Renewable Energy Systems Limited
Beaufort Court, Egg Farm Lane, Kings Langley
Hertfordshire WD4 8LR, United Kingdom
T +44 (0)1923 299 200, F +44 (0)1923 299 299
E info@res-group.com, **www.res-group.com**

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Email: energyevidence@Infrastructure-Commission.gsi.gov.uk

Dear Sir/Madam

RES Response to: National Infrastructure Commission call for evidence

RES is one of the world's leading independent renewable energy developers working across the globe to develop, construct and operate projects that contribute to our goal of a secure, sustainable and affordable energy future. RES has been an established presence at the forefront of the wind energy industry for over three decades. Our core activity is the development, design, construction, financing and operation of wind and solar PV projects and we are also active in electricity storage, DSM and transmission. Indeed, we have this week announced our first UK battery storage project, drawing on our experience in this sector in the US and Canada. Globally, we have built approximately 10GW of renewable energy generation, including approximately 10% of the UK's current wind energy capacity.

We consider ourselves well-placed, therefore, to comment on the important issues addressed in this consultation and welcome the opportunity to respond. We would also urge the NIC to consider, under its remit and in further consultations, a broader examination of the energy sector and how to stimulate the necessary investment in the generating infrastructure needed in the transition to a decarbonisated energy system. We hope you find our comments below of interest and will be more than happy to assist with any further information as required. The key points we would like to make are:

1. By allowing mature low-carbon technologies continued access to the electricity market, it is possible to balance supply and demand whilst minimising cost to consumers and achieving decarbonisation objectives. Based on the recent CfD Pot 1 clearing prices, onshore wind and solar, with system integration costs, remain the cheapest form of low-carbon generation technology and expected cost reduction will make them the cheapest generation options in the UK.
2. Further reform of the electricity market is required to provide a fair and competitive route to market for these technologies but the complexity should not be overestimated and this requires a clear strategy for a smooth transition.
3. Flexible demand side response (DSR), electricity storage and international interconnections are no-regret options for consumers and should be pursued aggressively, providing benefits of £2.9bn independently of the energy mix.
4. Rapid resolution of the barriers to market for storage is required in order to provide multiple routes-to-market; this includes facilitating commercial deployment of battery storage for ancillary services today.
5. Interconnector benefits significantly increase with regional cooperation on security of supply so without this the UK will not accrue the full value of the benefits of interconnectors, increasing the importance of alternative forms of flexibility (DSR & storage)

Yours faithfully,

Alex Coulton
Senior Policy Analyst, RES Western-Europe
E : [email address redacted]
T : [phone number redacted]
M :[phone number redacted]

National Infrastructure Commission call for evidence

Framing the discussion

The government has committed to '*guaranteeing [consumers] clean, affordable and secure energy supplies*'. This creates two boundaries within which the government and its infrastructure policy and programme must operate:

1. Security of supply and the provision of uninterrupted energy to consumers
2. Decarbonisation, which is a decreasing carbon intensity of the power sector

Although a clear limit on decarbonisation is yet to be established through the implementation of the 5th Carbon Budget, it is emerging that the market is already accounting for decarbonisation risk. Indeed our internal estimates of unabated gas LCOE based on commercial commodity prices are in the range of £55-65/MWh. However, Trafford developers announced that they could not secure finance for installations with an LCOE below £72/MWh[1]. We expect that the impact of the decarbonisation agenda on plant load factors, operating life span combined with the expectations of competitive low-carbon technologies are now being factored into financiers' decisions. The recent COP21 only consolidates unabated fossil fuel generation limits and the risk of financing such plants.

In this regards, there is sometimes a fundamental misunderstanding from stakeholders that an increase in the LCOE of unabated CCGT plant is caused by variable renewables generators. Wind and solar PV deployment are an emergent property of our decarbonisation imperatives and it this the decarbonisation agenda that requires unabated fossil fuel generation to be reduced over time. Thus even in a heavy nuclear scenario, the utilisation rates and life span assumptions of unabated CCGT must decrease in as carbon emissions are squeezed out of the system.

Figure 1 provides an illustration of the implications of the decarbonisation boundary on fossil generation in the build up to 2020. Although the exact boundary illustrated here might be up for debate, the fact that a boundary exists is indisputable.

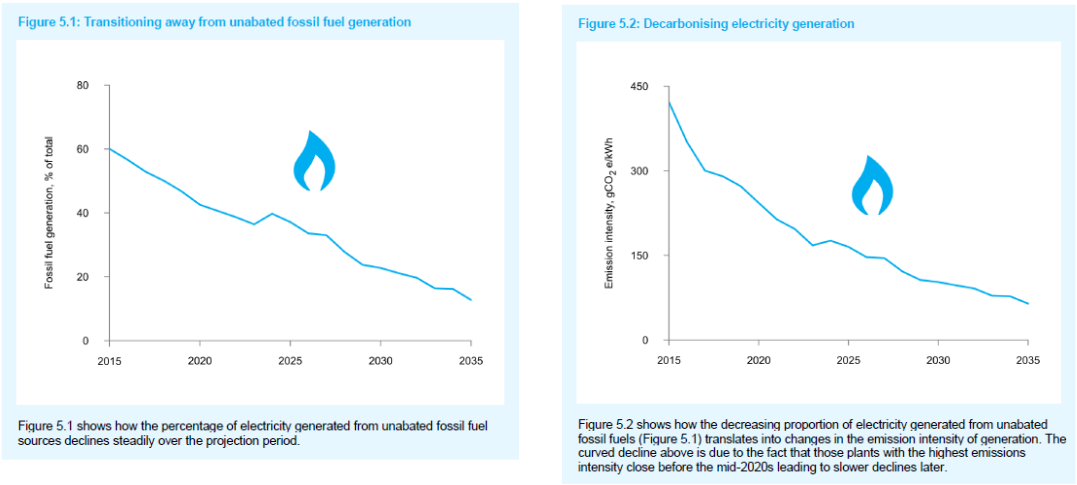

Figure 1 – Illustration of the implications of a 100g Co2e/kWh by 2030 target on unabated fossil fuel generation[2]

By 2030 the Committee on Climate Change (CCC) estimates that the UK will require more than 202TWh per year of new generation.[3] Of this,178TWh per year must come from sources other than unabated fossil fuel fired generators. Looking at the known cost data, we can build up a 'snap shot' of existing technology options for the UK, see Figure 2, that clearly highlights technology priorities required to deliver affordable power.

[1] Blow to UK energy plans as new gas plant in doubt, the telegraph, 11/10/15 http://www.telegraph.co.uk/news/earth/energy/11925444/UK-energy-crisis-Trafford-gas-plant-in-doubt.html

[2] DECC's 'Update energy and emissions projections 2015' report, https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2015

[3] Power sector scenarios for the fifth carbon budget, CCC, 2015, https://d2kjx2p8nxa8ft.cloudfront.net/wp-content/uploads/2015/10/Power-sector-scenarios-for-the-fifth-carbon-budget.pdf

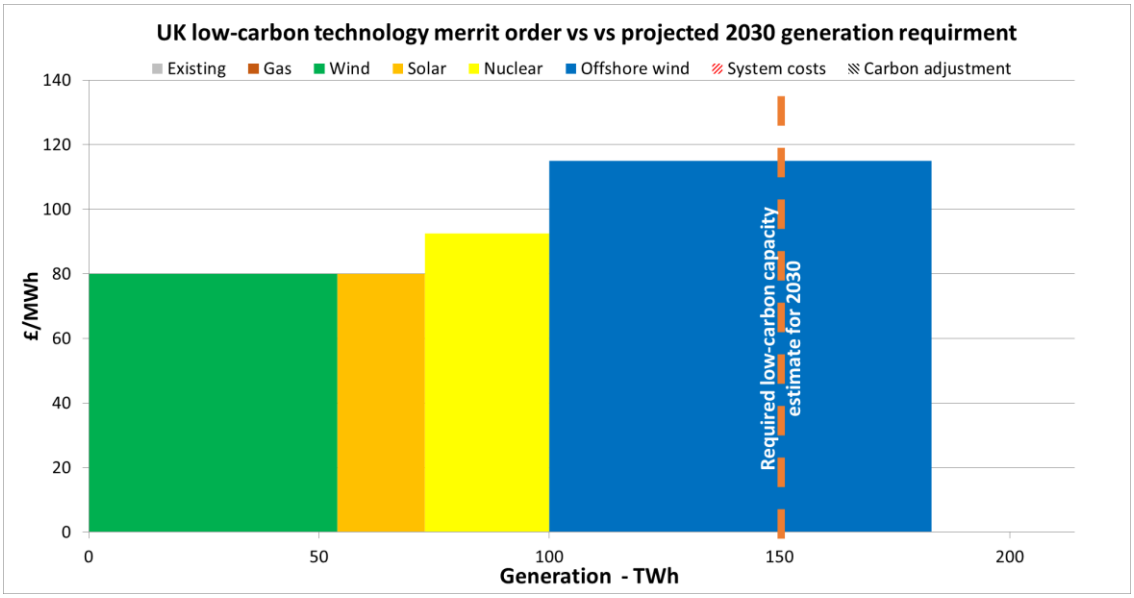

Figure 2 – Illustration of a snap-shot of the UK's low-carbon technology merit order respecting deployment limitations linked to site availability and system integration

Amongst the most affordable low-carbon technologies we can see significant levels of variable renewables. As we see, the inevitable retirement of traditional generators and the capacity adequacy concerns around the reliability of these technologies has increased. Part of this response therefore touches on the need for ongoing reform of the electricity market so that system integration costs can be better accounted for.

It is also important to highlight that increased flexibility on the system from flexible technologies[4] is a no-regrets option. Indeed, the CCC analysis highlights benefits of between £2.2bn to £2.9bn to the consumer exist even with limited decarbonisation ambitions. Importantly, benefits increase with greater variable renewable energy penetration, which makes the deployment of flexible technologies a priority.

4. Electricity interconnection and storage

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?

The electricity market is not a single market but multiple markets and these are in constant state of flux in order to respond to changing policy imperatives and technological innovation and disruption.

Within the electricity market the wholesale market has been depended on as a generation dispatch mechanism as well as a mechanism to stimulate capital investment. Today the wholesale market is a demonstrably and exceedingly efficient dispatch mechanism, so much so that ongoing transformation of the power sector, from changes to the generation mix to the smart revolution, mean that it can no longer deliver the investment required for the scale of new-build generation the UK needs. It is widely recognised, including by government, that the wholesale price is not currently an adequate investment signal for the procurement of any new energy generating infrastrucure.

For the foreseeable future, the scale of new-build generation required to meet projected demand and replace retiring plant must therefore be procured by Government. To address market failures and deliver a more cost-efficient and cost-reflective electricity market the previous Government therefore delivered three critical market reforms: the Capacity Market, the Contract for Difference and the Electricity Balancing Significant Code Review[5].

[4] In this report flexible technologies is used to describe flexible demand response, electricity storage and International interconnections
[5] https://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review

Continuing the reform

We believe there is a need to move towards a truly technology-neutral competitive mechanism as soon as possible. This would meet government objectives of affordability, security, decarbonisation and also true competitiveness but requires further reform to the electricity market. For instance, different technologies have different system integration costs and carbon emissions and these real costs need to be taken into account in the design of technology-neutral auctions to achieve true competition. Critically, internalising the system integration costs to the cost of each generator means that all generation becomes reliable capacity and this creates an overlap between the CfD and CM mechanisms. As the CfD and CM overlap, reform will be required and it also becomes necessary to create a means to deliver investment in flexible back-up generation for variable renewables. At the moment, we feel this might be best achieved through adjustments outside the Capital Investment Market, see Figure 3 for an illustration of the transitional requirements.

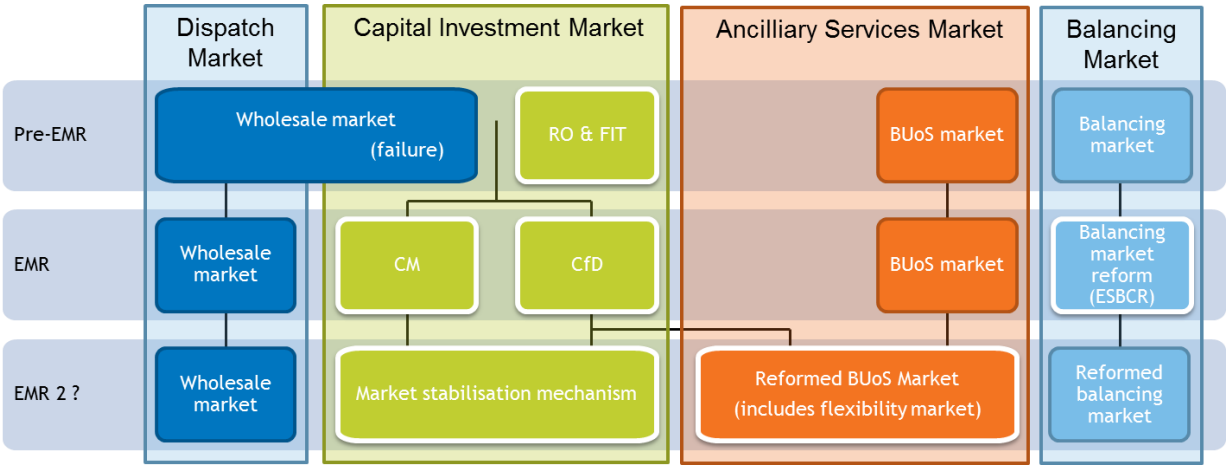

Figure 3 - Illustration of electricity market structure, recent reforms and possible future structure. The extent of reforms illustrated in the EMR 2 phase is significant and requires an extensive, structured and evidenced based policy development process with broad stakeholder engagement.

The complexity of such broad reforms should not be underestimated. With a concerted and cooperative approach we believe Government might be able to deliver these by the end of this Parliament and the RES group is willing to help champion this work to ensure as speedy delivery as possible.

Securing a cost-effective future

During such a complex and lengthy process, outcomes are highly uncertain and this is even more so because our proposed reforms does not fit simply within the European Commission's State Aid guidelines.

Government cannot therefore guarantee a rapid implementation that will support continuous investment, maintain a high level of investor confidence and support the evolution of market participants without clear transitional arrangements. Additionally the scale of the new low-carbon generation requirements to meet our 2030 ambitions should not be underestimated.

We therefore firmly believe that, in the name of cost-effective infrastructure growth and affordability, continued and controlled investment in mature low-carbon technologies must continue. Fortunately, the competitive CfD mechanism has proven to be effective at delivering new capacity at lowest costs. Broader electricity market arrangements are also adequate today to support controlled investment in mature low-carbon technologies without creating significant, if any, risk to or impact on consumers and broader government ambitions.

Because of the changed role of the wholesale market, we cannot understate that without a Capital Investment Market (see figure 3), continued investment necessary to maintain essential skills, experience and diversity within the mature low-carbon sector will be lost before the transition can be achieved and this will come at significant cost.

We believe the NIC therefore need to push for regular annual mature technology auctions to be announced as soon as possible, thus allowing stakeholders to focus policy and regulatory capital on EMR 2 reforms. We could potentially see a role for the NIC in the running of annual allocation rounds, thus allowing DECC to focus on these reforms.

Ensuring short-term cost effectiveness – the system integration cost (SIC) question

In order to continue investment under the current CfD framework it is important that we are certain of the real cost of different technologies so that the Government procurement decision through the CfD truly delivers to the Government's manifesto commitments of keeping bills *'as low as possible*' and '*cutting carbon emissions as cheaply as possible'*.

The conclusion of our analysis is that the burden created by variable renewables on the system is relatively small and mature renewables procured through the future CfD rounds will remain lowest cost. The Committee on Climate Change's 5th Carbon Budget power sector annexes provides the most up-to-date data on the SIC of low carbon technologies. This work correctly identifies that:

- The system integration costs vary with the energy mix and installed capacity of a specific technology.
- The only cost that is not internalised to the cost of generation is the cost of back-up generation.
- It is possible that other internalised costs, such as system operation costs (dealt with through the balancing and ancillary markets), might not be perfectly distributed.

This analysis does not, however, break down these various SIC. We understand that the majority of the costs are associated with the need for back-up generation and have therefore ignored this for now. Figure 4 is an extrapolation of the CCC's SIC data that illustrates the range and increase in SIC with installed capacity. This highlights that SIC remain below £10 per MWh penetration levels of solar below 20GW and wind below 40GW.

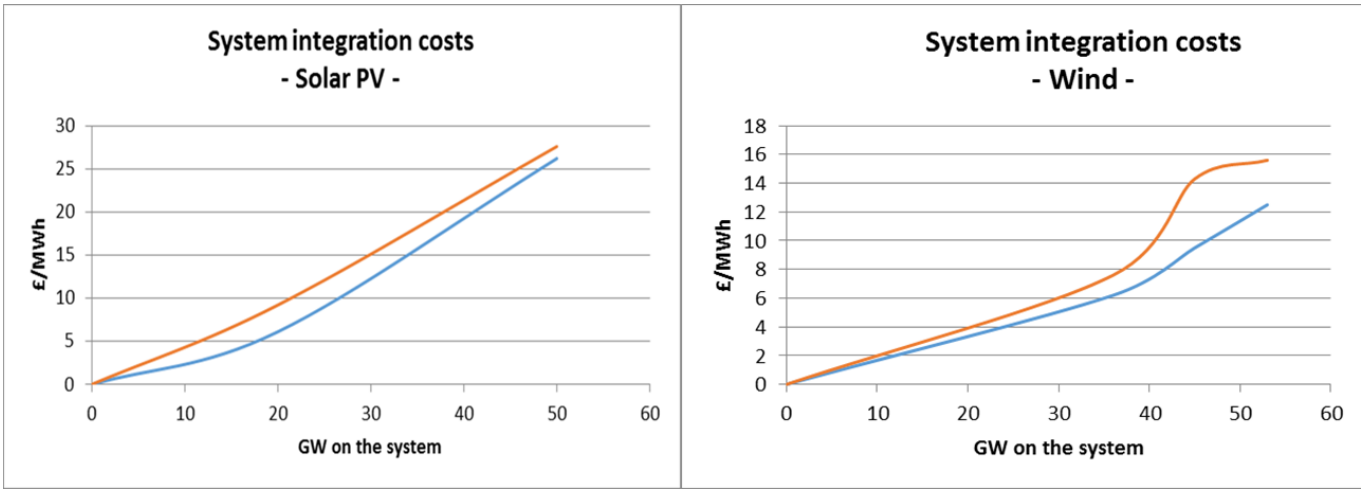

Figure 4 - Upper and lower boundary of SIC for different levels of penetration as defined by Table 3.1 in the CCC Power sector scenarios for the fifth carbon budget 2015.

In figure 5 we therefore investigate this by applying the SIC adjustment to the £82/MWh clearing price of the 1st Pot 1 CfD auction, including known lifetime benefits for consumers, resulting in a ~£85/MWh or additional ~£3/MWh above the clearing price.

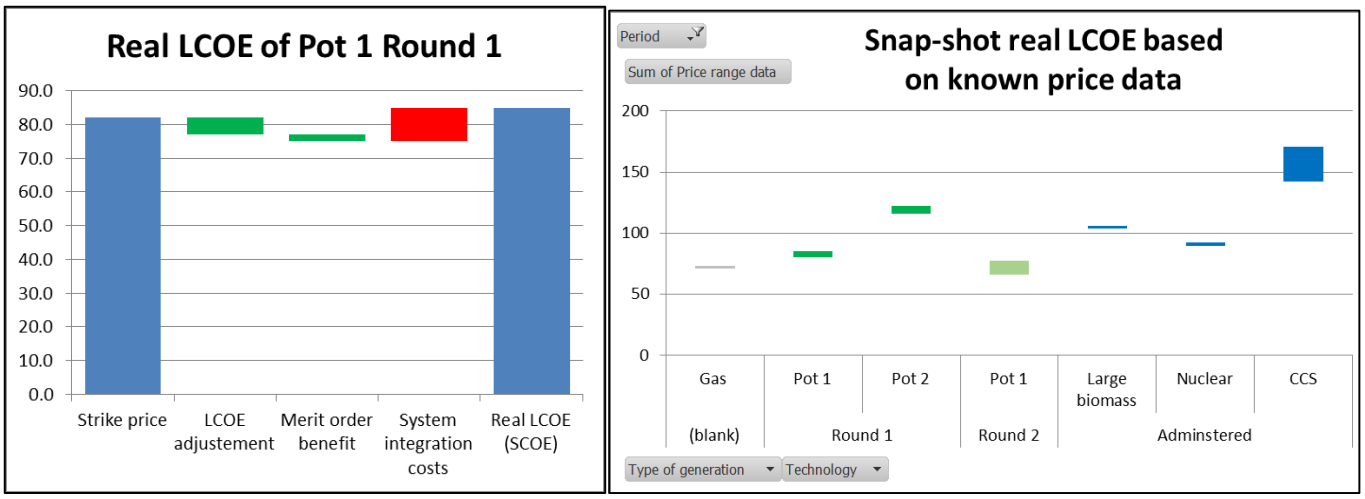

Figure 5 – On the left, adjustment of the pot 1 clearing price to get the real LCOE and on the left plotted against the real LCOE of known price data points, including estimates based on expected range for pot 1 round 2 clearing prices.

This evidence demonstrates that mature technologies allocated competitively through the CfD are the lowest cost low carbon generation technologies and represent no-regret investments for consumers. We also believe that another allocation round, that does not overlap the RO closure period, will yield clearing prices around £70/MWh which on a real LCOE cost comparison would make these technologies the cheapest available generation sources accessible to the UK and an invaluable benchmark to support any further procurement of nuclear power plants.

Figure 6 is an illustration of a snapshot of the entire UK's technological merit order reflecting 'real' costs and deployment limitations.

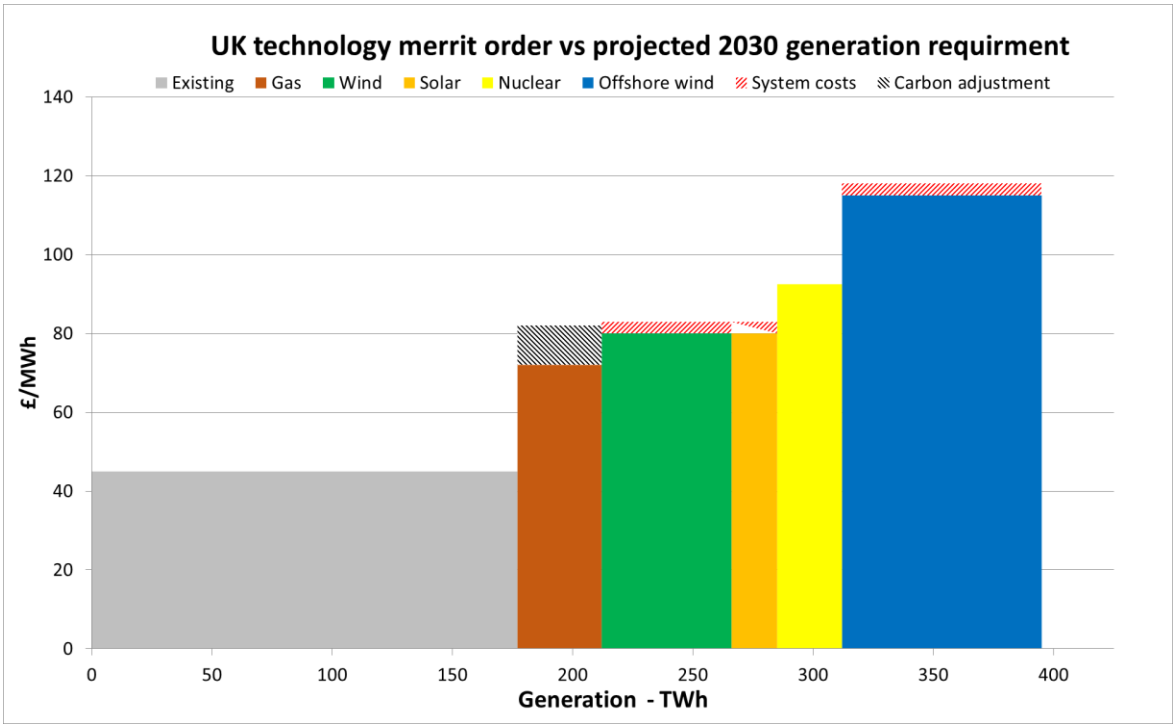

Figure 6 – Illustration of a snap-shop of the UK technology merit order based on known price information and adjustments for real LCOE against generation requirement data for 2030 in line with the CCC report

With minor tweaks to the current CfD framework today we therefore believe that limited allocation of Pot 1 CfDs can continue with no risk to consumers and meet Government commitments.

- **What role can changes to the market framework play to incentivise this outcome:**
  - **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 believe that the NIC has not quite pin-pointed the correct starting point for their investigation which feels influenced by large suppliers and generators.

The changes and reforms that have been undertaken and continue to be required are driven by the radical changes in the technologies that are fueling the energy transition towards a secure decarbonised power system. This transition is marked by two very distinct features:

- It takes place primarily at the distributed level not the transmission level.
- It includes significant penetration of variable renewable generation.

We believe the building blocks to an efficient decision around the status of the system operators are twofold:

- An investigation into the cost-effectiveness and adequacy of the ancillary services market in light of the ongoing and future changes to the market.
- The need for a Distribution System Operation role as both the level necessary to manage and facilitate distributed generation and demand side response.

We believe that the NIC must break with the traditional attitude towards infrastructure which is perceived as large centralised projects and consider what its role should be within a distributed system with as many market participants as there are generators and consumers.

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

The regulated parts of the electricity market are continuously being reformed in order to deliver cost-effectiveness and cost-reflectiveness. The implementation of Cash-Out reforms in November are reforms that seek to make market participants more accurately responsible for their imbalances. These reforms are significant and developing a full understanding of their impact and success will take time and no further reform is currently justified. Ofgem and market participants are carefully monitoring the impacts of a process that will take the best part of 3 to 4 years. The processes that have led to these reforms are well established and effective in dealing with the balancing rules and we see no reason to diverge from these.

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

It is commonly thought that flexibility is associated with the deployment of variable renewable energy technologies. However, solutions such as interconnectors, DSR and storage stand on their own merits providing the correct regulatory and market access can be facilitated.

The CCC report makes a very clear case that flexibility is a critical component of any future electricity system and can provide benefits to consumers of £2.2 to £2.9bn in 2030 even if the power sector only achieves an average grid intensity of around 200 gCO2/kWh. Figure 7 is extracted from the CCC report and highlights the level of ambition (full flexibility) that we should be aiming for.

Benefits of a flexible solutions increase with the penetration of variable renewables which can consequently be increased providing additional option value to the UK generation mix.

Table B3.3: Flexibility deployment in Imperial/Nera scenarios

	No additional flexibility	Low flexibility	Medium flexibility	Full flexibility
Flexible plant	None	All new plant to have more flexible/efficient characteristics		
Interconnection	Current (4 GW)	Minimum of additional 3.4 GW (7.4 GW total)		
DSR (max 69TWh)	None	25% potential	50% potential	100% potential
Energy storage	Current (2.7 GW)	Additional 2.5 GW	Additional 5 GW	Additional 7 GW

Source: Imperial College (2015) *Value of Flexibility in a Decarbonised Grid and System Externalities of Low Carbon Generation* Technologies; Imperial (2012) *Role/Value of Energy Storage Systems in the UK Low Carbon Energy Future.*

Figure 7 - CCC flexibility assumptions

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

As the UK has very few operational electricity storage sites, UK energy policy, market arrangements and network access and charging rules are not adequately set up for storage. This results in a number of unnecessary barriers to the uptake of electricity storage. In order to realise the value to the UK that storage delivers, these barriers need to be addressed. We consider that the four main barriers are:

1. Electricity market arrangements should be updated to allow the UK to take advantage of the benefits of electricity storage. Under current market arrangements, electricity storage is inappropriately penalised compared to other market participants. One key example is that of final consumption levies: electricity storage gets charged final consumption levies such as Feed in Tariff and Renewable Obligation recovery charges, even though electricity storage doesn't consume electricity and those fees are then paid by the true end consumer. This results in double charging and a discriminatory cost penalisation on storage compared to demand side management (DSM) and generators providing flexibility. One quick and beneficial solution to this final consumption levies issue would be for DECC and Treasury to confirm that final consumption levies should be applied on net import instead of gross import (netted over an appropriate period of time such as 24 hours). Overall, market arrangements should be updated to reflect that electricity storage is different and separate from consumers and generators so that it is correctly treated.

2. Network access and charging rules should be updated to reflect that electricity storage is different from consumption and generation. Network access and charging rules currently negatively treat electricity storage as both a generator and a consumer. In addition, the contribution electricity storage makes to network security is not correctly reflected and its contribution to system stability isn't considered at all. This means that storage is disproportionately charged for making use of the network and unduly delayed from connecting to it, even though it is a solution to network problems. Network access and charging rules should be updated to reflect that storage is a different category from consumers and generators so that the value of its contribution to the network and UK system is recognised.

3. The status of energy storage should be clarified in the UK legal and regulatory framework. At the moment storage is not a defined activity within legislation or the licensing regime. This lack of clarification:
    a. Is a barrier to making changes to industry codes as codes follow the principles set out in the governing licence (which are silent on storage), and there is no single commonly accepted definition of storage that can be used to develop code modifications; and
    b. Results in the perception of regulatory risk by investors and potential users of storage such as DNOs.

    A solution that can be implemented quickly and that provides a commonly accepted definition of storage should be sought.

4. A major benefit of storage is the versatile and valuable ancillary services it can provide to alleviate system and network challenges and so mitigate a number of the barriers to the move towards a low carbon future. Historically ancillary service contracts have been short length – typically one month to two years. These short

contract lengths are suitable when ancillary services have been provided by generators whose CAPEX investment is predicated on another revenue stream such energy generation. As we move to a future where the best value providers of ancillary services are dedicated service providers whose only revenue is from ancillary service income, contract lengths must be increased so that these projects are financeable in the first place. Longer contract lengths will mean that the cost of capital decreases and the same services can be offered at a lower price (as CAPEX recovery can be spread over a longer period). Longer service contracts will also give increased cost and network planning certainty to the SO and network companies who buy the services, so enabling better longer term infrastructure planning decisions. The regulator Ofgem should ensure that there are sufficient price control incentives on these companies to enable longer term incentives.

- **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.)**

The most appropriate scale for storage will be determined by its use case and technology type. Given ever changing technology costs, evolving service requirements, the development of new non-storage service providers (e.g. DSM), and that the potential uses of flexibility aren't fully understood, the best value technology and scale for storage cannot accurately be predicted and will likely change with time.

However looking over the next seven years, Distribution Network Operators (DNOs) have been awarded £39bn to invest in distribution networks within the current RIIO-ED1 price control period. This significant investment reflects the fact that most new load growth, an increasing amount of generation growth and an increasing proportion of network challenges will be on the distribution network. Given the high uncertainty about the exact magnitude and timing of load and generation growth, adding greater flexibility such as storage on the distribution network (either directly connected to the network or behind the meter) is a no regrets move. We believe that DNOs should be actively encouraged to deploy it now as it will deliver consumer benefits.

We have examined adding storage onto the transmission network and see it as important in the long-run to the integration of high levels of low carbon generation; however in the short to medium term it is unlikely to deliver the same benefits to consumers as distribution connected storage. Flexibility is useful on the transmission network, but flexibility on the distribution network has the potential to provide greater benefit – put simply, storage technologies connected to distribution networks could be used to manage transmission network constraints, but storage technologies connected to the transmission network can't be used to alleviate distribution network constraints. We have examined adding storage at the domestic scale and found that greatest cost benefit to network companies currently comes from having storage at the distribution scale.

However, in response to the inference of this question, we would be concerned if there were a central direction by a single entity as to where on the network storage should be located, as it is not possible to know at this stage where it will provide best value to the system and consumers. We believe a more beneficial approach to all parties would be to remove unnecessary barriers to storage and have clear price signals from network companies as to where it would be of benefit, so that it can be deployed at least cost to consumers and in the most valuable way to network companies and the system.

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

We believe that increased interconnection will benefit the UK consumer and energy transition that is under way. There are, however, a lot of uncertainties and complex interactions with DSR, storage and interconnection all providing similar services and the optimum level of interconnection is difficult to pinpoint today.

It is also unclear to us whether or not all costs, benefits and risks associated with interconnectors are fully considered or can be fully capitalised upon. For instance interconnectors provide the opportunity to pool a number of ancillary services and reduce capacity margins with interconnection to different price zones around the UK contributing differently.

Additionally, the current approach of the UK government to security of supply means that the full benefits of interconnectors cannot be realised. Optimising interconnector use requires a regional approach to security of supply, for example regional capacity adequacy margins and regional shared ancillary services.

At the moment we believe that the voluntary 10% target by 2020 provides a no-regret level of interconnection and that development of further projects should be encouraged in light of very long development timelines and the option value associated with interconnectors.

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?

Demand Side Management (DSM), also known as Demand Response (DR), is an underdeveloped source of flexibility in UK. The potential benefits of DSM are significant although difficult to quantify:

- A report commissioned by Energy UK synthesising public data suggested that 20% of peak demand (12GW) could be successfully shifted on demand.[6]
- A paper prepared by Sustainability First says the technical potential of demand management (capping) at system peaks is between 33% in winter and 29% in summer.[7]
- Based on a study prepared by DECC in 2014 assessing the total cost reduction impact of a Smart Grid, DSR could have an overall reduction potential ranging between 20%-30%[8]
- Other estimates vary, but many suggest a potential energy saving of over 10% of peak demand.[9]
- In 2013 in the USA just the additional revenue earned by customers from DSR exceeded $2.2bn which comes in addition to the avoided infrastructure investment costs as a result of DSR.46.

The efficacy of DSM in supporting the stability of the network is increasingly demonstrated through advanced communication technology that enables the management of demand on a minute by minute basis to align with generation. This has been shown in the New Brunswick / PowerShift Atlantic project in the US.

UK firms have the ability to take a technological lead in the most sophisticated DSM technologies. However, to do so the regulatory environment has to provide an appropriate platform and be responsive to the needs of innovative new entrants.

Key to this is the ability of companies that are focused on delivering flexibility to contract across the market and the barriers to entry removed to allow the innovations that independents would like to promote (such as virtual power plants) to come forward.

An example of how this innovation can be enabled is demonstrated by the French Market reforms where there are clear roles developing for DR aggregators to deliver both capacity services to the network operator and energy balancing and arbitrage services to the energy markets through a separate supply account and the NEBEF rules.

This contrasts with the UK where the DR market does not have the depth of definition to allow DR aggregators to deliver across markets. Rather DR aggregators can contract directly with the network operator for a limited range of services; however any arbitrage services and time value based services are captured in the supply account of the existing supplier. This limits the development of innovative products and the potential for new and innovative companies to enter into this area.

The key challenge, when bringing about increased demand side flexibility, is a regulatory and market design challenge. Once this has been resolved successfully, then the investment will follow.

[6] Thermal Green Demand Side Response: UK Market Overview and the Potential for DSR
[7] Sustainability First, Paper 13: 'realising the Resource: GB Electricity Demand Project Overview, October 2014
[8] Smart Grid Vision and Routemap: Smart Grid Forum: February 2014
[9] SEDC, Mapping demand response in Europe today, April 2014