Delivering Secure Low Carbon Electricity – Call for Evidence

Response by E.ON UK

Summary

- We favour early decarbonisation of electricity supply by 2030 as a basis for decarbonising transport and heating from the 2020s to 2050, with a trajectory broadly in line with the Climate Change Committee's preferred scenario. The UK should be supporting deployment of a diverse range of low carbon generation sources on cost and security of supply grounds.
- The balance between different technologies will need to reflect the relative costs of different options to minimise costs to consumers, with investment decisions left to market participants to determine within the framework provided by Government.
- As average CO_2 emissions from the UK power system decline we would expect new uses of low carbon electricity to develop including for electric vehicles and space heating through heat pumps.
- For the period 2030 to 2050, we would expect increased demand for centralised low carbon power for transport and heating balanced by further improvements in the energy efficiency of the UK's existing housing stock and growth in low carbon generation at the domestic and community scale.
- Smart meters are key to the development of effective smart grids. Smart grids can facilitate more responsive demand to reduce the need for load-related distribution investment and accelerate investment in low carbon technologies at smaller scales connected at the distribution level.
- Our current view is that, with plant under construction, there will almost certainly be sufficient generation capacity available until at least 2015. New capacity is likely to be required to come online in 2016 to be ready for 2017.
- There will be a requirement for substantial new capacity from 2017 onwards. There are two main, related, challenges to investment: the impact of large volumes of wind generation on wholesale prices and on the economics of power generation investments (and on further wind investment) and uncertainty about future carbon prices.

<u>Impact of Wind Intermittency</u>

- Our analysis suggests the very high prices needed to remunerate more flexible plant operating at low load factors will both be relatively infrequent and unpredictable and may prove problematic from a political or regulatory perspective. We also see a potential loss of income for more capital intensive nuclear and CCS plants potentially displaced by wind generation or affected by periods of very low or negative wholesale prices arising from the incentive on renewable plant to bid negative prices.
- Smart demand has the potential to alleviate but not eliminate the effect on the wholesale market of large volumes of wind generation by shaving off part of the peak demand requirement and reducing the difference between peak and baseload demand and the need for peaking capacity.
- Our analysis suggests that the savings to consumers from reducing demand in response to wholesale price signals might not be sufficient on their own to incentivise smart demand certainly through a voluntary manual response to price signals. We therefore see more potential arising in automated control

of appliances where the consumer will not be significantly inconvenienced but with provision for the customer to override this.

- Further interconnection may be able to help address the impact of large volumes of wind but will only address the issue where flows are responsive to UK wholesale prices. The extent to which interconnectors can address wind intermittency issues needs further analysis.
- We do not support options which significantly expand the role of the system operator in contracting for capacity on a long term basis as this is incompatible with competitive electricity markets.
- While capacity markets could in theory provide a more reliable and market based source of peak income for back up capacity and baseload plants, practical experience has been difficult; the structure of capacity mechanisms may also alter significantly over time and may have limited value for investments which have long planning and construction periods.
- The existing energy only market should be allowed to develop and the potential of flexible demand, additional electricity interconnection and storage should be investigated as a means of addressing wind intermittency impacts, before considering structural changes to the market arrangements. The effect of the recession on demand allows more time to assess the effectiveness of these approaches.

Carbon Price Uncertainty

- The outlook for carbon prices is particularly uncertain at present and does not yet provide a reliable basis for investment in either technology given potential outcomes for fossil fuel prices.
- The priority for Government should be to deliver an effective global agreement at Copenhagen in December which should set legally binding targets for developed countries out to 2030 as a minimum, which will support the carbon price over this period.
- However, the scale and rate of UK low carbon generation investment implied by the Climate Change Committee's scenario for 2030 may still require additional policy support even with a successful outcome to Copenhagen. Government should begin to develop its thinking on reserve options to support the carbon price now.
- Any reserve options should be market-based and as far as possible fulfil the following requirements:
    - technology neutrality to enable the most economic solutions;
    - consistency with the EU ETS;
    - effectiveness in reducing investors' weighted average cost of capital (WACC);
    - capable of practical implementation within reasonable timescales.
- We have assessed a number of options against these criteria and favour on balance a Low Carbon Obligation similar in structure to the RO and operating alongside it. The Obligation would apply to suppliers who would have to contract for particular levels of low carbon generation (nuclear or CCS). This approach would provide a more reliable source of revenue than a carbon tax as zero/carbon plant become marginal on the system. It provides income for both nuclear and coal with CCS and effectively reduces the discount rates on investments.

Answers to Specific Questions

Question 1. How do you see the electricity system evolving between now and 2050? Are there other scenarios that could add to the evidence base?

1 We favour early decarbonisation of electricity supply by 2030 as a basis for decarbonising transport and heating from the 2020s to 2050, with a trajectory broadly in line with the Climate Change Committee's preferred scenario. The UK should be supporting deployment of a diverse range of low carbon generation sources on cost and security of supply grounds, and to avoid over-reliance on any single technology. The balance between different technologies will need to reflect the relative costs of different options to minimise costs to consumers, with investment decisions left to market participants to determine within the framework provided by Government.

2 We would expect to see an increasing role for renewables initially driven by the EU renewables target for 2020. The rate of growth thereafter should depend on the extent to which it can deliver carbon reductions at a competitive price compared to other low carbon technologies and an assessment of how the power system as a whole can most effectively deliver reductions in carbon dioxide emissions while achieving affordability and security of supply goals. However, assuming cost reductions can be achieved as a result of the deployment to 2020, we would expect continuing growth in renewables particularly through offshore wind with wave and tidal playing an increasing role.

3 The contribution from nuclear will decline initially as new construction will not keep pace with retirements but we would then expect the nuclear contribution to increase steadily thereafter, if it continues to receive political support, carbon and gas prices incentivise investment and capital costs are within current expectations.

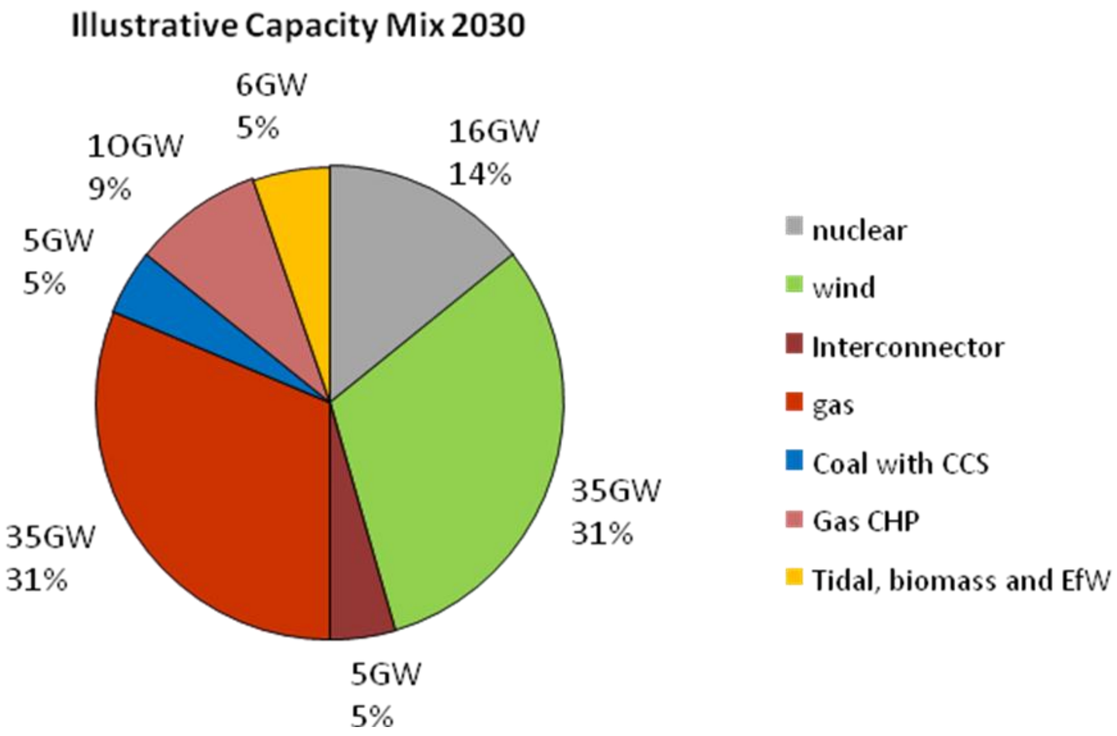
4 We would want to see significant investment in coal and CCS capacity, to avoid excessive UK reliance on gas for power generation, and to maintain a low carbon option should further nuclear investment prove problematic at some point. However, investment may be limited on the basis of the currently proposed policy framework, for the reasons set out in our response to the clean coal consultation.

5 This would increase the UK's exposure to the availability and price of gas, given that we would expect most existing coal plants to have closed by 2030. While growth in renewables and nuclear generation will reduce annual gas consumption significantly by 2030, meeting peak gas demand, which will coincide with low wind generation and cold winter weather under anticyclone conditions affecting most of the UK, will be challenging and will require secure but flexible access to imported gas supplies, particularly LNG, and significant further investment in gas storage.

6 Wind generation has a low capacity value (our analysis suggests of the order of 10%) in terms of the extent to which it can be relied on to be available to meet winter peak demand, because of its variable and less predictable nature. This means that other forms of firmer capacity will be required to meet

demand securely leading to a much larger total capacity investment. The ability of the power market to absorb large volumes of wind while at the same time rewarding nuclear and other forms of capacity at reasonable cost to the consumer will have limits and suggests the need for a balanced approach. This balance should depend on a number of factors including future demand growth, demand profiles over time and the responsiveness of demand to wholesale prices. The extent to which Great Britain is interconnected with continental Europe and Scandinavia and potential developments in storage technology will also be relevant.

7 A simplified illustration of how the UK power system might be composed in terms of generating capacity in 2030, reflecting the need for a balance between different low carbon technologies, is as follows. The relative shares of total electricity generated would be significantly different, with, for example, a significantly lower share for gas.



8 This would achieve a carbon intensity of around 60gCO_2/kWh by 2030, consistent with the Climate Change Committee's own preferred scenario.

9 In terms of demand, as average CO_2 emissions from the UK power system decline we would expect new uses of low carbon electricity to develop including for space heating through heat pumps and electric vehicles. Smaller scale development of renewable electricity technologies at the residential and community level may also begin to make some impact from 2020 onwards, depending on how the economics of photovoltaics and biomass or biogas-based CHP develop in the UK.

10 While currently we would expect demand in 2020 to be little higher than in 2008 given the effect of the recession and energy efficiency policies, we agree with the Climate Change Committee analysis that demand for power will begin to increase during the 2020s as heat pumps and electric vehicles increase in market penetration. The timing of this is subject to a great deal of uncertainty and will depend significantly on how strongly Government and EU policy incentivise the required changes. With decarbonisation of the power system and with improving heat pump performance, heat pumps will have a lower carbon impact than gas-fired central heating well before 2030. The extent to which demand will fall and then rise will also depend significantly on Government's ability to implement effective energy efficiency policies.

11 For the period 2030 to 2050, we would expect increased demand for centralised low carbon power for transport and heating balanced by further progress in securing energy efficiency improvements to the UK's existing housing stock and growth in low carbon generation at the domestic and community scale. Many of the assets built over the next 20 years will still be operational in 2050 with the possible exception of gas-fired CCGTs. In terms of supply we would see a continuing role for renewables including marine technologies other than wind, a continuing programme of nuclear investment, and wider deployment of CCS on gas and coal-fired plants. The UK will also need to encourage demand to be as flexible as possible in order to accommodate high levels of variable wind and tidal capacity. It is also worth observing that over this timescale it might be more appropriate to look at the potential impact of high levels of interconnection with the rest of the EU and to view the UK less in isolation than appears to be the case in the call for evidence.

Question 2. How could smart grids contribute to efforts to decarbonise the UK's electricity generation mix while maintaining security of supply?

12 We would expect smart grids to facilitate investment in low carbon generation technologies at smaller scales connected at the distribution level, partially offsetting the need for additional centralised generation, although the extent of investment in these technologies will primarily reflect their cost-effectiveness in reducing CO_2 emissions or delivering renewable targets and the level of support they are afforded under the Renewables Obligation (RO) and feed in tariffs (FITs). Smart grids can facilitate more responsive demand to reduce the need for load-related distribution system investment as distribution networks absorb additional sources of generation and new sources of demand such as heat pumps and electric vehicles. By reducing the need for new infrastructure, they can accelerate the introduction of distributed renewable generation and connection of demand.

13 There is uncertainty about what technologies constitute a "smart grid". We support the work being carried out by DECC and the electricity industry on developing functionality, design and interoperability standards and a rollout plan. "Smart" grids should be a natural extension of the existing control strategies on the distribution network. We define the physical embodiment of a smart grid as containing sensors, control and actuation to provide flexibility to change the operational objectives of an electricity network. A smart grid should provide elements of system balancing at all scales from building to UK level, rapid

reconfiguration/self healing networks to keep the lights on, and optimise operation where distributed and variable renewable generation is connected to a network.

14 Where wind generation connects in small numbers to local distribution systems its variable, unpredictable nature can be a problem in voltage control and supply balance. The enhanced control offered by a smart grid means the various generation sources, storage devices and demand curtailing can be balanced to minimise the disruption of an uncontrolled generation source. Smart grid control also enhances security of supply by recognising the multiple sources of generation and storage, scheduling the optimum balance of generation, storage or demand side response, and reacting to a loss of generation or increase in demand at a local level to minimise network losses.

15 Smart meters are key to the development of effective smart grids. A key function of the smart grid is communication around the network and data acquisition from multiple points. Smart metering will provide the link with end users, who may have both demand and generation requirements and be able to offer electricity storage. Smart meters allow the distribution network operator (DNO) to understand end-user demand profiles and to optimise demand, generation or electricity storage to balance the requirements for energy close to the point of use. This maximises use of transformer and cable capacities and minimises energy losses in the network. It is therefore essential that smart meters provide the functionality which, together with data and communications infrastructure, will enable smart grids to provide these capabilities.

16 A critical part of a smart grid would be the ability of the DNO to provide signals to loads that are operated by consumers. However, we would expect this to be managed in conjunction with suppliers who have the primary interface with customers. Customers will need to be incentivised to provide the required level of demand side response to both DNO and wholesale market signals as we doubt that widespread direct load control by DNOs or by suppliers would be acceptable. We discuss this in response to subsequent questions.

17 With or without smart networks, more investment in distribution network capacity will be needed to meet future demand growth, to allow demand to respond more rapidly to available renewable supply, and to support growth in low carbon generation to decarbonise the heat and transport sectors. Furthermore, as the distribution network is not designed to cope with significant amounts of local generation, in terms of voltage control, fault level and operational control, upgraded control mechanisms would be needed to move energy around the network, and thus facilitate low carbon generation.

Question 3. What are your views on the assessment of the outlook for spare electricity generation capacity and its implications for security of electricity supplies?

18 Our current view of supply and demand is that, with plant already under construction, there will almost certainly be sufficient generation capacity available until at least 2015. New capacity is likely to be required to come online in 2016 to be ready for 2017. These dates are strongly influenced by our

assumptions about the new build rate and closure dates for existing plants. In particular, there are risks around the availability dates for new build plants as over 4GW have only just started construction.

19 There will be a requirement for substantial new capacity from 2017 onwards with the amount dependent on a range of factors including the rate of closure of existing capacity and decisions on life extensions of older CCGTs, and the extent to which the Industrial Emissions Directive allows plants to maintain operation after 2016. While there is in principle sufficient new fossil and nuclear build at various stages of development to provide this capacity, uncertainty surrounding demand, the rate of economic recovery, the stability of raw material prices and the carbon price as well as the availability of project funding will influence investment decisions. Also relevant to both new plant investment decisions and to life extensions of existing CCGTs which may be required in the latter part of this decade and beyond will be the impact of large volumes of wind generation on wholesale power prices after 2020 and plant load factors highlighted by the Pöyry and other studies including our own analysis. We discuss this issue and the difficulties facing investors in low carbon generation arising from uncertainty about future carbon prices in response to question 5.

20 The relative attractiveness of the UK electricity market compared to other markets in the EU is also an important consideration.

21 We recommend that DECC should more actively discuss with project developers their investment intentions over this period and rely less on analysis by consultants on whether prices may or may not be sufficient to support investment.

22 It is also true to say that the large majority of this capacity is gas-fired CCGTs given the limited progress that developers have made in pursuing new coal-fired plants while the Government has been defining its position on coal and CCS, which may lead to gas becoming a dominant fuel source particularly if there is delay in progressing nuclear and renewable ambitions.

Question 4. What are your views on the assessment of the operational challenges of managing the electricity system with a higher penetration of intermittent generation?

23 There will be a substantial additional requirement for reserve capacity given that our analysis indicates that wind generation has a capacity credit of about 10% of its nominal capacity value as noted in paragraph 6. Leaving aside the question of whether the market will incentivise provision of sufficient reserve in the first place, we believe that the challenges associated with ensuring that this capacity can respond flexibly to variations in wind output and demand are manageable, allowing for improvements in wind forecasting techniques.

24 It is also worth noting that wind generation designed to Grid Code requirements has less reactive power capability than synchronous machines. It is conceivable therefore that there could be insufficient capability for reactive power at times when a region has a lot of wind generation in operation with most

of the synchronous plant displaced. This is likely to increase the requirement for other reactive compensation plant, even when overall demand levels can be met.

25 The impact on DNOs also needs to be considered. The increase in intermittent generation, as well as the increase in generation connected at lower voltages, mean that there is a need for an enhanced system operator process that includes the management of distribution as well as transmission networks, and links into customer demand and generation. We specifically envisage the distribution network operator having a requirement to manage thermal, voltage and possibly fault-level network constraints in real time in order to manage efficiently its networks and accommodate new demand and generation requirements within appropriate timescales. It seems unlikely that one system operator could manage and optimise generation, transmission and distribution for the whole of Great Britain, utilising the demand side opportunities of some 29 million customers and managing the effect of less predictable distributed generation. We therefore see a new Distribution System Operator role for the distributor, and welcome further debate on the responsibilities and interfaces with the GB TSO at the grid boundary. The roles and responsibilities of DSOs and the TSO will need to be clearly defined to avoid any potential overlap or confusion, as each will want to optimise its own assets and systems.

Question 5. What are your views on the assessment of the challenges for investment during the transition to a low carbon electricity generation mix, specifically for investors in low carbon electricity generation, and in flexible electricity generation?

26 We see two main, related, challenges. The first is the impact of large volumes of wind generation on wholesale prices and on the economics of other power generation investments and indeed on further investment in wind itself. We agree with the DECC conclusion that wholesale prices will become significantly more volatile. However our analysis suggests the very high prices needed to remunerate more flexible plant operating at low load factors will both be relatively infrequent and unpredictable (as the weather conditions which give rise to very low wind output across the UK only occur say two or three times across a number of years) and may prove problematic from a political or regulatory perspective as lobbying by industrial consumer groups may be effective in encouraging regulatory scrutiny to suppress high prices. We also see a potential loss of income for more capital intensive nuclear and CCS plants potentially displaced by wind generation or affected by periods of very low or negative wholesale prices arising from the incentive on renewable plant to bid negative prices.

27 In these circumstances some existing marginal capacity, probably less efficient gas-fired capacity, may not receive sufficient income to remain economically viable and may be closed. While this would then have the effect of restoring price levels and income for the remaining capacity, it would lead to plant margins which are somewhat lower than they are now. As the market is currently configured this might lead to supply interruptions occurring somewhat more frequently than is currently the case. There are, however, a number of potential responses to this issue which we consider below.

28 This effect is also relevant to wind investment. Given that significant conventional generation will need to be retained on the system to maintain security of supply during periods of low wind generation, high

volumes of wind generation will also tend to coincide with generally high capacity margins and thus low wholesale prices, while low wind generation will tend to coincide with low capacity margins and higher prices. At periods of high wind generation and low electricity demand, wholesale prices may go negative. This effect is accentuated as additional wind generation is added to the system, effectively further reducing income per unit generated from the wholesale market.

29 This is reflected in our investment decisions on wind projects. For investments made in the next few years, the impact is likely to be marginal. However as the effect becomes more apparent with more wind on the system, investment will be adversely affected. While it would be possible to compensate for this for wind and other renewable capacity through the level of support offered under the RO, we believe that this issue needs to be considered as part of the wider effect on all capacity described above.

30 The second challenge relates to uncertainty about the carbon price generated by the EU ETS. Investment in both nuclear and coal and CCS capacity requires a price of carbon to be factored into wholesale power prices to support the initial investment, although a range of other factors, including relative fuel prices, are of course also relevant. At present there is significant uncertainty about future carbon price levels in the absence of a comprehensive international agreement on reductions in greenhouse gas emissions to succeed the Kyoto Protocol which would trigger a tightening of the EU's own ghg reduction targets and the EU ETS cap. Furthermore it is unclear to what extent any new agreement will set binding targets for the period 2020 to 2030 which is the period which will cover the majority of early operation of new nuclear and coal and CCS projects, and is thus particularly relevant to investment decisions being taken over the next few years. Developers are unlikely to commit to these huge capital investments without more clarity about how these investments will be rewarded over their lifetime. In relation to investment in new coal and CCS, we have already made the point that, to the extent that there will be a requirement to fit further CCS or achieve a specific emissions performance standard, by a defined date, Government would need to commit to fund this.

31 The priority for Government now is to deliver an effective global agreement at Copenhagen in December which should set legally binding targets for developed countries out to 2030 as a minimum, which will support the carbon price over this period. While such an agreement will be effective in helping ensure that ghg emissions across the EU as a whole will fall to the required level, the scale and rate of UK low carbon generation investment implied by the Climate Change Committee's scenario for 2030 referred to in question 1 (including for example a requirement to fit CCS to new coal plants by defined dates), may still require additional policy support. Government should begin to develop its thinking on these reserve options now and we describe our preferred approach in our response to question 14 below.

Question 6. What are your views on the problems that smart demand could address?

32 We believe that smart or flexible demand has the potential to alleviate but not eliminate the effect on the wholesale market of large volumes of wind generation by shaving off part of the peak demand requirement and reducing to some extent the difference between peak and baseload demand and the need for peaking capacity. It is currently uncertain what the potential is and whether this response will

evolve quickly enough to respond to the impact of wind generation on the wholesale market. The UK can learn from experience in countries where the level of wind penetration is already significantly higher than in the UK (for example Germany is at 8% and Spain 14%). At the distribution level smart demand can avoid the need for some load related distribution reinforcements.

33 Flexible demand could also contribute to CO_2 emissions reductions by reducing requirements for spinning reserve and hot standby fossil plant, and shifting demand from more carbon-intensive peak plant to lower-carbon baseload capacity. It can also contribute to security of supply by providing stability by modulating (increasing or decreasing) demand in the event of unexpected system frequency excursions, reducing transient peak demands on distribution networks.

34 Improved generation and network asset utilisation, reduced cost of balancing services, potentially avoided wholesale price volatility and potentially avoided peak plant construction should lead to a lower overall cost of the power system that would pass to consumers. Consumers who change their energy use (i.e. by providing a flexible demand service) may also benefit financially from either controlling their demand or shifting demand to avoid peak prices with more dynamic tariffs, which are the two principal ways of rewarding the value of flexible demand supplied by consumers.

Question 7. What are your views on the estimates of potential smart demand among the different consumer groups, and the approach used to reach these estimates? What other approaches or estimates might be helpful?

35 In the short term we see some potential for reducing demand from commercial air conditioning systems which currently account for about 1GW of demand. How this can be exploited effectively needs further analysis.

36 The provision of smart meters over the period to 2020 will facilitate demand side response in the residential and small business sectors if they are of an adequate specification. We see some potential for consumers to shift demand in response to price signals. Our initial analysis suggests that annual potential savings from more flexible demand through the energy market in 2020 could be around £120M. A reduction of 1.3GW of peak demand occurs and the demand trough is raised by about 1.4GW. This assumes, however, the deployment of two million air source heat pumps with 400,000 participating in demand side response, 500,000 ground source heat pumps with 100,000 participating, and 850,000 electric vehicles with 170,000 participating. This means, that across all households, the total savings would be £5 annually, but the savings for the consumers who take advantage of this would be around £20 annually. For 2030, we assume 4.5M participating air source heat pumps and 1.5M ground source heat pumps out of 6M and 2M respectively, and 12M participating electric vehicles out of 16M. For 2030, the reduction in peak demand is about 9GW with savings for the customer of up to £40 per household. Should the balancing mechanism market be more significant than it is now, there might be additional value for the end residential customer, but commercial customers may be able to exploit this value in a more effective way than residential customers would be able to do.

37 We do see additional potential as electric vehicles and heat pumps increase their share of their markets to shift load away from peak demand periods. Price signals would be the most appropriate way of ensuring this for electric vehicle charging, assuming deferring charging away from the evening peak is convenient for consumers, while pricing and automated control of heat pump systems with thermal storage may be the most appropriate way forward. Simply shifting demand away from the daily evening peak will make a significant contribution as this is the period when low wind availability would have most impact.

38 Overall this analysis suggests that the savings to consumers might not be sufficient on their own to incentivise smart demand certainly through a voluntary manual response to price signals. We therefore see more potential arising in automated control of appliances where the consumer will not be significantly inconvenienced but with provision for the customer to override this function. However more data is needed on how consumers will respond in practice to price signals. There might be some additional benefits for some industrial and commercial customers especially through the reserve market by bundling a number of consumers and bidding in demand interruption contracts with the TSO. However, the SO will not attribute 100% capacity credit to these contracts.

39 Additional incentives could be provided by networks seeking to incentivise consumers to shift load to avoid the need for load related network investment should there be a high uptake of electric vehicles and heat pumps. Distribution networks will need to take a proactive approach to demand side management as heat pumps and electric vehicles uptake will bring additional demand onto the networks system. Either additional capacity would be required or the current capacity could be optimised through demand management. Networks could for example, increase DUoS charges to deter consumers through supplier tariffs from using their heat pumps or charging their electric vehicles at peak times.

Question 8. What are your views on the smart demand measures set out? In particular, for each of the measures, the Government are interested in your views on:

- **Whether and how they should be explored further**
- **Their usefulness for maintaining a balanced system in different timescales**
- **Their appropriateness for different customer groups**

40 The emphasis of further work should be on identifying how residential and commercial customers can be incentivised by suppliers to shift load in response to wholesale market price and DNO signals, particularly on the relatively infrequent occasions when the power system is under significant stress. This can either be through encouraging customers voluntarily to shift demand in their use of appliances which are not amenable to automated control, such as washing machines or dishwashers, or to accept automatic control of appliances such as freezers, refrigerators and air conditioning, where reducing demand over peak demand periods will not have a noticeable effect on the consumer, but with an override function which would enable consumers to maintain the appliance in operation if they wished.

41 The level of reward, price volatility and duration of price spikes will be the crucial signal to consumers to manage demand. However, we are not aware of any UK data on the price elasticity of demand under these circumstances, or on how consumers would respond in practice to peak prices, or to more complex

tariffs. This is a critical area that requires exploration by Government and the industry. Those industrial and commercial customers who are subject to very tight margins on their revenues will be most likely to be interested in propositions regarding demand management. For residential customers, the savings on the wholesale market on their own may not be sufficient to incentivise large scale uptake, as discussed in response to question 7.

42 Time of use tariffs are one of the principal ways of incentivising flexible demand in the UK residential and SME markets, certainly up to the day ahead stage and their potential merits investigation in more depth. We would encourage DECC to investigate with the industry and consumer groups a number of specific areas:

- how could tariffs in principle contribute to UK system security, and anticipate forecast variable renewable output?
- the acceptability of more complex tariffs for consumers and the ability of tariffs to incentivise a response from different types of consumer;
- the capability of consumers to respond (either with automatic or manual interventions).

43 The extent to which consumers will choose to override automatic functions and the subsequent customer reaction to the resultant cost penalties need to be considered in the light of experience in the US.

44 Low frequency relays, for example used in refrigeration, are a useful device for new appliances but may prove less acceptable to consumers if retrofitted to existing appliances. However their impact is likely to be small as their main function is to provide a low frequency safety net that will probably be called upon infrequently.

Question 9. Are there other measures that the Government should look at?

45 The Government might consider the potential for 'virtual power plants' that may be formed by the centralised despatch of distributed generation operating in standby mode. This could be a useful source of power at critical system peaks. It could also consider the use of flexi-fuel heating systems as a way of backing up variable renewables on the demand side. When wholesale power prices are high because of low wind output, heating systems that primarily use heat pumps could be switched to fossil or biogas to reduce power system demand at these times.

Question 10. What are your views on the costs, benefits and risks of smart demand as set out above? Are there others?

46 Given our expectations of planned smart metering functionality, time of use tariffs should be a relatively low cost measure. However, as suppliers aim to provide tariffs to differentiate themselves, align to consumer lifestyles or wholesale pricing, there is a risk of customer confusion and resistance which suppliers will need to manage. The initiation of trials amongst consumer groups could help suppliers learn from experience.

47 The relationship between tariff and available technology is important. Economy 7, storage heaters and teleswitching allow customers to take advantage of tariffs. Constructing tariffs that appear to simply penalise energy use, without providing customers with the means to alter their demand may well be unacceptable. Time of use tariffs will need to be supported by technologies that allow electricity use to be identified, monitored and controlled (through manual or automatic systems) to provide consumers with the power to manage their demand, or by choice, not compulsion, delegate that control to a third party.

48 With time of use tariffs, significant amounts of data will also have to be processed and the costs of those processes will add costs to the end customer.

Question 11. What are your views on the barriers to customers providing smart demand? Are there other barriers?

49 We broadly agree with the barriers to uptake as outlined in the call for evidence, and would also note that most consumers are unaware of the challenge of keeping the power system in balance now, and this will need be to communicated in simple terms.

50 Government also needs to take the broadest view in terms of smart demand technologies. For instance, a heat pump or CHP device has little flexibility in operation without the use of a hot water heat store. These are essential technologies to decouple heat and power demand and allow customers to provide smart demand. Therefore, we would recommend incentivising or mandating heat storage devices, and consider how these devices may be retrofitted in houses where space may be at a premium and combi-boilers have allowed hot water tanks to be removed. This is likely to be much more cost-effective than a similar capacity domestic electricity storage device.

51 With more complex time of use tariffs, tariff confusion could be a barrier to uptake in general, as discussed above in relation to costs, but this could be addressed by suppliers making available a number of tariff options of different complexity to suit the needs of the customer.

52 Security of both infrastructure and data are critical issues, and it will be necessary to protect systems against malicious use. Customer consumption data should be made available to suppliers with appropriate data confidentiality safeguards, but aggregated data (e.g. for a GSP supply group) for particular classes of customers in a given segment of the market should be made available to the market as a whole, to help facilitate an efficient functioning market.

53 Consumers may be resistant to mandated smart demand measures that have an impact on their lifestyle and reduce their control. Therefore we are not supportive of measures where appliances (particularly in a domestic context) are effectively being controlled by an external agent such as a DNO or supplier unless this has been made clear to the consumer in advance and he or she has the ability to override the feature if he or she chooses to do so.

Question 12. What measures could be taken to overcome the barriers to smart demand? What are the costs and risks of these measures?

54 Given that price signals will be crucial in making smart demand work, there will need to be a commitment to and trust in a well-functioning wholesale market. Market or regulatory interventions which suppress peak prices will damage the prospects for smart demand as they will the provision of additional supply capacity.

55 Suppliers will need to manage an awareness campaign that communicates the underlying case for incentivising flexible demand and the potential individual and public benefits that arise from it. Government and regulators will also need to play an important role in this.

56 Energy suppliers will naturally provide demand aggregation for domestic and SME markets although separate aggregators could emerge. Larger industrial or commercial consumers with dedicated energy managers are more likely to be able to take advantage of aggregation services, whether or not provided by suppliers.

57 The Government should consider how energy storage devices (particularly thermal stores) could be incentivised or required for heat pumps and mCHPs, as this is crucial to enabling either device to provide flexible demand and generation respectively, and also whether building codes should be revised to allow heat stores to be accommodated.

58 The Government should work with the industry to consider how DNOs can provide incentives through suppliers to consumers for smart demand to overcome distribution network stress.

59 "Energy channels" on digital broadcasting platforms, and the internet might be used to send tariff or other information that may influence consumer energy use. The key point is that this information must be available in the right format and detail level on any mass technology platform that a consumer might reasonably wish to use. If day-ahead tariffs are widely deployed, then information on tariffs for the next day might be transmitted during/adjacent to weather broadcasts.

60 Market rules (including the possible creation of new markets), technology and other standards plus codes of practice for suppliers and aggregators will need to be developed to enable market development.

Question 13. What are your views (and any evidence) on the supply side measures? In particular, for each one, your views on:

- **Its potential benefits and costs**
- **Any issues arising from the measure for security of supply, carbon emissions reduction, or the Government's other objectives**
- **How the option might work in practice**
- **The need and likelihood for further technological development, where relevant**
- **Any regulatory or other barriers that should be considered**

- **Whether the Government should consider the measure further**

Long-term strategic reserve capacity

61 We do not support options which significantly expand the role of the system operator in competitive electricity markets. This is because:

- it may encourage a progressive and possibly unintended shift toward models where the system operator takes a central role in procuring capacity on the system subject to regulatory or political direction on the basis that this is the easiest solution to any short term capacity issues which may arise. This is fundamentally inconsistent with competitive market structures and the BETTA/NETA market arrangements in particular. There is little if any evidence to suggest that this type of centrally directed approach is an efficient means of meeting security of supply or affordability goals or encouraging innovation, as those who can recall the days of the CEGB will remember;

- partial contracting by the system operator of peaking or reserve capacity on a long-term basis will generally depress wholesale prices, increase the perception of regulatory risk and uncertainty about the role of the system operator as an effective market participant, and reduce returns for other capacity. Lack of transparency of such bilateral contracts for reserve means that balancing actions arising from such contacts are unlikely to be accurately reflected in spot wholesale prices. It is important to give timely and appropriate price signals to the market (including future larger scale demand side response) to ensure it can respond appropriately; and

- unless the system operator is effectively separated out from transmission functions, decisions may also be taken in a way which is influenced by the objectives of the wider networks business.

Capacity Mechanisms

62 We have examined the potential role of capacity markets in addressing the issue and of an obligation on suppliers to contract for capacity at a margin in excess of expected demand specifically.

63 While such an approach could in theory provide a more reliable and market based source of peak income for back up capacity and baseload plants, we broadly agree with the DECC analysis of this option. Practical experience has been problematic with mixed success in the UK and elsewhere. The structure of capacity mechanisms may also alter significantly over time as it is difficult to implement correctly in the first instance (for example in setting the level of capacity margins or capacity values) and is thus likely to have limited value for investments which have long planning and construction periods such as nuclear power plants. It may also distort trade and investment within the EU electricity market particularly as capacity outside the UK would need to be eligible for such an obligation to meet the requirements of EU electricity market legislation and internal market rules.

64 While preferable to a single buyer model, our view is that the existing energy only market should be allowed to develop and that the potential of flexible demand, additional electricity interconnection and storage should be developed as a means of addressing wind intermittency impacts, before considering structural changes to the market arrangements. The effect of the recession on demand allows more time to assess the effectiveness of these approaches.

65 In terms of incentivising early investment decisions, priority should be given to supporting low carbon generation including nuclear and coal and CCS.

Interconnection

66 Additional interconnection has a potential contribution to make, although less than flexible demand. Much depends on how interconnectors are used across the two connected systems and the generation and demand patterns and price characteristics of each connected system.

67 If interconnector imports into the UK market run more or less continuously as base load before gas plants are required for back up, interconnection capacity does not substantially reduce the level of back up capacity required as the interconnector effectively substitutes for UK baseload generating capacity. This is typical of how the IFA currently functions. Interconnectors operating in this way would in principle reduce the total UK capacity requirement provided the UK is willing to rely on interconnector capacity for security of supply purposes.

68 Also if adjacent markets are similarly affected by large volumes of wind, as is the case with Germany and other north-west European markets, there may be limited scope for importing electricity into the UK at times of low wind generation as these markets may be affected by similar conditions. Our analysis suggests that anticyclones affecting the UK and much of North West or Western Europe are not untypical and that the overall capacity value of wind generation only increases marginally when taking a portfolio spread across this wider region.

69 However, if the interconnector flows could respond to volatile UK prices, additional interconnector capacity could shave peaks and increase UK demand during periods of over capacity.

70 The potential contribution of interconnections thus requires further analysis.

Electricity Storage

71 Storage is a potential long term contributor to help absorb wind generation, but, with current technologies, our calculations show that it would be less expensive for energy companies to balance load through the traditional means, through adjusting the contribution from fossil generation given the wind generation profile and demand profile. This suggests that it may be difficult in the short term to incentivise provision of storage on a commercial basis. Other factors that restrict the current competitiveness of storage are that it incurs significant electrical losses and requires significant space

(and therefore planning permission). Presently, it incurs far greater losses than those from long-distance transmission routes. It has a relatively low energy density compared to fossil fuels, creating the requirement for far greater space.

72 Nevertheless, storage should continue to be progressed. Given the relative isolation of the UK from the continental system, high levels of wind penetration will mean that network balancing will be more of an issue in the UK than in most other parts of Europe. Electrical storage technologies may for example find a niche in the balancing services market if the alternative is to rely on baseload thermal plant to provide dynamic balancing services.

Question 14. Are there other ways of maintaining security of supply or supporting low carbon investment, given the challenges for the electricity system identified, that the Government should consider and how might these work?

Question 15. What evidence and analysis do you have of the need for, costs, benefits and risks of these?

73 While renewable capacity is effectively incentivised through the renewables obligation, new nuclear and coal and CCS investment rely on an adequate carbon price to support the investment. The outlook for carbon prices is particularly uncertain at present and does not yet provide a reliable basis for investment in either technology given potential outcomes for fossil fuel prices. While, for E.ON at least, this is not an immediate issue for new nuclear investment, we will need to judge, when we come to take an investment decision in 2012 or 2013, whether the range of possible outcomes for the carbon price supports a positive investment decision.

74 For new coal with CCS capacity, while Government is proposing to introduce a levy on suppliers to fund CCS demonstration, the question remains of how to incentivise investment in further CCS retrofit or new coal and CCS plants after the demonstration period is complete. This issue will become acute if the Government confirms a policy of effectively requiring CCS by a given date or subjecting the plant to a limited operating regime which would restrict investment returns. In circumstances where new coal plants are required to fit CCS or are subject to an equivalent emissions performance standard, investors in new coal plant now will need to reach a judgement about whether the EU ETS will generate a sufficient carbon price to support the further CCS deployment at this later date. Uncertainty around future regulation and funding thereof will clearly increase the risks associated with investment in such plant.

75 The effect of increased wind generation on the system potentially displacing generation from nuclear and CCS abated coal generation and depressing average wholesale prices, adds to the potential shortfall in revenue which might arise, and investors will need to judge the effectiveness of some of the proposed policy solutions explored above.

76 In our view, these issues are most effectively addressed by working to provide an effective and robust emission trading scheme with a cap which delivers a substantive carbon price over a period which is

relevant to, say, the first ten to fifteen years of operation of a new nuclear and coal and CCS capacity, in other words to 2030 as a minimum.

77 The immediate objective should therefore be to secure an effective, comprehensive international agreement, which will lead to the EU adopting a 30% ghg emission reduction target by 2020 on 1990 levels and a further tighter target for 2030.

78 Nevertheless it is possible that a comprehensive agreement is not achieved at Copenhagen or shortly thereafter, or that the carbon price will not rise to adequate levels even if agreement is reached taking account, for example, of the effect of the global recession on EU demand.

79 Given that the UK wishes to achieve domestically sharper and longer-term reductions in CO_2 emissions than the EU ETS currently provides for and the advice of the CCC that the UK power sector should aim to be significantly decarbonised by 2030, we recommend that the UK Government consider policy measures which could act to strengthen signals for low carbon investment, which it could introduce should the need arise.

80 In our view, we would propose a number of criteria for assessing such reserve options. Any further measures should be market-based and as far as possible fulfil the following requirements:

- technology neutral to enable the most economic solutions;
- consistency with the EU ETS;
- effectiveness in reducing investors' weighted average cost of capital (WACC);
- capable of practical implementation within reasonable timescales.

81 We have assessed a number of options against these criteria and our conclusions are summarised below:

Policy Option	**technology neutral**	**consistency with the EU ETS**	**effectiveness in reducing investors' WACC**	**Capable of practical implementation**
Low Carbon Obligation	It can support low carbon technologies neutrally which would incentivise the least cost option but could be banded into two categories to support both nuclear and CCS. It would operate alongside the RO.	Yes. The higher the carbon price the lower the support needed from the LCO price.	Yes. Experience with the renewables obligation suggest that this can provide a robust long term framework for investment provided benefits for existing investments are grandfathered when the structure is altered.	In principle we do not see practical problems in effectively extending the RO mechanism to other technologies. State aid clearance would be required.

			The mechanism can continue to reward capacity in the 2020 and 2030s in a similar way to the RO.	
Floor to the EU-ETS Price through minimum auction price	Yes	Yes	Limited unless the price is set at a sufficiently high level and over an extended period Furthermore as low or low carbon generation sets the wholesale market price with increasing frequency during the 2020s, the floor price would become progressively less effective in rewarding low carbon investment unless its level was raised substantially.	Unlikely to secure agreement between member states to a useful carbon price in the near future; action by one or two MSs to support the price by setting a minimum auction price unlikely to be effective.
Carbon tax on CO_2 emissions or fossil fuel consumption	Yes	Yes - it can support the price signal although UK carbon taxation will have a slight negative effect on the EU carbon price.	Limited. Investors will need to consider whether the tax will still be in existence during the 2020s and 2030s and at what level. This is subject to significant political uncertainty. Furthermore as low or low carbon generation sets the wholesale market price with increasing frequency during the	Capable of being implemented in the UK domestically. Implementation at EU level would require extended discussion although the existing excise duty regime could provide a framework

			2020s, the carbon tax would become progressively less effective in rewarding low carbon investment unless the tax level was raised substantially.	
Contract for Differences on the carbon price	No. Government actively involved in selecting technologies and projects for the award of contracts.	Yes in as far as CfD payments vary in relation to the carbon price	Could be effective for individual projects. CfDs can be an appropriate means of supporting a limited number of demonstration projects after a competitive process but are not suited to supporting whole classes of low carbon generation where there are practical difficulties in designing a system where projects can compete.	Would leave the Government with a potentially large and variable liability if extended to a wide range of investments.

82 This analysis leads us to favour on balance a Low Carbon Obligation similar in structure to the RO and operating alongside it. The Obligation would apply to suppliers who would have to contract for particular levels of low carbon generation (nuclear or CCS). This approach would provide a more reliable source of revenue than a carbon tax as zero/carbon plant become marginal on the system. It provides income for both nuclear and coal with CCS and effectively reduces the discount rates on investments.

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