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Response to NIC call for evidence - electricity interconnection and storage

Dear NIC,

Britain's electricity supply to business and homes will be less costly, more secure, and emit less carbon, if additional electricity storage is deployed. Current market barriers, legislation and a lack of clear government strategy have combined to deter most investors and storage companies from delivering these three desirable outcomes.

At Quarry Battery Company we are developing the first pumped storage to be built in the UK for 40 years, and the first to be built using private funds. It is at Glyn Rhonwy in north Wales and we aim to have it operational in 2019.

We want to see a fairer market and legislative framework around storage so that the sector can flourish, with different companies and technologies competing to offer storage solutions at all levels in the electricity supply grid so that British households and industry are the winners.

In our view Britain is only a few steps away from catalysing the build-out of a sustainable national storage fleet – perhaps without the need for subsidy or major legislative changes.

In the following pages we highlight barriers and offer solutions that would help any storage technology or developer equally.

Yours sincerely,

Dave Holmes
Managing Director
Quarry Battery Ltd.

What changes may need to be made to the electricity market to ensure that supply and demand are balanced, whilst minimising cost to consumers, over the long term?

Quarry Battery is an energy storage company, and so our answer naturally focusses on this area of a smarter future energy network. We have written a short paper on this topic which shows that storage can help reduce costs to the UK consumer by enhancing the performance of renewable assets, in particular that a 10GW fleet of pumped storage with 31GW of Wind would deliver the same number of renewable MWh as a 40GW Wind fleet, while improving Wind load factor, reducing curtailment, improving flexibility and reducing costs; please see this link. However, there are many more benefits brought by storage than this paper shows. Various academic and industry commentators have shown similar results including Imperial College[1] Energy Futures Lab and the Carbon Trust[2].

The NIC call for evidence barely mentions carbon emissions. While we understand that Carbon considerations are perhaps not within the NIC's remit, it cannot operate in a vacuum and must be mindful of the legal framework surrounding carbon emissions in the UK. The third and fourth carbon budgets in particular look difficult to achieve. It will be highly regrettable if we fail to meet the forthcoming carbon budgets, particularly if significant potential decarbonisation, available from grid scale storage, has been neglected. Please see this link for a carbon payback calculation for our site in North Wales.

Storage is not a single thing. There are a number of different storage technologies, each in a different place on the spectrum of response speed, scale, geographic freedom, charge density, cost, reliability, maturity, longevity and environmental impact. This ecology presents useful options for storage solutions at every scale and in every place, but it also makes it potentially difficult to create policy that is perfectly focussed on consumer and UK benefits while treating all technologies at all scales in a transparent and accurate and free-market manner. The challenge for policy-makers is to unlock the value of storage without picking winners or losers or blighting its development with undue costs or uncertainty. For this reason aligning commercial and public interest by addressing market failures should be the first step.

Two logical moves have already been made. Firstly the Capacity Mechanism assists by identifying the value of energy security [at least in part] and providing a mechanism which supports those who can deliver services in a stress event. Secondly the move to PAR1 single pricing better reflects the extremes that the electricity market should reach in free-operation. In the past policy makers have been wary of high and low energy prices and this has suppressed a market signal that is now free. The PAR1 calculation still disguises the extreme highs and lows to some extent, but it is at least progress from the previous system. Both of these interventions support new storage by closing the gap between market signal and required economics and both leave electricity consumers as winners; improving security in the case of the CM and further reducing cost through greater efficiency in the case of the single pricing.

These interventions have evidently not been sufficient to stimulate the bigger players in the market such as SSE, who explain their reluctance to invest in the Coire Glas scheme as follows:

> *"…making a Final Investment Decision to progress the Coire Glas scheme will require overcoming a number of commercial and regulatory challenges. These include changes in the existing transmission charging regime for pumped storage and a satisfactory and supportive long-term public policy and regulatory framework."*

[1] https://workspace.imperial.ac.uk/energyfutureslab/Public/Strategic%20Assessment%20of%20the%20Role%20and%20Value%20of%20Energy%20Storage%20in%20the%20UK.pdf
[2] http://www.carbontrust.com/media/168551/tina-electricity-networks-storage-summary-report.pdf

The gap between the current economics of storage and its required economics is different at different scales and for different technologies. However there are further modest market and legislative changes that could be made to help close the gap. We believe it is sensible to focus on these. Major changes may take a long time to achieve and have the potential to create further uncertainty.

While storage has clear benefits in partnership with renewable forms of electricity, it is not only in a renewable UK that storage offers benefits to the grid; far from it. The existing pumped storage facilities in the UK were not built for renewable balancing and yet have been a very important feature of UK grid stability over the past half century. The maturity, reliability, efficiency, speed and longevity of pumped storage sets it head and shoulders above all other forms of energy storage at grid scale. It does not matter which mix of electricity generation we end up with, especially if we seek to electrify heat and transportation, storage will help us. The UK should strive to get it built and with a low carbon future on the horizon, and historically low costs of capital: now is the time.

Storage is currently considered to be "generation". It is treated as such in the planning process, in the environmental impact regulations, in the way it connects to the grid, in the way it interacts with the market and in the way it is rewarded for the services it provides. Storage is a square peg in a round hole and market barriers and failures can be found in the gaps.

What are the barriers to deployment of energy storage capacity?

The core challenges facing storage are:

- Difficulty in raising funds to begin a storage business
- Lack of transparency in current market
- Complex revenue streams
- Uncertain future revenue streams
- Build finance hard to secure

All of these challenges are related to market clarity, stability and investor confidence. While we have one of the most transparent energy markets in the World, the majority of Balancing Mechanism contracts, especially at the fast response end of the BM, appear to be bilateral and opaque between National Grid PLC and the service provider. It is difficult to evidence the value of grid balancing and build a business case in such an environment. For now many "build and operate" investors struggle to see a suitable return without substantial low-cost bank finance, while banks don't understand (or cannot see directly) the revenue stream and so are reluctant to make the required capital available at a reasonable rate. The complexity of trading behaviour required for a storage unit makes it difficult to communicate to all except energy traders, which rules out most of those able to provide the required finance.

The specific market failures are:

- Connecting
- Taxation
- Lost revenues/ External benefits
- Regulatory risks
- Transparency

Connecting

The problem - Academic commentators such as the Energy Futures Lab at Imperial College London, have shown how storage is bizarrely and unfairly penalised for bringing system benefits. A new power station causes stress on the local grid and increases distribution and transmission infrastructure costs. It rightly pays connection charges which help offset the cost of reinforcing the grid to handle its output. But storage is not a power station. It tends to absorb energy when there is too much and release it when there is too little. It therefore *reduces* pressure on existing infrastructure, *saving* grid reinforcement costs, and increasing its effective capacity.

The solution - Storage should not foot the bill to connect to the network. The DNO and SO benefit from storage in the form of reduced network reinforcement costs, so it is right that they should share some of that benefit with the storage developer. We suggest that the network operators should bear the cost of new storage connections. However we need to consider possible unintended outcomes; what if the storage facility never gets built, or it not operated for the full design life? The result in both cases would be that DNO or SO is left with a redundant asset. In yet another scenario a potential site for storage exists but it is so distant from a possible connection point that the cost of connection is simply uneconomic. It is clearly not in the public interest to force a DNO or the SO to pay for the connection in such a situation.

There is a middle path, which is that the storage developer pays the initial connection fee, but rather than facing an ongoing annual charge, the developer is gradually paid back the initial cost of constructing the connection, less maintenance fees. This could be worked out, say, on a 10% pa basis so that the developer has to perform a useful storage role for a considerable time in order to recover the initial funds. A worked example where a connection costs £10m and maintenance runs at £100k pa would run as follows:

Year of operation	Asset balance	Connection running costs	DNO Payment to developer
0	£10.00 m	£0.00 m	£0.00 m
1	£10.00 m	£0.10 m	£0.90 m
2	£9.00 m	£0.10 m	£0.80 m
3	£8.10 m	£0.10 m	£0.71 m
4	£7.29 m	£0.10 m	£0.63 m
5	£6.56 m	£0.10 m	£0.56 m

In this worked example the DNO gradually refunds the developer for the connection fees it paid, and after 20 years 86% of the cost of connection has been recovered, and the line has been maintained all along. This leaves the connection cost risks with the developer, while returning to the developer some of the externalised benefit the storage scheme has conferred upon the network.

For a sense of scale – connection costs at our site in Glyn Rhonwy are over 10% of the required CapEx, and this would make our scheme much more attractive to investors while not causing undue risks for the DNO.

Taxation

The taxation problem -

Energy consumption is taxed. But if a MWh of electricity is stored and then later returned to the grid it has not been consumed. Despite this simple fact, and despite assurances given by HMRC and Ofgem to DECC that consumption taxes would not be applied to storage, the reality is that they are. The Lithium Ion battery at Leighton Buzzard storage project currently pays consumption taxes because it operator did not receive adequate reassurance from HMRC and Ofgem that the taxes would not be levied.

The solution -

We do not propose the abolition of consumption taxes for storage. No storage is 100% efficient, so charge-discharge cycle losses mean that some energy is consumed, even if the majority is returned to the grid. Complete abolition of consumption tax would not properly encourage and reward cycle efficiency. We propose that rather than reading the import meter and applying taxes, the tax is calculated as the difference between import and export, which represents actual consumption.

A side consideration here is those storage technologies that can turn electricity to fuel such as hydrogen. The operator could choose to feed it into a fuel cell and regenerate electricity, or feed it in to the gas network. How should consumption taxes be applied in such a case? What if the hydrogen was used on site for some other process? Or put into a vehicle for transportation? Is this storage or consumption? We suggest that once an electrically-created fuel [or store of heat or cold or other potential energy source] is used for something other than to return electricity to grid, the energy used has been consumed rather than stored. The [import-export = consumption] formula follows this logic and seems a simple and clear way to proceed in what could quickly become quite confusing with significant bureaucratic overhead on any tax collection.

Lost revenues/ external benefits

Storage creates externalised benefits for the system. Capturing more of these benefits for the storage provider will help better align commercial interest with the public interest.

Curtailment

Curtailment is where a generator is asked to switch off as their electricity is not required. Fossil fuelled plant has long been curtailed, but curtailment is increasingly being resorted to for renewables. Because renewables are subsidised, operators will only curtail if paid the value of the subsidy to do so.

Storage is a cheaper and lower carbon alternative to curtailment, reducing the cost of electricity, increasing the efficiency/ load factor of existing renewables fleet, and boosting carbon reductions.

Avoided infrastructure – Grid

Storage lessens stresses on the grid, reducing the need for costly new network infrastructure or costly reinforcement of the existing transmission and distribution systems. Our suggestion on connection fees above would address this market failure.

Avoided infrastructure – Generation & interconnection

Renewables and interconnectors are funded by subsidy or subsidy-like mechanisms; the more we build the more it costs.

Renewables plus storage have a higher load factor than renewables without storage, and will cost Britain less. At QBC we have modelled how a 10GW fleet of new pumped hydro storage would enable a 31 GW wind fleet to produce the same amount of electricity at less cost as a 40 GW wind fleet *without* new storage (and with greater energy security and less carbon). If Britain builds renewables until the need and price signals for storage show the required incentive, and *only then* focuses on storage, the risk is suboptimal cost, impaired UK security and increased carbon emissions. It will also make the job of the SO job more difficult. This is the situation that Germany now finds itself in.

We believe it is better to build renewables and storage in step with one another and deliver a secure low carbon electricity supply at optimal cost. Portugal shows wisdom in linking renewable power to storage according to a 3.5:1 ratio. The identical ratio would not necessarily apply to the UK, but a formal recognition of a linkage would aid investor confidence, stimulate developer ambition and concentrate the minds of policy makers. California has made the link between generation mandatory. The ratio is one to first understand in the UK context and then to keep an eye on.

It is useful to the UK consumer to reduce, postpone or enhance CapEx spent on renewables by building storage alongside, while still delivering on our legally binding carbon responsibilities.

Sovereignty

While it allows international power trading, interconnection could also make the UK dependent on other countries for energy security. More storage would enable the UK to increase its security and self-reliance.

Trade balance

By storing excess power for later release rather than importing electricity Britain will improve its trade balance.

Flexible capacity

The problem –

The Capacity Mechanism rewards storage technologies only as generators. Following lobbying efforts from ourselves and others the CM rules were changed to give generators' obligations in the more dynamic and urgent Balancing Mechanism primacy over their responsibility in the less critical Capacity Mechanism. This avoided the trap wherein BM units would have remained static when the system most needed flexibility. However, the "BM trumps CM" rule only encourages the desired behaviour; it does not fully appreciate the fact that storage assets can work in both directions as generators and absorbers. In a stress event both abilities are desirable.

The solution –

Creating a new class of capacity that recognises the value of flexibility to grid stability would enable storage to be properly rewarded for its enhanced provision during times of poor grid stability. However the legislative burden of such a move and the risk of unwanted side effects might make such a suggestion unappealing. A similar result could be achieved under the existing system by adapting the de-rating factor for storage technologies. Each technology is "de-rated" according to its likely reliability in a stress event. Pumped hydro for example has a derating factor around 97%, meaning that a 100MW unit will be counted as a 97MW unit in the Capacity Mechanism. Since storage is not only generation, and a 100MW storage unit can in fact deliver a power range of 200MW [+100MW to -100MW] it is our opinion that the derating factors for storage should reflect this greater range of ability. The creation of a bespoke "mechanism" for flexibility, balancing or storage is one to consider if it is not felt that the Capacity Mechanism a suitable vehicle, or if desired changes to the UK generation mix are not coming to fruition.

It has been argued elsewhere that the CM is cost neutral to the taxpayer. This is because the CM revenue received by new build is expected to suppress the energy price by an equivalent amount. Provided the energy market is competitive the argument is not without merit. Increasing the CM de-rating factor for storage therefore should not have an adverse effect on consumer energy bills. In our opinion the jury is out on whether or not the CM adds costs to the taxpayer, and while it seems likely that energy costs would rise if the CM were suddenly removed from the market place, it is difficult for us to perform such an equation. Whatever the answer, the CM is unlikely to pass all costs on to the consumer and so could be seen as a low cost option. In the case of storage, tweaks to the CM would be good value for the taxpayer given the cost suppression, security and carbon benefits storage delivers.

BSuoS charging [Balancing Services use of System]

The problem -

Storage is a net contributor to grid stability, yet it pays the same charges levied on the generators, and transmission and distribution assets that fund the balancing mechanism – the system that keeps the grid stable. While it does not necessarily follow that all storage in all places and at all times will assist in stabilising the grid, it is generally uneconomic for storage to act otherwise since it makes its revenue by buying surplus power and addressing spikes in demand. The charge is therefore an illogical barrier to storage.

The solution -

Modify the BSuoS charging regime for storage. This could be done in a number ways, each with different outcomes.
The current regime can be visualised as follows:

	Transmission	Distribution
Importing	£ BSuoS charges	£ BSuoS charges
Exporting	£ BSuoS charges	£ BSuoS revenues

For distribution connected storage above the meter, BSuoS charges and revenues interact and more or less cancel one another out. An efficient storage facility operating in a way that benefits the grid can reduce the charges or even turn BSuoS into a revenue stream. This is the case for our first project at Glyn Rhonwy, where BSuoS net revenues are around £100k pa, which is a welcome but relatively insignificant contribution to the overall economics. The more efficient storage is and the more it acts in the interest of the grid, the more it reduces charges and increases revenues.

For example:

	T	D
I	£	£
E	£	£

Do nothing… makes no difference to the costs of balancing the grid, and provides no change to the storage market signal.

	T	D
I	-	-
E	-	-

Storage immune to BSuoS… This has the effect of boosting transmission level storage, while not really changing the environment much at the distribution level, and in fact slightly harming our project at Glyn Rhonwy as described above.

	T	D
I	£	£
E	£	£

Reverse charges for transmission storage exports… This has the effect of neutralising BSuoS at transmission level, while having no effect on distribution level storage.

	T	D
I	-	-
E	£	£

Remove BSuoS import costs for all storage… this has the effect of boosting both transmission and distribution level storage, while not changing the landscape heavily.

	T	D
I	-	-
E	-	£

Remove all BSuoS charges… This boosts both transmission and distribution scale storage.

There are a number of permutations. Simple and logical regulatory tweaks to BSuoS can have a marked effect on storage price signals without adding additional cost to the UK consumer. We would recommend one of the last two options as a significant first step, and suggest that further adjustments might be considered as the build out of new storage develops.

At the distribution level, the "remove all BSuoS charges" option would boost revenues at our Glyn Rhonwy scheme from £100k pa to around £800k pa. Since this is a form of revenue banks can easily grasp and are prepared to rely on, it would be helpful in securing project debt finance.

At transmission level the "remove all BSuoS charges" option would boost the net profit of transmission owned pumped hydro by about 10%, as reported by the Institute of Civil Engineers in its recent report[3] "Energy Storage: Realising The Potential". The redistributed costs would increase the BSuoS charges for other parties by just 0.3%. The change could be applied only to

[3] https://www.ice.org.uk/getattachment/media-and-policy/policy/electricity-storage-realising-the-potential/ICE-(2015)-Electricity-Storage-Realising-the-Potential.pdf.aspx

new schemes, or for the first say 20 years life of new facilities, if an unnecessary windfall to existing schemes was to be avoided.

Regulatory risk

The risk of revenue streams diminishing or drying up altogether is a serious concern to developers, investors and debt funders alike. Just as the Bank of England has helped navigate the UK though a time of fiscal uncertainty by being clear about the interest rate, so too can policy makers be clear about what the direction of travel is, even if the detail is a little hazy. The CM and the PAR1 pricing mentioned earlier are excellent examples.

A suite of small positive changes, flagged early and often will send a powerful signal to investors. Large changes would need to be mindful of creating uncertainty and causing a hiatus to our first scheme, and perhaps look to bespoke support should such a situation arise. Economics would deteriorate for the builder of a single plant if there were suddenly another 10GW of pumped storage on the horizon, so the aspiration of government to build storage needs to match the incentives offered for investors to be confident of their decisions. In the words of one of our key investors;

> *"The profitability of PS plants will decline as additional plants are built out and compete in the various markets into which fast response electricity is sold. Accordingly, until the future size of the sector is capable of being estimated by investors, even if only approximately, it will not be possible to construct a convincing revenue model for any new project. The predictable consequence is that early stage investing becomes unacceptably risky, and the cost of capital too high for economic viability.*
>
> *What makes this uncertainty even worse is that we can't tell what factors will influence Government thinking on sector size. Does CO2 saving any longer count with this Government, the Chancellor, or now for the NIC under Lord Adonis, which is the Chancellor's creation? The Climate Change Act 2008 is the law of the land, and it sets very specific legally binding staged targets for decarbonisation. If not taken into account, this consultation will be legally flawed, and may be challenged. Yet the NIC's call for evidence contains no reference, direct or implied, to the Act, its imperatives, or whether decarbonisation will be a factor in the NIC's thinking on sector size."*

Transparency

The Balancing Mechanism is serviced by companies able to adjust their power output/ input quickly enough to be of utility to the System Operator in managing Grid stability. This service is procured in three ways: firstly through open processes such as the Fast Reserve tendering market, secondly ad hoc through bids and offers and thirdly through bilateral contracts between the SO and service providers. The opaque bilateral contracts unfortunately form the majority of contracts in the Fast Reserve end of the Balancing spectrum and this makes it difficult to evidence their value, frequency or contract length to investors or financiers. Increasing the independence and transparency of the SO would assist in resolving this issue in the long term.

Re-classification of storage?

We are aware the government is pondering a re-classification of storage to make it distinct from its current home in generation. This would fit well with our statement above *"Storage is a square peg in a round hole and market barriers and failures can be found in the gaps."* However creating a new regulatory home for storage does not necessarily change anything, since it is the regulatory detail that will deliver change. This document has therefore focussed on the current market and the specific detail of suggested solutions/ realignments. The question on reclassification appears to be a legislative one – is it easier or quicker to effect the desired change by tweaking the current frameworks or by inventing something new? We do not know the answer, however whether or not storage is re-classified we ask that the market failures and solutions presented here are considered.

Summary

In this submission we have identified modest market framework adjustments that we believe are sufficient to unlock investor money and stimulate the development of new storage schemes.

1. Return connection fees to the developer over time
2. Remove double taxation, applying the formula [consumption = import-export]
3. Make logical changes to BSuoS to enhance storage price signals
4. Improve CM de-rating factor for storage to recognise the enhanced role it plays during a stress event
5. Improve Balancing Mechanism transparency by removing the secrecy surrounding bilateral contracts, through making the SO independent or through other measures
6. Consider re-classifying storage if this helps enable better alignment of commercial and public interests

The changes suggested are storage technology neutral and we believe would not require major changes to legislation or add significant cost to consumers. We believe they would bring the energy market into better alignment with the public interest by allowing storage to capture a fairer reward for the unique multiple services it provides.