at a reasonable level.

A revenue cap and floor model provides revenue certainty for debt and other fixed costs and should attract investment capital and enable development of large-scale, long-duration storage investments. The cap on returns provides a benefit to consumers for the floor revenue guarantee they are providing.

Taking these alternative models in turn, the merchant model is one where there is limited policy intervention needed but is the least likely to realise the benefits of large-scale, long-duration storage. The other models i.e. CFD floor, RAB, and revenue cap and floor all require a policy intervention to underwrite revenues to some degree.

- The RAB model regulates returns, but customers face risks from cost overruns.
- The CFD floor model leaves construction risk with investors but does not regulate returns.
- The cap and floor model leaves construction risk with investors and also regulates returns.

The cap and floor model appears to strike the most appropriate balance between attracting capital to large-scale, long-duration storage projects. The following sections describe how the cap and floor regime is applied to large scale electricity interconnector investments, and then how this regime may be adapted for large-scale, bulk-storage projects.

Existing practice: the cap and floor regime for interconnectors

As a strong advocate of competitive energy markets, Ofgem has been keen to ensure that opportunities for cross-border trading through interconnectors are maximised. Before the cap and floor regime was introduced, Ofgem had adopted a policy of treating electrical interconnectors as merchant projects as for any other generator. Their principal source of revenue was through congestion rents, including those earned through market coupling arrangements, whereby capacity on interconnectors is allocated according to price differentials between the two connected markets.

As such, interconnectors were required to secure their construction financing against future expectations of market revenues, including the sale of interconnector capacity to market participants and the provision of system services. The lack of certainty about future revenues meant that few interconnectors had been built. This merchant risk meant that it was difficult to secure the necessary finance, particularly project finance, for these capital-intensive construction projects.

After consulting with market participants, Ofgem came to the view in 2010 that GB consumers were missing out on the cost benefits available from increased interconnector capacity due to their regulatory position. They decided to change their policy for regulation of interconnectors to attract the necessary financial investment and realise the future benefits for consumers.

In developing its new policy, Ofgem noted that the preferred EU approach was for fully regulated interconnectors. Ofgem considered that there were disadvantages in that this approach could reduce commercial incentives to optimise the projects and lead to higher than necessary costs for consumers.

Ofgem preferred the cap and floor regime to unlock investment in interconnectors by reducing risks to investors. It was a compromise between the advantages and disadvantages of the merchant and regulated models. Ofgem also wanted to retain contestability so that any interested party could propose to build an interconnector, whether on a merchant basis or using the cap and floor.

The width between the cap and floor was designed so that developers were exposed to the benefits provided by the interconnection and so were incentivised to identify and develop projects in a way that maximises them. Unless the cumulative revenues during the assessment period were above the cap or below the floor, no payments would be made to developers on behalf of consumers and developers would not return revenues to consumers.

The Interconnectors and the ESO have licences that are granted and regulated by Ofgem. Ofgem has the powers to adjust these licences to implement the terms of the cap and floor regime. The regime has been developed to be compliant with EU legislation and has been applied by adapting the existing licencing and regulatory arrangements. Cap and floor payments and rebates can be reconciled through existing transmission charging arrangements.

Ofgem put the cap and floor regime in place as a pilot project for the NEMO interconnector between Belgium and GB and has continued to apply this regime for the last 10 years. The key features of the cap and floor regime for interconnectors involve three key stages as described below:

Stage 1

Selecting projects and granting a cap and floor

Firstly, an interconnector must apply to Ofgem for access to the cap and floor regime, during an application window period. Ofgem will assess each project application against qualification criteria, including an economic impact assessment. This assessment will consider the combination of projects that are proposed in a window, thereby also reflecting their interactive impacts on costs and benefits. The following criteria are included in the assessment:

- Estimated impact of the project on GB electricity wholesale prices
- Estimated impact of cap and floor payments on electricity bills
- Cost of reinforcements to the GB transmission system
- The impact of the project on operation of the GB transmission system

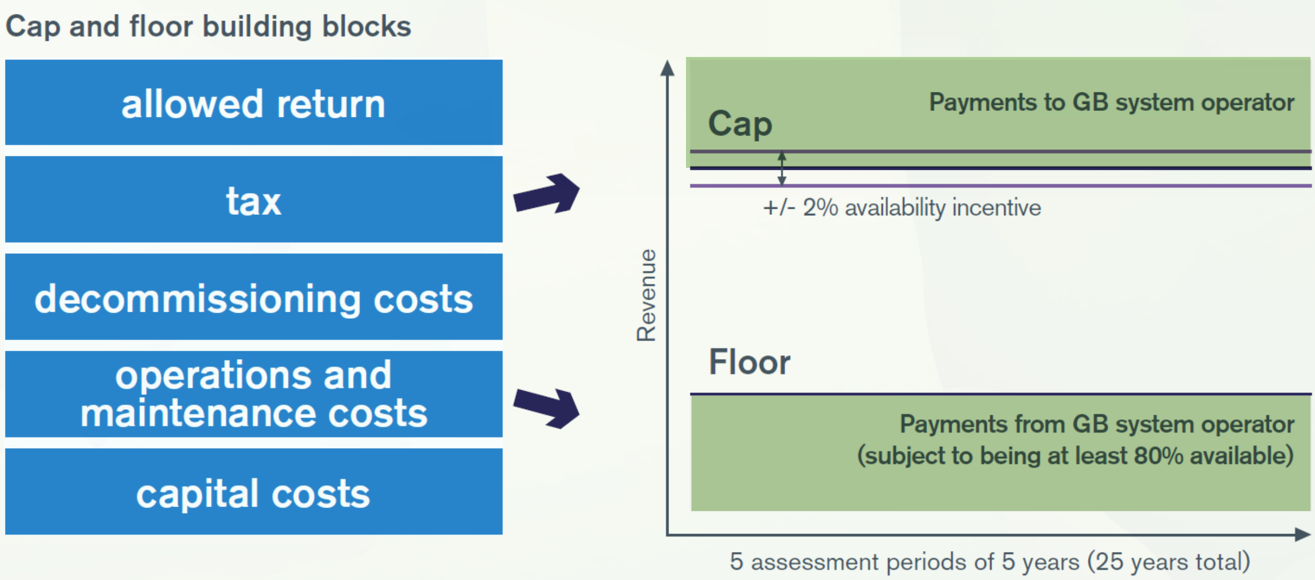
If this analysis shows an individual project meets these need case requirements, called the ‘initial project assessment’ (IPA) stage, then a cap and floor regime can be granted in principle to a project by Ofgem.

Selecting projects and granting a cap and floor

- A floor sets the minimum amount an interconnector can earn. It will be able to recover its investment in eligible assets, a rate of return on its net capital investment based on a cost of debt benchmark (determined by national regulators) and its efficient operating costs at the revenue floor. If the actual revenue is less than this floor, then it will be topped up from transmission charges applied to all transmission system users by the GB electricity system operator (ESO).
- A cap sets the maximum amount that an interconnector can earn. It will be able to recover its investment in eligible assets, a rate of return on its net capital investment based on a cost of equity benchmark (determined by the national regulators) and its efficient operational costs at the revenue cap. If the actual revenue is more than the cap, then the excess revenue will be transferred to the ESO and used to reduce transmission charges.
- The cap and floor levels are built from capital costs, operations and maintenance costs, decommissioning costs and allowed return. The efficient costs of the interconnector including interest during construction, are assessed, and decided by Ofgem.
- To qualify for the cap and floor, the interconnector must maintain a minimum level of asset performance (80% in any applicable year). The cap may also increase or decrease by +/-2% based on availability performance
- The cap and floor regime duration is 25 years, and actual revenues earned against cap and floor are assessed every year (previously every 5 years).
- There are also risk-sharing arrangements with consumers for force-majeure events.
- EU compliance - the regime complies with interconnector requirements under EU legislation. Developers will need to comply with EU network codes and unbundling requirements.

The following diagram sets out a summary of the building blocks used in the cap and floor regime for interconnectors.

Diagram 1: Interconnector cap and floor model[4]



4 Ofgem website https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors

Stage 2 - Final Project Assessment

Secondly, Ofgem will undertake the ‘final project assessment’ (FPA) stage to assess the efficiency of the developers’ capital costs and determine the preliminary cap and floor levels. Ofgem will also make their final decision on whether to grant a project a cap and floor regime. Each project is considered individually at this stage.

The FPA stage and cap and floor decision would be expected to be completed before project financial close and commencement of construction.

Stage 3 - Post Construction Review

Third, the ‘post construction review’ (PCR) stage is where Ofgem assesses the efficiency of operations and maintenance costs and conducts a review of final capital costs to set the final cap and floor levels.

The cap and floor regime commences operation alongside the interconnector commencement of operations.

Benefits of cap and floor interconnector projects

Consumers

The interconnector cap and floor regime has led to a planned increase of around 11 GW of additional interconnector capacity to the 4GW of historic capacity. This increase should provide significant cost benefits to GB consumers from increased wholesale market coupling, together with decarbonisation and security of supply benefits. The following table lists the interconnector projects that have been developed under the cap and floor regime.

Economic development

The regime has attracted an estimated £11 billion of new capital investment. However, much of this expenditure has either taken place in the connecting countries or through procurement of cables and HVDC equipment from international equipment suppliers, thereby reducing the economic benefits to the UK in terms of jobs and other associated supply chain benefits.

Table 1: Cap and Floor Interconnector projects[5]

PROJECT NAME	DEVELOPERS	CONNECTING COUNTRY	CAPACITY	DELIVERY DATE
NEMO	NGIH and Elia	Belgium	1000MW	2019 (in service)
IFA2	NGIH and RTE	France	1000MW	2020
NSN	NGIH and Statnett	Norway	1400MW	2021
Viking	NGIH and Energinet.dk	Denmark	1400MW	2023
Greenlink	Element Power	Ireland	500MW	2023
Gridlink	iCON Infrastructure Partners	France	1400MW	2024
NeuConnect	Frontier Power, Meridiam and Greenage Power	Germany	1400MW	2024
NorthConnect	NorthConnect, Lyse Produksion, E-CO Energi, Vattenfall, & Agder Energi	Norway	1400MW	2024
FAB Link	Transmission Investment and RTE	France	1400MW	2025

5 Developer and Ofgem websites https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors

Applying a cap and floor regime to large-scale storage

Regime design

A regime to support large scale, long duration storage could be similar, both in terms of process and regime design, to that for interconnectors.

- The process for selecting projects could be contestable, technology neutral, and include a needs case assessment for each project.
- A cap and floor could be developed such that merchant risk was removed from revenues needed to secure debt and essential operational costs, and equity returns would be capped.

These aspects are discussed in more detail below. Some practical considerations concerning the implementation of the regime are also discussed.

A contestable application process

Similar to interconnectors, application windows should be introduced to allow projects to be assessed against a delivery readiness and consumer benefit test. These windows should be technology neutral, allowing large scale, low carbon storage technologies such as pumped storage, compressed air, and hydrogen to apply.

Qualification criteria might include:

- Project readiness and delivery timescales – For example, do projects have planning consents, grid offers, construction plans, etc? What is the technology readiness level? What is the date of delivery?
- Longer-term storage duration requirement e.g. projects have a minimum of 6 hours of continuous running at full load capacity
- Storage technologies are low carbon. This would be needed to ensure that flexibility services are not provided by unabated gas plant.

Again, similar to interconnectors, a cost benefit assessment should be applied to each proposal, assessing the following:

- Estimated cost benefit to consumers from longer term storage being available, including wholesale market and system operation benefits.
- Estimated cost benefit to consumers of reduced transmission investment due to storage being available (after netting off connection costs)
- Estimated social benefit to consumers from longer term storage being available, including decarbonisation and security of supply benefits
- Estimated project costs of storage solution.

This would be a contestable and interactive process, where all the proposed projects in the window would be considered together. Only projects that met the qualification criteria and which were able to show a positive cost benefit assessment for a range of need case assumptions would be awarded a cap and floor in principle. These awards would be conditional on satisfactory progress against project milestaones.

A storage cap and floor regime

The cap and floor regime for longer term storage should maintain the key features of the interconnector regime, namely:

- A floor which is the minimum amount a storage project can earn. It should be able to recover its investment in eligible assets, a rate of return on its net capital investment based on a cost of debt benchmark and its efficient operating costs at the revenue floor.
- A cap which is the maximum amount that a storage project can earn. It should be able to recover its investment in eligible assets, a rate of return on its net capital investment based on a cost of equity benchmark and its efficient operational costs at the revenue cap.
- The cap and floor levels should be built from capital costs, operations and maintenance costs, decommissioning costs and allowed return.
- Availability incentive - to qualify for the cap and floor, the storage project should maintain a minimum level of asset availability. The cap may also increase or decrease based on availability performance.
- The cap and floor regime duration should be 25 years, and actual revenues earned against cap and floor should be assessed every year.
- There should be risk-sharing with consumers for force-majeure events.

As for interconnectors, the appropriate methodologies for calculating cap and floor levels, efficient project costs, and incentivising performance should be developed and established.

Application of the regime

However, as these are energy storage projects rather than interconnection projects, there will be some important differences. For example, Ofgem's approach of using existing interconnector and transmission licences to implement the interconnector regime is not likely to be applicable.

For a cap and floor regime to be implemented, several issues will need to be addressed. These include:

- **Regime design** – a BEIS policy consultation and decisions will be required to adopt this contestable cap and floor approach, including an impact assessment of the costs and benefits. This should:
    - Specify large scale long-duration storage as a low-carbon flexibility asset that requires a market-based support regime to attract investment.
    - Specify the new-build low-carbon technologies that will qualify.
    - Specify the performance parameters needed e.g. duration, delivery times.
    - Specify the key parameters of the cap and floor regime.
    - Ensure the regime complements and does not conflict with other existing electricity market polices including Capacity markets and low-carbon CFD's.
    - Ensure the regime complies with State Aid and other EU electricity market legislative requirements, as applicable
- **Treatment of different technologies** – while proven technologies such as pumped storage should be able to participate in such a regime, other technologies may not be able to, probably because they are not yet at a state of technological readiness or have higher or less certain costs. In these circumstances, the regime would need to ensure that it did not present barriers to the development of other technologies.

Large scale storage could be treated similar to the way in which various renewable technologies have been subsidised in recent years. This could provide higher initial subsidies for technologies at early development stages until experience drives costs to reduce to competitive levels. The cap and floor regime could be designed to recognise that different subsidy levels may be required for different technologies. Such subsidy levels could potentially be derived through the contestable bidding windows or set in advance by Government.

- **Application process administration** – this would require the development of an application process including qualification and assessment criteria, and the identification of an administrator for the application process and ongoing operation of the regime.

  Ofgem administers the application, cost and revenue assessment, and ongoing regulation for interconnectors and could be the appropriate body to perform this role for large scale storage. The ESO could also perform some of the administration activities.

- **Licences** – the terms and conditions of the cap and floor regime should be set out in a modified generation licence applicable to each qualifying project.
- **Payments and rebates** – floor payments and cap rebates would need a mechanism to put them into effect. There appear to be three main options for the payments or rebates to be applied. These are:
  - Balancing charges, run by the ESO, where the adjustments could be made alongside other balancing charges.
  - Low-carbon levy framework, run by the Low Carbon Contracts Company (LCCC), where the adjustments could be made to levies charged to suppliers.
  - Transmission charges, run by the ESO, where the adjustments could be made in a similar way to those applied for interconnectors.

The leading options would appear to be the low-carbon levy framework or balancing charges. The use of any of these options would require suitable rules and responsibilities to be put in place.

Such changes as those described above are likely to require legislative change to put them into effect and this will take time. However, given that there will need to be a lead-time for suitable projects to prepare for an application window, an early statement of policy intent could have a positive effect on investment and development appetite.

This should lead to a pipeline of potential projects and technologies being readied in anticipation of legislative changes.

The benefits

Application of a cap and floor approach would attract investment into longer-term storage. Large scale, long duration storage projects can enable the growth of renewable electricity generation to achieve NetZero targets, while also helping to maintain security of supply and minimise costs to consumers. It will help realise the £8 billion per annum of benefits available from a more flexible energy system.

Furthermore, investment in these projects would also drive economic growth in the UK to a much greater degree than interconnectors. For example, a 500MW pumped storage project is a major civil engineering project requiring a large local workforce. Academic and industry research[6] indicates this could provide around 1700 direct construction jobs and a further 250 indirect jobs for such a project. Around 70% of the c£600 million capital cost could be spent in the UK economy. A 10GW pipeline of these storage projects could raise these figures by around twenty-fold.

6 Assuming 8500 construction job years and 1250 indirect job years over a 5 year construction period. Sources – NREL large hydro model and Rutovitz analysis: https://opus.lib.uts.edu.au/bitstream/10453/43718/1/Rutovitzetal2015Calculatingglobalenergysectorjobsmethodology.pdf and https://www.nrel.gov/analysis/jedi/

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