National Infrastructure Commission call for evidence - Electricity interconnection and storage

Response on behalf of the Solar Trade Association

About us

Since 1978, the Solar Trade Association (STA) has worked to promote the benefits of solar energy and to make its adoption easy and profitable for domestic and commercial users. A not-for-profit association, we are funded entirely by our membership, which includes installers, manufacturers, distributors, large scale developers, investors and law firms.

Our mission is to empower the UK solar transformation. We are paving the way for solar to deliver the maximum possible share of UK energy by 2030 by enabling a bigger and better solar industry. We represent both solar heat and power, and have a proven track record of winning breakthroughs for solar PV and solar thermal.

We welcome the opportunity to respond to the National Infrastructure Commission's call for evidence and look forward to working with the Commission on these areas in the future.

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Would you like this response to remain confidential?	No

Introduction

The Solar Trade Association welcomes the creation of the National infrastructure Commission and the priority that is being given to energy in this initial call for evidence. However, we would like to be assured that the Commission is working within national carbon budgets, which may be tightened following the international Paris Agreement. We are confident that solar energy can and will make a huge contribution to the UK's future energy demand. The costs of solar PV have fallen dramatically over the last decade and the technology has established itself as a leading source of renewable energy (indeed its capacity has recently overtaken that of onshore wind). Whilst cost reduction has been the major factor that has brought about this progress (coupled with the support available through government incentives), other key factors include the technology's scalability (from domestic to multi-

megawatt), the speed with which it can be deployed and its popularity with the public – it consistently achieves top ratings (80%+) in DECC's quarterly opinion surveys. Furthermore solar PV generates power free of carbon emissions, has no moving parts and therefore high reliability and can be deployed in a wide variety of situations, from domestic rooftops to marginal agricultural land (where it can complement food production and contribute to biodiversity).

We firmly believe that, with a supportive policy framework, solar power will be able to compete without subsidy within 5 to 10 years. This will occur initially in the built environment, where solar self consumption competes with retail electricity – often known as socket or retail parity. Electricity from large-scale land-based solar is already one of the cheapest forms of renewable power and is expected to compete with new gas-fired power stations in the early 2020s.

For all its benefits, solar is often seen by the incumbent energy hierarchy as disruptive. By its nature solar is a variable energy source, generating at virtually zero marginal cost. It almost universally feeds into the distribution rather than the transmission system and therefore suppresses demand for central generation. Therein lies one of the main challenges, as the UK's grid has been designed for central generation feeding through the transmission then distribution systems to consumers. Accommodating distributed generation requires significant reconfiguration and investment, which should at least in part be socialised to encourage use of these valuable renewable resources.

In her 'energy reset' speech on 18 November 2015, Amber Rudd said the following: "*Some argue we should adapt our traditional model dominated by large power stations and go for a new, decentralised, flexible approach. Locally-generated energy supported by storage, interconnection and demand response, offers the possibility of a radically different model. It is not necessarily the job of Government to choose one of these models. Government is the enabler. The market will reveal which one works and how much we need of both*". Whilst it is true that the market will decide, the ways chosen by the government to enable growth of distributed generation will be crucial to the market's decisions.

Together with wind energy, solar has contributed to significant reductions in the wholesale electricity cost (known as the merit order effect), offsetting its cost to consumers through the Levy Control Framework[1]. Its logical role is to generate as part of a broad mix of technologies, including storage, interconnection and, in the short and medium term, flexible gas-fired generation.

Government has been surprised by the speed at which solar's costs have come down and market deployment has accelerated. Its reaction has been to limit deployment by reducing financial support. The STA published our Solar Independence Plan for Britain in June 2015, setting out solar's potential to achieve up to 25GW deployment by 2020 (from around 10GW now) as well as the policies for achieving that. We would welcome discussing our plan with the Commission as its contents are as relevant now as when it was published.

[1] See the recent report by Good Energy: http://www.solar-trade.org.uk/renewables-bring-down-the-wholesale-cost-of-energy-finds-new-study/

Response to the call for evidence questions

There is some confusion about how the Commission fits into the wider decision-making on electricity sector rules and regulations, which is already highly fragmented. While we would welcome the long-term perspective that the Commission could interject, the questions asked by the Commission on energy are highly specialised and technical and reforms in some of these areas are underway amongst a myriad of groups. There is also general concern about the current direction of UK energy policy in relation to meeting both EU renewable energy and national carbon targets, and which seems to lack understanding of the transformation new technology is enabling in power systems overseas. In general there is widespread concern about energy policy amongst the policy community, and Treasury's increasing involvement in decision-making appears to be taking investors away from a clear low-carbon trajectory. Similarly it is unclear whether the Commission is aligned to meeting UK carbon budgets. This is clearly essential for the credibility of the Commission and its recommendations.

1. 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?

Demand and supply are balanced effectively in the UK by National Grid as the System Operator. The balancing system is extremely reliable. Despite many hysterical headlines about blackouts, a recent ECIU report was able to identify only one outage over the past 10 years, which was caused by a thermal power plant. Faults in power supply typically occur locally in the local distribution networks as a result of strong weather events disrupting power distribution, like the recent flooding. In this regard it is surprising that the Infrastructure Commission has been asked to focus on such a specific market-regulatory area, rather than wider questions about the strategic direction of the power system to guide infrastructure investment. Strategic direction is sorely lacking in the UK. A modern, low-carbon electricity system particularly requires major changes to the business model of Distribution Network Operators to enable much more active management of local networks. This is the issue most frequently cited as severely holding back the modernisation of the UK power system and in our view this should be a key focus for the Infrastructure Commission. Please see our May 2015 internal discussion paper on the strategic needs of the grid, attached to this submission in confidence.

Balancing supply and demand is fairly cost effective. Latest Ofgem data shows that balancing adds only modest costs to a typical household energy bill. Keeping generation to contracted forecasts is not a perfect art for all generation types, but imbalances are small, leaving National Grid with a relatively modest cost for balancing services. These services anticipate the biggest risk to the system which is a single infeed loss, i.e. when a large thermal or nuclear plant suddenly comes off the system. The balancing system needs to be able to respond to this eventuality. According to ECIU there were 900 unplanned failures in coal and gas plant in the first 9 months of 2015. It is not possible for distributed solar output to change this rapidly – even the recent solar power eclipse had a much slower impact on power loss and is predictable years ahead.

Again, contrary to media coverage, where journalists rarely understand how the electricity system works, solar power has very high forward predictability. Because solar is generated on distribution networks, not transmission lines, it appears to National Grid as demand reduction. From discussions with network operators overseas, we understand wind is now forecast with 98% accuracy. Solar is in

many ways easier to forecast as it has a more predictable generation pattern that ramps up with demand – i.e. during the day when demand is highest. Methodologies for forecasting solar output are improving in the same way that they have for wind, but they are already around 93-95% on the continent. National Grid has been surprised by the growth of solar and rather slow to adopt effective forecasting tools, but this should not prove problematic.

Certainly the ambient renewables entering the electricity supply require the system to balance supply sources more carefully, as well as balance supply with demand, but the forward predictability of ambient renewables is relatively easy to manage. EU markets have moved towards greater emphasis on day-ahead markets to ensure marginal cost renewables can be accurately forecast and dispatched. As variable renewables reach higher levels of penetration it is important that the system moves to value flexibility. Renewables can be considered the 'rolling baseload', since the merit order dictates that they will dispatch first. It is important that the system allows this in order to minimise prices for consumers and to minimise carbon, and that other generation can respond to remaining demand needs on the system. There is no evidence that systems are less reliable as result of variable renewables – quite the contrary; Germany and Denmark with high levels of variable renewables boast some of the most reliable electricity systems in the world.

The everyday onus to balance supply with demand is on suppliers who are expected to deliver as contracted and penalised if they fail to do so. In turn a supplier might contract with a solar generator under a Power Purchase Agreement. These can be long-term in nature so the supplier needs to form a view about the likely balancing costs for solar. In practice this premium is low for solar power (lower than for wind), again reflecting its predictable output. Ofgem last year changed the penalties under the Balancing and Services Code, so that there is now a single marginal cash-out price in place of the previous dual imbalance prices. Imbalance risk is set to increase given plans to implement 24 hour switching. There has been criticism of these changes favouring large vertically integrated companies over smaller players (they effectively meant a retrospective change for solar project income). This seems to be a trend under the Significant Review Code, which is monopolised by incumbent industry experts. As was pointed out, changes that disadvantage smaller players is to the detriment of competitive pressures which are in the interest of consumers. The UK electricity market is still characterised by relatively high volumes of positions locked in significantly ahead of delivery and which is still illiquid and lacking transparency.

National Grid has a wide range of tools it can draw on ensure that demand and supply are adequately balanced. There was a lot of coverage recently of the NISM event, which provides an indication to the market that either more demand reduction or more capacity is needed. However beyond this there are emergency measures that can be deployed such as via interconnectors, maxgen and voltage reduction.

The interesting questions for the UK balancing system are:

- how much more emphasis could be put on day-ahead markets
- how could the process around setting rules, as well as the rules themselves, be made fairer and more inclusive for smaller players in order to increase competitive pressures going forward

- how much of the centrally procured balancing services could be more cost-effectively left to the market. Experience on the continent suggests that there is far greater scope to let the market provide solutions, and evidence suggests that this has significantly reduced costs.

Interestingly the German Government, which has a much higher volume of ambient renewables than the UK (though also a higher level of interconnection), is not convinced of the need for a Capacity Market, with a discussion document last year suggesting that flexibility was best left to the market. This STA paper submitted to DECC in August 2015 on integrating solar into the networks may be helpful for your inquiries. This includes discussions with network operators on the continent who tell us they have more flexibility in the markets than they need, and it is extremely cheap to purchase this in the market. What is interesting is how they are merging market operations across countries to enable effective trading of power by whole regions. It is also interesting that they have moved to quarter hourly trading to help improve accuracy balancing supply and demand – this proved very helpful apparently in managing the solar eclipse.

An open market in UK balancing services in future?

The view of some utilities and power experts here is that the UK power market will develop in the same way as Germany's where balancing services have been opened up to the market, rather than being centrally procured by the system operator. This has created a market of aggregators and private balancing services which has significantly reduced balancing costs in Germany – indeed balancing costs have fallen by 50% in Germany since 2008. Denmark also operates a similar system.

Germany and Austria now have quarter-hourly trading products and gate closure for trading is 30 minutes ahead of real time. This means intra-day forecasting is very accurate. These markets were put to the test by the recent solar eclipse, which resulted in 2-4 times the normal variations in solar power output, yet markets proved able to handle this. Traders are now also 'bundling' regional markets in Denmark, Belgium, Holland, Switzerland and Germany, for very cost-effective inter-country trading. The UK is not yet taking part in this.

Traders and grid operators we spoke to in these regions said storage is 'completely over-estimated', even 'foolish', as they already have more cheap flexibility in the market than they need.

What role can changes to the market framework play to incentivise this outcome:

As above, it is likely that much more can be left to the market to provide flexibility instruments to enable cost-effective balancing of supply and demand. However, the Government has now introduced the Capacity Market, which will presumably limit options here. We understand the CM auctions were greatly over-subscribed and have resulted in considerable subsidies to existing coal, gas and diesel plant. While flexibility needs to be valued in the market, there are important questions to ask as to whether this is the most cost-effective, sensible, future-proofed and low-carbon way to deliver system flexibility and security.

Government has not made the decisions it should be making in relation to the extent to which it wants to use nearer-time markets, Demand-Side Response, smart networks, Time of Use Tariffs and interconnectors to better balance demand and supply, or indeed to incentivise a more efficient power system. It is inherently inefficient and expensive to require an entire national power system to be

specified to a fleeting period of peak demand. Introducing the Capacity Market before having made these decisions seems unwise.

Is there a need for an independent system operator (SO)? How could the incentives faced by the SO be set to minimise long-run balancing costs?

We assume by this question, you mean whether National Grid should not be the system operator given much larger interests in transmission network assets. In theory clear independence seems sensible and this is consistent with the EU's Third Energy Package. There is uncertainty about how future networks will evolve and resistance in the UK to new technology. In our view, a modern system will place much more emphasis on active and smart local networks, with solar generation embedded at or near the point of use, which potentially provides considerable savings on transmission networks, particularly as storage becomes increasingly cost-competitive. Distributed power investments will increasingly be made regardless of central government policy, and government would be wise to recognise technology trends. Transmission assets, often reinforced to meet fleeting peak demand, are extremely expensive. Many country-wide analyses undertaken by the World Alliance for Decentralised Energy demonstrate that a much more distributed power system could yield very considerable overall system cost savings. The IEA has undertaken similar analysis. This is an important reason for taking a much more strategic approach to future network development and why we are interested in the IET concept of a "System Architect." A system operator that has vested interests in transmission assets may not be considered an objective stakeholder within a strategic review of system architecture.

However, in practice in our experience National Grid is an extremely well run and professional organisation, with not only a clear corporate responsibility goal to deliver low-carbon systems, but broader international experience of system transformation overseas. The Chief Executive of the National Grid has rightly recognised that solar is 'the new baseload for consumers'. We consider National Grid to be a high quality and responsible company. It is doing a robust job in managing the grid nevertheless intermittent renewables are making balancing and managing the grid more challenging. The STA has lead the way through its grid in initiating discussion, research and collaboration with National Grid. The STA and its members are keenly seeking to be part of the solution to these challenges. The NIC and DECC need to engage with and support these initiatives.

How to incentivise the SO to minimise long-run balancing costs is a regulatory question which we do not feel qualified to answer, however, above we have suggested ways in which this could be done, including through far more liberalised markets in balancing services.

Is there a need to further reform the "balancing market" and which market participants are responsible for imbalances?

As above, the BSC has recently been reformed and in a manner which raises questions about how these decisions are made and ultimately in whose interests. All market participants are responsible for imbalances. Solar imbalances will reduce as forecasting improves. Solar will never be responsible for sudden large disruptions to power supply (barring eclipses), which are more expensive to correct. Interestingly in Germany, which has a lot of solar power, some solar runs below capacity so it can respond extremely quickly to market imbalances elsewhere on the system. The liberalised market itself is providing the incentive to do this, thus pricing the value of flexibility.

There is a difference between day-to-day imbalances and the need to ensure sufficient flexible generation capacity annually for short periods where variable wind and solar output falls short. It is important to recognise this distinction. In relation to managing this, there is a much wider range of tools that UK needs to be making use of including interconnectors, smart grids and DSM, ToUTs and load shifting (please see our longer briefing), rather than procuring more capacity through the CM.

To what extent can demand-side management measures and embedded generation be used to increase the flexibility of the electricity system?

This question is best answered by DSM providers. However, solar power can contribute to the inherent security of the power system. Solar does not leave the UK hostage to geopolitics or sudden fuel price spikes, by virtue of its highly distributed nature it cannot suddenly disappear off the system like a large thermal plant, and it is extremely reliable since there are no moving parts. Solar can also provide a wide range of grid services that have yet to be understood and exploited in the UK, adding to system efficiency and flexibility and potentially reducing the costs of some grid services. National Grid is beginning to recognise some of these opportunities – unfortunately we have had to cancel a joint workshop on this due to pressure of policy changes. Grid services solar can provide include voltage control, system inertia, frequency control, fast reactive power and reducing grid losses. Please see our paper for more details.

2. What are the barriers to the deployment of energy storage capacity?

We are optimistic that in the medium term (3-5 years) there will be a significant amount of innovation, cost reduction and entrepreneurial spirit that the solar industry is famous for applied to storage, in order to make storage a game changer for the energy industry. This view is similar to many other bodies, including the International Renewable Energy Association (IRENA)[2] UBS Bank[3], National Grid[4] and Deutsche Bank[5], who all believe that solar + storage is a future game-changer, but in the timeframe of the next 5 years rather than 6 months.

There are two key areas where storage can add a significant amount of value: at the consumer level and at the grid (distribution/transmission) scale. Both of these applications involve the storage of energy but they are completely different in terms of operators, owners and technology. They are highly complementary as they provide different services: for example, a domestic system could smooth out PV generation throughout a sunny day, while grid-scale storage could provide grid quality services such as fast frequency response or voltage control. Research in the US by the Rocky Mountain Institute found a very wide range of potential services that battery storage systems could provide[6], including grid, utility and customer services. The main conclusion was that additional value can come

[2] https://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_Electricity_Storage_2015.pdf
[3] http://www.theguardian.com/environment/2014/aug/27/ubs-investors-renewables-revolution
[4] http://www.energypost.eu/interview-steve-holliday-ceo-national-grid-idea-large-power-stations-baseload-power-outdated/
[5] https://www.db.com/cr/en/docs/solar_report_full_length.pdf
[6] http://www.rmi.org/electricity_battery_value

from providing multiple services, rather than just one. Batteries are only part of the solution – other technologies such as pumped hydro, flywheels and power to gas can provide similar services.

Research and development into storage is ongoing but it is now innovation in the shape of commercialisation and deployment that need to be focussed on to reduce costs and develop the market. The breakthrough in cost reductions for solar came from the supply chain, not research and development - innovation is not simply confined to a lab.

Other countries are actively developing the skills, markets and industries to be world leaders within storage: particularly Germany and the US. The UK has the potential to be a world leader in storage, with British companies innovating (Powerstation, Moixa, Sunamp). However, they need the right regulatory environment to flourish, otherwise other countries will win the race. The UK, with its old grid architecture, is a good candidate for storage to provide grid services either at the distributed or grid level.

Although financial benefits through subsidies may be one way of incentivising storage deployment in the short term, it is more important to set up **a clear legal and regulatory framewor**k to allow the market to innovate. The things that need to be done are:

- Storage needs to be a clear strategic sector for the NIC – future deployment of solar will depend on it. Start with a strategy building on the work of DECC and Ofgem.

- Clear regulation: storage is currently viewed as both a generation and a demand asset, so there needs to be a classification of storage specifically to stop this. Indeed there appears to be confusion on an EU-wide level as to exactly what storage's status is or should be and this is hampering progress throughout the EU. **Achieving a clear classification for electricity storage within EU legislation and regulations, that can then be transposed into UK regulations, would therefore appear to be the highest priority for the UK government.**

- Specific recommendations that seek to level the playing field for energy storage so as to realise its full value for the grid should be a key strategic focus for the NIC. It is believed that NG and Ofgem are already considering such changes.

- Turning DNOs into DSOs – currently DNOs are unable to procure balancing services as National Grid can, instead they are simply in charge of the operation of the distribution network. This means that they spend a significant amount on new wires and stations, even if by spending a lesser amount they could procure storage or other services that would mean the upgrades were not required. DNOs need to be empowered to be a part of setting up a decentralised energy network which is what the bodies described above are expecting to happen.

Within the Capacity Market, facilitating and incentivising generators to incorporate storage into the grid as part of hybrid wind/solar + storage plant should be an area of focus. Energy storage must be treated exactly the same as for example DSR and not be penalised when it imports power from the grid to charge in readiness for stress events or to peak shift power to the evening peak period. It should be noted that 450MW of DSR was enabled through the most recent CM auction. This, as applied to storage and other low carbon technologies, needs to be more fully encouraged within

amended CM rules. CM rules could also be changed for all participating technologies by enabling shorter-interval discharges of storage during a particularly long stress event and ensuring these are not penalised (or at least more allowance given to hedge power so as to entirely fulfil the CM obligation).

These regulatory changes will set the groundwork for the industry to be able to innovate and develop over the coming years. The UK could potentially become a world leader in this area, but clear signals are required for the market.

There is also the potential for the NIC (or another body like Innovate UK) to sponsor monitored field trials of solar and storage. Some of these are already ongoing at a small scale, but large-scale commercial trials are also required. This could be a cost-effective way of kick-starting a storage market by providing hard evidence of the performance and economics of storage in a range of market applications.

Whilst we cannot comment on or endorse the contents, we would like to draw the NIC's attention to the following report published by UK Power Networks (funded under the LCNF): Electricity Storage in GB: Smarter Network Storage – Recommendations for regulatory and legal framework[7].

We are keen to meet with the NIC to discuss storage further and define how solar and storage can play a part in the future energy mix with a better balance of supply and demand.

3. What level of electricity interconnection is likely to be in the best interests of consumers?

Greater EU market integration reduces both the cost of balancing services and the need for reserve requirements since countries can draw on other grids to balance. The Impact Assessment for the European Electricity Balancing Market[8] estimates greater system integration will result in €3bn per annum of benefits and 40% potential reduction in reserve requirements, including €51m benefits from UK-France balancing. The most recent report for the European Commission recommends that the UK needs greater interconnector capacity[9]. For example, the UK can import just 5% of peak demand capacity compared to Belgium on 43%. The UK currently has 4GW of interconnector capacity, with an indicative target in Europe for members to reach 10% of peak capacity by 2020. We understand the 5 new interconnector projects in train would deliver a further 7.5GW of capacity. National Grid's most recent Future Energy Scenarios notes that the investment climate for interconnectors has improved. Government's own analysis shows greater use of interconnectors has the potential to save consumers £9billion to 2040[10]. Traders we spoke to said that expanding the market base through interconnectors is the key way to keep the costs of renewables expansion low. Power peaks in Germany, France and Norway do not coincide with UK peak demand, so there is good potential to securing peaking capacity this way.

Clearly improving interconnectors is in the interest of consumers and for the realisation of a low-carbon power system. This is why interconnectors are such a focus of the EU's new market design, which seeks to

[7] http://innovation.ukpowernetworks.co.uk/innovation/asset/bfd24073-a7a4-44cd-b492-7cbb588e7bfO/SNS_ElectricityStorageRegulatoryFramework_SecondReport_v1.0+PXM+2015-09-30.pdf
[8] https://ec.europa.eu/energy/sites/ener/files/documents/20130610_eu_balancing_master.pdf
[9] http://ec.europa.eu/energy/sites/ener/files/documents/2014_countryreports_unitedkingdom.pdf
[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266460/More_interconnection_-_improving_energy_security_and_lowering_bills.pdf

optimise value for consumers and take advantage of new technology. It is surely in the interest of British consumers to catch up with, and ensure consistency with, market reform across Europe. We understand further EU electricity market design proposals are expected later this year.

4. What can the UK learn from international best practice in terms of dealing with changes in energy technology when planning to balance supply and demand?

Please see the examples cited above and in our referenced paper. In addition to examples of more liberalised balancing markets in Europe there are growing examples of smart grids internationally e.g. in the USA, China, Korea, Mexico etc. We recommend the IEA's International Smart Grid Action Network: http://www.iea-isgan.org/?c=395/397

For a very long time electricity networks have been exceptionally un-innovative. For decades they have operated under Rate-of-Return regulations, which reward investment in passive system assets. Distributed solar power is transforming how electricity systems work and who owns generation assets. Solar enables consumers to be producers and, combined with developments in information technology, enables the development of local smart grids. While solar is perceived as disruptive by the incumbent industry, at the level of the local grid solar is a unifying technology that puts consumers, power, storage, IT and electric vehicles at the heart of the power system. Smart grids are now a key international area for technological innovation. Much of the UK's energy infrastructure is now aging and in need of replacement. This is therefore a critical moment to make strategic decisions about the future of the UK power system. We hope the Commission will recommend the UK adopts a clear strategic vision consistent with the rapid technological change climate change demands and with international best practice.