THE BARTLETT
INSTITUTE FOR SUSTAINABLE RESOURCES
ENERGY INSTITUTE

Energy Security and Net Zero Committee Inquiry
Keeping the Power On: Our future energy technology mix

Supplementary evidence from the UCL Institute for Sustainable Resources (ISR)

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The UCL Institute for Sustainable Resources' mission is to provide evidence, expertise and training to respond to climate change and support sustainable transitions for people and planet.

This supplementary evidence follows an oral evidence session on 6th March 2024 where Jim Watson appeared as an expert.

1. **UCL ISR's written evidence (p5) called for the Government to carry out a review of which energy technologies to prioritise for innovation and deployment funding, at least once every five years. How could this help and how could it backfire?**

In Minister Bowie's evidence to the committee on the 20th March 2023, he suggested the government should continue to support a full range of technologies, whether developed or currently unproven. In reality, an economy such as the UK's does not have the financial resources to support all possible low carbon technologies at scale. It is therefore essential for the government to carry out regular reviews of technologies that receive public funding, and to identify clear priorities. These reviews would help to maximise the opportunities for UK technological leadership, and wider economic benefits.

As we note in our written evidence, the government has been reviewing innovation priorities in a systematic way since the early 2010s. This has involved two iterations of analysis: once in the early-to-mid 2010s, and a second in 2019. The advantage of such reviews is that they provide a valuable and independent evidence base to help decision-makers understand which technologies have the most potential to meet UK policy goals, including emissions reduction, energy security, cost reduction and economic prosperity.

A five-year cycle of reviews would balance the need for some certainty of innovation funding, particularly for early-stage technologies, with a need to respond to a rapidly changing context. In some cases, innovation has led to quick reductions in technology costs. In addition there continue to be very significant changes in the geopolitical context, patterns of international trade and technology leadership, and UK policy priorities.

There are potential disadvantages, of course. Five years is unlikely to be enough time for some technologies to develop from an early stage to commercial maturity. In some cases, this process has taken decades – and it has not always been clear that a particular technology will be developed and deployed successfully. Even offshore wind, which is one of the UK's biggest success stories, experienced a period of rising costs in the early stages of deployment. At that stage, a narrow assessment of the technology could have ruled out further support for innovation.

2. **Given its poor round-trip efficiency, does it make sense to prioritise the development of green hydrogen, with hydrogen storage, for use in the electricity system?**

To meet our net zero goals for the electricity system, we will need long duration electricity storage. There are many types of storage technology. It will be beneficial to have a range of technologies within the system as they perform differently across a variety of factors. These include efficiency, but also storage duration, cost, material use, and the provision of ancillary services.

Hydrogen storage can have inefficiencies through the process of conversion from electricity to green hydrogen, and conversion back to electricity when needed. It is also likely that there will be some leakage of hydrogen during the storage period, although this should be monitored closely. However, hydrogen storage is an important option due to its potential operation over longer durations.

Previous analysis conducted for BEIS in 2022[1] classified long duration storage as having more than 12 hours of discharge duration. That study showed that the most cost-effective long duration storage technology is hydrogen stored in salt caverns, with a potential discharge duration of up to 720 hours. This finding is complemented by recent research by our UCL colleagues,[2] who investigated least cost designs for net-zero compatible power systems for the UK. Using a model with high temporal and spatial resolution, they found that systems with nearly 100% variable renewables (wind and solar) supported by long duration hydrogen storage and batteries, would be the most cost effective.

Therefore, round-trip efficiency alone shouldn't drive decisions about which storage technologies to prioritise. Some technologies or specific projects may be of relatively lower efficiency but could have lower costs, provide other services that decrease total system costs or provide other local benefits. Having said that, policies to support storage should define minimum efficiency levels over the lifetime of each project. This is important because some storage technologies may decrease their efficiency significantly during their lifespan.

3. Is the Government doing enough to ensure that we will have the right level of firm capacity in the 2030s, including through retaining existing power plants if necessary?

Firm capacity usually refers to sources of electricity generation that can produce power predictably and continuously. However, as the electricity system continues to decarbonise and the share of variable renewables increases, there will be an increasing need for flexible (or dispatchable) capacity. Whist firm capacity (such as nuclear) could play a significant role in a decarbonised electricity system, flexible capacity will arguably be more important.

Traditionally, flexibility has been provided by fossil fuel plants – particularly gas-fired plants. To deliver a decarbonised electricity system by 2035, the share of generation provided by unabated gas will need to fall rapidly from current levels. At the same time, new forms of flexibility will need to be deployed, including long-duration flexibility options such as long duration storage, hydrogen power plants and large-scale plants with carbon capture and storage. The flexibility provided by these options will not be the same, for example due to different response times.

The government's second Review of Electricity Markets (REMA) consultation sets out proposals for managing this transition[3]. Our view[4] is that the government has overestimated the need for new unabated gas plants to provide flexibility into the 2030s, and is not doing enough to support the demonstration and early deployment of zero- or low-carbon options for long-duration flexibility.

[1] https://www.gov.uk/government/publications/benefits-of-long-duration-electricity-storage
[2] Price, J. Keppo, I. and Dodds, P. (2023) The role of new nuclear power in the UK's net-zero emissions energy system. Energy 262, 125450; https://doi.org/10.1016/j.energy.2022.125450
[3] https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements-rema-second-consultation
[4] We would be happy to share our full response to the consultation with the Committee if this would be useful.

4. **Do you agree with the National Infrastructure Commission's view that a net zero energy system will be cheaper overall than our current one? Why/why not?**

    - **What is the fairest and most cost-effective way to fund the infrastructure we need to complement wind and solar?**
    - **Is it possible and practical for the Government to define a measure of whole-system value and use it to compare technologies?**

We agree with the National Infrastructure Commission that shifting away from fossil fuels to low carbon electricity, dominated by renewables, will provide cheaper power in the long-term. This is because fossil fuel prices remain comparatively high, and have been the main driver of steep rises in electricity and gas bills over the past two years. Shifting to low carbon sources of power and electrifying heat and transport will significantly reduce vulnerability to high fossil fuel prices – and future fossil fuel price shocks. As the NIC also notes, completing the transition to a low carbon energy system will require significant capital investment – even if the cheapest forms of low carbon power (wind and solar) are prioritised.

As we note in response to Q3 above, there is also a need to invest in sufficient short- and long-duration sources of flexibility within the electricity system. Whilst general incentives such as the Capacity Market will help to drive cost effective investments in flexibility, current market arrangements are not sufficient to drive the transition to low- or zero-carbon flexibility investment. Therefore, the government will need to complement any reforms to the Capacity Market with specific incentives to support the demonstration and early deployment of long duration storage and other options such as hydrogen power plants. The recent DESNZ consultation on policies to support long-duration storage[5] is a welcome signal that some of these policies are under development. However, there is a risk that they will not be implemented quickly enough.

The concept of whole system value is attractive in principle since it could allow different future electricity systems to be compared, based on their whole system costs. This could address an important shortcoming of technology-based metrics such as the levelised cost of electricity. Whilst levelised costs can be useful to compare generation technologies with each other, they do not include the impact of each technology (or power plant) on the electricity system – and whether it imposes costs (e.g. for integration) or provides benefits (e.g. greater flexibility).

In practice, however, whole system value is difficult to define given the complexity of electricity systems. It will be affected by a wide range of factors including which generation technologies are already present in what proportions, their relative technical and financial flexibility, current network investments and constraints (including interconnectors), the level and types of storage on the system, the level and diversity of demand side flexibility available, and current and future weather patterns. Having said that, it is important to evaluate the costs of electricity systems as a whole. Scenario analysis, such as a recent study published by our colleagues at the UCL Energy Institute[6], can help to identify characteristics that are more (or less) likely to deliver a low cost system.

5. **Which nuclear technology options, if any, should the Government be supporting?**

    - **What can the Government do to ensure its future nuclear projects are affordable?**
    - **The CEO of the Nuclear Industry Association told us (Q114) that there is no credible analysis that shows that you can deliver a low-carbon and secure energy mix without nuclear being an integral part of it. Do you agree?**

[5] https://www.gov.uk/government/consultations/long-duration-electricity-storage-proposals-to-enable-investment
[6] Price, J. Keppo, I. and Dodds, P. (2023) The role of new nuclear power in the UK's net-zero emissions energy system. Energy 262, 125450; https://doi.org/10.1016/j.energy.2022.125450

There is credible analysis that shows that it is possible to have a low carbon and secure electricity system without new nuclear power plants. For example, modelling published by our colleagues at the UCL Energy Institute assessed the role of new nuclear plants in addition to Hinkley C[7]. This research focuses on how to meet the net-zero target in 2050 whilst balancing supply and demand on an hourly basis. It uses a model called highRES, which has a high spatial and temporal resolution. Our colleagues conclude that new nuclear capacity only plays a role in a least-cost electricity system if a number of other options are not available – including bioenergy with carbon capture and storage (BECCS), long-term storage and the expansion of interconnectors.

If the government wants more new nuclear plants to be built beyond Hinkley C, there is a clear need to deliver them in a more cost-effective way. All three plants using the Hinkley C design in Europe have been affected by significant delays and cost overruns. When the government announced a deal to subsidise Hinkley C via a Contract for Difference (CfD) in 2013, it was scheduled to be completed in 2023. Two years later, developer Electricite de France (EdF) said that the nominal construction cost would be £18bn[8]. EdF now expects Hinkley C to be completed by 2029 at the earliest, at a cost of £31-34bn (in 2015 prices)[9].

One alternative approach that has been supported by successive governments over the past decade is to support small modular reactors (SMRs). In principle, these reactors could be produced to standardised designs, with a greater potential for cost reductions than large-scale pressurised water reactors. However, it is not yet possible to determine how much SMRs will cost. Whilst Rolls Royce have claimed that its SMR design will generate electricity at a cost of £40-60 per MWh[10], it would be unwise for government to rely on such estimates. The nuclear industry has a poor track record of delivering projects on time, and has a history of significant cost over-runs.

The government's competition for developers could help to determine which SMR designs have the most potential for cost-effective deployment. Whilst the government is supporting six companies to develop their designs, there is a long way to go. Final investment decisions are not expected until 2029, and the deployment of any SMRs is likely to require significant public subsidies.

6. Should the Government continue to support large-scale power from biomass, and in future, bioenergy with carbon capture and storage?

- **Could reforms to the biomass sustainability criteria change your opinion?**

In principle, bioenergy can provide a significant contribution to meeting the UK's climate change targets, including by delivering 'negative emissions' when combined with carbon capture and storage (as BECCS). Many assessments of how to meet the UK's climate change targets, including those by the Climate Change Committee, foresee an important role for BECCS. It is therefore understandable that the government wishes to continue to support large-scale bioenergy plants such as Drax, and their conversion to BECCS plants.

Whilst we agree that existing bioenergy power plants with long remaining lifetimes should be prioritised for retrofitting with CCS, we are much more cautious about supporting new power-BECCS plants, especially if they are large scale. This is due to uncertainties about the availability of sufficient volumes of biomass, questions about the sustainability of some sources of biomass, and uncertainty about life cycle emissions

[7] Price, J. Keppo, I. and Dodds, P. (2023) The role of new nuclear power in the UK's net-zero emissions energy system. Energy 262, 125450; https://doi.org/10.1016/j.energy.2022.125450
[8] https://www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/news-views/agreements-in-place
[9] https://www.edf.fr/en/the-edf-group/dedicated-sections/journalists/all-press-releases/2023-annual-results-substantially-higher-nuclear-power-output-in-france-good-overall-operational-performance-new-commercial-policy-net-financial-debt-reduced-trajectory-15degc-validated-by
[10] https://world-nuclear-news.org/Articles/Rolls-Royce-on-track-for-2030-delivery-of-UK-SMR

from BECCS plants. As the CCC often emphasises, there are also important questions about the best use of available biomass resources.

With respect to life cycle emissions, current policy proposals will need greater clarity about the minimum CO_2 capture efficiency for BECCS plants, and whether this takes into account emissions in the fuel supply chain – including GHG emissions from biomass transport, storage and processing. The government's Biomass Strategy (2023) did not fully define new biomass sustainability criteria, and another consultation expected before that happens. Without stringent criteria, coupled with monitoring, reporting and verification processes, power-BECCS may not deliver negative emissions at the scale expected or required. Poor sustainability performance could also undermine public trust in this technology, and its role in helping to deliver carbon removals.