RIIO-2 Sector Specific Methodology: response to the Ofgem consultation and its proposals on Innovation

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1 Opening remarks

The submission by the UK Energy Research Centre (UKERC) to the Science and Technology Select Committee's inquiry on Technologies for meeting Clean Growth emissions reduction targets in December 2018 noted that "*private companies tend to underinvest in R&D because they can't capture the returns from higher investment*"[1]. This is particularly true of regulated utilities.

Regulated utilities' returns are especially sensitive to the decisions of regulators. The utilities are unlikely to invest in innovation – or research and development in general – if it does not deliver benefits to the company within a price control period.

Innovation in the regulated network utilities is not like innovation in a market economy generally. For the most part, private actors invest in innovation through research, development and demonstration in order to

1. grow their income; or
2. reduce their costs.

Outcome 1 can be achieved through a new or enhanced product or service that is more attractive to customers than those offered by competitors thus growing the customer base. Income can also grow if an enhanced product or service is bought at a premium price by a similarly sized customer base. A further possibility is to create a new market for a product or service that did not exist before. (An example of this is smart phones).

The regulated network companies do not have the possibility of growing their customer base. They can only grow their income if the regulator defines mechanisms by which it might happen, e.g. in reward for improved services, something that Ofgem introduced in RIIO-1. For the most part, though, a network licensee's main motivation for investing is to reduce future costs. The key then becomes whether and when the cost reductions will be realised and whether the investor can retain the value of it. Crucial to that is the period for which incentives and income are defined – the price control period – and how incentives and income might be redefined by the regulator at the start of the next price control period. In respect both of gains relative to incentives set by Ofgem and of cost reduction, why might a privately owned business invest in innovation if the ability to keep returns beyond the current price control period is uncertain? My own experience of innovation investment decisions by network licensees suggests that, without shared investment from customers in the form of an innovation allowance, they will not invest in initiatives that have a payback beyond the current price control period.

[1] http://www.ukerc.ac.uk/publications/technologies-for-meeting-clean-growth-emissions-reduction-targets.html

In its RIIO-2 Sector Specific Methodology consultation, Ofgem is "*proposing a number of reforms to the existing RIIO innovation package*" including:

- "*new measures that ensure network companies undertake more innovation as BAU*
- *removing the [Innovation Rollout Mechanism] IRM reopener*
- *introducing a new innovation funding pot to replace the NIC and better focus on the big strategic innovation challenges within networks and system operation*
- *increasing third party engagement, including legislative underpinning for direct access to Ofgem-administered funds, to support potentially new and transformative business models and solutions*."

This document presents some personal views and experiences with respect to the above proposals made by Ofgem and the questions Ofgem has asked in respect of network licensee innovation.

2 CSQ44. Do you agree with our proposals to encourage more innovation as BAU?

2.1 Business plans, 'business as usual' (BAU), carrots and sticks

Ofgem states that "*In their Business Plans, we expect companies to demonstrate how they will be applying innovation through their BAU activities, and what the consequential impact might be on their future expenditure requirements*."

This assertion can be understood as being consistent with the habitual assumption by regulators of monopolies that there will be 'efficiencies' – cost reductions – that can be passed through to customers. Since liberalisation of the electricity sector, this has represented a fair assumption: many costs – though not all – have come down and customers' bills for network services have, in general, also come down while continuing to receive an acceptable service. The challenge for Ofgem, whose responsibility lies towards customers, is in judging whether customers' bills have come down far enough (or, against a background of increasing need for capital investment, will increase by a minimal amount) and what can be expected in future. This should be judged in a way that does not unduly threaten the financial viability of the network licensees in such a way that would put the delivery of services at risk[2].

At least some of the cost reduction seen to date will have been as a result of innovation within the respective businesses: in general, changed organisational arrangements or business practices (often motivated by a desire to reduce the total cost of staffing) though sometimes through changed specifications to equipment allowing assets to be bought more cheaply than was assumed in a price control submission. My own impression is that these 'innovations' – which, particularly in the case of organisational restructuring and 'downsizing', cost the business[3] money in the short term – have only been embarked on in the expectation of a rapid payback.

In contrast to the innovation allowances – a 'carrot' made available on a 'use it or lose it' basis – future 'efficiencies' assumed by the regulator in the setting of future income could be seen as the 'stick' approach. For example, my understanding is that in setting the cost allowances for the

[2] Although Ofgem, with good reason, often points towards an 'information imbalance' between the regulator and the regulated, it still retains a responsibility to inform itself as well as possible. The seemingly high churn of staff within Ofgem and the apparent difficulty of gaining familiarity with what the network licensees do day-to-day are unlikely to help in this regard.

[3] Or the company pension fund?

Distribution Network Operators (DNOs) in RIIO-ED1, the utilisation of certain 'smart' technologies was assumed with particular assumed costs and benefits based on EA Technology's 'Transform' model. In other words, technological innovation was assumed in the baseline income; if a network licensee fails to achieve it, they will be punished by their cost being higher than their income.

In RIIO-2, as in every price control, there will debate about what level of cost reduction can be expected and how much of the benefit should be kept by licensee shareholders and how much by customers. This should, of course, be informed by experience from past price controls.

As part of the preparation for RIIO-2, I trust that Ofgem will be reviewing the assumptions it made in the setting of income in RIIO-1. In respect of distribution, this should include the extent to which the assumptions in 'Transform' were correct in the cases in which demand growth, connection of generation or improvements in reliability of supply or safety warranted the technologies' use[4]. It would also be interesting to know from Ofgem if it has examples of network licensees investing their own money (without dependency on innovation allowances) in cost reduction measures when a positive net present value is expected only beyond the current price control period.

2.2 The length of a price control period and how long significant innovations take to be realised

One main advantage of a long price control period such as the eight years used in the first round RIIO price controls is to provide an incentive to the regulated utilities to innovate. If they invest in innovation in the early part of the period, they have time to earn a return on it.

It seems to me that the biggest problem with RIIO-1 was uncertainty. The various factors that, with the benefit of hindsight, led to a number of commentators, e.g. Dieter Helm, Citizens Advice and Centrica, to argue that energy network licensee profits were excessive could not have been known with any confidence at the times of the RIIO-1 settlements. This, at least in part, seems to have led to Ofgem returning to a 5 year price control period for RIIO-2. However, as Ofgem itself has noted in its "RIIO-2 Sector Specific Methodology", "*increased expenditure on research and development can make companies look inefficient in the context of a five year-price control period, if the cost of these activities does not deliver benefits within that period*". This makes the availability of innovation funding more important for RIIO-2 than in RIIO-1.

It has been well documented that in the years following liberalisation of the electricity supply industry in Britain, the industry's expenditure on research and development (R&D) declined dramatically, particularly in the distribution sector (Figure 1).

As shown by Gross et al., significant or disruptive change as a result of innovation generally takes many years from the development of the first ideas to the achievement of commercial viability. (Figure 2). The development of ideas and resolution of the associated uncertainties requires patient investment in Research and Development (R&D) and subsequent investment in demonstration and

[4] New technologies or approaches that, for example, facilitate connection of generation at lower cost than via established means are, of course, only required when a generation connection application is required. My understanding is that questions have been raised about the accuracy of the assumptions in 'Transform' and that a more detailed appraisal of the costs and benefits of the different technologies was a major part of the motivation for the 'DS2030' project commissioned through the Energy Networks Association in 2014, funded out of the Network Innovation Allowance and completed in 2016. Among other things, the project's "Stage 6" report noted that "DS2030 studies have shown some smart solutions to be more appropriate to certain network types, highlighting that they must be applied with consideration of the characteristics of the network. Extrapolation of the application of smart solutions highlighted by the project must be undertaken with care since effective network solutions are problematic to generalise, being dependent on factors such as network and demand characteristics".

deployment of those ideas that seem like 'winners'. Such investment in R,D&D by network licensees over the medium to long term would almost inevitably have been cut when the licensees learned that the benefits that arose from a portfolio of R&D investments were unlikely to be retained by the licensee if they arose only in a future price control. Since then Ofgem has introduced a number of schemes designed to encourage the regulated energy network licensees – electricity and gas, transmission and distribution – to innovate and to be free to use a certain amount of customers' money to do so provided certain conditions are met[5]. In my opinion, Ofgem should be highly commended for this initiative. The success of the various schemes – the Innovation Funding Incentive (IFI), LCNF, NIA and NIC – can be seen through the increased investment in innovation and, I many instances changes to the way things are done within the sector. (Figure 2).

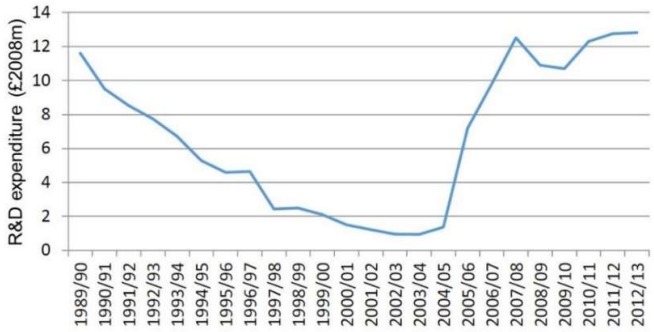

Figure 1: R&D expenditure by Distribution Network Operators[6]

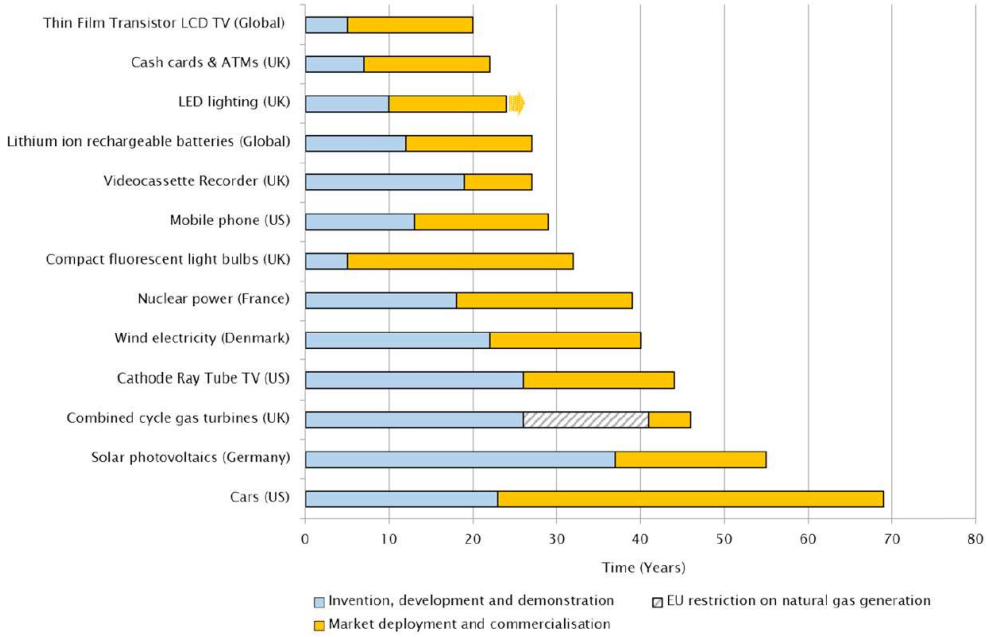

Figure 2: Time taken for innovations to reach commercial viability[7]

[5] See https://www.ofgem.gov.uk/network-regulation-riio-model/network-innovation

[6] T. Jamasb and M. Pollitt, "Why and How to Subsidise Energy R+D: Lessons from the Collapse and Recovery of Electricity Innovation in the UK", Energy Policy, 2015

[7] Gross, Robert, Richard Hanna, Ajay Gambhir, Philip Heptonstall, and Jamie Speirs. "How long does innovation and commercialisation in the energy sectors take?" Energy Policy 123 (2018): 682-699.

For the most part, the energy network licensees are seen by their shareholders – i.e. by investors – as low risk investments with unspectacular but safe returns. They are not exposed to competitive markets except insofar as Ofgem seeks to compare one licensee with another in price reviews, to reward 'good' performers and punish 'bad' ones and to introduce competition in the delivery and maintenance of major new infrastructure schemes. The regulated utilities' income is largely fixed and well-known quite far in advance. However, as I noted above, their scope for making very large profits through some kind of competitive advantage is limited.

2.3 The totex incentive

Ofgem notes that "*We expect companies to fund lower-risk operational and maintenance innovation projects as BAU. Incentives already exist for companies to undertake this type of innovation through their base revenues. The totex incentive mechanism will ensure that companies will continue to share the benefits of these innovations*".

As I noted above, the network licensees do indeed have an incentive to fund innovations that allow them to meet their licence obligations at a cost lower than their base revenues, provided a net reduction in cost can be achieved within a given price control period. To the extent that cost reductions have been achieved as a result of this (rather than being as a result of, for example, windfalls in terms of wider market pressures that have reduced the cost of equipment or people, or simply of reduced need for capital expenditure), this incentive would seem to have been effective.

The ability to invest in operational measures (which increase operational expenditure, i.e. opex) in order to reduce investment in asset based measures funded by capital expenditure, i.e. capex, in the meeting of licence obligations has the potential to be a powerful mechanism. That is, the ability to reduce total expenditure – totex – relative to income while still meeting licence obligations should be useful[8]. However, it may also be argued that such evaluations should always have been carried out, mandated by the transmission and distribution licences:

- A transmission licensee is responsible for the development, maintenance and operation of "*an efficient, co-ordinated and economical system of electricity transmission*"[9]and "*facilitating effective competition in the generation and supply of electricity*"[10].
- A distribution licensee is supposed to "*permit the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity; and facilitate competition in the generation and supply of electricity*"[11].

Neither of the above licence conditions makes any distinction between capex and opex to deliver the obligations. On the other hand, in practical terms, identification and implementation of the most economical and efficient means of permitting network development, maintenance and operation and facilitating competition in the generation and supply of electricity depends on access to appropriate information. Where all the relevant options are within the power of a single licensee, there should be few barriers to 'doing the right thing'. However, increasingly, options and their impacts cross the boundaries between transmission and distribution and between different energy vectors. They therefore require timely and complete exchange of information between different

[8] For some further discussion on operational versus asset-based measures, see, for example, K. Bell and S. Gill, "Distributed energy resources: technical, regulatory and policy challenges to delivering a highly distributed electricity system", Energy Policy, January 2018.

[9] See, for example, licence condition E8, Transmission Licence: Standard Conditions, 01 February 2019

[10] See, for example, licence condition B12, Transmission Licence: Standard Conditions – 01 February 2019

[11] See, for example, licence condition 21, Standard conditions of the Electricity Distribution Licence, 25 August 2017.

parties. Notwithstanding the introduction of new licence obligations with respect to, for example, the Network Options Assessment, increasing regulatory separation between different parties, such as the split between transmission owner and system operator, threatens to make clear and rational responses to a totex incentive more difficult.

3 CSQ45. Do you agree with our proposals to remove the IRM for RIIO-2?

The next steps from an innovation project depend on the nature of the project, in particular,:

- Was it seeking to understand and manage a risk? Or did it aim to exploit an opportunity for cost reduction, an increase in benefits for current consumers or an increase in benefits to future consumers (against a background of continued government commitment to decarbonisation)?
- If the latter, what technology readiness level (TRL) was it starting from and how far did it progress as a result of the project?

Even if an innovation intended to exploit an opportunity had progressed to a TRL of 9 (indicating commercial readiness), further investment will, often, still be required:

- in the case of an evaluation of an innovative product or service developed by a 3rd party, to buy the evaluated product or service for 'business as usual' use;
- in case of an 'in-house' method or service, to embed it within everyday business practices.

The latter may involve, for example, modifications to software or staff training.

An innovation that has progressed the technology readiness levels but has not yet reached TRL 9, if it still holds the promise of allowing an opportunity to be exploited, would require further investment before commercial viability is established. This would be best pursued through a further, suitably defined innovation project.

Projects concerned with understanding and managing risk are intended to improve knowledge and may reveal a need for new business processes or products to help manage that risk. These, too, may be pursued through a suitably defined innovation project.

If the network licensee benefits from the further investment required to implement or advance an innovation and the benefits would accrue within a price control period, the licensee should fund the investment. Otherwise, there is a risk that the investment will not be carried out.

4 CSQ46. Do you agree with our proposals to introduce a new network innovation funding pot that will have a sharper focus on strategic energy system transition challenges?

In my view, a focus on strategic energy system transition challenges would be welcome. There are many very large system challenges to be addressed including, for example,

- How to ensure stable operation of the electricity system when an increasing amount of the infeed to it is connected via power electronic converters?

- How to ensure adequate flexibility on the system in order manage wide and potentially quite rapid variations in 'residual demand' and its uncertainty beyond a few hours[12]?
- What is the right mix of sources of energy given the wide inter-seasonal variation in demand and the intermittency of renewables?
- What signals can be used to incentivise energy users to make available and exercise their flexibility such that whole system costs of meeting energy needs are minimised?
- How should investments in significant new infrastructure be correctly identified across the different actors that might be responsible for delivery of the infrastructure, and how should it be paid for?
- How to ensure sufficiently resilient supplies of energy[13] against a background of significant change and uncertainty?

It will be necessary for the most urgent questions in the energy system transition to be identified, projects to be scoped correctly and appropriate parties engaged to steer and deliver the projects. Various stakeholders may be expected to contribute to setting of the R&D challenges and helping to direct the work. These include BEIS, the Committee on Climate Change, the Energy Innovation Board, UKRI, academics, the electricity and gas system operators and the network owners. However, other challenges and opportunities for the network licensees around which there is significant uncertainty should not be neglected. These include the ongoing need to manage legacy assets in a cost-effective way that, as part of a system of assets, delivers acceptable reliability of supply.

Ofgem has noted an ambition for "*increasing third party engagement, including legislative underpinning for direct access to Ofgem-administered funds, to support potentially new and transformative business models and solutions*".

It seems to me that many of the most difficult questions around the energy system transition concern the regulatory and commercial environment. This includes the way the roles of parties regarded as natural monopolies are defined and their incomes determined, and how the relationships between different parties are managed. This, in turn, means not just business models, but also codes and standards that concern the equipment that different parties own and operate and how it affects the system. As noted by, for example, the Future Power System Architecture initiative, revisions to codes or standards can take an inordinate time. They must also be well-informed and this requires appropriate R&D that the network licensees may be reluctant to fund without an innovation allowance.

UKERC and HubNet commissioned and, in August 2016, published a systematic review and synthesis of Low Carbon Networks Fund (LCNF) projects[14]. The review's main findings can be summarised as follows:

- 'Active' management of generation connected to the distribution network and flexible industrial and commercial demand should both be viable 'business as usual' options.
- Voltage control equipment, which has performed well in trials, could be used more often and can release network capacity more cheaply than historical 'fit and forget' solutions.

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[12] 'Residual demand' may be understood as that to be met after utilization of the available low carbon sources of power.

[13] 'Reslience' concerns not just the ability to prevent adverse consequences from unplanned events, but also, where some adverse consequences cannot be avoided, to contain them and recover from them.

[14] See : http://www.ukerc.ac.uk/publications/a-review-and-synthesis-of-the-outcomes-from-low-carbon-networks-fund-projects.html

- Battery storage is not yet cost-effective, and flexible domestic demand not yet effective in avoiding the need for network reinforcement. Both innovations require further development both in terms of implementation and the commercial frameworks within which they might be used.
- The distribution network operators (DNOs) reach mixed and sometimes contradictory conclusions on other innovations such as real-time thermal ratings of network branches and network reconfiguration for power flow management.
- Many LCNF projects focussed on equipment that was, up to that point, unfamiliar to DNOs in Britain. Knowledge has been gained on commissioning and operational performance, but more now needs to be done on system level methodologies and business processes such as optimal operation, support for investment decision making, and commercial and regulatory frameworks.

As noted by Frame *et al.*, "learning in respect of more optimal utilisation of existing equipment and around commercial frameworks … were under-explored in the LCNF projects."[15]

The reason why there has been relatively little innovation by the regulated energy network utilities around business practices and commercial arrangements is not clear to me. One possibility is that it is associated with the criteria that Ofgem has defined in respect of eligibility for NIA or NIC funding. In respect of NIA these include[16]:

> "*A NIA Project must … involve the Research, Development, or Demonstration of at least one of the following:*
>
> - *A specific piece of new (ie unproven in GB, or where a Method has been trialled outside GB the Network Licensee must justify repeating it as part of a Project) equipment (including control and communications systems and software);*
> - *A specific novel arrangement or application of existing electricity transmission and/or electricity distribution equipment (including control and/or communications systems and/or software);*
> - *A specific novel operational practice directly related to the operation of the GB Transmission System and/or the GB Distribution System; or*
> - *A specific novel commercial arrangement*."

In addition,

> "*the Network Licensee must be able to set out in its PEA [Project Eligibility Assessment, a document that must be completed before a project starts]:*
>
> *i)* *An estimate of the saving if the Problem is solved;*
> *ii)* *A calculation of the expected financial benefits of a Development or Demonstration Project (not required for Research Projects);*
> *iii)* *An estimate of how replicable the Method is across GB in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the GB Transmission System/GB Distribution System, where it could be rolled-out; and*

[15] See https://www.sciencedirect.com/science/article/pii/S0301421518301101

[16] https://www.ofgem.gov.uk/publications-and-updates/version-30-network-innovation-allowance-governance-documents

iv) *An outline of the costs of rolling out the Method across GB*."

Three things may be noted:

1. The set of project types does not include practices relating to planning of the electricity system.
2. Before a project starts, estimates both of future financial savings and implementation costs must be provided.
3. No scope is given for the exploration of the risks associated with continuation of existing practices.

In my experience, reasonable estimates of the financial savings and implementation costs of new business practices or commercial arrangements requires research which, in my view, should be eligible for NIA funding in respect of promising innovations. Although no guidance has been published by Ofgem on quite how good the estimate of costs and savings should be, in my experience, the need for an estimate of costs and savings sometimes leads the network licensees to decline to pursue projects primarily concerned with processes and business models. However, in spite of what I would see as flaws in its governance (which I discussed in section 7.4), the NIA mechanism has much to commend it.

An NIC project must address one or more of the set of four types of project as noted above for the NIA. However, it cannot involve 'research' and must be concerned only with 'development' or 'demonstration'[17]. Information on the expected financial benefits to consumers that "*the Project could deliver to customers*" must be provided as part of the project application. Justification must be provided "*that the scale/cost of the Project is appropriate in relation to the learning that is expected to be captured*".

Business models will normally affect multiple actors. Demonstration of them should therefore feature the active engagement of actors beyond just the lead utility. The UKERC/HubNet review of LCNF projects revealed that projects that attempted to engage outside actors were particularly problematic. I understand from some of the regulated utilities that customer protection arrangements can act as a barrier to the testing of novel models. The recent UKERC review of energy system demonstrators noted that "*a number of projects reported difficulty in engaging consumers and/or recruiting participants*."[18]

5 CSQ47. Do you have any views on our proposals for raising innovation funds?

Aside from industrial or commercial funding, the main sources of finance for innovation through UK Research and Innovation (UKRI) or the European Commission.

UKRI was only recently established and draws together Innovate UK and the research councils, the latter of which are the main supporters of university research. Ofgem has noted the need for greater coordination across different schemes established for the support of innovation. UKRI would seem like the natural party to take on a large part of the responsibility for that, though it should be ensured that it has the capacity to do so. In my opinion, at least one major recent decision by UKRI

[17] https://www.ofgem.gov.uk/publications-and-updates/version-30-network-innovation-competition-governance-documents

[18] http://ukerc.rl.ac.uk/TOOLS/EnergyDemonstrators/index.html

suggests what I would see as a lack of understanding of the extent of the remaining energy system transition challenges.

Centres for Doctoral Training (CDTs) are one of the three main ways by which UKRI, though the Engineering and Physical Sciences Research Council (EPSRC) provides support for Doctoral Training. On February 4th 2019, 75 CDTs were announced by UKRI "to develop the skills needed for UK prosperity"[19] with funding through EPSRC of £444 million and a further £2.2 million from The Natural Environment Research Council (NERC). None of the 75 has a scope concerned with the energy system or the electricity system. I regard this outcome as highly unfortunate. Issues associated with the energy system and with the electricity system in particular have, emphatically, not been resolved. Just as with LCNF and NIA projects, there has been a focus in UKRI funding on individual technologies and, in my view, a neglect of their performance on a system and the associated commercial arrangements and standards that ensure adequate, cost-effective collective performance. Such arrangements and standards should also drive investment in appropriate future technological capabilities.

In my opinion, funding for energy system related R&D at particular technology readiness levels (TRLs) should not be regarded as the sole responsibility of one party or another.

Much of the work needed to progress the technologies, methods or business models used within the energy system builds on more fundamental research and subsequent projects that start at a TRL or between 3 and 7. In such a range, many of the questions concern practicability and the close engagement of parties such as the network licensees is essential. They can comment on the fit – or otherwise – with existing practices and, crucially, provide use cases and data allowing developments to be tested. However, such inputs to projects funded by UKRI require time and effort and, in some cases, the necessary legal arrangements to protect any commercial sensitivities[20]. Since, usually, such input has little short-term value to the network licensee, they are more likely to provide it if is part of a project that is framed around potential future benefits to network customers as well as the wider economy and is co-funded out of a network licensee innovation funding scheme.

As I will discuss in section 8, co-funding of innovation by both network licensees and public bodies such as UKRI through EPSRC has been extremely important to date. Much of the innovation and training effort will be lost if it is not continued[21].

6 CSQ48. Do you think there is a continued need for the NIA within RIIO-2?

Where IFI, LCNF, NIA and NIC have been successful has been in giving the regulated energy utilities scope to address uncertainty, to explore an idea and gain knowledge about it before committing to it fully; in other words, to undertake R&D that the companies' response to the regulatory regime – the downward squeezing of costs – would not otherwise entertain. If done well, the R&D would be of long term benefit to consumers as innovations could be identified in which there can be confidence,

[19] https://epsrc.ukri.org/newsevents/news/seventy-five-centres-for-doctoral-training-announced-by-ukri-to-develop-the-skills-needed-for-uk-prosperity/

[20] A discussion on issues around access to data and examples of good and bad practice can be found in the UKERC response to the Ofgem/BEIS call for evidence on a smart, flexible energy system. See pages 50-53 and the Appendix of the main response document here: http://www.ukerc.ac.uk/news/ukerc-response-to-beis-ofgem-call-for-evidence-on-a-smart-flexible-energy-system-.html

[21] I discuss support for knowledge and skills further in section 9.

not only with respect to delivering the core service at least cost but also in enabling new services to aid the low carbon transition. These outcomes would be consistent with Ofgem's obligations to "*promote efficiency and economy on the part of those licensed under the relevant Act*" and have regard to "*the need to contribute to the achievement of sustainable development*".

The existence of uncertainty is the main driver for socialisation of risk and the use of customers' or taxpayers' money. The aim of R&D is to reduce uncertainty through the generation of knowledge. It is my impression that at least some expenditure under the LCNF, NIA and NIC has been more concerned with knowledge transfer – paying for a particular network licensee to acquire knowledge that already exists elsewhere – than with generation of knowledge. Examples of this might include the installation of a certain item of network control equipment by a particular network licensee that has been used, apparently successfully, by another network utility for some years. If that other utility was in the UK, would the use of NIA or NIC money be reasonable? Why should it make a difference if the other utility was outside the UK? The NIA criteria as currently written suggest that it would and that use of NIA money, at least, would be justified. Do regulators in other sectors, e.g. telecoms, similarly regard the acquisition of knowledge from outside the UK as representing a valid use of customers' (rather than shareholders') money?

The UKERC/HubNet review of the Low Carbon Networks Fund recommended that support for network innovation is continued in order that learning can be built upon and the revival in the regulated energy utilities' ability to lead research, development and demonstration is consolidated. Furthermore, it recommended that work in understanding potential innovations at low and medium 'technology readiness levels' (TRLs) should be recognised and funded even if the TRL advancement would not immediately lead to full commercial deployment of the technology. It also recommended that project reporting should detail the TRL advancement that has been achieved. I have been pleased to see that version 3.0 of the NIA governance rules published in July 2017 reflects at least some of these recommendations[22]. However, the UKERC/HubNet review also urged a deeper appreciation by both network licensees and Ofgem of the scientific process in particular in respect of (a) the design of trials/experiments in order that robust evidence can be gained and (b) the clear reporting of results, including those innovations for which results obtained were not what was expected.

7 CSQ49. If we were to retain the NIA, what measures could be introduced to better track the benefits delivered?

7.1 Judging the success of innovation funding

Quite correctly, Ofgem is keen that customer's money is efficiently spent. It places a great deal of emphasis, especially in large NIC projects, on efficient project planning and adherence to plans. It may well be argued by Ofgem that they recognise that the process of innovation is uncertain and that plans can change or activities can slip. However, in my experience, the electricity network licensees often lack confidence that their explanations and arguments for changes to a plan or the schedule of expenditure and deliverables will be understood and accepted by Ofgem. Furthermore, in many cases the regulated utilities have interpreted 'success' of an innovation project as only arising if the idea being investigated is subsequently adopted as business as usual. In a significant number of cases, this appears to me to have the result that:

[22] https://www.ofgem.gov.uk/publications-and-updates/version-30-network-innovation-allowance-governance-documents

1. Even for NIA (in which research is permitted not just development or demonstration), projects are commissioned only if they are judged to have a high chance of 'success', in which case there would seem to be relatively little doubt about how the project will proceed and what its outcome will be; one then wonders why innovation allowance money – designed to account for risk and uncertainty – was needed; and,
2. negative or inconclusive results can tend to be hidden even when they are quite understandable and contain important learning[23].

In my view, 'success' should concern the *quality of the evidence gained* that an innovation should be adopted or regarded as a standard, commercially viable option (and how to use it), or that it should not (if certain conditions are not met). This implies that a robust, informed judgement regarding the proposed innovation can now be made. This, in turn, implies that one of the criteria for assessing whether a given innovation project should be funded is whether there is a *clear articulation of relevant research questions* and a *clear plan for how to gain answers to the questions supported by the collection and evaluation of evidence*. It may well be that the answers obtained are not what was expected at the outset; however, if the evidence is strong (including evidence that the question is harder to answer than first thought), that would be a success.

7.2 Co-funding and TRLs

The need for 'success' is often interpreted by network licensees as meaning that NIA or NIC money can only be used for development of products, services or processes that are already at a high TRL. As I noted in section 4, Ofgem's guidance on NIA says that it can involve Research, Development or Demonstration. However, one regulated energy utility Innovation Manager has said to me:

> "Our regulator made it clear that they want to be focused on the high TRL. They are of the view that other sources of funding (EPSRC, Innovate UK etc.) are more appropriate for the protected development of IP and/or low TRL."[24]

As I discussed in section 5 there are good reasons for shared funding. From a network licensee and Ofgem's perspectives, UKRI funding can represent excellent leverage. An example of this is the existing CDT on "Future Networks and Smart Grids" hosted by University of Strathclyde and Imperial College. The whole of a PhD is, fundamentally, an educational exercise in which an individual learns the practice of research. However, when a research topic is suitably defined, it also delivers learning of value to others, not just the student. This is the case for a number of students in the Future Networks CDT[25]. The funding from UKRI enables the basic training provided in years 1 and 2 of a student's 4 year programme while NIA funding contributes to the funding of a number of students in their 3rd and 4th years when they are working on a specific research topic that meets the NIA criteria. The combination of funding allows many more students to be funded and more questions to be addressed than would otherwise have been the case.

7.3 The scope of NIA, who pays and who benefits?

In section 4, I quoted the main NIA governance criteria that outline the permissible scope. I have little disagreement with it although the scope for investment in new business methods and

[23] To be fair, I see this tendency as reducing. In recent times, my impression is that many of the network licensees are becoming more open in respect of sharing lessons on difficulties encountered, and this is much to be welcomed.

[24] Email correspondence to Keith Bell.

[25] Due to EPSRCs decision not to fund the CDT's renewal (mentioned in section 5), it admitted its last cohort of 10 students in October 2018.

processes or new commercial or regulatory arrangements that promise customer benefits in the medium to long-term might be more explicitly laid out. In addition, what uncertainty is really associated with a specific piece of equipment or method that is in use elsewhere but not, to date, in Britain? What is really different about the physical, commercial or regulatory environment in Britain that means its deployment would represent a risk to GB network customers, network licensee staff or the general public?

A broadening of the scope of NIA should, in my view, address the fact that innovation should enable the whole energy system's transition, not just that in one sub-sector. For example, an innovation in the electricity networks sector might result in benefits in the gas sector (such as, for example, reduced need for new compressors) or vice versa. This suggests two tests for the appropriateness of specific innovation funding for the energy network licensees:

1. The benefits (in respect of lower costs to consumers, maintenance of adequate reliability of supply, or improved social acceptability, e.g. safety or environmental impacts) would either
    a. accrue to another network licensee; or
    b. accrue to the funded licensee only in a future price control period.
2. The uncertainties are such that some socialisation of risk is appropriate.

If the answer both the above questions is "yes", it should be permitted for customers' money to be used to fund the proposed project, at least in part.

In my view, there is a failure in Ofgem's published NIA and NIC criteria to clarify that uncertainty is not just something that prevents exploitation of an opportunity but might instead concern a threat that is not well understood.

An example of the former might be real-time thermal ratings: how is it done, what does it cost, and what are the risks and benefits? An example of the latter is the public's perception of electromagnetic fields. There is no clear, consistent evidence of a detrimental effect on health but some people believe there is. There would appear to be a clear need to keep investigating, but who pays for that work? Other examples are:

- will retirement of conventional, synchronous electricity generation plant and an increase in the connection of power sources and loads via power electronics lead to new interactions that cause the system as a whole to be unstable;
- what would be the impact of SF_6 gas being banned[26];
- how significant are cyber-security threats and how might they be best managed?

Some of the new system risks and uncertainties highlighted in, for example, National Grid's various 'System Operability Framework' publications are starting to be addressed, albeit, slowly[27]. Nonetheless, to avoid the risk of delay in addressing future issues, perhaps there is a need for Ofgem or Government to be more proactive in highlighting areas in need of investigation, as might be done through the proposed innovation funding in support of the 'energy system transition'.

[26] Sulphur hexafluoride – SF_6 – is an excellent electrical insulator widely used in power system switchgear to aid the extinction of arcs created by the isolation of short circuit faults, and increasingly used in compact high voltage substations. It is also an extremely potent greenhouse gas.

[27] See https://www.nationalgrideso.com/insights/system-operability-framework-sof

In my view, it is correct that NIA is not used to pay for the project management and bureaucratic overhead associated with the development of NIC projects. However, given the scale of investment sought, it is also extremely important that NIC proposals and future 'energy system transition' project proposals are built on strong foundations of knowledge and appropriate evidence. NIA represents a means by which knowledge that informs the definition and aims of NIC projects can be developed.

7.4 Governance of NIA

7.4.1 NIA documentation

It is, for me, understandable that Ofgem is questioning the effectiveness of NIA as the network licensees have not been consistent in their reporting of it. As has been noted in, for example, the UKERC/HubNet review of LCNF and the UKERC response to the Ofgem/BEIS call for evidence on A Smart, Flexible Energy System, the network licensees' performance in undertaking innovation projects supported by LCNF, NIA or NIC has not been perfect. For example, there has been significant variation in the quality of evidence reported, access to project data and reporting on where the investigated innovations are intended to be taken next or, or if no further action is planned in the short-term, why not or what conditions would need to be satisfied for there to be deployment or further development work.

A number of questions must be answered when registering a new NIA project:

1. What is the problem(s) being addressed?
2. What method(s) will be used?
3. What is the project's scope?
4. What are its Objectives?
5. What are the 'Success criteria'?
6. What are the TRL at the start of the project and what is it expected to be at the end?
7. What is the "Potential for new learning"?
8. What is the estimated cost saving if the problem is solved?
9. Is the work being duplicated or has it been done before?

Many of the above questions are reasonable. However:

- In general, so little detail is provided on, in particular, Methods, that it will be hard for the initiator of a new project to answer question 9 with confidence based solely on Project Registration documents.
- The Registration and Closedown documents are provided only as pdfs on the ENA's 'smarter networks portal' making it difficult to search their contents.
- The involvement of 3rd parties is not recorded making it difficult to see how wide such involvement is or for 3rd parties to see what kinds of opportunities might exist for them in new projects.
- An over-emphasis on TRLs might bias projects towards technologies to detriment of the project portfolio also including work on the commercial and regulatory environment.
- Especially in respect of projects concerned with understanding risk, it will be difficult to give an accurate estimate either of potential customer savings or customer costs.
- Research and Development are fundamentally concerned with resolving uncertainty; framing of project 'success' in terms of outcomes that would allow an innovation to be taken forward rather than in terms of the learning to be achieved might bias the project portfolio towards only high TRL technologies.

Project Closedown reports are also to be completed. These ask for information on the following:

1. Scope
2. Objectives
3. Success criteria
4. Performance compared to original aims and success criteria
5. Lesson learnt for future projects
6. Planned implementation

Again, the above is generally reasonable. However:

- Often, the information provided in the Closedown document is scant and no additional reports with greater detail are made available.
- The learning from the project might be that no implementation should be planned.

(To state again the Objectives is reasonable as they might have changed since project inception. The reasons for change should be explained).

I would urge that consideration is given to revision of the Registration and Closedown documents. In addition, new guidance should be written to accompany them. In respect of the Closedown, the questions asked of the project leader might include:

- What uncertainties were being addressed?
- What has been found?
- What are your recommendations for what should happen next?
- What does that depend on?
- Whose responsibility is it?
- What would be the benefits and to whom would they accrue?
    - How has that changed since the beginning of the project?
        - Have the expected benefits changed?
        - Has the likelihood of benefits accruing changed?

The benefits can include a reduction in the likelihood or extent of adverse outcomes such as system instability. Dependencies in respect of next steps might include, for example, the growth of electric vehicle charging. In order that confidence in the net benefits of a portfolio of innovation projects can be identified, once any follow-on work or implementation or deployment are indicated, it will be extremely important that the systems for documentation make the link with the founding work and that the outcomes of the further steps are reported.

7.4.2 Ensuring good practice

There is significant value, I believe, in NIA being quite light touch and avoiding the very high bureaucratic overhead associated with, for example NIC (in which significant sums go to consultants for the production of project management paperwork). However, the relative lack of oversight, e.g. in respect of avoidance of duplication or in ensuring publication of findings, including data, leads to legitimate worries about the consistency of good practice.

In what might be an over-generalisation, my feeling is that the electricity and gas network licensees had, over the last 25 years, broadly forgotten how to undertake, manage or report R&D with the result that experiments – necessary to test ideas or gain knowledge – are not always well designed and reports sometimes fail to follow good scientific practice in providing the means by which others might test the results and conclusions. As the 2018 UKERC review of energy system demonstrators

shows, this failing is not limited to regulated energy utilities. The review identified 119 projects of which 64 (54%) had apparently been completed[28]. Of these, only 56 had published any kind of final report. The quality of reporting was found to be highly variable with Innovate UK and Low Carbon Infrastructure Transition Programme (LCITP) projects often being particularly poorly documented.

I believe there is now evidence that at least some network licensees are becoming much better at managing and reporting R&D. However, a recent development at one major regulated utility – the Electricity System Operator – has been the establishment of an Innovation Team (responsible for commissioning and managing innovation projects) that, when first established, had no power systems experience or expertise within it. While members of the team might have been aware of the uncertainties involved in innovation and have some experience of managing innovation projects, they had no understanding of what research questions might be pertinent for an electricity utility or which parties would be qualified to try to answer them.

An articulation of 'good practice' in managing R&D would help. The ENA did publish such guidance related to the Innovation Funding Incentive (IFI) and Registered Power Zones (RPZ) in the form of Engineering Recommendation G85, but it has not been updated since December 2007. I would be happy to contribute to the revision of such guidance and of NIA governance documentation if asked to do so[29].

7.4.3 Auditing NIA processes and projects

As noted, one advantage of NIA is its relatively light touch. Another is its flexibility: projects do not need to be defined months or years in advance and can be defined in an agile manner to address system risks or opportunities as they emerge. However, it would be in customers' long-term interests if its aims are applied consistently and well. Following the example of financial auditing in which there is no attempt to check every financial transaction but, instead, a sample of them is checked from beginning to end in order to establish confidence in the process by which they are managed, so might a random sample of NIA projects out of a portfolio be reviewed in terms of documentation, management and learning.

8 Examples of effective innovation projects

It is important to recognise that any innovation project seeking to exploit or develop an apparent opportunity is, to some extent, a speculation: an idea that is judged to have promise – in NIA terms, to reduce costs to network customers at some point in the future or give an improved service – has some uncertainty associated with it and might turn out not to be as cheap, as effective or as practical as hoped. It should therefore not be expected that each and every R&D project achieves what was hoped for in terms of realisation of the expected opportunity. Nonetheless, the learning should be useful, even if only to tell others not to bother pursuing the same idea or to try doing it in the same way. Moreover, the value of R&D should be assessed in terms of a portfolio of projects: some of the ideas explored will be taken forward while others will be put to one side, perhaps only temporarily, or abandoned. If the number of ideas taken forward and adopted is small but the value

[28] http://ukerc.rl.ac.uk/TOOLS/EnergyDemonstrators/index.html

[29] In December 2018, funding was announced by EPSRC for an 'Energy Revolution Research Consortium'. This has the stated aim to "enable and inform demonstrators and demonstrator design projects (funded by the [Prospering from the Energy Revolution] PFER programme) through their lifetime; undertaking analysis and evaluation, building and driving best practice and, leading knowledge exchange through national and international engagement with policy, academic and industrial communities." (See https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/S031863/1). Given that aim, it may be expected that the consortium can contribute to improvements in governance and good practice in R&D by energy network licensees.

of them is large, they can pay for and justify the entire portfolio. In addition, projects not immediately taken forward have an option value. Examples pertinent to the electricity networks sector include those that suggest how to accommodate new low carbon loads (such as EV charging or heat pumps) or low carbon generation at least cost but which are not required until a sufficient number of such loads or generators have been connected; at that point, the network licensee should be ready to roll out the innovation solution rather than starting the R&D towards it only now.

In the rest of this section, I present just a few examples of the effectiveness of small scale R&D projects that have benefitted from one or other of the innovation allowances made available to network licensees by Ofgem. In addition, benefits arise from PhD students or post-docs, often co-funded through an innovation allowance with other funding such as through EPSRC or a scheme such as the Energy Technology Partnership in Scotland, subsequently joining the industry. There are many such examples of individuals who did research at, for example, the Universities of Strathclyde or Manchester or Imperial College joining companies such as National Grid, SP Energy Networks, SSE Networks, Electricity North West or UKPN and assuming responsible positions. Crucially, given the importance of making the practice of 'innovation' part of 'business as usual', they do not sit solely in innovation teams.

8.1 Active Network Management (ANM)

In some respects, the fundamental concept of 'active network management' – to adjust the output of generation in order that network limits are respected – is only something that has been done on transmission networks for decades. However, to do it automatically and continuously on a distribution network and to do so cheaply and robustly has taken significant development effort, both to build confidence in the technology and to persuade both generators and DNOs that it is worthwhile. The first steps to scope out ANM, develop and test it were taken at the University of Strathclyde through a PhD project supported, so I believe, through an RPZ innovation project. Further development was supported through subsequent investment both from industry parties and from innovation schemes through to scale demonstrations in LCNF to the point where, now, it is a 'business as usual' option ready to be deployed when required. It also represents significant export potential as it underpins the products and services offered by Smart Grid Solutions, a company that is building a strong base not just in the UK but also in the US and, so I understand, has customers in Belgium, the Netherlands and Germany. As such, it is showing both network customer value through the existing ANM connections in Britain and wider economic value. It could be quite argued, I believe, that it would not exist were it not for patient funding – development took a number of years from first inception to commercial viability – by GB network customers through the various innovation allowances. This dependency is especially true of the schemes allowing work at quite low TRLs and some degree of speculation and experimentation at a small scale, exactly the thing for which NIA is well suited.

8.2 Power system protection

Power system protection is essential for detecting faults on the network and identifying faulted sections allowing them to be safely and quickly isolated from the system, thus ensuring continued stable system operation. Protection failures or incorrect settings put this at risk[30].

[30] There are thousands of instances of protection on the GB power system. As an example of what happens when protection goes wrong, the disconnection of a large part of South London, including supplies to the London Underground, in August 2003 was attributed, in large part, to an incorrect protection setting.

Work at University of Strathclyde for the development of an intelligent system for detecting protection setting errors has been funded by National Grid through the IFI scheme (a scheme similar to NIA).

In the project, it was found that different contractors (e.g. companies like Alstom and ABB who provide protection equipment and commonly perform the initial settings actions for National Grid Transmission Owner) have different interpretations of the setting policies, which could potentially lead to issues. The intelligent system also succeeded in identifying settings that are non-compliant with the most recent version of the setting policies but are still being used in the system. This was fed back to the protection team at National Grid which, in turn, changed the way it engaged with contractors.

Another key finding of the project was the large variation in the proprietary settings of protection and the software tools used. This introduces a need for checking and a significant burden on protection engineers, thus increasing the risk of manual errors. The project team developed a more streamlined engineering process for digital substations based on standardised protection settings. This led to a journal publication and involvement with a CIGRE working group (WG B5.50), where these recommendations will be included in the technical brochure for improvements for a future IEC 61850 standard. Thus, the work can be said have had an international impact. Although not (as far as I am aware) explicitly quantified, between the various impacts, the value (in terms of increased reliability of supply and reduced engineer burden) can be judged to have far exceeded the cost of the project.

8.3 How to manage reduced system inertia

The challenges arising out of the reduced operation of synchronous generation powered by thermal sources has been attracting growing attention, but a clear view on the best way to manage the problem has yet to emerge.

Two recent PhD students at Strathclyde have taken different perspectives on the problem: one to study how a 'virtual synchronous machine' (VSM) might be defined and what its benefits to the system might be; the other to approach the definition of ancillary services for frequency response (frequency containment reserve) in a new way. Each has had a contribution to their funding through NIA (via National Grid in the first case and SP Transmission in the second). The latter case was a co-investment with EPSRC through the Centre for Doctoral Training in Future Networks.

One of the outcomes of the first project has been to inform developments in ENTSO-E working groups concerned with defining future requirements for generators. There is much further work to be done on the whole VSM idea which has the potential to make a huge difference to stability of the system when it is operating with a very high 'non-synchronous penetration'.

The work on possible new ancillary service arrangements and the associated modelling developed at the university has encouraged a number of industry parties to engage with the ESO and to challenge the existing ways of doing things with the promise of reduced balancing service costs. It has also allowed an analysis to be done of the impact of high 'non-synchronous penetration' on annual balancing service costs (found to be of the order of £40 million in 2020) thus allowing exploration of measures to reduce those costs.

8.4 The effect of wind generation on transmission system flows and associated costs

Research conducted at Strathclyde and funded out of IFI looked into the implications of the development of wind generation on the GB system in respect of expected power transfers across the transmission system. Fundamental work was done on the modelling of wind farm behaviour and a

novel methodology developed to assess its interaction with other sources of power and the effect on the network. This eventually led to revision of the Security and Quality of Supply Standard (SQSS) , the formal document defining transmission network owners' and operators' legal responsibilities with respect to design and operation electricity transmission system. The main idea that arose from Strathclyde research was a separate treatment of 'economy-driven' transmission from 'reliability-driven' transmission, motivated by facilitation of the electricity market and security of supply respectively. This idea was formally captured in a revision to SQSS.

9 Further observations

9.1 Engagement of 3rd parties: intellectual property

Ofgem has noted that "*We will also take into account the arrangements they will have in place to make the transition to BAU happen and the quality of their plans to involve third parties within their innovation programmes".*

Third parties are already heavily involved in gas and electricity network innovation projects. However, I have some concerns about the way they sometimes seem to be engaged by some of the network licensees. Innovators' primary currency is their ideas, formed as intellectual property and the associated intellectual property rights (IPR). They depend both on other people picking up their ideas and on gaining some value from them themselves in order to help fund their continued creative and developmental work.

The energy network licensees are regulated and, for the most part, are monopolies whose activities are closely scrutinised by Ofgem to ensure value for the licensees' customers, both present and future. As already noted, Ofgem has deemed that it is permissible for licensee customers' money to be used to fund licensee innovation through the NIA and NIC, subject to a number of conditions. For example, "*One of the purposes of the NIA is to allow learning to be shared amongst Network Licensees. The NIA Project must develop new learning that can be applied by Relevant Network Licensees.*"[31] In addition, "*We recognise that the Projects financed by the NIA may create IPR either for the Funding Licensee or for any Project Partners (whether for one, both or jointly)*" and "*Network Licensees must ensure that their IPR arrangements allow for the Dissemination of knowledge in respect of a Project. … It is not expected that the confidential details of IPR would be disclosed in Project Progress Information, only sufficient information to enable others to identify whether the IPR is of use to them. … Each Participant shall own all Foreground IPR that it independently creates as part of the Project. Where Foreground IPR is created jointly, it may be owned in shares that are in proportion to the funding and work done in its creation*."

I have become aware that some network licensees have been adopting the following practices in respect of innovation projects:

a) insisting that all Foreground IPR in an innovation project is fully and exclusively owned by the network licensee;
b) asking third parties to volunteer their ideas but then commissioning others to take them forward.

The explanation given by some utility representatives of practice (a) has been that it is needed in order that the network licensee can disseminate the learning. It seems to me that such a position is incorrect given the various stipulations of the NIA governance arrangements summarised above, and

[31] Ofgem, Electricity Network Innovation Allowance Governance Document version 3.0, 2017.

betrays a certain lack of expertise or awareness on the part of at least some network licensees in respect of the management of innovation. Moreover, in cases where a university of the 3rd party, it is common practice for the university to own any Foreground IP independently developed or to institute shared ownership, to offer a free licence to a client to use the university's Foreground IP developed in the project, and to actively promote dissemination of knowledge through publications[32].

It is not clear to me how widespread the above practices are but both of them are likely to act as deterrents to 3rd parties volunteering to become involved with network licensees or to offer their ideas.

9.2 University engagement and development of people

In a context of continually squeezed public spending where the research councils are under the same pressures as other public bodies, the support provided by the NIA and NIC has been extremely valuable in recent years in helping to ensure that academic work is industrially relevant and has 'impact', in providing funding to employ researchers, and, not least, in developing people whose knowledge and skills can be transferred to industry not just through projects but also through subsequent full-time employment with companies. For example, many PhD graduates and a number of post-doctoral researchers from UK universities who have worked on network innovation projects supported by IFI, LCNF, NIA or NIC have gone on to work with network licensees or SMEs working on energy system innovation. These people will be crucial to the definition and delivery of significant energy system change.

In respect of university engagement, the NIA has, it seems to me, been the more significant of the two Ofgem-sanctioned innovation funding streams currently open to regulated utilities. It permits work on research, not just development and demonstration, and, although its governance is not without flaws (as discussed in section 7.4), has a much lower bureaucratic overhead than both the NIC and routes to funding through UK Research and Innovation (UKRI). It is therefore of considerable concern to many in the academic community that Ofgem is actively considering dropping the NIA.

One of biggest challenges faced by universities is the attractiveness of contracts offered to researchers. They are typically offered only in respect of specific projects and are inevitably fixed term, often with salaries that do not compete with other sectors where numerate, problem-solvers are sought. One example of a need for greater coordination between different sources of R&D funding therefore lies in investment in building and retaining research capacity. This is, in my view, of long-term importance whether the funding comes exclusively from Government or can be helped by other funding sources.

It is reasonable for shareholders and customers to share the cost of investing in future capability in the shape of future leaders on technologies and practices that will benefit shareholders and customers. In other words, it should not just fall to the wider base of taxpayers to pay for investment in people (as would be the case if developed of research and innovation capability that joined the network licensees were funded solely through UKRI).

[32] Dissemination of knowledge through high quality publications is a key output for measure for universities that they are strongly incentivised to pursue.

9.3 A culture of innovation

In the RIIO sector methodology consultation, Ofgem asserts that "*The [time limited innovation] stimulus should lead to a cultural shift in the companies so that more innovation takes place as part of their BAU activities.*"

According to the Guidelines on the Meaning of Research and Development for Tax Purposes published by the Department of Business, Innovation and Skills in 2010,

> [a] project which seeks to, for example,
>
> (a) extend overall knowledge or capability in a field of science or technology; or
> (b) create a process, material, device, product or service which incorporates or represents an increase in overall knowledge or capability in a field of science or technology; or
> (c) make an appreciable improvement to an existing process, material, device, product or service through scientific or technological changes; or
> (d) use science or technology to duplicate the effect of an existing process, material, device, product or service in a new or appreciably improved way (e.g. a product which has exactly the same performance characteristics as existing models, but is built in a fundamentally different manner)
>
> [will be R&D].

In my view, the above guidance on R&D underplays the significance of R&D leading to new business models or processes. By way of comparison, according to the OECD (quoted by HM Treasury in its recent consultation on Innovation in Regulated Utilities), "Innovation involves the creation and diffusion of new products, processes and methods. It encompasses a wide range of activities including R&D, organisational changes, training, testing, marketing and design."[33]However, importantly, the 2010 guidance points to "an increase in overall knowledge and capability" and the scientific process or technological change. How much of the innovation, i.e. business change, carried out and funded by network licensees themselves to achieve cost reductions can be said to have been the result of "an increase in overall knowledge and capability" or a scientific process? As I suggested in section 2.1, my impression is that much 'innovation' invested in by the network licensees themselves in order to achieve cost reductions has involved changes to staffing arrangements or procurement policies[34].

It is one thing for Ofgem to expect a 'culture of innovation' within the network licensees. It is quite another for it to actually exist.

In my experience, there are many individuals within the regulated network companies who, even nearly 30 years after liberalisation of the electricity supply industry was first put in train, have a strong public service ethos, especially at a working level but also among managers. Encouragingly, I also see this among a good number of new recruits, many of whom are graduates of the university where I teach and lead research. I do meet network licensee employees who want to see things done better. However, the combination of creativity, insight and empowerment that might drive

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[33] "The Innovation Imperative Contributing to Productivity, Growth and Well-Being", 2015

[34] It may be useful for Ofgem to try to establish, somehow, if my impression is correct. This would provide Ofgem with better information on what kinds of 'innovations' might be expected to be undertaken as 'business as usual' without a need for additional funding, and which would not.

significant innovation is, whatever best intentions there might be, harder to find[35]. There is, in my experience, a still observable culture of "but this is the way we've always done it" and, on occasions, a resistance to ideas "not invented here". Also, importantly, the bottom line, which I believe Ofgem cannot simply wish away, is likely to be the following. In an investor-owned utility, investments will only be made if a return can be realised given the prevailing rules and financial incentives under the regulatory arrangement: the income that has been set; any adjustments to income related to performance measures, licence non-compliance or factors to account for external variations in costs outside of the licensee's control; and reputation. This last factor is perhaps the least tangible. In spite of how fundamental a viable network connection and a stable system are and the 'stakeholder engagement' that Ofgem has been encouraging, the network licensees are perhaps the companies within the gas and electricity supply industries that are least visible to most customers. There is little scope – or once a party has connected, no scope – for a customer to take their business elsewhere if they are dissatisfied with the price or service they are given. In other words, the customer base is largely fixed and so its growth cannot be a motivation for innovation. However, I believe that many senior network licensee managers are well aware of the harm that can be done by poor service and, to be fair, published metrics in respect of reliability of supply are generally good and, in some respects, have been improving[36]. To what extent will senior decision makers within the network licensees put those metrics at risk if a return on an investment cannot be reached within a single price control period, and will they make the resources available – in particular, the time that can be spent by creative, informed individuals to develop and test ideas – to realise significant innovations?

10 Concluding remarks

I believe it is correct that Ofgem should re-assess the need for and value of the various innovation allowances. The regulator has a duty to protect network customers' interests and needs to be sure that customers will benefit from the use of their money. However, as the Scottish Government's Energy Networks Vision published on March 12th notes[37], there is a need to "have a much better understanding of how to balance the interests of today's consumers against those at different points in the future." This is key to the incentivisation and utilisation of R&D involving the energy network licensees. Important as it is that bills to today's network users are kept to a minimum, it should not be at the expense of higher bills or poorer service to future users.

The effect of a reduced cost to customers in a particular price control period is a squeezing of budgets for the network licensee. Ofgem sees this as an incentive to innovate and, normally, it should be. However, one outcome that can arise (and I understand has arisen) is that budgets for asset replacement are cut and equipment is procured that meets the bare minimum of present day requirements with no opportunity for future benefits or 'smart control'. This includes the omission from distribution network equipment of, for example, actuators for automation, no current transformers for measurements and monitoring, no remote terminal units and no modems. It would also mean a failure to specify equipment that, while 'over-sized' relative to the present day ratings

[35] In my experience, PhD graduates are an especially important source of people with this combination of characteristics. However, having a PhD is not guarantee of such characteristics, and individuals with fewer formal educational qualifications can also be important innovators.

[36] Actually, in some respects I do worry that, in respect of a system that, based on historical experience worldwide and its engineering characteristics, suffers a major failure very rarely but, when it does, can happen very quickly and have massive consequences, there is a certain amount of complacency, not least in respect of the system's changing dynamic characteristics and its long-term resilience.

[37] https://www.gov.scot/publications/vision-scotlands-electricity-gas-networks-2030/

requirements, would entail significantly reduced losses over the medium to long term and a reduced 'whole system' cost.

Ofgem expects that a 'cultural shift' will have happened so that "more innovation takes place as part of [the network companies'] BAU activities". It seems to me that innovation in the sense of some degree of change does happen within companies and has happened, but only to the extent that it delivers a reduction in cost or a gain relative to income adjustment mechanisms in the short-term. I would like to see evidence that the companies have invested their own money in innovation that yields a net return or benefit to consumers only in a future price control period and in innovation that requires considered exploration and development of technological, procedural or institutional options and resolution of uncertainty. Resolution of uncertainty includes an evaluation of the risks associated with business practices or network technologies *not* changing even though many other things on the system are changing. The exploration and development of options and resolution of uncertainty deliver enhanced knowledge. Where the risks of not doing the research and development would affect customers or the benefits of enhanced knowledge would accrue to them, it is reasonable that they bear at least part of the cost of the R&D.

A focus within larger innovation projects on the 'energy system transition' seems reasonable, provided the challenges to which projects are directed are appropriately identified and well defined. The challenges associated with management of legacy assets should also not be neglected. As a former industry colleague once put it to me, "universities can help us to answer the questions we can't answer; however, they can also ask the questions we never thought of asking". When seeking answers to questions, it is important that the right partners are engaged in the research, development and demonstration, and that network licensees are closely involved, i.e. at a much deeper level than simply project management or as passive observers. More often than not, they would be responsible for implementation of any ideas that are proven to be commercially viable and have net benefits; transfer of knowledge to them will be essential. In addition, many of the most pressing energy system issues affect more than one party in the industry. They go beyond interest in 'bits of kit' and often concern commercial and regulatory arrangements, including codes and engineering standards. If a network licensee is expected to fund their own involvement in innovation projects that seek knowledge, they would only invest if their own benefits are likely to exceed their costs. In respect of system issues, the costs and benefits are unlikely to be equally shared between the different parties that are affected.

UKERC reviews of electricity industry R&D and energy system demonstrators have found wide variation in the quality and accessibility of reporting. Although the ENA's Smart Networks Portal has been a very welcome development, it is far from perfect. The content of official project documentation is not searchable and often contains little detail. It is hard to tell which 3rd parties were involved and did what and only sometimes are fuller, additional reports made available and very rarely can external parties access project data[38]. This, frankly, is not good enough and there is a clear need for all network licensees' practices in respect of definition, conduct and reporting of innovation projects to rise to the level of the best. They should learn from academic best practice and the governance arrangements around, in particular, NIA, can and should be improved.

There are many advantages to the NIA, including its flexibility and low bureaucratic overhead. It allows risks or opportunities to be explored in small projects before committing to larger

[38] The review of energy system demonstrators carried out by the Energy Systems Research Unit at University of Strathclyde on behalf of UKERC and published in 2018 found only 4 out of 64 completed projects had made any data gathered during the project publicly available. http://www.ukerc.ac.uk/publications/review-of-uk-energy-system-demonstrators.html

development or demonstration efforts. Some NIA projects will reveal a strong case for further work while, in others, the learning is that the idea, or the idea in that particular form, should not be pursued or not pursued any further right now. There are many examples of knowledge that is finally of value to customers being gained through NIA or its forerunners that is unlikely to have been gained otherwise. Across the portfolio of projects, I am confident that the net benefits outweigh the total costs. The NIA helps relationships between collaborators to be built and maintained allowing knowledge to be transferred and people's knowledge and skills to be developed, something is in customers' long-term interests. Significant enhancement of NIA can be achieved through gearing with public sector funding such as through EPSRC, although the latter is being made more difficult due to an apparent re-orientation of EPSRC's priorities for doctoral training away from the energy system and, within it, the gas and electricity systems.

The implication of Ofgem's consideration of the need for NIA is that it is contemplating scrapping it. The materiality of the upside and downside consequences of getting rid of NIA should be assessed. Scrapping it on the grounds that the licensees' reporting of its use has not made the benefits sufficiently clear would save a certain amount of money on network customers' bills (an amount that is likely to be small relative to other measures that Ofgem might adopt). However, it would also mean giving up the opportunity for relatively early stage, quite small scale exploration of ideas and system risks that, over time and across the portfolio of projects, would be of benefit to customers. As much as anything else, larger 'energy system transition' projects are very likely to depend on knowledge gained from such smaller projects; as Ofgem's proposals stand at the moment, areas of innovation such as how to manage legacy assets in the medium to long-term would also suffer. It cannot be assumed that the gap left by scrappage of NIA would be filled by UKRI. Instead of scrapping NIA, I would advocate retaining it though with a revised remit backed up with improved governance to ensure better quality work and clearer reporting of outcomes.

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