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SMART, FLEXIBLE POWER SYSTEM
E3G RESPONSE TO DBEIS AND OFGEM CALL FOR EVIDENCE

Background

E3G has been working to develop policies that will facilitate the early decarbonisation of the power sector since it became apparent that this would be critical to deliver the emissions reductions necessary to tackle the threat of climate change. In 2009, E3G was lead author for the European Climate Foundation Roadmap 2050 report[1] which identified three key recommendations to support power sector decarbonisation:

> Interconnected markets and larger balancing areas

> Efficient and flexible consumption

> Market reform to support the above.

Whilst there is now widespread agreement on the benefits of interconnection and efficient and flexible consumption, no consensus has emerged on the appropriate market design and industry governance that will deliver the necessary changes[2].

The Fifth Carbon Budget, approved on the 20th July last year, committed the Government to 57% emissions reductions by 2032. This was in part recognition of the importance of the Paris Climate Change Agreement and the risk that the UK will be left behind as progress in other countries accelerates.

The UK now has the opportunity to create a smart, flexible energy system improving the quality of people's lives and increasing the productivity of the economy. This consultation from DBEIS and OFGEM is a welcome step forward since it recognises that there are still some significant outstanding issues to address. E3G is, therefore, pleased to respond and to set out some of our latest thinking about what needs to be done.

Emerging consensus

Power system flexibility has always been critical given the limitations on electricity storage and the need to balance supply and demand in real time. However, as we look forward, flexibility will become even more important[3]. Decarbonisation of the power sector will inevitably require the deployment of large quantities of renewable generators whose output depends on availability of natural resources rather than the varying demands of consumers. Moreover, decarbonisation of the heating and transport sectors will involve some degree of

[1] European Climate Foundation (2009) **2050 Roadmap Reports**

[2] E3G (2016) **Plugging the Energy Gap**

[3] National Infrastructure Commission (2016) **Smart Power**

electrification. The power system will therefore be required to replace part of the energy storage capability in these sectors that is currently provided by fossil fuels[4].

Traditionally, power system flexibility has been provided by large thermal power stations connected to the transmission network. These will need to be progressively retired as the power system decarbonises. Also, much of the emerging need for flexibility will arise at the local system level as a result of embedded renewable generation and changing consumer demands for heat and transport[5]. Large centrally connected power plant is less able to provide the flexibility required to balance supply and demand at local level[6]. Therefore, current sources of flexibility are becoming less available and less appropriate for the emerging situation.

Alternative sources of flexibility are available, most notably from:

> Increasing the size of balancing zones through power system interconnection[7]

> Power storage, where technical capabilities are improving and costs reducing, and

> Demand side response as consumers adjust the time at which they take power from the system.

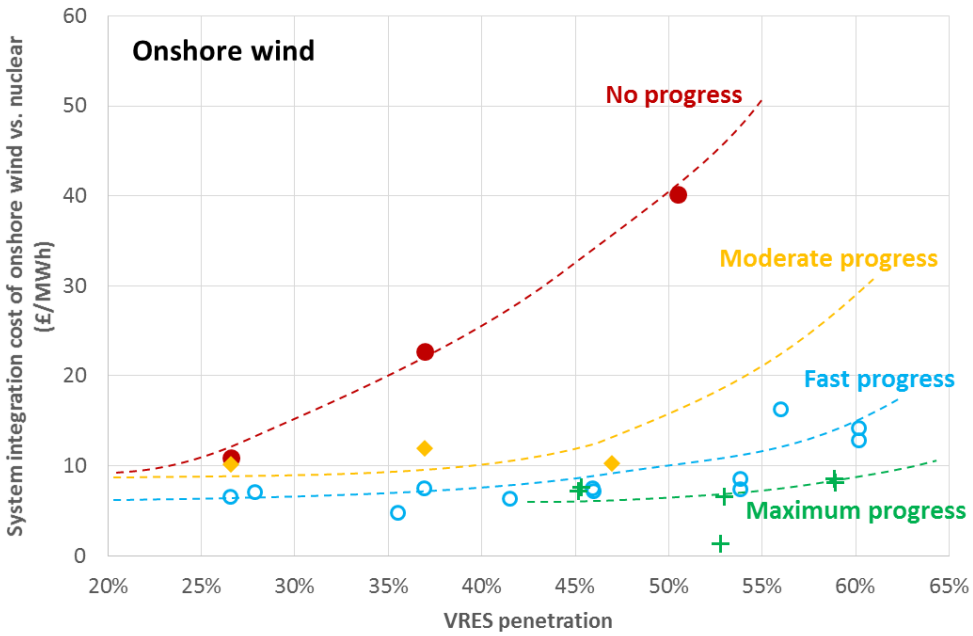

Figure 1. The system integration costs of onshore wind at differing levels of market penetration in four system flexibility scenarios[8].

[4] E3G (2016) **Response to National Infrastructure Commission call for evidence**

[5] Institute of Civil Engineers (2016) **National Needs Assessment**

[6] National Infrastructure Commission (2016) **Smart Power**

[7] E3G (2015) **North Seas Grid**

[8] Imperial College London (2016) **Whole-system costs of variable renewable in a future GB electricity system**

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However, none of these new forms of flexibility by themselves provides a ready solution to the emerging needs for system flexibility. Using interconnection to increase the size of balancing zones relies on the co-operation of different national governments to design and implement efficient and consistent trading arrangements. In particular, the statutory objectives of system operators must not distinguish between national demand and that in neighbouring countries. Also, whilst interconnection can be particularly helpful in efficiently integrating large renewable resources, such as offshore wind, it is less relevant where the need for flexibility arises at the local level. Finally, the Brexit process adds uncertainty to the development of the EU internal energy market and the participation of Great Britain[9].

Storage technologies are developing quickly, largely driven by the desire to improve performance of electric vehicles, although the rate of on-going performance improvements and cost reductions remains uncertain. In particular, technologies are currently limited to relatively 'short cycle' response and are not capable of delivering power output for long periods of time.

There is broad consensus that the potential for demand side response is significant and, as yet, largely unexploited[10]. However, the ability to realise this potential is uncertain since it depends on the engagement of consumers and major changes in the way they use energy. It is, therefore, widely assumed that the provision of demand side response will only begin to increase significantly as building automation systems are deployed which will allow consumption to be adjusted with little or no active participation on the part of the consumer.

There is no silver bullet that will address the emerging need for system flexibility and it is likely that all the alternatives described above will be required to some degree. Also, the evolving nature of the technologies involved, and the immaturity of markets, suggests that innovation will be critical in achieving an efficient outcome. Unfortunately, there is not long before a more efficient power system is required. Recent analysis by Imperial College suggests that the costs of inflexibility could begin to escalate in the early 2020's as the deployment of renewables proceeds[11]. The major requirement for flexibility at the local level will be driven by the decarbonisation strategies for the heat and transport sectors and is likely to begin to grow in the late 2020's (although it could be earlier than this if the deployment of electric vehicles exceeds current expectations)[12].

[9] Chatham House (2016) **UK Unplugged? The Impacts of Brexit on Energy and Climate Policy**

[10] See the European Commission (2016) **Clean Energy Package Market Design Impact Assessment**:'According to recent analyses, the current theoretical demand response (or flexibility) potential accounts for approx. 100GW of which up to 40GW could be economically activated. However, currently only approx. 21 GW (predominantly in the industrial sector) are activated indicating that the demand response potential is underutilised.'

[11] Imperial College London (2016) **Whole-system costs of variable renewable in a future GB electricity system**

[12] Committee on Climate Change (2016) **Sectoral Scenarios for the Fifth Carbon Budget**

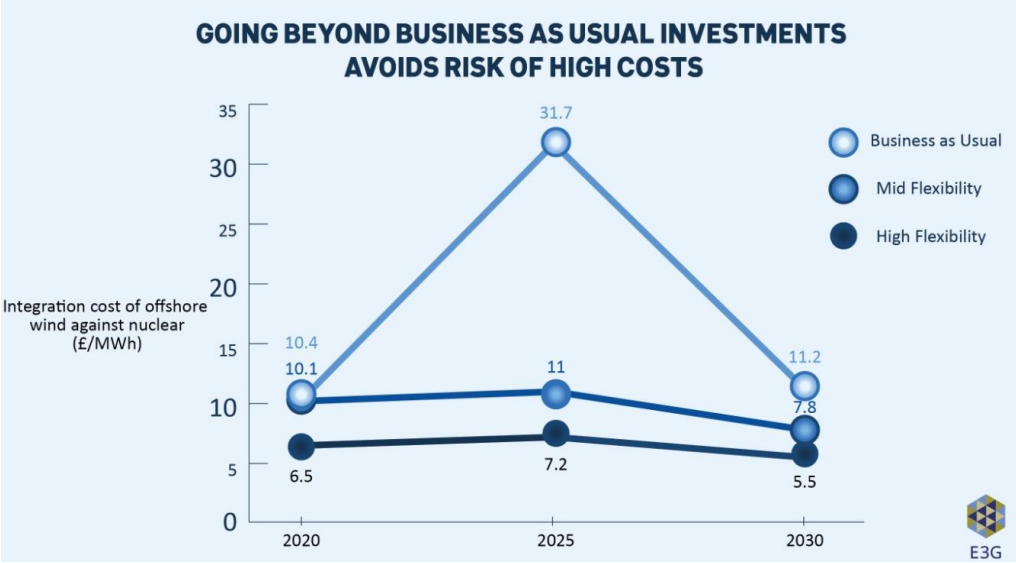

Figure 2. Imperial College London, the system integration costs of offshore wind in three core scenarios from 2020 to 2030 showing the risk of significantly higher costs in the early 2020s without additional investment in flexibility above business as usual[13]

There is, therefore, considerable emerging consensus over the increasing requirement for power system flexibility and the need to consider the energy system as a whole rather than focus on individual sectors. In particular:

> There must be significant progress in the deployment of new sources of flexibility over the next 5 years to allow the efficient integration of renewable resources[14].

> Market arrangements that ensure efficient deployment of flexibility between energy and networks and between local and national levels must be established within 10 years to support the decarbonisation of heat and transport sectors[15].

The DBEIS and OFGEM consultation does not address the challenges associated with optimising the use of interconnectors in the provision of flexibility and, therefore, the comments in this response focus on the creation of flexible power markets within Great Britain.

Key questions to address

Power market liberalisation has been based on the principle that cost reflective market pricing is the most effective way to drive optimal investment and operational behaviour and to lead to efficient outcomes. It is, therefore, reasonable to apply this same principle to ensure power markets deliver the required levels of system flexibility. However, there are concerns that the new products and capabilities that are required will not emerge efficiently purely in response to accurate market price signals.

[13] *ibid*

[14] E3G (2016) **Plugging the Energy Gap**

[15] *ibid*

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It is already well-understood that there are significant obstacles that prevent promising immature technologies from achieving mass market scale and a variety of Government 'market creation levers' are available to help such technologies achieve maturity. This is not only relevant to storage but to the raft of smart devices and associated communication infrastructure that would be required within an automated building energy management system.

The biggest challenge to the principle of relying purely on market price signals involves the role of consumers in enabling the demand side response potential to be fulfilled. Studies in behavioural economics confirm that individual consumers (business and household) are unlikely to behave as 'rational economic agents', adjusting purchasing behaviour to achieve the most economically advantageous outcome. This is evident in the energy sector from the resistance on the part of many consumers to reduce household energy bills by £100's each year by switching energy supplier or accepting free energy efficiency upgrades[16].

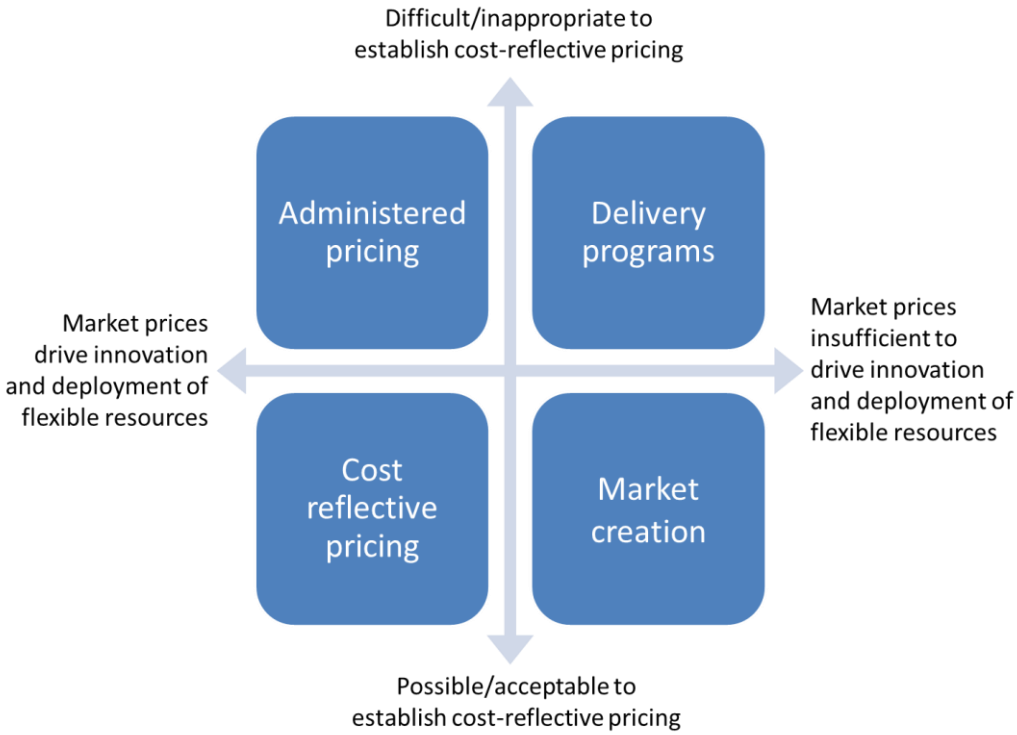
There are also practical difficulties. It has never been possible to develop a single pricing methodology that can accurately allocate resources between investments in energy or networks, or even between energy balancing and system balancing[17], in existing markets where trading is only used to manage the transmission system. The migration of many of the system balancing and network investment challenges to the distribution level will significantly increase the complexity involved. Put simply, it is extremely unlikely that it will be possible to design markets that efficiently allocate flexible resources between energy balancing and network investment and between local and national levels such that it leads to system-wide efficiency.

Finally, there are political limitations on the use of market pricing to achieve behavioural change on the part of the mass consumer market. Prices that rise sufficiently to attract action from those consumers who can respond may be extremely painful for those consumers who are unwilling or unable to respond.

The chart below sets out these issues diagrammatically. It can be seen that relying on cost reflective pricing is only appropriate if there is both a firm belief that market prices will drive the necessary innovation in, and deployment of, flexible resources and that it is both practical and politically acceptable to establish such a pricing regime. In all other circumstances, different approaches are required.

[16] Competition and Markets Authority (2016) **Energy Market Investigation: final report**

[17] Energy balancing involves matching overall supply and demand whereas system balancing involves the need to adjust supply and demand at a local level as a result of system constraints (e.g. transmission congestion or the need for spinning reserves)



The evidence to-date, as discussed above, suggests that it is not reasonable to assume that market pricing alone will be able to drive innovation and deployment of flexible resources at the rate and to the extent required. However, whether this can be effectively addressed with some targeted market creation options (e.g. product standards, obligations on suppliers and/or network operators) or whether more co-ordinated rollout programme of smart technologies will ultimately be required (as is the case for smart meters) is unclear.

It is also unclear how market arrangements should be adapted for the new situation. Whilst no set of arrangements will be capable of providing the 'right' price signal that is relevant to network operators and those operating in energy markets at both local and national level, there may be some administrative approximations that prove adequate. In particular, the optimal market design will depend on the relative value of the flexible resources in energy balancing versus offsetting infrastructure[18], and at transmission level versus distribution level, along with the overall impact on individual consumer bills.

Proposed way forward

The timescales to develop new sources of system flexibility are short. Action must be taken now (in this parliamentary term) to ensure there is significant progress in the deployment of new sources of flexibility before the early 2020's and enduring market arrangements must be developed and implemented by the mid-2020's.

The implementation of targeted market creation options appears to be a low-regret action. There is a long track history of developing product standards and obligations on market participants and this experience can be used to ensure that costs to the consumer are

[18] E3G (2016) **Plugging the Energy Gap**

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minimised[19]. Not only would they ensure that system flexibility increases and prevent costs escalating in the early 2020's but they would provide valuable lessons about the longer term delivery potential and the challenges involved.

Market creation mechanisms that can, and should, be implemented in the short term include:

> Requirement on suppliers to offer an accredited flexibility tariff(s). This must involve the consumer adjusting consumption in response to a short term price signal or instruction and, therefore, go beyond simple time-or-use pricing.

> Obligation to sell a certain number of these contracts to consumers of different types (industrial, commercial, residential). This will require the supplier and consumer to install the relevant communication and control systems and will help to drive the supply chain in these products.

> Standards requiring that owners of certain energy intensive appliances (electric heating, electric vehicle charging) and electricity intensive industrial processes must be on an accredited flexibility tariff.

> Obligations on the Transmission System Operator and Distribution System Operators to offset of proportion of their network expenditure through investment in new flexibility services. In the case of the Transmission System Operator, this should include reductions in capacity auction costs where resources can effectively provide firm capacity as well as network support services.

Much of the uncertainty relating to the future design of market arrangements involves the interactions between sectors at a local level. Whilst there have been many small scale pilots testing different aspects of a smart energy system, there have not been any large scale demonstrations testing the impacts on the system as a whole. Now is the right time for 'city scale demonstrations' to test and develop our understanding of the costs and benefits of smart, low carbon cities as well as providing an opportunity for targeted regeneration. Costs can be contained by asking city authorities to compete for funds to establish smart energy zones with low carbon heating and electric vehicle and supporting infrastructure. This process should involve:

> A competition for pre-allocated central Government funding.

> The requirement to install a certain number of low carbon heating systems, power storage systems, EV charging infrastructure, building automation systems suitable for providing flexible consumption, and, building retrofits to improve efficiency[20].

> Some form of incentivisation to ensure installations help to reduce overall energy system costs.

[19] E3G (2016) **Rebooting Europe's Energy Leadership: Consumer focused energy innovation**

[20] Whilst building retrofits to improve energy efficiency are not typically associated with the development of a smart, flexible power system, they are a vital element of the overall energy system transformation since they significantly reduce overall system costs. It is, therefore, very important to use city scale pilots to drive forward this aspect of energy system improvement.

- Award(s) based on the extent of the learning achieved, scale of deployment (number of installations), cost and ability to raise other sources of finance, plus wider industrial strategy benefits.
- A new smart power delivery body is needed to oversee this combined program of market creation and city scale pilots operating under a clear set of statutory objectives (it may be appropriate for Ofgem to act as the delivery body with the statutory objectives included as new duties). The following statutory objectives are required:
  - Ensure flexibility from new sources grows at a minimum rate where 'flexibility' and the 'minimum rate' are defined by Government on basis of what is needed to minimise overall energy system costs.
  - Define enduring market arrangements by 2022 on basis of learning achieved through market creation mechanisms and city scale pilots.
  - Deliver the above at least cost to consumers and taxpayers by running effective auctions and tightly regulating delivery of required outcomes.

Summary of recommendations

The challenge for policy makers is to achieve tangible progress towards a smart, flexible power system whilst leaving space for innovation in technologies and market design. We have proposed three key policy strands to help meet this challenge:

1. A targeted package of market creation measures including product standards and obligations on market participants.
2. A programme of Government funded city scale pilots to create smart energy zones with low carbon heating and electric vehicle and supporting infrastructure.
3. Establishing a new smart power delivery body to oversee this combined program of market creation and city scale pilots operating under a clear set of statutory objectives.

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