Comments on the initial findings of Ofgem's Electricity Transmission Network Planning Review

Keith Bell, University of Strathclyde, January 5th 2022

1 The need for change

In November 2021, Ofgem consulted on its vision for Centralised Strategic Network Planning of the GB electricity transmission network that would "take a GB-wide holistic view to develop an optimised plan for taking forward low regret anticipatory [strategic investments] … so as to achieve the Net Zero target in the most efficient way"[1].

In some ways, it seems strange that an industry consultation on the need for a strategic view on transmission network development should be required; that need has always been has always been there and should have been part and parcel of the licence conditions of the transmission licensees. Perhaps two things are now different and mean that a reset on quite how that need is met is appropriate.

1. We have very different circumstances now from those that have prevailed for most of period since liberalisation of the electricity supply industry in Britain and the regulation of private companies entrusted with network investment. To a large extent, the need for investment in transmission network capacity has related to facilitation of individual new generation or interconnector connections with only a few examples of major 'strategic' investments on the Main Interconnected Transmission System (MITS) motivated by accommodation of increased power flows across particular boundaries resulting from development of multiple new generators (such as the Western HVDC Link) or growth in local demand (such as the London Power Tunnels). However, in the next 2-3 decades and especially up to 2030 by which time the UK Government has an expectation of 40 GW of offshore wind capacity being operational in British waters[2] and to 2035 by when Britain's electricity system should have no unabated use of fossil fuels[3], there will massive changes to the generation mix, far outstripping anything seen in the 'dash for gas' in the 1990s. An incremental approach to network development and regulation will no longer suffice.
2. The fragmentation of the electricity sector that liberalisation and the introduction of competition brought about has increased, with separation not just of generation but also of system operation from network ownership, the delegation (to date) of the design and construction of connections of offshore wind farms to generation developers, and new processes envisaged to change the way competition is enabled for "large onshore transmission investments"[4].

[1] Ofgem, Consultation on the initial findings of our Electricity Transmission Network Planning Review, 5 November 2021, https://www.ofgem.gov.uk/publications/consultation-initial-findings-our-electricity-transmission-network-planning-review

[2] https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy

[3] https://www.gov.uk/government/news/plans-unveiled-to-decarbonise-uk-power-system-by-2035

[4] Dept. for Business Energy and Industrial Strategy, Competition in Onshore Electricity Networks, August 2021

Although there has been huge growth in distributed generation, i.e. that connected within the distribution networks[5], there remains a need for significant transmission network capacity in order that use can be made of larger scale generation such as large wind farms, nuclear power and, one supposes, gas plant with carbon capture and storage. Most of that generation capacity is – and will be – located quite far from the main demands, often on or, in the case of offshore wind, beyond the periphery of the existing transmission network. The transmission network therefore remains a key enabler of use of electricity, competition in the wholesale market for electrical energy, and security of supply.

2 Classes of electricity transmission

In the sense of enabling use of different generation resources to reduce emissions or support security of supply and facilitating competition in the electricity market, there is nothing fundamentally different about offshore transmission compared with that onshore.

It seems to me that the most significant (but not the only) possible delineation of transmission development leading to allocation of responsibilities to different parties would be the distinction of 'connection' from 'infrastructure' where the former facilitates operation of just one party connected to the network while the latter benefits many parties. A further category might be defined for infrastructure built between two otherwise separate markets: 'interconnection'.

To date, network capacity offshore has, in effect, been classed as concerning only 'connection' or 'interconnection'. The size and distance from shore of new offshore wind developments suggests that major opportunities would be missed if offshore network assets were to continue to be treated only as either 'connection' or 'interconnection' or – as in the case of the Western HVDC Link and the Caithness-Moray scheme which both make use of undersea cables – as an 'onshore' asset as it connects only onshore sources or sinks of power to each other. These opportunities include those for the rationalisation of total network capacity and the number of individual transmission routes, and provision of multiple routes from any one wind farm to the onshore network in order that access to the market might be provided more reliably[6]. Moreover, because electrical connection of offshore wind farms and interconnectors depends unavoidably on connection to the onshore electricity network where the demand is, and a major driver for onshore network development will be accommodation of offshore wind and interconnection, it seems abstruse for the onshore and offshore networks to be planned separately, delivered by separate processes and be the subject of separate reviews.

3 Uncertainty and scenarios

One important impact of the introduction of competition and fragmentation of the industry is that any one party's access to information is limited. Unlike in pre-liberalisation days, no single party has access to all the information that would help to inform investment in both generation and transmission and, in theory, allow an optimal overall investment plan to be developed and implemented.

[5] S. J. Gordon, C. McGarry and K. Bell, "THE GROWTH OF DISTRIBUTED GENERATION IN GREAT BRITAIN AND ASSOCIATED CHALLENGES," The 9th Renewable Power Generation Conference (RPG Dublin Online 2021), 2021, pp. 318-323, doi: 10.1049/icp.2021.1381.

[6] Bell, K.R.W. and Xu, Lie and Houghton, T. (2015) Considerations in design of an offshore network. CIGRE Science and Engineering, 1. pp. 79-92. ISSN 1286-1146

From a transmission network developer's point of view, exactly where and when generation capacity will be built and where and when existing generation will be retired are uncertain. Generation owners themselves face uncertainty in quite what decisions other generators will make and what impacts those decisions will have on the wholesale energy market. For as long as a major part of the business case for development of generation depends on centrally run auctions such as for low carbon contracts for difference or for capacity, generators face uncertainty in quite how Government will determine such auctions should be run, when and for how much capacity. Although there is a general expectation that demand for electricity will grow as a large proportion of the energy used for transport and for heating in buildings and industrial processes is electrified, there is also uncertainty about when that growth will begin and how quickly it will proceed. (Arguably the biggest influence on this demand growth is government policy, both at a UK level and within the devolved administrations, since that will – in the short to medium term, at least – determine the regulations and financial incentives that will be the biggest drivers of the demand side of the energy system transition).

One way of trying to make sense of the various uncertainties is to form scenarios describing possible futures.

Ofgem's consultation[7] makes a number of references to scenarios in section 4, e.g.

- "[Scenarios] should be based on both a top down GB wide approach to forecasting and a bottom-up approach which takes regional factors like approved local energy plans into account … assumptions are robust and/or aligned with government policy intentions."
- "move away from the current broad scenario-based approach used in the FES to a less mechanistic approach that makes assumptions, at least for the nearer term future, that are governed more by strategic thinking".
- "Data sources should be robust and drawn from a range of sources, including taking robust input from stakeholders".

At one level, there should be very little uncertainty – net zero and the Carbon Budgets are goals set in legislation[8] – although there is still quite a lot of uncertainty at the level of exactly how those targets will be met. For example, although there is also a Government goal of 40 GW of offshore wind by 2030, we don't yet know exactly where it will all be.

Leaving different network owners to develop their own scenarios and spatial detail will risk creating confusion about what exactly needs to be done in respect of, for example, transmission investment in the short to medium term. For example, it doesn't make sense for SHET to simply say that x GW of wind will be built in their patch by, say, 2030 without showing that that is consistent with what the market is likely to concurrently deliver elsewhere in GB. Meanwhile, NGET might assert that 10x GW will be developed in their patch and not offer a narrative for how much would be developed in Scotland under similar circumstances. That is, developments in different areas are not entirely independent of each other.

It seems reasonable to me to suggest that *someone* needs to develop **credible whole-of-GB and whole-of-the-energy-system narratives under different but self-consistent sets of assumptions**. I suppose this is what NGESO has been trying to do for the FES, but it has hitherto lacked the spatial

[7] Ofgem, Consultation on the initial findings of our Electricity Transmission Network Planning Review, 5 November 2021, https://www.ofgem.gov.uk/publications/consultation-initial-findings-our-electricity-transmission-network-planning-review

[8] Relevant legislation includes that passed by the Scottish Parliament.

detail[9]. As I discuss below in the section on Responsibilities, it's also unclear how they've formed the scenarios or used input from specific, key stakeholders. On the other hand, there's perhaps a limit to the spatial detail that NGESO might be able to present publicly in case it is interpreted as saying something about the commercial viability of certain generation developments.

A strong stakeholder engagement and scenario development process might be extended to the development of spatial detail that is held privately and shared among the transmission licensees and Ofgem. However, that information would need to be made public when planning applications are made and the need case is challenged.

4 Clustering

Ofgem has proposed that transmission owners "should strongly consider clustering two or more large interrelated projects for regulatory submission and planning consents purposes where it is appropriate to do so"[10].

It seems extraordinary that interactions between projects are not already being considered in the processes that currently inform transmission network planning. However, if they're not, they certainly should be, not least because it's so important in ensuring that the right overall mix of projects is taken to next stages of development and that planning and delivery risks are appropriately managed.

Broadly speaking, it seems to me that there are three types of interactions between projects, which I tentatively suggest might be summarised as follows:

1. *Mutually dependent*: A significant part of the power transfer enabled by Project A depends on Project B being built.
2. *Commonly facilitated*: Project A and Project B both require similar developments, e.g. a new substation in a particular zone or wayleaves in a particular route corridor.
3. *Mutually exclusive*: If Project A is built, Project B is not needed. That is, the two projects represent alternative means of meeting a similar need such as for a particular level of increase in power transfer capability between two specific zones.

It makes obvious sense for projects of Type 1 to be 'clustered', i.e. assessed together or as part of a package.

Types 2 and 3 both represent opportunities for rationalisation, of design, cost and planning applications. This might lead to Projects A and B being replaced by Project C that represents a more efficient means of meeting a combined set of needs. Care is required in respect of both types of interaction, however: current expectations of power transfer capability between two particular zones might suggest that development of both Project A and Project B is unnecessary. However, such a judgment is likely to have been made for a limited time horizon. What might happen after that? And how confident are you about the current judgment anyway? The prudent thing to do might be to develop a project that leaves open the option of being extended or adapted to changed circumstances. For example, an overhead line might be built to a 400 kV design even if, in the short-

[9] This has led the Scottish Government to commission a separate set of scenarios that provide better detail for what might happen in Scotland. https://www.gov.scot/publications/scotlands-energy-strategy-position-statement/pages/4/

[10] Ofgem, Consultation on the initial findings of our Electricity Transmission Network Planning Review, 5 November 2021, https://www.ofgem.gov.uk/publications/consultation-initial-findings-our-electricity-transmission-network-planning-review

term, it is operated only at 275 kV, or planning permission is sought for a substation with space for 8 or 10 bays even if only 6 are used in the short-term.

It seems to me that one key to rational planning of the transmission network will be to identify interdependencies of all three types among all potential investments.

5 Responsibilities and competence

I suggested earlier that, although it introduces competitive pressures and arguably provides incentives for innovation, fragmentation of the industry makes decision making more challenging. The introduction of competition in generation in 1990 and in 'supply' later on inevitably caused fragmentation. However, further fragmentation has been introduced by the UK Government and Ofgem through separation of the Electricity System Operator (ESO) from National Grid's transmission owner (TO) business and the introduction of offshore transmission owners (OFTOs). Additional fragmentation seems likely through the opening up of the possibility of non-incumbent transmission owners developing and maintaining onshore transmission assets for 'large onshore transmission investments'[11].

Although it is not the only important party, the ESO already seems to have a key coordinating role in strategic development of the transmission network. It is currently part of a privately-owned business – National Grid – that also has a regulated TO business and an interconnector business.

Since regulatory separation of National Grid's ESO and TO businesses into NGESO and NGET in April 2019, I am aware of questions being raised by all three incumbent GB onshore TOs about NGESO's understanding of issues that affect practical development of the transmission network's physical infrastructure, e.g. around route planning, planning consents, costs, contracting, and development timescales. I understand that there have also been disagreements between the TOs and NGESO about the execution of power system analyses.

The system operator part of National Grid would appear to have a track record of reducing its capacity to carry out all the duties of a system operator expected of it by the regulator. For example, Ofgem has pointed towards a lack of testing of compliance of generators with the Grid Code, passivity with respect to the potential impacts of distributed generation on system security, and insufficient robustness in monitoring and validating the performance of individual ancillary service providers[12]. Given the pressure on National Grid's management to deliver a return to shareholders and the lack of scope for a regulated company to expand its business by gaining new customers or offering new products or services, it is inevitable that it will seek to reduce costs. For a business whose main assets are its people, that means reducing the number of people and the average salary. Does that also mean encouraging the early retirement of more experienced, more knowledgeable, more expensive individuals, leaving significant responsibilities in the hands of people who are learning 'on the job' and lack anyone to mentor them?

BEIS and Ofgem have proposed that NGESO should be taken out of private for-profit ownership and made into some new form of 'Future System Operator' (FSO). It appears that the primary motivation for this is not reduction of conflicts of interest between NGESO and NGET but reduction of the *perception* by other parties of conflicts of interest[13]. However, BEIS and Ofgem have also suggested

[11] Dept. for Business Energy and Industrial Strategy, Competition in Onshore Electricity Networks, August 2021
[12] Ofgem, Investigation into 9 August 2019 power outage, 3 January 2020, https://www.ofgem.gov.uk/publications/investigation-9-august-2019-power-outage
[13] https://www.gov.uk/government/consultations/proposals-for-a-future-system-operator-role

that the FSO might take on additional responsibilities relative to what NGESO does now, such as for coordinated planning of both the gas and electricity systems.

In order that it can "develop a rounded and fully formed whole electricity system GB-wide view of system requirements, risks from uncertainties and mitigating solutions, without being constrained by network ownership boundaries", Ofgem is suggesting a need for a centralised transmission investment planning process and "a single, independent, expert body – a 'central network planner'" with, once it is established, "the FSO taking on the central network planner role as a core part of its overall role."[14]

Ofgem also considers "that the FSO will still need strong support from the incumbent TOs and third parties to develop feasible and deliverable options". Further, "There may be value in closer stakeholder co-working to break uncertainty deadlocks, e.g. through providing greater transparency in the mutual impacts between [electricity transmission] network investments and the siting, sizing and timing of developing supply or demand".

NGESO does undertake significant stakeholder engagement in the formation of its Future Energy Scenarios (FES)[15]. However, it is unclear (to me, anyway) how different stakeholders' views are taken into account in forming the scenarios. Presumably, some stakeholders' views are actively sought and weighted quite heavily. I expect that that would especially be the case were regional or local detail being used, e.g. drawing on information from devolved administrations and local government, in particular where local energy plans have been developed. The Climate Change Committee (CCC) and the Energy System Catapult (ESC) would also appear to be particularly significant as they have put a lot of effort into developing their own scenarios, albeit using different methods and, in the case of the CCC, covering the whole economy, not just energy[16].

Ofgem observes that the planning process "should be subject to some form of an open and ongoing consultation with potential delivery bodies … so as to mitigate against undeliverable options being proposed or recommended". The TOs and distribution network operators (DNOs) would appear to have key roles both in scenario formation and in the development of network asset and 'flexibility' options but will they have sufficiently strong incentives and resources to engage fully and competently? Will NGESO or the FSO recognise their key roles? What level of competence (and innovation and cost reduction) will be expected from any new 'competitively allocated transmission owner' at different stages of a network development such as outline design, detailed design, costing, seeking of planning permission, tendering, construction, commissioning and maintenance, and how

[14] Ofgem, Consultation on the initial findings of our Electricity Transmission Network Planning Review, 5 November 2021, https://www.ofgem.gov.uk/publications/consultation-initial-findings-our-electricity-transmission-network-planning-review

[15] https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021

[16] My understanding is that the ESC has leaned heavily on a single, whole energy system model, ESME, whereas the CCC analysed each sector in detail, ensuring consistency and coherence between sectors via a single, common, 'societal value of carbon' along with expert judgement. The various individual sectoral analyses made use of detailed modelling plus expert judgement, often via sector-specific 'roundtables' of sector experts. However, the degree of spatial detail varied between sectors. To my knowledge, NGESO has started to use a whole energy system model, UK TIMES, and uses its own judgement. A comparison of NGESO's, the ESC's, and CCC's and the Centre for Alternative Technology's scenarios for reaching net zero greenhouse gas emissions in the UK by 2050 is presented in a recently published paper: James Dixon, Keith Bell, Susan Brush, "Which way to net zero? A comparative analysis of seven UK 2050 decarbonisation pathways", Renewable and Sustainable Energy Transition, Volume 2, 2022, 100016, ISSN 2667-095X, https://doi.org/10.1016/j.rset.2021.100016

long will it take for Government and Ofgem to design the new competitive process and then implement it each time it is judged to be required?

In my experience, there are many conscientious individuals across the electricity industry who have a high public service motivation, particularly among the network licensees with which I have worked, including NGESO. However, where the knowledge and experience necessary for a particular party's role is not yet held by that party, it will take time to be acquired[17].

There has always been a challenge for regulation in trying to ensure that transmission licensees' obligations are met efficiently with a judgment needed on the balance between consumers' interests in lower bills and their interests in electricity sector actors' licence obligations being met fully. A decision on the resources to be made available to the FSO and on its priorities will still need to be made somewhere by someone, and there still needs to be confidence that the FSO's duties are being discharged competently. In other words, although governance arrangements might have changed, potentially difficult judgments will be unavoidable.

6 Decision making

The sorts of processes (and abbreviation soup) outlined by Ofgem are intended to lead to 'good' decisions on what transmission network assets to build.

Actually, different kinds of decision are required at different stages of a process, not just one for each proposed new asset of "build" or "don't build". For example, whether to go ahead and outline different possible line routes, develop estimates of the costs of civil engineering works, commission initial environmental assessments, or to do detailed substation layouts and outage requirements, or develop functional specifications prior to going out to tender for electrical equipment.

At any stage, an option might be retained, developed further, or put to one side. The cost of retaining or developing an option one stage further would generally be small relative to the cost of developing it fully and commissioning it, or that of causing delay to utilisation of low carbon energy or reduction of constraint costs.

Ofgem notes that "the economic assessment should include a cost benefit assessment methodology that strikes an appropriate balance between cost and environmental and community impact. This should reduce the chances of material changes to option design or delivery timing at later stages due to adverse stakeholder engagement and/or major issues with planning consents."[18] In this, Ofgem is absolutely right and the position they are taking represents a welcome change from what previously came across as a focus solely on minimum financial cost.

In what currently seems to pass for a strategic transmission network planning process – the Network Options Assessment[19] – there has so far appeared to be little attention paid to the risk that

[17] There has always been a degree of 'churn' within the sector with individuals moving between companies. However, there remains a general challenge in increasing the overall pool of people with different sets of competencies, in particular skilled Technicians, Chartered Engineers and individuals with advanced engineering knowledge. Although the networks sector in general has supported initiatives such as the Power Academy (founded in 2004), individual companies have a very mixed record of support, and generally weak support for the two Centres for Doctoral Training – one run by University of Strathclyde and Imperial College and the other by University of Manchester – that had most relevance for the sector.

[18] Ofgem, Consultation on the initial findings of our Electricity Transmission Network Planning Review, 5 November 2021, https://www.ofgem.gov.uk/publications/consultation-initial-findings-our-electricity-transmission-network-planning-review

[19] https://www.nationalgrideso.com/research-publications/network-options-assessment-noa

transmission network development will be delayed by the slow granting of planning consents. Any application for planning permission needs to be built on a credible need case if there is going to be any chance of obtaining planning permission and getting something built in time. The transmission licensees collectively need to ensure that that is done.

Any mechanistic process seeking a perfectly optimal network development plan risks arbitrary judgements on data that obscure key dependencies and sensitivities. Complex optimisation models are prone to 'penny switching' – changing the nature of the result significantly when the data change only slightly. They also make results very difficult to explain. Models should be an aid to decision making and judgement not a substitute for it[20]. They depend on expert users. However, perhaps if a need case to a planning enquiry says "my model says so", that need case might be harder to challenge, provided the model has been built on sound principles, been implemented well and uses good data.

A particular challenge to all the network licensees but particularly NGESO or, in future, the FSO is the need for the rationale behind a network development plan to be clearly explained and well defended, both to Ofgem (which, in the end, approves the funding) and a planning authority.

Ofgem has a vision for "potential new [electricity transmission] network planning arrangements … that would take a GB-wide holistic view to develop an optimised plan for taking forward low regret anticipatory [strategic investments]."

"Low regret" is mentioned 11 times in Ofgem's consultation document. A few observations are probably worth making in connection to "low regret".

1. The ambition is for "low" not "zero" regret. This is, in my view, quite correct in light of the existence of uncertainty and of the potential for adverse consequences – "downside risks" – to arise from each type of decision: "build", "do not build" and "wait and see". (The perfect can be the enemy of the good).
2. The various potential regrets and assessment criteria include those of stranded assets, delays in network reinforcement leading to higher constraint costs in system operation, delays in network reinforcement leading to failure to meet the carbon budgets, or high impacts on natural capital.
3. The extent of apparent regret depends not just on the dimensions of assessment – capital cost, constraint cost, greenhouse gas emissions, impact on natural capital, etc. – but also on the scenarios. A weakness of a min-max regret approach to decision making is that it is very sensitive to the most extreme scenario, even when it is judged to have a very low probability of happening. Although it is very difficult to be confident about the probability of any one scenario turning out (apart from being pretty sure that the future will be not be precisely the same as any scenario that you might think of), an approach such as assessing the conditional value at risk ought to be less sensitive to a single outlier but still broadly concerned with minimising the extent to which a decision might turn out to be wrong.

Ofgem has suggested that a centralised transmission network planning process "could send clear earlier signals to users of the system (e.g. offshore wind, hydrogen electrolysis plant etc.) about where and when key parts of the [electricity transmission] network will be built, their high level design, and potential impact on network charges. This could help inform their decisions on siting,

[20] Hawker, G. S., & Bell, K. R. W. (2020). Making energy system models useful: good practice in the modelling of multiple vectors. WIREs: Energy and Environment, 9(1), [e363]. https://doi.org/10.1002/wene.363

capacity etc. and could enable efficient and timely investment by those users."[21] That raises the tantalising possibility of 'anticipatory' network investment and of a shift away from transmission development solely following network users' choices that have already been expressed through connection applications towards network investment leading and guiding users' choices. Given the very long development timescales of major transmission projects – the "Second Yorkshire Line" and the rebuilding of the Beauly-Denny line to 400 kV both took many years from proposal to realisation – this seems sensible.

7 The need for 'system thinking'

Things are different now. Incremental electricity transmission network development is not enough; a massive transition is under way. Risk of stranded assets is very far from being the only consideration and should certainly not be the over-riding one.

The need for 'system thinking' or a 'whole system approach' has become a common trope in recent years, though what it means in practice has not always been well defined. As I have heard Eric Brown say when he was with the Energy System Catapult, "yes, I agree with the need for 'system thinking', but what do I do about it on Monday morning?"

In order to get things done in a timely way, decisions need to be made. That requires clear delineation of responsibilities and authority and trust. In a webinar on "A Systems Approach to the Energy Transition for Net Zero" organised by the Energy System Catapult and INCOSE on November 12th 2021, I set out my thoughts on the keys to 'system thinking' in the context of the energy system transition:

1. Recognising the links:
    a. between technical, economic and social influences;
    b. between different energy vectors.
2. Being clear about boundaries and responsibilities, and what factors or influences cross them.
    a. Note that not everything is measured in the same way or is directly comparable, e.g. what matters in an environmental assessment may be difficult to quantify relative to the cost of energy or the need to reduce greenhouse gas emissions.
3. Engaging people who know the detail while retaining the bigger picture.
    a. Iteration will be necessary between different scales (time and space) and different spheres of authority.
4. Being prepared to cede authority to those responsible for the bigger picture.

Of those 4 keys, perhaps the most difficult is the last one, particularly when different parties share some responsibility and might not fully trust each other. Although authority will finally need to be ceded to whoever is responsible for the bigger picture, it will be incumbent on all parties to take steps to build up trust.

8 How might uncertainty be reduced?

A trained economist might legitimately challenge this view but limited access to information and, hence, uncertainty seem to me to be inevitable consequences of the introduction of competition. At the same time, competition suggests active participation of multiple parties for which competitive

[21] Ofgem, Consultation on the initial findings of our Electricity Transmission Network Planning Review, 5 November 2021, https://www.ofgem.gov.uk/publications/consultation-initial-findings-our-electricity-transmission-network-planning-review

advantage depends on information and how it is used, and on not giving away 'trade secrets' to competitors. The uncertainties around operation of a market will be argued by advocates of competition as a price worth paying for the encouragement of innovation and cost reduction. In practice, information can be gained from competitors and a whole sector can learn from the innovations of market leaders.

Government has often stated a desire to keep out of the way of the energy market and let participants just get on with it, make keen judgments on what their customers want and innovate to gain competitive advantage, driving learning for the sector as a whole. Uncertainty is always present in markets, and successful market actors are usually those that are best able to manage those uncertainties.

In reality, energy policy never been as simple as that. In particular, for as long as electricity from fossil fuels has a lower long-run cost than that from low carbon sources, the energy market cannot be left to itself to play its part in meeting carbon budgets. Government has therefore intervened to drive the market in a certain direction, and continues to intervene even though the long-run levelised cost of energy from wind and solar now appears to be much lower than that from gas powered generation. This continued intervention has been argued to be justified by the high capital outlay that needs to be financed and the uncertainty around generation developers' future revenues from wholesale markets. Until there can be confidence that energy users will be able to put a financial value on 'security of supply' – something that supply interruption events and the ensuing public disquiet suggest they cannot – intervention may also be necessary in order to provide energy users with some level of protection around the continuous availability of power, e.g. through continuation of the capacity market or something like it, supported by network design standards.

If Government continues to intervene, it would appear to have the option of intervening in such a way that reduces the uncertainty faced by market actors and regulated networks businesses with the benefit – for generation developers – of reducing cost of capital and – for regulated networks businesses – of reducing the risk of stranded assets and of barriers to utilisation of low carbon generation. For example, a CfD auction might be conducted zone-by-zone for pre-determined amounts of capacity[22], thus providing network developers with greater confidence on the location of new offshore wind generation (and enhancing the spatial diversity of sources of power, e.g. spread across the Irish Sea, the English Channel and the northern and southern North Sea, thus aiding system operation).

How does Government want to proceed: to keep out of the way, maximising the scope for innovation and sharpening competitive pressures such as through introduction of new locational pricing arrangements in wholesale markets (which will introduce new uncertainties)[23] or new processes to introduce competition at an earlier stage of network development; or to provide

[22] If it's ok for Government to set a target for the total capacity of offshore wind generation such as 40 GW by 2030, why might it not be ok for that target to be spatially disaggregated?

[23] I noted earlier that Ofgem believes that centralised transmission network planning process "could send clear earlier signals to users of the system (e.g. offshore wind, hydrogen electrolysis plant etc.) about where and when key parts of the [electricity transmission] network will be built, their high level design, and potential impact on network charges". If the locational signals in Transmission Network Use of System charging are replaced by those from locational wholesale energy pricing, will a centralised network planning process be expected to provide published forecasts of locational prices? If actors in competitive markets are believed to be best placed to manage the uncertainties present in those markets and the most successful actors are those that do it best, what value would any of those actors place on forecasts of market prices coming from a central network planner?

greater certainty, to the electricity industry and consumers, and to society as a whole that carbon budgets will be met (with the possibility that, while carbon budgets might be met, they might be met at higher overall cost)?

9 About the author

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Between 1998 and 2005 he was a transmission network investment planner with National Grid. Since joining Strathclyde in 2005 he has collaborated on a number of projects with the various transmission licensees, some of them concerned with methods and tools to inform transmission network planning. At UKERC, leads the research theme on Energy Infrastructure Transitions.

He has written this in a personal capacity.