## To whom it concerns,

Please find below Dunelm Energy's response to the National Infrastructure Commission's call for evidence, Section 4: Electricity Interconnection and Storage.

*Dunelm Energy was set up by Ian Marchant after he left SSE (CEO 2002-2013). The company provides advice, assistance and connections to companies and individuals involved in the disruptive changes in the Energy Industry (http://www.dunelmenergy.co.uk/home.html).*

Response: (embolden text highlights key messages)

## Executive Summary

The physical nature of our energy system is changing, rapidly. As we decarbonize, not only do we drastically reduce the **flexibility** and **resilience** within the system (by removing existing energy storage in the form of fossil fuel stocks), we simultaneous increase our demand for electricity (through electrifying heat and transport). The situation exacerbates - we increasingly demand more flexibility and resilience from the very system within which it is rapidly reducing. **Instead of continuing to see the system as supply side driven, we need to appreciate the importance of demand-side management and energy storage, particularly at the distributed residential scale.** So far we have only scratched the surface in terms of using available assets. We must put needs before technology – assessing our current and future needs for resilience and flexibility, and then deciding how, at what level in the system and which approach/technology is most appropriate.

Key concepts included here:

- Negative capacity market
- Quantifying the extent to which demand-side management and energy storage, located at the residential level, can dramatically reduce the nation's peak electricity demand.
- Energy efficiency feed-in tariff
- Demand side merit order
- Smart voltage appliances
- Restructuring the ownership model of the ISO, eliminating the need to set incentives at all and encouraging long rather than short term strategy

## Introduction

We don't realise the vast extent to which energy storage currently, and always has, played a role within our energy system. If we look in some detail at what these ***existing*** **forms of energy storage** are – see Figure 1 – we can see that the amount of latent energy storage already in use is not only **colossal** but overwhelming dominated by **fossil fuel stocks** (primarily in the form of coal, petrol and gas stocks).

It is this that has and does provide the electricity system with **flexibility** and **resilience**. We believe that it is useful, indeed necessary, to define energy storage in conjunction with providing these two services. Society wants flexibility and resilience, and *uses* energy storage to deliver these two requirements.

**Traditionally** the relationship between *electricity* demand and supply (often the focus of the energy ecosystem) has been almost **entirely managed by the supply side**, through the ability to produce it on command; generators are called upon to alter output and are able to respond by simply feeding more or less fuel into their power stations. The UK system relies upon this approach to provide back up, fast response capacity, removing the need to store electricity and instead physically stock piling the original fuel source required.

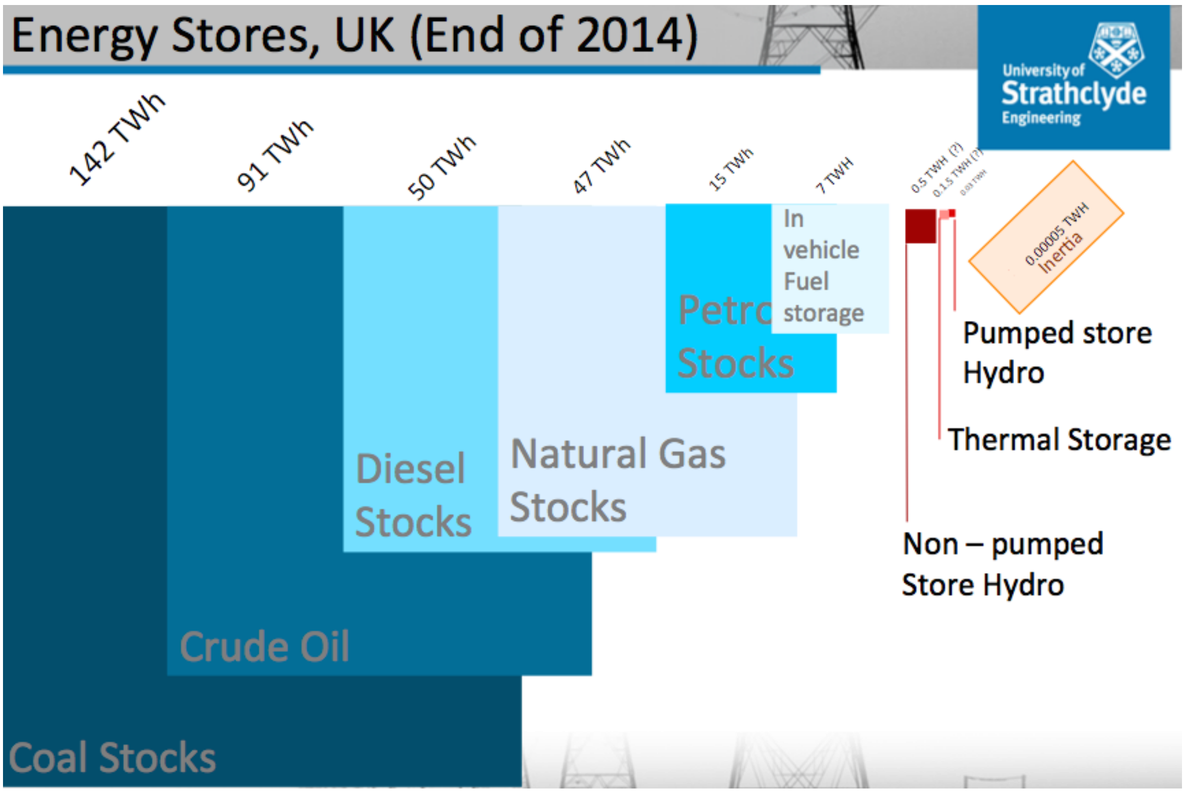


*Figure 1 (Simon Gill, CEP, Strathclyde University)*

The physical nature of our energy system is however **changing, rapidly**; with the exception of biofuels and to some extent hydropower, low carbon energy sources do not allow the level of energy produced to be dictated. As we **decarbonize**, not only do we drastically reduce the flexibility and resilience within the system (by removing existing energy storage in the form of fossil fuel stocks), we simultaneous increase our demand for electricity (through electrifying heat and transport). This **exacerbates the situation** as we demand more flexibility and resilience from the very system within which it is rapidly reducing; we will be faced with less of what we need, just when we start needing more. What will happen, for example, when our electric car battery needs to be recharged at the same time as our heat pump needs to work and we want all our lights and gadgets to function, but it is a still calm night?

**Demand-side management and energy storage are ways of addressing and alleviating this.**

Thus far short term tactical reactions have characterised the response to balancing electricity supply and demand. For example, both the capacity market and more recently enhanced frequency response has failed to address strategic questions, such as how much energy (all energy, not just electricity) we will actually need, what resilience we should expect in the provision of that energy and how much flexibility we will demand. This analysis should take a long term view of between 10 and 30 years, and will need to consider the degree of electrification that may occur.

As we face the challenge of future-proofing our energy infrastructure, we suggest three steps:

1. A **strategic assessment** of **long term needs**
2. An Independent System Operator that thinks long rather than short term
3. A realisation that the demand side is nearly entirely missing (inefficient scheduling of demand does not count). Why efforts are not being made to make sure it is considered on an equal footing to the supply side baffles us. Why is there no negative capacity market for example?

## Demand-side management

Instead of continuing to see the system as supply side driven, we need to appreciate the importance of the demand side. **So far we have only scratched the surface in terms of using available assets**. This must be expanded, eventually giving the demand side an equal footing to the supply side. Otherwise the best options will not be selected, nor the best solutions implemented. Costs certainly will not be minimised, especially in the longer term.

Appendix 1 illustrates that equipping and incentivising just ~345,000 households to shift 1.7kWh of electricity consumption (15% of average daily demand) from the evening peak to other parts of the day can reduce *national* peak demand by an incredible 10%. We estimate that the total private cost of doing so equates to ~£52m/yr (with a kWh/yr cost of £89). Comparing this to the £1.53bn forecast to be spent on improving the network per year between 2013-2021, this clearly shows that the equivalent of a very small proportion of spend (3.4%) could be directed towards a very manageable and targeted amount of DSM.

DSM can be realised through (1) **informing** behavioural change, (2) **controlling** and/or (3) **automating** assets.

The Green Alliance's *Getting More for Less: realising the potential of negwatts in the UK electricity market* report is an excellent piece of analysis, that proposes the implementation of a new support mechanism for energy efficiency. Please take the time to look over the document (attached), which suggests that a new strategy should seek to enable the development of business models based around **aggregating the delivery of energy efficiency measures rather than assuming that their cost effectiveness is a sufficient motivation**. The implantation of a feed-in tariff (FiT) is recommended, such that suppliers are paid per kilowatt-hour of avoided use. While DECC is wary of FiTs given the difficulties controlling spending within the existing scheme, an auction mechanism like contracts for difference, rather than demand-led pay-outs, would prevent runaway spending. It is estimated that the total cost of an energy efficiency FiT would add around £1.1bn to the Levy Control Framework by 2030, but it would reduce demand by 6.4GW and therefore lower electricity bills by £4.8bn overall. The report states that, even with the conservative assumption that, of the potential savings by 2030, an electricity efficiency FiT resulted in just half being realised by 2025, this would still represent a net saving of £2.4bn off consumers' bills by that time. This would take the net impact of the LCF to only £6.6bn on customers' bills by 2025, as opposed to the £9bn already recommended by the CCC. Further, levelling the playing field in the capacity market by "generating" negawatts would, by the report's calculations, save almost £4bn in capital investment. There would also be additional savings from avoided operation costs and deferred investment in transmission and distribution infrastructure.

Producing a **Demand Side Merit Order**, just like we have with the supply side, is another suggestion – a long held view on how to improve the balance of electricity demand and supply. As energy economists are already familiar with the Levelised Cost Of Electricity produced for base/mid merit/peaking plant in £/MWh, adopting the same approach to cost the equivalent Levelised Cost of Electricity *shifted/stored* at consumer/distribution/transmission level in £/MWh should be investigated further.

## Energy storage

Debate about energy storage tends to get dominated, right from the start, about technology; be it batteries, phase change material or pumped storage hydro. Instead, and foremost, we need to separately **assess our current and future needs for resilience and flexibility**, *then* **decide at what level in the system that need can most efficiently be meet** and only then determine the choice of technology. **We must put needs before technology**.

We see 4 levels at which energy storage can be deployed:

1. Household
2. Community / local substation
3. Generator
4. Grid

We believe there is **too much focus on large scale** (third and fourth levels). It is **increasingly possible to position energy storage at the smaller**

**distributed end**, rather than relying on fewer centralized schemes. Of course the need for aggregation is introduced here, but it need not be as daunting as some clearly find it. The following bullets explain how both resilience and flexibility can be achieved at the smaller end of the scale:

- **Variable voltage appliances** – the influence of digit and smart technology is a key enabler. Introducing a simple regulatory measure such that all appliances must be fitted with a variable voltage chip could provide the electricity system with an enormous amount of **flexibility**. DECCs *Towards a Smart System* report already highlights that automated voltage control through the use of power electronics can play a key role in increasing flexibility of our existing network infrastructure cost-effectively. We illustrate (in simple terms) that if grid voltage dropped and as such current increased proportionally, a smart kettle could prevent this by increasingly the time taken to provide the same amount of energy to heat a fixed volume/temperature of water. If for example the voltage dropped by 10%, the time for the kettle to boil would increase by a similar proportional amount ~3:20 rather than 3mins. Ultimately, the appliances could have variable voltage performance (dynamic rather than fixed response) providing real-time active support to the system rather than adding to the system inertia, that would hardly be noticed by customers.
- We estimate that 5 – 6kWh of energy storage is required to give the average household 24hrs of effective electric energy **resilience**[1]. Appendix 1 explains that installing 2.5kWh of energy storage capacity in ~233,000 households, at a direct private cost of ~£76m/yr (£130/kWh/yr) could reduce *national* electricity peak demand by 10%. Installing a 7.5kWh unit in ~83,000 properties would deliver the same result at a similar cost of ~£79m/yr (£136/kWh/yr). Comparing this to the £1.53bn forecast to be spent on improving the network per year between 2013-2021, again shows that the equivalent of a very small proportion of spend (~5%) could deliver very significantly at the grid level. It is worth highlighting that this analysis uses the current cost of battery technology available on the market – as seen in the solar PV market over the last 5 years costs can dramatically reduce, especially with mass roll out – it is reasonable to expect costs of energy storage to do the same.
- **Society is already comfortable with certain forms of distributed energy storage** – unfortunately this does not yet apply to electrical or thermal energy storage. Transport is a particularly striking and familiar example – the average car in the UK stores sufficient energy to meet 2-3 weeks use[2]! Indeed, if we knew there was a supply crunch most would probably stretch this to a month or so. Given there is already inertia for this scale of energy storage, we suggest it is harnessed and directed towards helping to balance electricity supply and demand.

We also need to consider whether we *care* about the level at which energy

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[1] Assumptions: 4115 kWh/yr = 11kWh/day = 5.6kWh storage (if consumption halves in light of supply constraints)

[2] Assumptions: 14 gallons/vehicle, 31 miles/gallon = 434 miles/vehicle, 162 miles/week = 2.7 weeks of storage

storage is located – whether we want the energy storage to provide additional services/address ancillary issues such as fuel poverty for example. **Modeling and "system thinking" is thus required.**

Finally, we would like to highlight that one of the key challenges that must be addressed is the fact that not only is energy storage **charged twice**, for both providing and using electrons, the **value** of doing this at times when it can then provide flexibility and resilience is **not rewarded**. Having never been an issue previously, this needs addressed.

## Independent System Operator

There is most certainly a need for an Independent System Operator (ISO). We suggest however that the current **ownership structure** is not as effective or efficient as it could be, especially with regards to minimising long-run costs.

When an ISO is owned by the *same company as the transmission assets* (TSO) (as is the case with National Grid in England and Wales) this creates **conflicts of interest**. Additionally, when it is owned by a single *commercial* organisation, as is currently the case, this gives rise to **incentive problems** and reduces the visibility of cost and effectiveness. We suggest that mutualising the ISO is both a practical and attractive step; restructuring such that it acts as a not-for-loss company for the benefit of the whole electricity network and its users. It could be jointly owned by the state, TSOs, generators and suppliers. This structure would enable the profits of efficient ISO operation to be shared by the public and the taxpayer, and so instils clear objectives to maximise social welfare *and* system efficiency. Moreover it unites the aims and roles of owner and customer, in turn allowing the ISO to focus on customer service. Ultimately it will be far better equipped to proactively plan for developments and changing needs within the industry, whether they originate from generators, suppliers or consumers.

Incentive scheme: **Adopting a mutualised structure removes the need to set incentives at all**. It goes to the heart of the issue and solves from there, as the interests of the industry and consumer are aligned. The ISO will no longer have any incentive to maximise the apparent costs of system operation on to customers in order to outperform a short term incentive. It will be able to seize longer term opportunities to improve the efficiency of the whole network. Furthermore, the conflict of interest that currently exists due to the fact that NG acts as the ISO as well as the TSO for England and Wales (i.e. the same entity both operates and owns the network) is removed[3].

Statistics 2013/14: Currently the ISO is buried within National Grid's large UK transmission business so it is difficult to assess its current performance and value (illustrating part of the problem). Turnover in 2013/14 seems to have been £132m with an operating profit of £48m, of which £26m was derived from out performing the incentive scheme. **This huge amount of money could be better used to minimise long-run balancing costs**.

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[3] While there is no evidence of inappropriate behaviour, the incentive to recommend a bigger network for example, which in turn increases revenue, exists.

It is important to note that **this approach (mutualisation) does not suggest starting from scratch**, which would be extremely daunting and likely unadvisable. Rather, it takes both the existing skills and expertise within NG (the current ISO) as well as maintaining NG as a part owner, and **fundamentally restructures the model**.

A new, genuinely independent ISO could also be responsible for additional functions such as administering the Capacity Mechanism, the CfD mechanisms and other centralised functions currently undertaken by National Grid and Ofgem. It would place the ISO at the heart of the industry and truly enable it to take on the role of system architect if desired.

*Giving evidence to the Energy and Climate Change select Committee in January 2015, Dermot Nolan (Ofgem CEO) stated that he sees a "strong case" for establishing an ISO to replace National Grid's current position as transmission operator and asset holder[4].*

## Appendix 1

Please see attached excel document for detail of calculations and data sources. Please feel free to flex the parameters/assumptions to further analyse the data.

[4] http://www.cornwallenergy.com/News/Features/Ofgem-evaluating-benefits-of-ISO-model & http://utilityweek.co.uk/Error/AnoymousSubscribe/ofgem-%E2%80%98strong-case%E2%80%99-for-iso-to-replace-national-grid#.Vg0qfY9Viko