Consultation Response

The Institution of Chemical Engineers (IChemE)

Energy Security and Net Zero Commons Select Committee

Inquiry

Keeping the power on:

Our future energy technology mix

Energy Security and Net Zero Commons Select Committee Inquiry

This inquiry is to look at how the energy mix of the UK needs to change in the near future and what technologies (small fission reactors, hydrogen, geothermal, tidal, wave, solar, batteries storing renewable-derived energy, and biomass) might be applied immediately to deliver a national capability to keep the power on while delivering against net zero targets.

The focus would be on what on-demand generation technologies might be deployed when renewables are insufficient to meet demand. This would touch on current options needing investment in both resource and skills development and any regional variations.

Introduction

The Institution of Chemical Engineers (IChemE) is a professional engineering institution with 30,000 members. IChemE is a not-for-profit, qualifying body and learned society that advances chemical engineering's contribution worldwide for the benefit of society. We support the development of chemical, biochemical and process engineering professionals and provide connections to a powerful network of members in more than 100 countries. The Institution of Chemical Engineers has its head office in the UK with regional offices in Australia, New Zealand, Malaysia, and Singapore.

This response has been produced by IChemE members in the UK and draws on the Institution's expertise within the clean energy sector. Key documents referred to in this response are hyperlinked within the text for ease of access. IChemE's position on climate change was published in November 2020 and reflects the Institution's commitment to work collaboratively with all stakeholders to contribute to a net zero future. Between 2020-22, IChemE also produced sectoral plans to support climate change action in multiple industries and jurisdictions, including energy transition, clean energy, water, food, and pharmaceuticals and encouraged debate through its centenary project. IChemE supports its members in applying their expertise and experience to make an influential contribution to solving major global challenges, including achieving the UN Sustainable Development Goals.

IChemE would welcome the opportunity to provide more detailed information and response to the Energy, Security and Net Zero Committee on the points discussed in this consultation if required. It can successfully leverage its experience within chemical and process engineering on topics related to climate change and clean energy to participate in debate on net zero.

Consultation Response

As an Institution we have limited our response to addressing three of the seven questions (no. 4-6) posed in the terms of reference, primarily looking at question 4, examining the range of technologies needed for both Energy Security and Net Zero.

4 What current technologies could usefully be deployed at scale to deliver better energy security in the UK?

Setting the context for 'Keeping the Power On', we see that the demand for power has been declining over recent years due to improved efficiency measures, and a market that is increasingly supplied by renewables, displacing fossil fuel generation. That market is now starting to grow considerably as a result of the move towards electric vehicles and heat pumps, and industry's efforts to electrify. These changes present three major challenges for the power system; the need to speed up the deployment of renewables; managing their intermittency; and, with heat demand added, managing increasing seasonal demand. In turn this introduces a fourth challenge, the retention of fossil fuel generation to match shortfalls ensuring short term energy security. Nuclear and biomass technologies continue to provide baseload supply but offer limited room for short term expansion. Addressing this demand, will require further deployment of the main renewable technologies at scale and at pace, and here in the UK this will be primarily **Offshore Wind** as this is the easiest to implement (from a political / planning perspective) but is furthest away from the demand. **Onshore Wind** and **Solar with Batteries (both roof top and ground)** have an important role to play as they are cheaper to deploy and can be located closer to main grid hubs. Expansion of offshore wind capacity will require longer tie-ins and grid reinforcements, as already envisaged in the recent Winser report. Further work is needed to ensure resilience and reduce costs and impact of **Grid Network Expansions**. The key to their delivery is the ability of the UK energy system to maximise its capacity and interactions using smart digital technologies (**Smart Meters** and **Distributed Control Systems)** resulting in improved matching of supply and demand.

Heat (cooling) networks in high density population areas are an important way to deliver the lowest operational cost decarbonisation of heat into homes and buildings. Centralised heat generation centres deploying water or ground source heat pumps can be combined with other heat sources - for example, waste heat recovery - to provide heat into the system. The government should move to introduce the long awaited heat network regulations to give consumers confidence and protection. To manage renewables intermittency, three things are needed, namely:

- Low carbon back up generation consisting of green hydrogen-based power stations and/or fossil gas with Carbon Capture and Storage (CCS)
- Shifting consumer demand to smooth peaks
- New storage beyond batteries

The government's programme for **CCS** servicing both power and industry must also be implemented at pace for mid-term energy security, allowing retention of legacy power generation capacity. In turn the UK needs to retain much of its offshore gas supply capacity so that it can meet its own energy needs. However, every effort is required to reduce the carbon footprint of our **Offshore Oil and Gas Production Facilities**, through electrification programmes and reductions in fugitive emissions. To increase our energy security in light of the Ukraine war, Centrica has reopened the **Rough Gas Storage** facility last winter, to help with peak winter gas demands for both heating and power.

Hydrogen already plays an important role in industry, and a high priority must be given to carbon capture at steam reforming facilities to produce **Blue Hydrogen**. The government's excellent plans for the decarbonisation of our industrial clusters should be progressed at pace, and we are encouraged to see many industries collaborating at these sites. More widespread use of hydrogen and electricity in these clusters will further enhance decarbonisation, strengthening their longer-term ability to underpin the UK economy. A recent study by ESC reported on the potential barriers to hydrogen deployment. Most of their findings are soft issues relating to policy and planning rather than technology issues, though, particular for IChemE, is the need to establish a hydrogen standards framework.

On the demand side every effort should be given to reducing demand through building retrofit insulation programmes, enhancing public transport and encouraging active travel through improved cycle lanes and walking routes. Improving the efficiency of energy use is commended through the roll-out of **Electric Heating** and **Heat Pumps**. UK Building regulations for insulation should be radically revised to improve the insulation of new homes.. However, this can only be achieved if the ventilation of homes is controlled. Adding more insulation without this will result in unhealthy indoor living conditions and mould growth. Current technologies use Mechanical Ventilation with Heat Recovery; these work well, but require development to make them less cumbersome to install and allow them to be used on existing properties. However, we must recognise that widespread deployment of these technologies is not without issue, and subject to public debate and concern.

As we move beyond the short-term use of blue hydrogen and carbon capture and storage, we need to progress more sustainable technologies to ensure energy security. Underpinning this future is the need to consider how we can store energy to manage demand fluctuations and intermittency. Short term storage can be provided by **Batteries** (MWh capacity); weekly storage by **Stored Water** (GWh capacity). Unfortunately, the UK is not well equipped with stored hydro or pumped storage sites and environmental objections to flooding valleys is strong. We believe that current options are limited to 'outsourcing' this solution to Norway and perhaps Iceland via high voltage DC undersea cables, but longer-term storage (TWh capacity) requires a different solution. Some new innovations using potential energy storage are emerging such as those by Energy Vault. As we see today, much of Europe is insisting that its gas storage is filled in a timely manner to 90% to enhance winter energy security. The UK, Germany, Netherlands and Japan are heavily dependent upon natural gas and experience significant seasonal demand variations - the longer-term, TWh scale, solution for this is improving insulation in buildings and perhaps **Hydrogen Storage**, already being contemplated by the UK government in its hydrogen strategy.

It may be feasible to use complementary technologies here, and we recommend evaluating the use of surplus renewable energy to produce green hydrogen through **Electrolysis.** The disadvantage will be that these are high capital cost options that may be uneconomic to use intermittently – the feasible parameters could be established by studies. With their depleted natural gas fields, the UK, Netherlands and Germany are all well positioned for seasonal hydrogen storage. Being not so well equipped, Japan has financed and implemented pilot scale hydrogen, ammonia and e-LNG as a fuel imports (Japan was the first country to adopt large scale LNG imports). Small quantities of green hydrogen are already being produced for niche opportunities, but this scale will increase, and costs will drop.

The energy efficiency of the hydrogen cycle is low and burning hydrogen in a **Hydrogen Power Station**, further reduces that efficiency. **Easy to electrify solutions should be progressed at pace rather than delayed waiting for hydrogen.** However, the utilisation of the last kWh generated at a renewable site on a windy day and finding the last kWh of power needed on a cold day present tomorrow's challenge. The difference in price of those energy units may be sufficient to drive the future hydrogen cycle and it may be that there is some application of using stored hydrogen to generate electricity. The economics of this needs to be evaluated and compared with other options such continuing CCUS on natural gas fired power stations.

If we look at hydrogen as a future resource, then we can also look at alternative ways to utilise it *directly* to reduce peak day power demands and, here, two technologies can benefit both consumers and system. Firstly, **Hydrogen Hybrid Heat Pumps** that primarily operate on electricity, but use a small hydrogen boiler to back up heat provision on cold days. Their natural gas equivalents were studied back in 2018 for BEIS. These will reduce power use on those peak demand days, while many consumers will be able to limit property modifications needed for a standalone configuration. Secondly, plug-in **Hydrogen Hybrid EVs**, that can be refuelled quickly en route, using facilities to service the heavy transport sector. These are being developed by European manufacturers, such as Renault and Mercedes, and would reduce the demand for fast charging facilities. Drivers would still benefit from efficient plug-in electricity at home or on street for most of their mileage, while fewer fast chargers would reduce investment and peak loadings on the power grid. Hybrid rail stock are already being considered for trains operating on mixed electrified/unelectrified networks.

Today most consumers benefit from the redundancy of two energy supply systems. Safe **Conversion of the Gas Grid** to hydrogen would retain that redundancy maintaining security of energy supply. Today the gas grid supplies three quarters of a typical household's energy supply, with a seasonal swing. Tomorrow's demand with hydrogen would be much reduced from today's natural gas, but, if viable, conversion offers an alternative to a standalone power grid which would need added redundancy to provide the same level of security. Further work is required to decide where it is appropriate to use hydrogen in the gas network.

Although it will not impact on immediate energy security concerns, there are at least two major recycling issues that are building and that will impact our security. The first is the efficient **Recycling of Batteries**, particularly lithium-ion. Developing the technologies to recover materials will improve energy security by reducing the need for imported raw materials. This is particularly important as the service life in many battery applications is under ten years. The current technologies in this area are not achieving viable economics. A second area of concern is the **Recycling of Wind Turbine Blades**. These are being made from composite materials that we currently have no technology to recycle. The blades typically have a fatigue life of twenty years, and the first generation are already heading for landfill.

If we look at these technologies in the round, longer term system optimisation will allow surplus (summer) hydrogen production from renewables to balance non-electric energy demand in transport and heating.

As we can see, we need a wide range of technologies to meet net zero goals, both short and longer term, both established and developing. Chemical engineers are working across different industry sectors on many or most of these technologies contributing to our net zero objective. Most importantly they can leverage their systems knowledge and collaboration skills to enhance our energy system as it migrates through this complex transition.

5 Are there technologies that have not been able to develop their potential and should be abandoned?

Our recommendation would be to put the following technologies on a lower priority for funding, rather than abandonment and require that they provide a sound business case before being considered. The future is hard to predict, and a small funding is usually worthwhile for the options with lower probability of success in the required timescale:

Geothermal and **Tidal** **technologies** have not been able to develop their full potential due to local restrictions, cost and environmental impacts.

Small modular nuclear reactors (SMR) need to be trialled to prove their potential. It is accepted that **large nuclear reactors** are costly and not schedule effective, but at the moment, they are the only technology available to provide base load generation without carbon emissions. SMRs may be more effective. Given that the timescale for major projects is at best ten years from conception to commissioning, the unproven economics of SMRs mean that they are unlikely to have much impact before 2050. Their first project cycle for a prototype will not be complete before mid-2030s leaving the main wave to be installed in the late 2040s. Fusion is on the radar, but again remains a much longer-term opportunity for baseload power - perhaps something to replace offshore wind turbines when they reach the point of decommissioning.

Growing Crops for Biofuels, such as ethanol and vegetable oils are a niche energy source and should probably be prioritised for the aviation sector. The key concern is the ongoing debate over the priority of land to farming and other uses and the serious issue of the loss of habitat when virgin forests are destroyed.

Biofuels from waste products for anaerobic digestion to produce bio-methane is an established technology. Although the EU has estimated that there is sufficient waste to keep the gas grid supplied with methane, their estimate is dominated by growing sequential crops (i.e., cover crops grown between food crops) and tree harvesting waste. We believe that the economics of sequential crops, and the collecting and handling these solid wastes will make this uneconomic at a large scale.

6 What energy generation mix will get us to net zero the quickest in the most affordable way?

There is a hierarchy of strategies we must adopt to get to net zero in the quickest and most affordable way.

1) Reduce demand using energy and resource efficiency. This is the quickest and cheapest way to move towards a net zero future. All technologies and policies that support this aim should be deployed and supported now at pace on a 'no regrets' basis.
2) **Electrify what we possibly can**. Many of our energy needs can be satisfied through electrification. For example, domestic transport, public transport, cooking, heating, cooling, but look for synergies with hydrogen where appropriate.
3) **Generate and distribute renewable energy.** Both electricity and heat and cooling.
4) **Deploy hydrogen and fossil gas with CCS sparingly**. In industries and for applications that cannot be electrified easily. For example, alternative fuels for shipping and aviation, high temperature processes.

IChemE has delivered an extended answer to question 4, which somewhat pre-empts this question. Short term measures are all in place and plans for delivering these do not undermine any longer-term option.

As noted in question 4, a whole systems approach is needed to fully understand the lowest carbon, lowest cost, most secure approach to achieving net zero. This complexity of the question requires the use of system modelling and expert teams to operate and analyse outputs. The CCC, the ETI, the ESC and most recently, the Humber Industrial Cluster Plan have used whole systems models to understand optimal pathways to net zero across systems.

There are a number of viable pathways by which the UK can achieve this transition and there is some flexibility in how the UK can meet its objectives. Broadly, there are two competing visions: one that is based upon full electrification, which may or may not include hydrogen storage, and another that sees hydrogen as a *segue* from natural gas with wider application of the gas to meet our energy needs. The UK government already has this in its sights for a decision sometime in 2026, once more work is completed on the safety and business cases for hydrogen. It is possible to reduce emissions to very low levels if projects and systems are appropriately planned, supported, and implemented.

Time and effort should be invested in accelerating the build out of the common infrastructures and their business models needed by all to transition to a secure, lowest carbon, lowest cost energy system. In particular, this includes the electricity transmission grid, CCS systems including CO2 storage in the North and Irish Seas, district heating systems (especially to reduce reliance on imported gas and so improve energy security), hydrogen distribution networks (particularly to industry), and energy storage networks and systems.

Other countries are facing a similar dilemma, but, as we see from the earlier analysis, every region is different, and the optimum solution will vary. Ultimately the answer to what will get us quickest to net zero, may depend upon the response of the consumer. Consumers have many objectives, some look to achieving 'net zero at all cost', while others want 'no cost'. Above all they probably want choice, and one of the key things chemical engineers can offer is support to the government in its endeavour to work on a range of technological options that will ultimately provide more choice. It is likely that more direct government involvement in governance and strategic decision making for the use of the gas network across the whole of the UK will be needed.

Consumers and Business can make good decisions on new investments in energy. However, they need to consider the externalities, particularly of greenhouse gas emissions. To help make the right decisions, a system of carbon pricing is needed urgently to drive these choices towards net-zero. At the very least VAT should be removed from energy saving purchases. It sends the wrong signals if energy is subsidised and charged at a lower VAT rate.

Submitted by the Institution of Chemical Engineers to the Energy Security and Net Zero Commons Select Committee Inquiry

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