29 September 2016

Re: The Economics of UK Energy Policy Call for Evidence

Please find attached the Institution of Engineering and Technology’s written response submission to the above consultation.

This submission has been approved on behalf of the IET’s Board of Trustees, and takes into account the views of IET Members under the guidance of the IET’s Energy Policy Panel and should not be taken as representing in any way the individual views of the organisations for which the panel members work.

The IET would welcome the opportunity to discuss these points with the Ministers or Officials.

Yours sincerely,

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Written evidence submitted by the Institution of Engineering and Technology (IET) to the Economic Affairs Committee of the House of Lords in response to its call for evidence on “The Economics of UK Energy Policy”

30 September 2016 (21 September draft)

1. The IET

1.1 The IET is one of the world’s largest professional bodies for the engineering and technology community and, as a charity, is technically informed but independent. This submission has been prepared on behalf of the Board of Trustees by the Energy Policy Panel and takes into account inputs from the wider membership.

1.2 The Energy Policy Panel has worked closely with DECC and various parliamentary committees over recent years to contribute to the development of energy policy, particularly for electricity. We would like to continue to provide this service and would be pleased to meet the Committee if this would prove helpful.

2. Summary

2.1 The challenges set by the Climate Change Act have initiated a period of transformational change in the UK’s energy supply systems. The development of our energy markets will play a vital role in this transformation. We believe that:

- Energy markets should, first and foremost, be designed to deliver value to consumers. They should empower them to engage with markets where this is value enhancing. We must enable individual consumers and communities to engage with energy markets easily.
- Winning back consumer confidence should be a priority for all stakeholders in the energy sector.
- Energy markets must demonstrate the coherence and stability necessary to win back the confidence of the investor community.
- Energy policy must progressively recognise the need for whole-systems approaches; the energy policies and objectives for electricity, gas and oil must be considered together (i.e. a multi-vector approach). This is explored for the electricity system in the Future Power System Architecture report\(^1\), commissioned by Government and produced jointly by the Energy Systems Catapult and the IET at the request of the House of Lords Science and Technology Committee.
- Government should ensure that it has a proper understanding of the technical complexities and opportunities of the smarter energy infrastructure that is developing.
- Government should seek to achieve coherence and alignment in the future development of energy markets with energy regulation and new energy technologies, backed by relevant research and development.

2.2 It is too soon after the referendum to gain clarity about how we will trade energy with the EU countries after Brexit but it is clearly of great importance. Interconnectors (for

\(^1\) [http://www.theiet.org/sectors/energy/resources/fpsa-project.cfm?origin=reportdocs](http://www.theiet.org/sectors/energy/resources/fpsa-project.cfm?origin=reportdocs)
gas and electricity) already play a major role in meeting our energy needs and this will increase as new projects come into service. The Brexit negotiations will present risks and hopefully opportunities in the energy sector. We believe that Brexit may allow fresh thinking in relation to energy policy and we would encourage Government to explore all such opportunities.

2.3 The IET commends its Energy Principles\(^2\) to the Committee to assist in its deliberations.

3. Introduction

3.1 The IET welcomes this inquiry and in particular that it embraces the whole energy system. Historically, policies for the key end-use energy vectors (i.e. gas, oil and electricity) have been developed largely in isolation from each other. The IET believes that energy policy must in future be developed as a multi-vector challenge. However, the IET’s core strength is in the technological development of the electricity system and this is the main focus of this response.

3.2 While the IET is driven by engineering and technology, we are acutely aware of the way that commercial and regulatory issues interact and impact the physical development of our energy infrastructure for heat, power and transportation. We therefore strongly encourage the Committee to consider the interaction between energy markets, the way in which the naturally monopolistic parts of the system are regulated, and the efficient delivery and operation of our energy infrastructure.

3.3 The IET has recently worked with the Energy Systems Catapult to deliver the Future Power System Architecture (FPSA) report which was commissioned by Government. This report demonstrates how much more complicated the planning, development and operation of the electricity system is becoming. The new commercial structures that are already developing will also be much more complex than in the past and it is expected that energy markets will need to develop in response to this. Therefore, just as we believe that a multi-vector approach is required to achieve efficient engineering solutions, we also believe that similar coherence is required between energy markets, regulation and the physical delivery of infrastructure. We would welcome the opportunity to present the findings of the FPSA study to the Committee.

3.4 A key feature of the upcoming changes to the energy system is the rising importance of what happens in consumers’ premises – homes and businesses. However, we note that there is no direct reference to consumers’ needs in the questions posed. The rise of “big data”, low cost sensing and the internet of things is driving a wave of technological innovation, much of it from companies new to the energy industry. This promises to reduce costs to consumers, engage consumers more actively, increase choice, and help reduce greenhouse gas emissions. However, it will only flourish if existing market and commercial arrangements are changed to remove barriers, and configured instead to enable and facilitate this type of innovation.

While markets can develop and change incrementally we do not believe that they can re-invent themselves. There will therefore be a need for Government leadership to deliver the degree of transformational change that we believe is required.

4. The Questions

4.1 We have provided responses to questions 1, 2, 3, 4, 5 and 7.

**Q1 – What are the key economic challenges for the energy market which the Government must address over the next decade?**

4.2 A conventional market is characterised by there being multiple buyers and sellers of a product and a sufficient number of transactions for efficient price discovery to occur in a transparent way. This is not the situation that exists in electricity today. Further, it is unlikely that such a market is achievable in the near-future. For example, the introduction of ‘contracts for difference’ (CfD) for renewable electricity producers as part of the Electricity Market Reform means that a substantial proportion of all electricity produced could in time be effectively ‘taken out of the market’. So, our starting point for electricity is a market that cannot be assumed to function in the best interests of consumers.

4.3 We believe that there are a number of important questions and challenges that flow from those set out in the call for evidence including:

- How best can transformational market changes be implemented where they are justified?
- Do existing energy markets properly serve the needs of consumers? We must enable individual consumers and communities to engage with energy markets easily.
- How can we develop our energy markets to win back the confidence of the investor community so that the much needed renewal and expansion of our energy infrastructures progresses in a timely way?
- In the absence of a credible, global market for carbon, how can low carbon technologies best be compensated where their costs are acknowledged to be higher than more carbon-intensive alternatives?
- How can we move to more whole-system thinking and solution delivery from the siloed approach that currently prevails?
- How can the energy community most effectively help Government to understand the technical and engineering complexities of the energy future we are moving towards?

4.4 We have tried to expand on these points in the observations and ideas set out here.

*We will need transformational change in energy markets*

Established markets can be very successful at optimising around incremental changes, but left entirely to themselves they do not bring forward disruptive innovation that serves consumers well. Transformative change requires new ways of working, new ground rules, and new standards that enable competing players to share the same market place. The role of government here is not to 'pick winners' or dictate standards, but to be the instigator and
facilitator of change. It has taken this role with its smart metering initiative (i.e. a transformational change) and we believe that it will need to work with all energy sector stakeholders to catalyse further market changes, in particular recognising the need to encourage smaller parties to participate in energy markets.

**Markets must serve the needs of all consumers**

4.5 The role of small scale (domestic) and medium scale (community and business) driven generation and demand management is continuing to expand. This is changing the system fundamentally, with knock-on effects to the commercial models for larger generators. Storage at these scales is also likely to become significant, provided the market is configured to enable it. Further sources of demand management and possibly generation and storage are likely to emerge from virtual communities, for example electric vehicle fleets. All this offers an opportunity to reduce costs and empower consumers.

4.6 There is an opportunity here to harness a changing public mood, combined with social media tools, apps, peer-to-peer interactions and local markets. These present new opportunities as consumers become more engaged in their energy through smart meters, home automation, dynamic pricing, micro-generation and distributed storage. Many of the new business models needed for a future decarbonised energy system are inherently local, often at a street-by-street level. For this to happen at scale, incumbent organisations have to decide to switch from their business-as-usual model to collaborate in a new way, locally.

**We must rebuild investor confidence**

4.7 There is no doubt that, for a number of reasons, the confidence of the investor community has been eroded over recent years. In spite of the fact that large fossil plants are closing and that the ability to meet our winter peak electricity demand is at risk, investment in new generation is suppressed. The Electricity Market Reform mechanisms have not yet unlocked this problem. We must recognise that investment in major generation projects requires reasonable certainty about the likely revenue stream over a long timescale and that external risks, of whatever kind, do not result in a project risk profile that is non-financeable.

4.8 We must recognise that the profound change that is occurring from a technology perspective impacts the business model for new generation. A key characteristic of electricity produced from fossil fuels is that the cost of the fuel makes up a large proportion of the delivered cost of the electricity. In contrast, for renewable technologies, it is the capital cost of the generators that dominates the delivered cost of the electricity. For wind and solar of course the primary energy is free. This raises significant questions about how a future market for electricity might operate most effectively so that capacity and energy are properly rewarded.

**Rewarding low-carbon generation**

4.9 We recognise that it is unlikely that a credible global market for carbon will be established in the near-future. We therefore accept that the Government has to intervene in the market to ensure that sufficient renewable generation is built to meet our Climate
Change Act commitments. The CfD provisions of the Electricity Market Reforms are intended to meet this challenge. However, there is concern that the award of CfDs, which will significantly impact future consumers’ electricity bills, is not sufficiently transparent.

*We must promote whole-system and multi-vector thinking*

4.10 The Future Power System Architecture project has demonstrated clearly how much more complicated the future energy supply world will be. If customers are to be served well, we cannot allow this to develop in a haphazard way or be dominated by the self-interest of big players; the risks to supply security and consumer prices are too great. We believe that if we can establish a common view of the energy future we are moving towards we can put in place a coherent governance structure across the energy vectors that will allow stakeholders to design, implement and ‘own’ the energy markets of the future.

4.11 The future mix of generation, storage and demand management technologies provides a good example of how important whole-system thinking is. If there is no guiding strategy behind the growth of these technologies, we believe that the security of the power system could be put at risk. In a worst case scenario, the failure of the system would be followed by a very lengthy and difficult to manage period to restore electricity supplies. Our response to Question 7 gives more detail. Also, the intermittent nature of some renewable generation technologies means that there is an increasing need for additional, controllable generation or storage that can ‘fill the gaps’ when the wind isn’t blowing and in hours of darkness or heavy cloud cover. We need to make sure that our electricity market offers a sound business case to encourage developers to build plants that will meet this need.

*Helping Government*

4.12 We have worked closely with DECC and various parliamentary committees over recent years to contribute to the development of energy policy, particularly for electricity. We would like to continue to provide this service and would be pleased to meet the Committee if this would prove helpful.

**Q2 – Has the market and the Government responded effectively to changes in external circumstances, such as significant shifts in technology and prices?**

4.13 There are some encouraging signs that Government and industry are responding. For example, the Government has provided financial incentives for renewable electricity generation and the supply of heat (the Renewable Heat Incentive). It has also initiated the smart meter programme which lays the foundation for much greater consumer engagement with the energy market. In particular, it is an enabler for a much more flexible electricity system in which consumers (or companies acting on their behalf) play an active part in helping to balance the system in real time.

4.14 There are also encouraging signs, particularly on the demand-side, that energy suppliers see real opportunities to offer consumers new products and services that use consumer-friendly technologies to help manage energy usage.
4.15 However, there are negative indicators as well. As the Government is playing such a leading role in the electricity sector right now, its policies must, in part at least, be responsible for the suppressed level of investment in new generation capacity. Also, the IET believes that there needs to be much more coherence in setting energy policies so that clear linkages can be seen between the visions for low carbon heat, transport and electricity. The fundamental architectures of our energy infrastructures need to be challenged so that necessary changes are identified well ahead of need. To date the inherent resilience of the system has allowed it to cope with change well, but the pace of change is increasing and headroom for absorption decreasing, as exemplified in National Grid’s annually updated System Operability Framework.³ This leads to concerns over when tipping points could be reached such that system behaviour becomes unacceptably unpredictable. Our ability to forecast this is uncertain, as demonstrated in the IET’s work for the Council for Science and Technology.⁴

**Q3 – What are the emerging technologies which could materially change the energy market over the next decade and beyond? How should the Government promote research and development - could any shift in public funding improve the efficiency of the energy market? How long might it take for new technologies to displace the established capital stock?**

4.16 Starting with the emerging technologies, this can be divided into three parts; the demand side, the supply side and the system that brings them together.

*The Demand Side*

4.17 This is potentially the most important issue. Technology development on the demand side will fundamentally change the way in which our energy needs are met. Perhaps the best example right now is the development of electric vehicles. Developments in battery technology are making it increasingly likely that battery electric vehicles will win the battle to replace internal combustion engine vehicles in the next 10-20 years. This will have a direct and significant impact on the electricity supply infrastructure which will be quite different to an alternative future based on hydrogen vehicles for example. The growth of battery electric vehicles could increase electricity consumption by some 19 TWh per year or 6% of today’s consumption by 2035⁵.

4.18 The other major demand-side issue is the supply of heat. In end-use terms, residential gas consumption is currently 326 TWh (2015). This is close to our total electricity consumption of 334 TWh. While better insulation of buildings should reduce the space heating demand, the challenge of finding a credible replacement for gas in this market should not be under-estimated. If, as expected, a large proportion of space heating is electrified, this will add a further significant pressure on the growth of our electricity supply infrastructure, not least because the gas system is inherently able to manage large demand peaks at low cost, which the electricity system cannot. We very much look forward to

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⁴ http://www.theiet.org/sectors/energy/resources/modelling-reports/
⁵ National Grid 2016 Future Energy Scenarios – Gone Green
seeing the development of the Energy Systems Catapult’s “Smart Systems and Heat” programme which should provide essential learning to help strengthen the Government’s heat strategy.

4.19 Finally on the demand-side, we fully expect to see real growth in consumer products that will allow us all to better manage the way we use energy. This in itself brings technology and market challenges. The manufacturers and installers of products and technologies that are now entering the market are not taking full account of the impacts that they may have on our energy systems. We see this as a real risk and a strong justification for developing a clearer vision of the overall architecture of the multi-vector, future energy system that we need. It also raises questions about the way that our energy markets will need to develop as part of this vision.

Supply Side

4.20 The electricity supply-side technologies are well understood. Carbon capture and storage (CCS), tidal technologies and small modular reactors (SMR) could all be developed more aggressively but we don’t envisage any other major new developments reaching commercial maturity in the next 10 years, with the following caveats. Firstly, a question remains about the position of hydrogen in our energy future. While there are real positives about the introduction of hydrogen as an additional energy vector, real obstacles remain in its path. Taking transportation as a prime example, the efficiency burden of hydrogen production and the high materials cost of fuel cells does put hydrogen vehicles at a disadvantage compared with battery electric vehicles.

4.21 Secondly, while we do not see a radically new electricity production technology becoming commercial in the near-future we are concerned about the balance or mix of technologies that are actually deployed to replace unabated fossil capacity and meet additional electricity demand. The trend towards smaller generators also brings challenges. To illustrate this point with an extreme example, if our electricity generation portfolio consisted solely of nuclear plants and wind and solar generators it may not be possible to operate it in a secure way. This point is expanded below.

System Integration

4.22 There are ways of addressing this security issue using new solutions and technologies. The technology that is much discussed right now is energy storage. Substantially increasing the storage capacity in our electricity system could be a game-changer. It could make the electricity supply system much more like every other commodity supply chain where storage is used to maximise its overall efficiency. However, although storage could help the day-to-day management of the system there is little prospect of it addressing the massive seasonal differences in demand which will be exacerbated if we electrify space heating. The cost of energy storage technologies is reducing. Though it is currently too high to trigger widespread deployment, the downward trend suggests that this could change quite quickly. Solutions for inter-seasonal storage of heat in underground aquifers are effective in other countries given the right conditions, and hydrogen storage is possible (see 4.19 above).
4.23 The second system integration opportunity that presents itself is demand-side response or flexibility. Demand can either be controlled directly to respond to the needs of the system or it can be encouraged to respond using price signals. This is not a new idea but the opportunity to make demand-side response ubiquitous using today’s communications technologies is new and very exciting. However, while the technologies are available to deliver this, the market will need to develop to extract maximum value from it, and regulatory change will be needed, for example the extension of half-hour settlement to facilitate time of use tariffs at consumer level.

Research & Development

4.24 The Government is already investing more than £625 million in research and skills to pioneer a low carbon future through the Energy Programme of the Research Councils. There will never be sufficient funding to pursue every research opportunity and so prioritisation will always be necessary. We do not have a strong view as to how well the prioritisation system is working right now but we would question whether the linkages between the research community and industry are as effective as they might be. We recommend that the Committee considers whether there are effective linkages along the innovation pathway from pure research to technology deployment. This pathway should be bi-directional so that ideas flow back and forth in a productive way between fundamental research and the ‘real world’. This is particularly important in ensuring that the UK is able to recognise the opportunities for development of innovation which is at, or is approaching, prototype status and has the potential for early commercialisation.

New Technology Deployment Timescales

4.25 Asset renewal timescales in energy infrastructure are long. The current debate about developing new nuclear capacity demonstrates this point. For large scale capital investments, it is safe to assume that only those technologies that are already commercial, or are very close to being so, will feature in the energy system of 2030. However, the same is not true of consumer scale technology, where development and deployment rates could be much faster, more akin to mobile telephones. This disconnect creates challenges, because consumer level innovation and change could occur at a pace that substantially outstrips the ability of the traditional industry to respond, pointing to a need for greater agility in market, regulatory and commercial arrangements.

Q4 — What should the future balance between the roles of the public and the private sector be? Is further expertise needed within Government to understand the issues and to negotiate with external investors and suppliers?

4.26 We believe that Government has a vital role to play. It should:

- Develop coherent energy objectives and policies for electricity, gas and petroleum on a holistic (i.e. multi-vector) basis that are robust to normal political cycles.
- Take all reasonable steps to communicate to investors that energy markets will be developed in ways that reduce unnecessary financial risks.

6 http://www.rcuk.ac.uk/research/xrcprogrammes/energy/
• Only intervene in energy markets when step-changes in their operation are required and/or where clear market failures exist. Any such interventions should be transparent, well-signalled and win wide stakeholder support.
• Act as an enabler/catalyst for change, in particular removing unnecessary market and regulatory barriers where they are identified.
• Ensure that it has a proper understanding of the technical complexities of the smarter energy infrastructure that is developing.

4.27 The balance between the roles of the public and private sectors should have a clear linkage to the risks involved in delivering our future energy needs. It is generally good practice for risks to be owned by the party best able to manage them. Application of this principle can provide high level guidance as to the division of risks between the public and private sectors.

4.28 Generally, companies contemplating major capital investment will equip themselves with a sophisticated in-house and external team to position the investment and to analyse risks and opportunities in a sophisticated way. They will interact with supply chains with similar capabilities directed towards protecting and enhancing their own interests. Generally, government priorities are different, and governments have a poor understanding of the motivations of their private sector counterparts. This tends to lead to poor risk allocations, high risk pricing, and suboptimal outcomes. Relevant expertise from the private sector is available in the market, and government should consider making greater use of it.

4.29 There is also an industrial strategy dimension to this. Clarity of government expectation means that supply chains for equipment and services are more likely to establish in the UK, rather than serve the UK market from other countries. This then also creates a platform for export of goods and services from the UK.

Q5 – Are returns for private investment in the sector adequate or excessive? How should the Government attract sufficient investment?

4.30 With the exception of nuclear, most large scale investment in generation has been through competition or subject to market forces, so it can be argued that electricity consumers are paying a market price in that part of the sector. Likewise in networks, allowed returns are set at levels appropriate to risk taken. Feed-in tariffs for renewables have resulted in some degree of over-reward, particularly for early consumer solar PV, but steps to reduce tariffs in line with costs have dealt with this. However, we would caution over the timing of such changes, which on occasions have destroyed economic value in supply chains by creating market discontinuities.

4.31 Where this has become difficult in recent times has been in encouraging the construction of large thermal plant. This has been because of the uncertainty of the future usage of such plant, meaning that business cases have been difficult to make. When compounded with the economic difficulties of large players such as E.on and RWE (for reasons unconnected with the UK) this has resulted in an investment hiatus. One of the bigger challenges has been that the future electricity system inferred from the carbon
budgets of the Climate Change Committee leaves little apparent room for large thermal power plant, even though upcoming coal and nuclear closures mean such plant would be highly desirable in the shorter term – and useful in the longer term at lower load factors to cover gaps in renewable output.

4.32 The capacity auction system has incentivised the construction of some plant to meet short term requirements, but this has been generally small scale.

4.33 This could be fixed quite easily by holding auctions specifically aimed at new flexible CCGTs within the capacity mechanism. However, the scale and implications need thinking through properly. It would be a poor outcome for these new plants to cause innovation and local generation, storage and demand participation to be stifled. Additionally, they could be configured and sited for the future combined heat and power application, once the existing Government policy to encourage district heating in urban areas has borne fruit. This could raise the efficiency of their use of the energy in the input fuel from around 55-60% to around 85-90%, with concomitant carbon savings.

4.34 Where benefit is seen in encouraging investment by new entrants and entrepreneurs (for example in energy storage), it would be helpful to review whether market arrangements are aligned with the business imperatives of these small players. For example, small companies need a firm business case to demonstrate to their investors, so would have fundamental difficulties if their product price is to be set by an auction, or if their service contract (say for balancing services) is limited to a few years, much less than the life of the installation.

4.35 For DNOs (Distribution Network Operator), returns are set through the price control process and are consistent with the low risk profile of their businesses. As the DNOs accept the price control determination, it follows that the returns are broadly adequate. However, the future role of the DNOs is being considered. We may want them to extend the scope of their activities to bring benefit to customers and communities by being drivers of significant innovation and change (for example by becoming Distribution Service Operators). This will require them to take on more risk and regulatory returns may need to increase to continue to attract sufficient investment.

4.36 However, in the near-term, there could be an opportunity to exploit the DNOs’ lower cost of capital and purchasing power to kick-start investment in technologies that have yet to achieve market scale. The size of DNOs’ asset bases (on which returns are virtually guaranteed) means that significant investment in higher risk projects would be feasible without materially increasing their overall risk profiles.

Q7 – What preparations could be made to cope with the risk of a shortfall in energy supply? What would be the cost to the economy of the breakdown of the existing system?

4.37 It is important to differentiate between a shortfall in the capacity of our systems to meet demand at a particular point in time (i.e. not enough generation to meet peak electricity demand) and a shortfall in primary energy (i.e. imports of natural gas are constrained for some reason).
4.38 Energy and capacity shortfalls can occur at several levels:

- Strategic shortage because of the failure of an import supply chain, for technical, commercial or geopolitical reasons.
- Shorter term shortages because of technical failures, for example in gas stores or major North Sea facilities.
- In electricity, for reasons both of shortage of generation, and difficulties on networks.

4.39 We understand that the Government already has contingency plans to address energy/capacity shortfalls. The first priority here is to ensure that our forecasting techniques are sufficiently well developed to allow any shortfalls to be identified in timescales that allow appropriate actions to be taken. These techniques should of course be able to take account of a range of risks, in particular those risks that have an international component.

4.40 We recognise that it is not possible to have perfect foresight and that events can conspire to deliver unwelcome surprises. We are aware of the work of the Energy Emergencies Executive Committee and would encourage the HoL Committee to review its operation and effectiveness.

4.41 We would draw the Committee’s attention to a briefing paper that the IET published last year, “What’s behind your lights working?”. This explains the causes of electricity supply interruptions, the implications of different types of interruption or shortage, the unique challenges of operating the electricity system and the future opportunities for reducing interruptions.

\[\text{1 http://www.theiet.org/factfiles/energy/blackout-page.cfm}\]