

To: [energy.security@beis.gov.uk](mailto:energy.security@beis.gov.uk)

Subject: Capacity Market and Emissions Performance Standard review: call for evidence

Email Date-time: 24/9/2018 19:20

Dear Sir/Madam,

Please find below my response on behalf of Wind Farm Analytics Ltd to the consultation "Open consultation - Capacity Market and Emissions Performance Standard review: call for evidence"

<https://www.gov.uk/government/consultations/capacity-market-and-emissions-performance-standard-review-call-for-evidence>

This consultation closes at 11:45pm on 1 October 2018

I hope you may take my views into account. My main message is that the capacity market would be much better aimed at large scale energy storage on a competitive basis per MWh delivered.

Thanks for your work.

Yours Sincerely, Dr Theodore Holtom

1. Do you believe there is a need to maintain the Capacity Market? What conditions would be necessary for the Capacity Market to be withdrawn?

WFA: I believe there is a need to maintain the Capacity Market but in a different format. I think there should be competitive auctions for MWh energy storage capacity support, not MW support. Additional MWh energy storage support will facilitate the UK making more use of its ample renewable energy resources. This will increase energy security and reduce prices for the consumer. At the moment we have a ridiculous situation where lithium batteries are providing energy storage but they are far too small in capacity, can deliver only for a few minutes and far too expensive. We need an energy storage support mechanism that will encourage competition between energy storage units including pumped hydro which is approximately one hundredth of the price per MWh compared with lithium batteries and can offer many hours and days and weeks of delivery rather than just a few minutes – this is what is needed to match the UK wind and solar resource.

Therefore please withdraw the present capacity market in the present conditions and replace with a new capacity market reserved specifically for large scale energy storage which is what the UK grid badly needs.

2. Do you believe the current objectives of the Capacity Market remain appropriate?

WFA: No. They are letting down the consumer and they are hindering the energy security of the UK and they are hindering the decarbonisation of the UK energy system and they are letting down the consumer because they do not encourage competition between energy storage options including pumped hydro on the basis of price per MWh.

3. Do you think the arrangements outlined in section 3.1 are adequate to ensure sufficient capacity is secured through the auctions to deliver security of supply?

WFA: No. They are bloody stupid and its obvious. Surely we all know that there are many Gigawatt of wind and solar capacity on the UK grid? Surely we all know that renewable energy depends on the weather and one may have many dark short days in winter when solar offers little output and we may have many still days in summer when wind offers little output. It is also obviously possible that

solar and wind output can be low for a whole week. Therefore any school child could understand that we need large scale energy storage such as pumped hydro which could provide 10 or 40 GW for one week. This means that we can store excess wind or solar energy when it is not needed and deliver it when it is needed. No need for interconnectors or gas trade with hostile counter-parties. Just store the UK's ample renewable energy in a cheap and efficient way for the benefit of the UK consumer and also for UK industry and commerce. Please note that the world's biggest lithium battery may be of the order of 200 MWh of energy storage which would store 40000 MW slightly more than UK average demand for around 18 seconds. However it is perfectly feasible from an engineering perspective to build some meaningful strategic infrastructure in the form of pumped hydro facilities to store 40 GW for one week (168 hours) which is 6.72 million MWh. The fact is a single pumped hydro facility can store 100 or 1000 times more energy than the world's biggest lithium battery. We would only have to use a tiny fraction of the UK valleys and hillsides in order to obtain 100% renewable electricity grid. Open up the auctions to all forms of energy storage of course on a cost per MWh basis – pumped hydro will win hands down right now whilst the door will be open to innovation.

4. What are your views on the split between the T-4 and T-1 auctions and the amount of set aside?

WFA: No comment.

5. Has the Capacity Market been successful in supporting investment in capacity (new and existing), both directly and indirectly? If not, please identify any changes that need to be made.

WFA: No. It has been useless since it does not do the most important thing of incentivising pumped hydro cheap, green, non-polluting, home-made, tried and tested, efficient, strategic energy storage such as pumped hydro. The changes which need to be made are to introduce auctions of large scale such as 10000 MWh energy storage capacity where developers make their competitive bid on the basis of support needed per MWh capacity (note that MegaWatt.hour or MWh is the unit of energy which is of course different from MegaWatt or MW which is the unit of power capacity – the point is that energy storage offers power over a corresponding time period such as one hour and this is important if we have no wind for that one hour).

6. Do the current 1,3 and 15 year agreement lengths support investment in capacity and do they deliver against the objective of cost-effectiveness?

WFA: Short terms support mechanisms are not strategic. Pumped hydro developers need support sufficient to encourage long term assets such as pumped hydro which will deliver for the benefit of the UK over many decades such as 50 or 100 years, not like the short lifetime of lithium batteries which will die/lose efficiency after perhaps 6 years of daily cycling. Lithium batteries are fine for other things like electric vehicles but for bulk energy storage that's crazy! A 15 year support mechanism should be sufficient for pumped hydro investment. The support should be in the form of a MWh support payment (fixed at auction win) per metered MWh delivered during the 15 years – no money up front, no cost to taxpayer up front – and the asset owner must be free to trade the energy storage asset so they can continue to earn revenue in addition to the support payment and in response to market signals. They will deliver energy when its most needed and they will store energy when its least needed. This also means that hundreds of millions of pounds of curtailed UK wind energy will be stored instead of being dumped as is the case right now.

7. Should penalties be adjusted to strengthen incentives for delivery during stress events? If so, how should penalties be adjusted? Please provide a view on the methodology and factors to consider when setting penalties.

WFA: I'm not sure. I would have thought the market price signals should incentivise delivery during stress events and if the market is failing and cannot be made to succeed then we might as well nationalise the whole grid.

8. Do the current arrangements relating to credit cover and delivery milestones provide sufficient incentives / assurance that capacity will be delivered, with particular reference to DSR?

WFA: No comment.

9. Do the termination events and fees need to be adjusted to create the right incentives for delivery? If so, how? Please provide evidence to support your views. Please provide a view on the methodology and factors to be considered.

WFA: No comment.

10. Do any other changes need to be made to ensure delivery of capacity by the different types of technology? Please provide evidence to support your views.

WFA: Capacity auctions should be won on the basis of who bids the lowest required support per MWh capacity. Provided the auction capacity is meaningful such as 10000 MWh then cost effective clean long-life efficient non-polluting home-made pumped hydro energy storage can be allowed to compete. It would be possible to put a minimum time delivery requirement on the auction entrants such as one hour or 6 hour continuous running capability. Some evidence that we need more pumped hydro (or other large scale energy storage if it can compete on price per metered MWh delivered) would be the wasteful curtailment of UK wind farms which can be more than a million MWh of free UK green energy which is dumped every year – worth around £100 million in itself, although there is much more value than this in having large scale flexibility of pumped hydro (or other) energy storage to match our UK wind and solar assets. Please note that it will be possible for National Grid to recommend grid regions for the auction boundary such as "Southern Scotland" connection in order that the energy storage is deployed in a strategically meaningful way. By locating large scale energy storage strategically by regional auctions we can also recognise regional factors such as lithium batteries or other technologies may be more sensible in flat locations without significant hills and that wind farm curtailment, particularly wasteful in Scotland, could be addressed by regional auctions in those areas.

11. To what extent does the CM design ensure capacity resources are used in the most effective manner during stress events? Do you have any ideas on how it can further be improved? Please provide evidence to support your views.

WFA: No comment.

12. Do the de-rating factors correctly recognise the contribution made by different technologies to security of supply? What changes need to be made? Please provide evidence to support your views. For questions on interconnector de-rating, see Section 4.2

WFA: Scrap the de-rating factors entirely. They are not useful. Make sure that any support is paid according to the metered MWh delivered. This is the true measure of effectiveness of a generating unit in supporting security of supply.

13. Do you think there are there sufficient safeguards in place to reduce the risk of over-procurement? If not, what changes could be made to further reduce the risk of over-procurement?

WFA: No. We are over-procuring useless generating capacity from the wrong type of units. The changes we need are complete change of capacity market. We need to introduce ENERGY STORAGE capacity market auctions for procuring competitive energy storage MWh capacity in the grid-strategic regions where it is most needed to manage the UK's vast cheap but variable natural resource of wind energy and solar energy.

14. Do you believe that the auctions have been sufficiently liquid to date and to ensure strong competition? If not, how could we improve liquidity and competition? Please provide evidence to support your views.

WFA: No comment.

15. What further changes are needed to better facilitate the participation of new, innovative or smart technologies, including from DSR, in the Capacity Market? Please provide evidence to support your views.

WFA: As stated previously the single most important thing would be to introduce a large scale energy storage capacity market auction open to all types of energy storage including pumped hydro or innovative alternatives. The auction must be competitive on price for the consumer so tried and tested reliable technologies such as 100-year pumped hydro will win. It does not make strategic sense to risk all of the UK energy security on unproven innovative technology but perhaps it would be possible to ring-fence 5% of the MWh auction capacity for innovation projects? The problem would be how to assess whether the innovative proposals have merit enough to qualify – maybe this could be assessed by InnovateUK or UKRI in order to pre-qualify innovative technologies as having some technical viability before they may bid their competitive price into the innovative auction against other innovative proposals.

16. How could we go about allowing augmentation of batteries? Please provide evidence to support your views.

WFA: Batteries are only low scale, low duration, short lifetime, highly expensive forms of energy storage which are suitable for mobile phones but not for grid scale energy storage UNLESS they can compete with pumped hydro on price of MWh delivered at proper grid scale such as 10000 MWh.

17. Please provide any other ideas on how to improve cost effectiveness of the Capacity Market.

WFA: Wind Farm Analytics argues for Energy Storage Capacity Markets to reduce energy storage cost for the consumer via competitive auctions, paid for by Energy Storage Use of System charging which will be of negligible cost to the consumer and most likely save the consumer significantly thanks to the added flexibility and energy security provided to the grid.

<http://www.wind-farm-analytics.com/wp/energy-storage-use-of-system-esuos-charging/>

Energy Storage Use of System (ESUoS) Charging and Energy Storage Capacity Market (ESCM)

This page refers specifically to possible support mechanisms for energy storage within the Scottish government draft Energy Policy <http://www.wind-farm-analytics.com/wp/wp-content/uploads/2017/05/00513324.pdf> under consultation until 30th May 2017. ESUoS and ESCM are here proposed as a means of improving the policy so as to specifically design a workable mechanism to support low cost energy storage deployment including pumped hydro energy storage. These suggestions could also apply throughout the UK and in many other countries around the world...

Firstly please consider that there is a major drawback with the cap and floor concept, which has been mentioned as a possible support mechanism for pumped hydro energy storage investors: The cap and floor pricing which is mentioned without any detail in the draft Energy Strategy may not be so great for pumped hydro and our energy system security because the cap and floor mechanism will end up eliminating price signals. For instance a cap and floor on annual revenue would mean that if the revenue cap is earned by end of March then there is no incentive for the asset owner to operate any further for the rest of the year. In fact the logical asset owner would keep their machines idle for the rest of the year so as to avoid wear and tear and reduce long term O&M costs. If a revenue floor is set too high then the asset owner may not operate their machines at all. If a revenue cap is too low then it will disincentivise investment. If a revenue floor is too low then it might as well not be there. If a revenue cap is too high then it does not protect the consumer as intended. The setting of appropriate cap and floor levels is an arbitrary and risky approach.

We must support investors but ensure response to market price signals all year round:

Wind Farm Analytics agrees that we need to assist with long term certainty for energy storage investors because the present market is not delivering cost effective large scale energy storage such as pumped hydro which has long construction times before revenue flows as well as uncertainty in future market price conditions. We need a support mechanism which assists competitive investors to deploy large scale energy storage but leaves them free to trade in the market where price signals will encourage the competitive deployment of energy storage. The great thing about energy storage is that it responds very well to market price signals and system need – when price is low then energy storage will store and when price is high then energy storage will deliver.

Competitive auction rounds lowering cost for consumer:

Government wants to deliver value for the consumer and a suggestion of how to achieve this is to employ competitive auction processes and large scale Energy Storage Capacity Market (ESCM). The auction should competitively minimise the required support price per MWh of energy storage capacity. It is also important for renewable energy generator owners and achieving decarbonisation targets that we deploy the cheapest energy storage, otherwise renewable energy generators may suffer reputational damage by being blamed for grid instability and higher costs for the consumer thanks to unnecessarily expensive energy storage (such as large scale lithium batteries, although these may have their place for some specific services such as enhanced frequency response which already had its own auction). Note that a cap and floor system cannot be deployed in a fair auction-style competition because an auction competition requires a single price parameter (such as support

price per MWh of energy storage capacity) whereas cap and floor together constitute two prices. A competitive auction should establish who will build the energy storage for the least investment support per MWh of capacity.

Multiple auction rounds allow adjustable strategic planning:

The possibility of multiple auction rounds enables whole system long term strategic planning for energy security and accommodating existing and future renewable generators on the grid, as well as enabling electrification of heat and transport. A first round in 2018 might call for 1000 MW x two days storage duration = 48000 MWh energy storage capacity. A second round in 2019 might call for 3000 MW x 48 hours = 144000 MWh. A third round in 2020 might call for 6000 MW x 48 hours = 288000 MWh. In this example we would then be able to handle 2 days without 10 GW of wind capacity. Its just an example and grid strategists could obviously tune it as required. There is certainly a need for large scale bulk energy storage as demonstrated by many of our largest wind farms dumping between 10-30% of their annual energy through curtailment when the grid cannot handle their variability – some of those individual wind farms are dumping many thousands of MWh in a single night which is well beyond the capacity of the world's largest lithium battery, recently reported as 120 MWh.

No money required up front:

What does this cost? Imagine that the average lower (winning) auction price was £5000 per MWh energy storage capacity. We could imagine the winner(s) might be tried and tested, long life (75-100 year), large scale (such as 1000 – 100000 MWh per single installation) pumped hydro energy storage but the auctions can welcome all energy storage methods – if alternative or innovative energy storage systems can be cheaper for the consumer then let them compete in the auctions. Imagine one or many pumped hydro projects were offered to be built for the first auction of 48000 MWh. This would imply the auction winning competitive investors would get £240 million support toward constructing 48000 MWh capacity. Imagine the actual construction costs were £1200 million for 48000 MWh, then £240 million investor support would amount to a 20% capex reduction. No money is required up front! I suggest that the money is paid monthly or annually over ten years of operation. If the support for this 48000 MWh is £240 million then this amounts to £24 million per year for ten years, or £500 annually per MWh of energy storage capacity, paid over ten years.

How would investors be paid?

Energy Storage Use of System (ESUoS) charging can be introduced in proportion to annual metered MWh. So all generators attached to the grid will share equally the cost of energy storage in proportion to their annual energy generation. Transmission and Distribution Network Use of System charges (TNUoS/ DNUoS) are shared by all, so why not energy storage? Energy storage is just as important to our energy security as the transmission and distribution network so lets share the cost through an Energy Storage Use of System (ESUoS) charging system. Also, it is argued that energy storage should be exempt from transmission and distribution Use of System charging, although this is a separate issue. The investors would be paid by the relevant ESUoS funds raised at the end of each year/month of operation (for the first ten years I suggest as a reasonable investor time-line). Most importantly the operational asset owner will trade their asset freely (without any constraint except some basic safeguards such as they must be connected only in GB and not France) in the markets responding to price signals as efficiently as possible to determine whether the unit will store or deliver.

What does it cost?

Let us imagine average GB power is 40000 MW through the year – this is a ballpark figure although may have reduced a bit in recent years. There are 8760 hours in a year so this equates to approximately 350 million MWh of generation. Therefore the annual cost of our first auction of

48000 MWh energy storage capacity would be £24 million shared between 350 million MWh of generation, ie £0.06857 per MWh (less than 7 pennies per MWh).

What effect would this have on consumer bills?

EU statistics show that the GB consumer pays around £165 per MWh. Therefore if this cost was passed onto the consumer directly it would only amount to £0.06857/£165 or 0.042% on the electricity bill. Similarly if we increased the energy storage capacity from 1 GW to 10 GW for 48 hours then the cost would still only be a minor fraction of the electricity bill at 0.42%. This is an insignificant cost considering the benefits.

In fact the increased flexibility offered by large scale energy storage and avoidance of curtailment waste, as well as better utilisation of existing grid, would probably end up saving the consumer considerably. For instance, the Carbon Trust and Imperial College London have produced a report indicating that increased flexibility through large scale energy storage such as pumped hydro could save the UK consumer <http://wind-farm-analytics.com/wp/wp-content/uploads/2016/05/energy-storage-report.pdf> between £2.4 billion per year (equivalent to around £50 savings per average consumer bill) and £7.0 billion per year.

18. What are the main distortions in competition that need to be addressed to ensure a level playing field in the CM auctions? Please provide evidence to support your views and suggestions on how these could be addressed.

WFA: We are socialising transmission and distribution costs by paying use of system charges to regional monopolies. It would be better to socialise energy storage use of system charges to competitive energy storage asset developers and owners. Energy storage CM auctions should be bid on a support required per MWh capacity built or per MWh delivered. We should not be providing support per MW which says nothing about whether the unit is utilised. Large scale competitive energy storage will assist decarbonisation whilst reducing prices for the consumer, overcoming grid bottlenecks and eliminating unnecessary grid upgrades by better utilising the existing network as well as eliminating need for interconnectors with potentially hostile parties.

19. Are there distortions in the interaction of the various markets (wholesale, ancillary, CM) or their charging arrangements which impact the effectiveness of the CM? Please provide evidence to support your views and suggestions on how these could be addressed.

WFA: Of course there are vested interests which are corrupting our markets. They should be blown out of the water by free and open competition. One obvious conflict of interest is the idea that one company may own regional monopoly of transmission or distribution grid whilst managing grid connections of generators including their own generating assets. This can be resolved by prohibiting the ownership or development of generating assets by transmission or distribution network owners or operators. These companies should be encouraged to split out monopoly operations and sell them off. Meanwhile ancillary services should all be openly competitively tendered from qualifying units operating within the existing energy markets with full price publication for all to see.

20. How could the Capacity Market better complement the decarbonisation agenda, whilst still ensuring technology neutrality? Please provide evidence to support your views.

WFA: The capacity market should be for energy storage assets only and the support should be paid per MWh stored energy delivered. This capacity must be selected on a competitive auction basis

which is technology neutral. All technologies should be welcome to participate. Energy storage capacity will certainly support the decarbonisation agenda because solar farms and wind farms will be able to sell their output at a decent price even when energy is not in high demand. These renewable assets will no longer have to be wastefully curtailed. Its obvious that as we get large renewable energy assets on our grid as we already have in the UK – tens of GW then when the wind blows or when its very sunny then the electricity price is driven downward meaning that renewable assets are suffering low electricity prices exactly when they are most productive. This is an unfair market bias against renewables and disincentivises decarbonisation. ENERGY STORAGE CAPACITY MARKETS will resolve this.

21. Should wind and solar be allowed to participate in the Capacity Market? Why? Please provide evidence to support your views.

WFA: Wind and solar should be treated the same as any other generator. A nuclear power station breaks down all the time so its not more reliable than a wind turbine despite the variability of the weather. We should have energy storage capacity markets instead. Then this question becomes redundant.

22. What factors need to be considered to enable renewables to participate in the Capacity Market whilst ensuring security of supply? Please provide evidence to support your views

WFA: The capacity market should be specifically for energy storage and this has benefits for renewables by eliminating curtailment (evidenced by Balancing Mechanism data which shows around a million MWh of wind energy being dumped which could obviously be stored by pumped hydro or other energy storage deployed in the same grid region). Other evidence would be negative correlation of market prices with increased wind speed. Renewables will participate indirectly much better in a controllable grid by complementing energy storage which will store renewable energy when its not needed and price is cheap and deliver when energy is needed and price is high. The renewable generators will be able to get a better price for their cheap energy and the consumer will still get lower prices because of no need to pay for unnecessary grid upgrades and polluting fossil fuel generators as standby. We will have the clean (pumped) hydro power available.

23. What factors need to be considered to enable the participation of hybrid projects in the Capacity Market? Please provide evidence to support your views.

WFA: No comment except they should be treated the same as any other participant.

24. For co-located projects, do you think that all components of the site (both the CM eligible and the non-CM) will be able provide their full capacity during the system stress event due to local distribution or transmission network constraints? Please provide evidence to support your views.

WFA: Yes. Through appropriate metering this should be straightforward.

25. What factors need to be considered when developing the de-rating methodology for wind and solar? What approach could be taken to de-rating hybrid CMUs? Please provide evidence to support your views.

WFA: No comment.

26. What lessons can be learnt from the participation of renewables in other overseas capacity markets? Please provide evidence to support your views

WFA: No comment.

27. Is the current de-rating factor methodology for interconnectors appropriate for assessing their contribution to security of supply? Are there any particular challenges or risks you wish to highlight? Please provide evidence to support your views.

WFA: We should be self sustainable and without interconnectors. We do not need to introduce dependence on outside parties. Build our own energy storage instead. Create some UK jobs.

28. What other factors need to be considered to ensure that interconnectors and domestic capacity providers compete on a level playing field? Please provide ideas on how any issues you have identified can be addressed. Please provide evidence to support your views.

WFA: We should be self sustainable and without interconnectors. We do not need to introduce dependence on outside parties. Build our own energy storage instead. Create some UK jobs.

29. How could we facilitate direct participation of overseas capacity in the future? Please provide evidence to support your views.

WFA: We should be self sustainable and without interconnectors. We do not need to introduce dependence on outside parties. Build our own energy storage instead. Create some UK jobs.

30. To what extent do the current institutional arrangements support an effective change process? Please provide suggestions on how issues can be addressed. Please provide evidence to support your views.

WFA: No comment.

31. To what extent do the defined and allocated roles and responsibilities support effective administration and delivery of the annual processes related to pre - qualification, delivery and payments? Please provide suggestions on how issues can be addressed. Please provide evidence to support your views.

WFA: No comment.

32. Please provide any suggestions you have for improving the management of fraud and error risk. Please provide evidence to support your views.

WFA: No comment.

33. Are there any lessons from overseas capacity mechanisms that could be useful in improving the GB Capacity Market? Please provide evidence to support your views.

WFA: No comment.

34 To what extent has the EPS been achieving its objective? Please provide evidence to support your views.

WFA: No comment.

35. Is this current objective of the EPS still appropriate? Could it be achieved in a way that imposes less regulation? Please provide evidence to support your views.

WFA: No comment.

36. Have any issues arisen in the operation of the EPS which should be considered? Please provide evidence to support your views.

WFA: No comment.