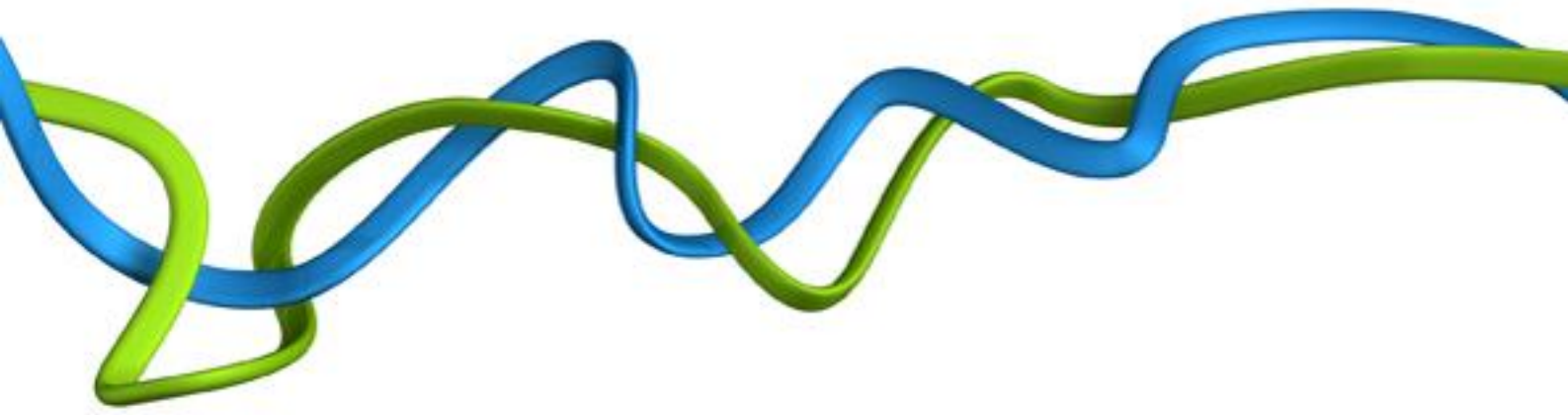
Cost of energy review

A response to the Department for Business, Energy and Industrial Strategy call for evidence following the Helm review

January 2018



Summary

We welcome the opportunity to respond to this call for evidence on Helm's independent review of the cost of energy. This response has been led by the Royal Academy of Engineering, with input from the Energy Institute, the Institution of Chemical Engineers, and the Institution of Engineering and Technology. This response has been developed through a workshop and consultation with Fellows of the Academy and representatives of these institutions from industry and academia, who are expert in a range of areas across the energy system.

The following response provides comments on the following areas: overarching themes of Helm's *Cost of energy* review; electricity generation; electricity transmission and distribution; and the cross-cutting issues of digitalisation and innovation.

The two key points made by contributors to this response were:

1. The government should set out a clear vision for the future of the whole energy system including electricity, heat, transport and industrial processes, and taking into account both industry and consumer perspectives. This should be based on **technical evidence** in addition to regulatory innovation and political decisions. This should include consideration of future technical challenges for the system based on the work of the Future Power System Architecture Project[1]. It is essential that this is a long term strategy taking into account the particular dynamics and timeframes of the energy system.

2. Based on this analysis and long term vision, **real world demonstrators** should be established. These should encompass the whole energy system to provide evidence of how technologies will integrate and combine with regulatory and commercial innovation in the real world. The Industrial Strategy Challenge Fund challenge, *Prospering from the energy revolution*, would be an excellent opportunity to develop such whole system demonstrators.

Overall comments on *Cost of energy*

- Many of the analyses, comments, and proposals in Helm's review are economic in nature, and therefore outside the direct areas of expertise of the Academy's Fellows. However, Helm's proposals depend upon technological advances and their interactions with regulatory, commercial, and economic elements of the system. Many of the technological trends and challenges facing the energy system are considered in Helm's review. There remains concern though among contributors to this response that the solutions set out in Helm's review are untested and that in some cases would be unworkable in practice, as they would raise technical, commercial, and political challenges, as outlined further below.

- Helm's review accurately identifies and analyses the challenges in the current electricity system. There is agreement among contributors to this response that the government's multiple interventions and the resulting patchwork of policies governing the sector have resulted in non-optimal outcomes and a complex landscape. Firms and investors struggle to understand and navigate this landscape, making it difficult for them to have confidence to make significant long-term investments. It may be valuable to consult investors on factors that could facilitate private investment in UK low carbon infrastructure. The current system is also heavily bureaucratic for many players including generators and network operators.

[1] Future Power System Architecture https://es.catapult.org.uk/projects/future-power-system-architecture-fpsa/

- The major trends that need to be accommodated in the future energy system are also identified in the review, including the likely increase in demand from electric vehicles and potential electrification of heating, the transition from a commodity market to a capacity market, an increase in distributed supply and storage and hence a need for an increased role for distribution network operators, and an increase in digitalisation that will have impacts across the system. Helm's review is correct that the energy system therefore needs a robust framework that provides resilience for the changes outlined, and within which firms can innovate and have confidence to make investment decisions.

- This accurate and helpful analysis of the problems and trends in the system means that the top-level principles in the review are appropriate. We agree with the review that there is a need to simplify the policy landscape, remove unnecessary bureaucracy, support increased regionalisation while retaining a national element related to security of supply, and support increased digitalisation of the system.

- However, there is concern among contributors to this response that the solutions set out in Helm's review are untested and are likely to raise challenges for implementation in practice.

- Helm's primary recommendation is to leave as many decisions as possible in the energy sector, including the energy mix, to the market. In contrast, contributors to this response believe that the system is too complex to be left solely to markets. The nature of the product, the differing timescales and other requirements for different players in the sector including the rapid nature of technological change, and the political implications of energy sector outcomes, mean that co-ordination is necessary in addition to competition.

- Therefore, we believe that there is significant value in a system architect role. **The system architect should be able to perform a long-term analysis of the whole system, set out the needs of the system, and an overarching vision for how these should be achieved. This vision should be based on evidence**, including from modelling studies and scenario analyses performed by independent groups such as the Energy Technologies Institute. The Future Power System Architecture project[2], led by the Energy Systems Catapult and the Institution of Engineering and Technology, would also provide a good basis for such work. This vision should provide a long term strategic perspective that considers the particular dynamics and timeframes of the energy system beyond short term political drivers. For example, this should consider the lifetimes of different generation assets, and the likely future demand side changes.

- In addition, a vision for the system would need to incorporate overtly political decisions, such as the contribution or absence of nuclear or carbon capture and storage (CCS) technologies from the UK's energy mix. Such decisions should be made in a timely manner that can be integrated alongside technological evidence. A vision for the system must also be flexible and adjustable to allow for changes in technology or other external factors. One possible means by which uncertainty of a policy could be further reduced, in addition to the use of evidence as outlined above, would be to publish with the policy a prescription of how the policy will be adjusted to keep the intended outcomes within a defined range.

- Additionally, it is uncertain how the technological innovations outlined in the review will impact consumer behaviour, business models, and interactions in the system in the real world. The complexity of the system means that these impacts cannot readily be

[2] Future Power System Architecture https://es.catapult.org.uk/projects/future-power-system-architecture-fpsa/

hypothesised or modelled. **The Academy therefore recommends that real world demonstrators are established, encompassing the whole energy system. These should include the full pathway from supply to demand, and include heat, transport, waste, and electricity, and both domestic and industry consumers**[3]. These should be informed and driven by the technical analysis and long term strategy as outlined above.

- Such demonstrators will be essential to provide real world, whole system evidence of how technologies will integrate and how different options will function effectively for all stakeholders. This will include for example how distributed generation, demand management and storage technologies will integrate with centralised generation, and explore regulatory and commercial as well as technological factors. Pilots must be run at significant regional or local scale, building on the smaller or single-technology demonstrations carried out to date. **The Industrial Strategy Challenge Fund challenge, *Prospering from the energy revolution*, would be an excellent opportunity to develop such whole system demonstrators.**

Energy vs. electricity

- The title and terms of reference for the review refer to the cost of energy[4]. However, Helm's review focuses almost exclusively on the electricity sector. The review does not explore future options for the broader energy sector, including heating, transport, and waste, in detail. This is a significant gap as there are complex interactions between these parts of the sector, and changes in one area are likely to have a substantial impact on the whole sector in the coming years. The increase in electric vehicles and possible electrification of heating will likely drive an increase in electricity demand but will also change the nature of that demand. These changes may lead to greater peaks and troughs in demand, for example, but also significant opportunities for demand side management and distributed storage. Such changes will have a significant impact on the optimal framework for electricity generation, transmission, distribution, and supply.

- Additionally, costs are currently considered and managed differently across different parts of the energy sector. For example, taxes on liquid fuels are an order of magnitude greater than those on gas and electricity, indicating that the aim of low energy costs is not consistent across different policy areas. Indeed, taxes on liquid fuels effectively function as a subsidy for electric vehicles. The review does not consider in depth how such differences could be addressed and this is likely to be a political consideration as technological changes occur across the energy sector. Beyond this, there will be complex interactions between energy policy and other policy areas such as congestion management or road pricing, and the technology that may influence them, such as smarter roads or autonomous vehicles.

- Since changes in any one part of the energy sector will significantly impact others, and indeed that energy policy will interact with other policy areas, a systems approach should be applied to any review of the energy system and its future direction, rather than a narrow focus on the cost of electricity. As outlined above, a joined up long term government strategy for the whole energy system is required.

[3] A critical time for UK energy policy: a report for the Council for Science and Technology 2015. Royal Academy of Engineering

[4] Cost of energy: independent review Terms of reference 2017 BEIS

Electricity generation

- The key principles outlined by Helm for an electricity generation market, that is to be technology neutral and market-driven, are broadly sound but have challenges for implementation in practice.

Technology neutrality and market-driven generation

- Historically, many government energy policies have aimed to be technology neutral. However, in practice these have favoured certain technologies due to differing levels of progress and technology readiness between types of generation. This has led to further government adjustments to compensate for unintended imbalance, leading to the complex layers of policies present today. This highlights the difficulties of being 'technology neutral' in the energy sector, where policies may support certain technologies as a necessary intervention in the short term but which do not lead to optimal solutions for the energy mix in the long term.

- Additionally, the scale and political nature of investments in some areas of the energy sector, such as nuclear power, mean that political support is required to bring them into practice, making 'technology neutrality' impossible. Therefore, since technology neutrality is challenging in the energy sector, we consider the role of an overarching system architect to be important to set out a long-term vision on which interventions and investments can be based.

- Unfettered free market signals can also be politically difficult in the energy sector, as society expects that all should have access to affordable energy. Electricity generation and storage assets take at least five to ten years to come online, meaning that they cannot respond rapidly to supply and demand signals in the market. These long timescales also mean they require clarity and certainty from government on future systems needs to incentivise investment, including on future volume requirements and indicative costings. The exception to this are technologies that can be built more rapidly such as diesel generators which, given their high carbon emissions, are not desirable. Currently it is felt that there are insufficient incentives in the system to facilitate investment in new generation and storage assets.

- This is particularly the case for generation or storage technologies that require very large capital investments such as nuclear power or CCS. Future scenario analysis suggests that either or both nuclear or CCS are likely to play an essential role in the UK's energy mix in future decades and that investments are urgently required to replace existing nuclear and fossil fuel stations that will be decommissioned over the next 10-15 years. Clear incentives and long-term certainty are therefore required to ensure future security of supply through investment in such large-scale generation. The extremely high dependence of these technologies on large physical infrastructure assets and the long timescales involved in their deployment, means that they cannot respond rapidly to short run marginal cost signals for supply and demand.

- Additionally, decisions about the deployment and development of new nuclear power plants have clear political aspects, as well as implications for UK competency and capacity relevant to defence. Therefore, these sections of the energy sector require political decisions and government support to incentivise investment, and cannot be left to respond to market signals. Clarity from the government on the direction for these sectors will also bring further benefits for the UK, including the creation of investment and jobs in the supply chain. We therefore welcome the recent government announcements to progress the development of a National Policy Statement for nuclear power between 2026 and 2035, and next steps for the support of advanced nuclear

reactor development[5]. These plans should be advanced rapidly to give the sector clarity and certainty to take forward investments. Similar political decisions and government support would also be required to support the development of commercial CCS projects. In the future, such government support may also be required to incentivise the commissioning of conventional power stations such as CCGTs, if these are required to ensure security of supply but unused most of the year. Such a change in business model may mean that market signals from the capacity market are insufficient to drive investment in these large long-term assets.

Intermittency and equivalent firm power markets

- Helm is correct that the current system does not charge variable generation for the costs imposed on the system and this can be interpreted as making the system not technology neutral.

- The equivalent firm power auctions proposed by Helm are one possible solution to the challenge of intermittent renewable generation. However, they are not the only one. The potential impact of different frameworks and approaches must be tested and evaluated through modelling and, if possible, real life demonstrator projects prior to deciding on any single solution to this challenge. There would be a number of significant governance and business challenges to the implementation of equivalent firm power auctions that must also be taken into account. These include determining the commercial models for companies in the sector and establishing who makes decisions about capacity definitions and limits.

- An alternative approach to equivalent firm power auctions is to consider a complete transformation in the demand side system. While Helm considers an increase in demand side management and a decrease in the division between local supply, storage and distribution, some contributors to this response feel that the review falls short of considering the full range of opportunities provided by flexible demand. The coming decades will see significantly greater control over demand, with increasing digitalisation and the uptake of Internet of Things technology across industry. Combined with changes in the nature of demand, through electrification of transport for example, this may radically change the requirements of the system for electricity generation. The requirements of this new system may or may not best be met by an equivalent firm power auction.

- Essentially, there is a risk that Helm's proposed market structure is designed for the existing system not a future one. The full range of possible future scenarios must be analysed and assessed, so that policy makers can make evidence-based and politically appropriate decisions about the future energy generation system and which options will meet the energy needs of the country. The work of the Future Power Systems Architecture project referred to earlier, that considers the complex requirements and future options of the UK's energy system, could be a useful basis for this.

- Although complex and piecemeal, existing policies have had significant success in a number of areas, including reducing carbon emissions and reducing the cost of renewable energy supply. It is difficult to evaluate in hindsight whether past and existing policies, despite being complex, may even have been necessary to achieve these aims. In any event, the positive lessons learnt from the successes should be built upon. However, Helm is correct that simplification of this landscape, as well as clear

[5] Statement on energy infrastructure: Written statement HCWS321 Richard Harrington MP, December 2017
Statement on energy policy: Written statement HCWS322 Richard Harrington MP, December 2017

frameworks to allow increased regionalisation and distribution of supply and storage, would be valuable.

Energy transmission and distribution

- There was agreement among contributors to this response that the eight year timeframe for periodic review of regulation of network operators is too long. While this was a positive and ambitious aim to provide certainty for the sector, it has proved too long in a sector with such rapid technological change.

- Helm's review accurately identifies the trends that are likely to significantly impact the work and business models of network companies in the coming decades. These include digitalisation and the need to incorporate more smart grid solutions, an increase in distributed generation, an increasing role for regional networks, and a decrease in differentiation between generation, distribution and supply. Particularly, there is likely to be a major shift in the management of the national electricity infrastructure from a national to a regional level.

- The DNOs will play a key role in driving and delivering these changes, and so there is good reason for Helm's proposed shift from distribution network operators to regional or distribution system operators. It is considered that some (but not all) of these operators are prepared and ready to adapt to these technological changes. However, they would benefit from the establishment of a clear government framework to support business investment going forward.

- For example, in relation to electric vehicle infrastructure it is currently unclear where responsibility for large scale investment, development and maintenance of charging points will primarily lie. This could sit with network operators, companies such as automotive fuel brands, independent firms, or a mixture of these organisations. The optimal solution will depend on many factors including the role of electric vehicles in the transport system in different regions of the country and road system, as well as social and political factors such as access to charging facilities for all customers. Indications from government of the desired outcome for electrical charging points, networks, and the role of electric vehicles in the transport system will be important to allow the market to make decisions and investments efficiently and effectively. Similar considerations will apply if hydrogen is used to power vehicles; a plausible scenario includes both electric and hydrogen vehicles and this should be considered if the government is to remain technology neutral.

Cross-cutting themes

Digitalisation

- Digitalisation is set to have a significant impact on the energy sector, as it is across the whole economy. Digital technologies will drive change in every part of the energy system, from smart meters and appliances in domestic houses, to the use of data to better manage supply and demand (including variable tariffs for domestic customers) as well as convergence across energy networks, to connected control systems for major power stations. Data sharing with other sectors is also likely to bring benefits, such as providing local authorities with data on fuel poverty, or city planners with data that can support appropriate infrastructure decisions. This growing level of interconnection should bring many benefits, including improved performance and innovation. It will be vital for the government to provide continued support for such changes as outlined in the government's industrial strategy and the industrial digitalisation review, including through the development of digital skills.

- Increasing interconnection also brings major challenges in terms of ensuring the cyber security and resilience of critical national infrastructure, including the energy sector. The Academy's recent *Connecting Data* report[6] recommended that regulators, including Ofgem, work with professional institutions and standards bodies towards establishing an enabling structure that promotes innovation while ensuring safety and resilience.

Innovation

- There is no appetite among contributors to this response for a full review of UK energy research and innovation funding or the development of a new UK national energy research centre, as proposed by Helm. Further coordination of research and increased opportunities to share outcomes are always beneficial and could help further reduce research duplication. However, the multitude of research institutions working on the energy system brings several advantages. These include allowing them to focus on complementary challenges and approaches and continuously building standards through competition.

- The increase in public research, development and innovation funding for the energy sector, as set out in the Clean Growth Strategy[7]and Industrial Strategy Challenge Fund[8], is very welcome.

- It should be noted though that in many areas of the energy sector, such as the use of hydrogen in domestic heating or CCS technologies, the innovation bottlenecks are in large scale demonstration and deployment of technologies, rather than basic research or early pilot demonstrators. It is therefore important that funding is focused on innovation, real world demonstrator projects and the transition to large scale commercial-scale deployment, in addition to fundamental research and development. Funders will require appropriate resources, capacity, and governance structure to deliver such large scale demonstrators.

- It is also key that levels of funding are sufficient to achieve the aims and goals of the innovation projects. Where support is required to translate innovation to commercial large scale deployment, such as in the use of hydrogen or CCS, it should be recognised that funding levels required to make a significant impact will be substantial due to the large scale infrastructure involved. Innovation funding for these areas must recognise the scale of the challenges faced.

[6] Connecting data: Driving productivity and innovation Royal Academy of Engineering and the Institution of Engineering and Technology. 2015
[7] The clean growth strategy 2017. HM Government
[8] Industrial Strategy: building a Britain fit for the future 2017. HM Government