We are pleased to respond to the consultation by Ofgem on their approach to setting the next electricity distribution price control (RIIO-ED2). This response draws on the expertise within the EPSRC Supergen Energy Networks Hub, which brings together the vibrant and diverse energy networks community in the UK to gain a deeper understanding of the interactions and inter-dependencies of energy networks. Led by Hub Director, Professor Phil Taylor from Newcastle University, the Hub integrates a wide range of industrial and academic partners with other energy network stakeholders.

We welcome the fact that the overarching objectives for RIIO-ED2 include explicit priorities on decarbonisation and protecting consumers, alongside the goal of enabling competition and innovation, to help increase efficiency. We believe that electricity networks have an important role to play in helping the UK to deliver on its target for net-zero emissions of greenhouse gases by 2050, and that the changes that will be needed should adhere to the principles of a "just transition" in which consumers, and particularly vulnerable consumers, are protected.

In the remainder of our response, we provide our thoughts on a selection of specific issues raised in the consultation letter.

How to set price controls for DSO functions

Decarbonisation requires DNOs take a proactive action to anticipate the forthcoming change, and invest ahead of needs. However the change is highly uncertainty as noted by Ofgem's consultation document as the future demand for network capacity will be more dependent on government policy, technology development, and social behaviour. Traditional network investment thus runs a high risk of assets being stranded in the long-run.

Question 9. Is there a need to separate out the revenues and outputs for 'traditional' DNO functions from DSO functions? How could this be achieved?

Against a highly uncertain future, it may make sense to separate DSO function from the 'traditional' DNO function. As core competence of DNOs is on the network development with a key aim of maintain the security of supply at a cost-effective manner, this requirement is largely met with asset investment. They thus have limited experience in quantifying and managing risks and uncertainties arising from renewable generation and flexibility from distributed energy resources.

Separating DSO from DNO would leave opportunity to introduce fresh thinking from other sectors to improve efficiency and earn extra revenue from existing network assets whilst providing cheap access to flexible network customers. For example, shared network access (SNA) scheme is developed for telecom industry and aims to incentivise the incumbent DNOs to give up its exclusive access to the network, leasing the spare capacity or back up capacity to a licensed independent party to provide ultra-cheap network access. The ownership of assets will be retained by the incumbent DNO while competition will be introduced in the operation of the spare capacity [1].

Question 10. In the event of the DSO function being delivered by a separate party, how might we determine the revenues for DSO activities? What type of funding model would be appropriate to set DSO revenues? In this event, would changes also be required to DNO revenues and outputs*?*

The separation of DSO from DNO should have a clear and major impact on DNO revenues and outputs. If it does not help DNO to increase its efficiency and reduce the cost of developing an efficiency system then the value from introducing DSO would be minimal. The challenges for setting revenues for future DSOs compared with ESO is the uncertainty on their ability to mobilise the untapped or under-utilised flexibility, and their cost in addressing congestion, constraints and supporting cross regions and cross transmission energy flows. This uncertainty also varies hugely between different regions and between areas within the same region but with different penetration and types of flexibility and intelligence. In the absent of better information, it may be helpful to set up a reference network showing an ideal network operation and investment against a set of future scenarios, where the actual operational performance could be compared and correspondingly rewarded or penalised.

Question 11. Where a DNO is undertaking a DSO function, what type of outputs or outcomes are necessary to measure how efficiently they are performing this function? Over what time period could these be measured?

At the initial stage of DSO transition, it would be a natural progression for DNO to take on DSO roles as there may not be many professional that have sufficient technical and commercial knowledge to undertake the challenges, nor sufficient returns for running a DSO business. As the knowledge, skills and ambition vary from one region to another, it may be helpful to use a universal and quantitative performance measure to reward and penalise a DSO at the start of energy transition. Instead, a qualitative measure to contrast the processes and new functions across different regions might be more appropriate, showing options that a DSO explores in address a specific system issue, how they quantify and manage risks, how they engage and support new solution providers compared with traditional providers.

<u>Meeting the needs of consumers and network users</u>

Question 22: We are interested to hear if there are new elements of the services DNOs will need to deliver that should be included in the current output categories. Alternatively, we welcome views on whether these should be captured by a new output category. For these new elements, we are interested to hear how delivery of these services should be valued and measured.

The core business of DNOs is to develop and maintain networks and distribute electricity from point of access at the transmission level to consumers, with optimal use of resources and taking account of any constraints. Historically, Ofgem has had the mandate to drive down the cost/price of electricity such that consumers get value for money, whilst also ensuring that the DNOs are rewarded reasonably for their risk. Efficiency has therefore always been at the heart of network operations and efficiency improvements were successfully incentivised by the previous RPI-X regime, although at the expense of fostering long-term innovative investment [2, 3, 4]. Given that innovation in electricity networks will be essential to meet the transition to a low carbon energy system, it has been given a high priority in the

RIIO approach. In the proposed RIIO-ED2, cost efficiencies of the networks which capture the cost of innovative projects should be tracked. However, it would also be advisable to calculate the cost efficiency scores of the networks without the cost of innovative projects to establish their performance in their primary and traditional functions. Benchmarking and setting efficiency targets (with variables that capture the quality of service) could be incorporated into the existing outputs of the RIIO /Totex model, with suitable rewards and penalties. It is our view that setting efficiency targets is still relevant as long as the incentive for pursuing innovative projects is still sufficient. Therefore, it is expected that a hybrid of incentives that both reward efficiency and encourage innovations in the distribution market could prevent a situation where inefficiency in the primary functions of networks is obscured by quest for costly innovation. By setting the right targets and thresholds of minimum efficiency gains and minimum innovative investments, DNOs are likely to perform on both indicators within a regulatory period. It has to be emphasised, the pursuit of high cost efficiency should not compromise on quality. Hence, quality regulation could be captured as variables in the efficiency measuring model or should be set directly against the network's revenue as is practised in Germany [5].

Enabling whole system solutions

Question 31: We welcome views on how RIIO-ED2 can best capture the benefit of whole systems solutions. We are also interested in views on how these benefits should be measured.

It is our opinion that the whole systems approach to energy systems is best thought of as being at the intersection of the energy vectors of electricity, heat and transportation. The whole systems approach considers the coupling between these vectors in order to address the energy trilemma: reducing carbon emissions, reducing societal costs, whilst maintaining system security [6]. It is difficult to assign a single monetary value to the benefits provided by these quantities. Nevertheless, it is our view that the inclusion of the 'whole systems' approach within the RIIO-ED2 framework could provide substantial benefits to consumers, by incentivising solutions that provide the optimal long-term system design [7].

The easiest benefits to measure are technical benefits, as benefits can be attributed to specific interventions by a DSO. If heat pumps can be utilised for frequency response [8], then both the DSO and heat pump operator should be remunerated, as the DSO is enabling the heat pump access to the frequency response market. Alternatively, if the losses in a system can be reduced using smart charging of electric vehicles [9], then the DSO (and ultimately, the consumers) should be paid for the resulting reduction in losses.

Additionally, social benefits (particularly with respect to social equity) should also be measured. For example, 11% of households are in fuel poverty in the UK [10]. A district heat system can provide low-cost, low-carbon heating for a fuel-poor neighbourhood, as well as provide a flexible load during times of high wind (wind causes an increase in heating demand [11]). Here, the measured benefit can be in terms of the reduction in energy cost for those fuel-poor households.

Finally, carbon that is saved should also be measured, in terms of tons of CO2 equivalent. For example, an electric hot water tank being used instead of a gas boiler reduces the need for gas infrastructure, and (assuming a low-carbon electricity supply) leads to a reduction in the carbon content of the resulting heat [8]. In this way, network operators should be incentivised to enable their customers to reduce the carbon intensity of their demand.

Question 32: We further welcome stakeholders' opinions on whether the electricity distribution sector's approach to whole systems should be different from the other sectors and, if so, why.

Within the whole systems approach, it is our view that all network types are unique and have their own physical and engineering constraints which must be respected. Nevertheless, the whole-systems approach takes the broadest possible outlook on a topic (in this case, energy systems) [12]. It encourages 'what-if' type questions, and as such whole-systems thinking should avoid being overly prescriptive in terms of implementation. It is our view that subsystems should only be considered in isolation within a 'whole-systems' type approach if such a system is completely decoupled from other subsystems (and, there are reasons for the lack of coupling to continue).

Given this, it is hard to see that there is an advantage to viewing distribution networks (in the long-term) as separate from the rest of the energy system of the UK, when considering the 'whole-system' approach to the study of energy systems. As an intermediary step, it may be practical to work from a DSO-only point of view. As the experiences and capabilities of the whole-system approach are developed by DSOs and industry, it could then be broadened to include all stakeholders within the approach, so that the full benefits of the whole-systems approach can be realised. The goal for the future should be a fully integrated, low-carbon energy system for the whole of the UK [13].

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