7th January 2016

To: Sir John Armitt, Commissioner of the National Infrastructure Commission

From: Angus Macdonald, CEO British Solar Renewables

Re: Call for Evidence

Dear Commissioner,

I am responding to your call for evidence, launched in 2015, on Electricity and Storage.

I am proud to lead British Solar Renewables, the largest integrated developer and operator of PV systems in the UK. Since our inception with three employees in 2010 we have developed, delivered and now operate 400MW of PV capacity, representing an investment of around £500m in that period.

Our view is that while the UK faces significant challenge in the energy "trilemma", the advent of new technology offers huge opportunity. Our fear, based on experience, is that the speed of technology and business innovation will far outstrip the ability of traditional central-generation thinking, network management and regulation.

BSR has specialised in delivering large scale projects, including 130MW on government property at RAF Lyneham and RAF Wroughton. We have procurement and joint-development links into China, including with CNBM (China National Building Materials), with whom we are working on the integration of energy with housing and commercial property on repurposed brownfield land.

With Western Power Distribution we are in the process of delivering what we believe will be the UK's first demonstration of a grid-integrated PV and battery storage system under the Network Innovation Allowance scheme. We are also working very actively with a number of UKplc customers on the development and integration of "behind the meter" generation and storage.

Two themes which commercial customers are bringing to us are their concerns about the rising cost of grid power, and the risk of grid outages or very high peak pricing.

We believe that those concerns are real, and that we have an unusual perspective on the energy market because:

- All of our projects have been developed and delivered very quickly relative to their operational life and level of investment; we nevertheless to achieve over 99.5% availability on all of our sites
- We have had to build strong working relationships with the major DNOs and understand the technical, financial and regulatory constraints within which they work
- We work with the major suppliers of PV and Storage worldwide, and are increasingly engaged in project delivery outside the UK
- We have developed a deep understanding of the drivers of the cost of grid power in our engagement with commercial customers, frequency response aggregators, and funders of embedded generation and storage

I hope that our views are useful to your Commission's work. We would be delighted to engage further in what we see as a vital part of developing the UK's economy and competitiveness.

Yours sincerely,

Angus Macdonald

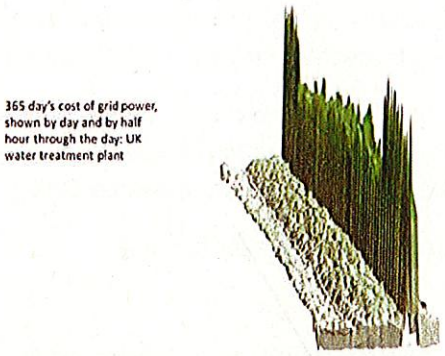
1. What changes may need to be made to the electricity market to ensure that supply and demand are balanced, whilst minimising cost to consumers, over the long-term?

Underlying Drivers

We believe that to answer this and subsequent questions it is first important to understand the drivers of change in today's energy market and systems.

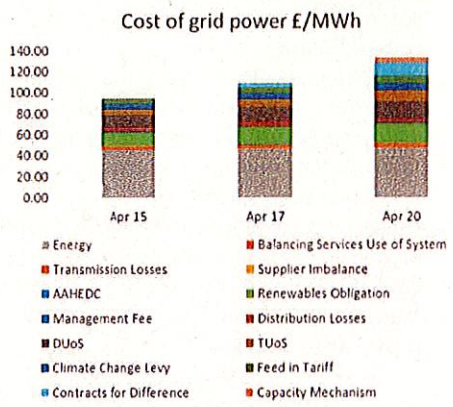
We identify the following:

- The cost of energy generation and supply will continue to be driven by the cost of peak periods (see chart)



365 day's cost of grid power, shown by day and by half hour through the day: UK water treatment plant

- The cost of delivered grid power will rise, not just to 2020 but also beyond, and will increasingly be biased towards 'system' charges (tax, TNO & DNO charges) and away from the underlying cost of generation



- The cost of distributed generation and storage will continue to fall to the point where subsidy of PV is not required; commercial battery storage is a fundable proposition today without tariff support
- Falling costs for distributed generation, rising charges for gird power and the fear of supply failure will spur the widespread adoption of embedded (behind the meter) generation, especially by the commercial sector who face larger impacts from loss of supply
- Reducing levels of fossil-fueled, rotational generation will bring a rising need for frequency management across the grid

Given that background of on-going change, we strongly support the objective of reducing the cost of managing the energy system to consumers through long-term planning and evolution of the system.

We strongly advocate the deployment of new energy technologies, and adapting regulation to encourage technical innovation and to enable a level playing field. We believe that the energy industry can achieve a balance between central planning and de-regulated delivery which is optimal for consumers.

Limits of Regulation and Central Governance

Having managed our business through four years of tariff support, we are however very familiar with how rapidly the changing cost of technology can outstrip the ability of central regulation to respond. We believe that the risk of over-investment in stranded, centrally governed assets is very significant (for example, over-investment in TNO-connected storage, as explained below).

We also believe that the current system of network and supply governance is prone to entrenched interests and is resistant to change. This underpins our support for development, for example, of a DNO type-testing facility at the Berkley College

Extract from submission for funding:

1. The UK is undergoing very rapid change in its mix of energy supply. As a de-regulated energy market and an early adopter of un-schedulable renewables, the UK market is now potentially in the vanguard of countries developing the technologies to deliver ever-lower carbon intensity.
2. This change is being forced onto a system of National Grid and Distribution Network Operators who are supplied by a relatively small pool of equipment suppliers: many global energy equipment businesses have focussed on HV (132kV, 400kV) generation and Transmission equipment, and have moved away from lower-voltage (11kV, 33kV) Distribution equipment supply.
3. The suppliers who have remained in the market have over time established scale and other barriers to entry, including operation of their own test facilities. The UK does not currently have a supplier-independent test facility for DNO voltage equipment.
4. Many of the changes to our grid systems will principally impact and will require investment in the DNOs' networks:
    a. PV is already DNO biased and will continue to grow at this level as it is installed on commercial and domestic roofs
    b. Battery storage and the charging of electric vehicles will follow the same pattern
5. Systems which we can anticipate being needed by grid operators, or demanded by consumers, include:
    a. Advanced switchgear (or cheaper versions of existing equipment)
    b. Storage-integrated DC:AC inverters (paired with PV generation)
    c. Rapid electric vehicle charging stations
    d. Distributed demand and storage management systems (linking multiple homes and commercial sites)
    e. DNO integrated and secure data capture and control systems (SCADA)
6. Because of a limited supply base for DNO grid equipment, the UK is faced with delay, a lack of innovation and higher prices for these types of equipment. It also faces, potentially, losing the opportunity to establish standards and export systems, equipment and expertise to the many countries worldwide (including the Commonwealth) whose electrical systems are very similar to those in the UK

The UK has successfully navigated a similar fundamental and technology-driven change in its infratsructure in the recent past, in the deregulation and digitisation of the telecommunications industry.

We take three lessons from the telecoms revolution:

- Embracing technology can yield huge dividends: growth of the de-rgulated City of London was dependent on (also de-regulated) digital telephony and data networks
- Telecomms systems are regulated by interface protocols, which maintain service while allowing separation of the roles of carriers (similar to energy networks), service providers (similar to generators, storage operators) and network administrators (DNOs, TNO, SO)
- The telecoms system in the UK has become increasingly complex and now offers levels of connecitivty and service which were never anticipated when the original interfaces between the above players were established; nevertheless the same structure has survived and service has been maintained (although the interface protocols have themselves changed beyond recognition)

<u>Answers to questions</u>

- What role can changes to the market framework play to incentivise this outcome:
    - Q: Is there a need for an independent system operator (SO)?
    - A: A large proportion of the changes to our system are and will be driven by changes in the cost and scale of generation and storage. These are DNO-level changes, as new capacity will be connected to the grid on the consumer's side of the meter while fossil-fueled central capacity is retired. The role of a System Operator should be to:
        - Project the rate of change of demand, and of the deployment of new technologies
        - Establish clear boundaries, and develop the roles and responsibilities (for frequency management, imbalance, generation) between DNOs and TNOs
        - Monitor and administer performance at those boundary points
        - Encourage minimum cost solutions, innovation and new technology adoption
    - The SO should not seek to guide investment, but should allow network operators to incentivise the deployment of technologies on their networks, providing a clear business case is demonstrated and services such as generation or frequency management can be delivered on a commercial basis. Cases for investment by TNOs should be compared with those presented by DNOs.
    -

- The balance of investment in for example storage should be on DNO networks as embedded batteries can provide a greater range of services, and therefore realise greater value, from the lower end of the system
- A role which is lacking in the current framework is the near-medium term projection of demand patterns and generation capacities. In an environment where embedded, deregulated generation is expanding, storage is rising and new loads such as electric heating and transportation are rising, network operation is out-stripping regulation. As a first step toward more effective regulation and as a guide to investment, a regularly revised view of where power is coming from, how it is being used, the volatility of balancing would be extremely powerful. This can be seen as an evolution of the existing pathways work, recognising that we are some way down the path to transition already.

- Q: How could the incentives faced by the SO be set to minimise long-run balancing costs?
- A: We do not see that a SO is best established as a commercial entity, rather that the SO role is an evolution or a replacement of existing system administration. We do see that a broader range of experience, not biased towards 'legacy industry' experience, is important in embracing change and overcoming obstacles through innovation as opposed to over-investment.

- Q: Is there a need to further reform the "balancing market" and which market participants are responsible for imbalances?
- A: Imbalance between supply and demand is a cost to all consumers. It may be appropriate, given rising levels of distributed generation, to extend imbalance management to smaller scale generators on a transparent basis. Aggregation of distributed generation, for the purpose of imbalance management, would be one way to encourage new approaches from asset operators.

- Q: To what extent can demand-side management measures and embedded generation be used to increase the flexibility of the electricity system?
- A: We see widespread adoption of embedded generation and storage within the next 5 years, as costs fall and prices rise. That brings huge scope for the expansion of these services. If encouraged in the near-term, we see that adoption in turn encouraging innovation and development of new technologies and business models, with potential for export worldwide.

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

- Q: Are there specific market failures/barriers that prevent investment in energy storage that are not faced by other 'balancing' technologies? How might these be overcome?
- A: We can identify three barriers to adoption:
    - Entrenched interest in existing technologies and relationships
    - Lack of clear standards (protocols) for interconnection and operation
    - Lack of opportunity to monetise the services which embedded storage can provide to DNOs, TNOs
- As an example there is a risk that the TNO, driven by traditional thinking and a desire to expand its asset base, over-invests in under-utilised storage and as a result kills the market for services to be provided by embedded storage.
- Any investment by monopoly players (TNOs, DNOs) in equipment such as batteries for Fast Frequency Response, should be tested (via open contract tender or another mechanism) against the open market/deregulated business case for investment

- Q: What is the most appropriate scale for future energy storage technologies in the UK? (i.e. transmission network scale, the distributed network or the domestic scale.)
- A: We reference the work of Professor Goran Strbac at Imperial College London in quantifying the difference in value between distributed and centrally-connected storage and believe that embedding storage is by far the cheapest way of enhancing our energy system.
- We do understand that multi-purpose batteries are potentially more expensive than single-application batteries but believe the world market for storage will continue to drive down costs for the most valuable equipment.
- We anticipate rapid adoption by Industrial and Commercial customers, together with rising adoption by domestic consumers over time

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

- Q: Is there a case for building interconnection out to a greater capacity or more rapidly than the current 'cap and floor' regime would allow beyond 2020? If so, why do you think the current arrangements are not sufficient to incentivise this investment?
- A: We believe that interconnectors should be developed, but that they should not receive favourable funding or support relative to other means of achieving the same goal.
- Q: Are there specific market failures/barriers that prevent investment in electricity interconnection that are not faced by other 'balancing' technologies? How might these be overcome?
- A: We cannot answer this question.

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?

- A: We believe the parallels between the management of change in telecommunications within the UK offers a strong guide to the management of:
    - Roles of players in order to encourage innovation and competition
    - The power and interests of incumbent players
    - Advancing technologies and evolving consumer needs