A REVIEW OF BRINGING ENERGY HOME

An independent assessment for the ENA

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EXECUTIVE SUMMARY

Introduction and scope of work

Frontier Economics has been commissioned by the Energy Networks Association (ENA) to provide our independent views on aspects of a recently issued policy paper, Bringing Energy Home (BEH).[1]

We were asked to comment specifically on:

- whether we considered that the policies outlined in BEH would be likely to achieve their stated objectives efficiently or otherwise;
- if not, then why not; and
- whether the balance of evidence suggested that the existing arrangements were likely to be better able to achieve BEH's objectives.

This report provides our answers to those questions. The views expressed in this paper are our own. Frontier works extensively on energy topics for policy makers, regulators and companies (in both the private and public sectors) across numerous geographies.

What is BEH trying to achieve?

The core policy proposal contained in BEH is to renationalise all of the existing energy networks, i.e. to compel their existing owners to sell their assets to the state at a price to be determined by Parliament.[2] A number of motivations are provided for this:[3]

- deliver better value for the public;
- accelerate and coordinate the investments needed to roll out renewable and low carbon energy;
- provide democratic control over nationally strategic infrastructure; and
- ensure decentralisation occurs equitably.

These objectives of better value for money, decarbonisation, democratic control and equitable de-centralisation are objectives already (either explicitly or implicitly) embedded into the current system of ownership and control of the networks.[4] Networks companies, under the existing model, are already actively pursuing their delivery.

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1 "Bringing Energy Home, Labour's proposals for publicly owned energy networks", Labour 2019 https://www.labour.org.uk/wp-content/uploads/2019/03/Bringing-Energy-Home-2019.pdf

2 We have not been asked to comment in this report on the question of the appropriate acquisition price.

3 See BEH Section 2.

4 See for example: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/675133/beis-energy-policy-2018.pdf

Our approach

If the objectives of BEH are then, by and large, a matter of consensus agreement, then the key question that is posed is **how best to achieve these agreed aims**.

We have adopted a structured and evidence based approach to addressing this question.

- We have identified the generic features of institutional and ownership arrangements for monopoly networks that are likely to lead to better outcomes.
- We have explored the extent to which these features are present or lacking in the existing arrangements and reviewed what the evidence tells us about the performance of this existing system.
- Since returning energy networks to state ownership is a key element of BEH's package of proposals, we have repeated this analysis for the pre-privatisation period, when UK energy networks were state owned, drawing on findings from authoritative studies published at the time.
- Lastly, we have explored BEH's wider set of proposals, identifying a range of potential effects that would arise from their implementation. We then provide a qualitative appraisal of whether these would be likely to help or hinder efforts towards net zero.

While at each stage we have tried to be as clear as possible around our approach, the evidence we have relied on, and why we have drawn our conclusions, we note that our review is necessarily **qualitative**. BEH provides a high level overview of how energy networks would be reorganised, but (entirely reasonably) it does not provide exhaustive detail. A full CBA of BEH is, in our view, not possible at this stage and we have not attempted to produce one. Instead we have tried to develop a clear methodology for exploring what the evidence tells us about the balance of risks between the existing arrangements and BEH.

Key findings

The aims and objectives of BEH are sound, and all are already central planks of existing energy policy. The key question is whether the BEH policies will better achieve these outcomes, compared to the existing model.

We have developed an evidence based approach to appraising the set of policy proposals contained in BEH. This has drawn on the historical performance of utility infrastructure in the UK under different ownership and governance models, together with academic and other evidence on what circumstances are likely to drive better outcomes for consumers.

Based on our review, the conclusion is clear. There is nothing in the BEH proposals that suggests we should have confidence that they will meet the enormous challenge of achieving net zero on time and at reasonable cost.

Given what we have learned from the history of how utility businesses have been owned and regulated in the UK, these proposals carry with them a very significant risk of being less effective – more costly and greater risk of delay – than the current

system. The model that is proposed is entirely unproven, and the issues with it fundamental.

We have the following specific concerns that:

- major change will bring delay, disruption and uncertainty;
- innovation may be disrupted;
- networks may face uncertain access to funding;
- geographic fragmentation of the sector will lead to inefficiency;
- a postcode lottery may develop around costs and reliability; and
- confused roles will create conflicts of interest and weak checks and balances.

In contrast, the existing system has delivered material benefits for consumers and wider stakeholders over almost three decades.

If an incoming Labour Government did wish to bring about a material acceleration in the speed with which the UK moves towards net zero, then we would argue that the existing system provides a strong foundation from which to make incremental changes. There should be no return to the ingredients of what has in the past proven to be a failed system. Below we provide further detail on how we have arrived at this conclusion.

As the UK heads towards its net zero target, there will no doubt be a need for the current arrangements to adapt further. There are four obvious areas that will require particular focus:

- **More dynamic system management ("DSO")**: the demands placed on networks in general, and electricity distribution systems in particular, are changing. Sources of electricity (and to an extent gas) are becoming smaller and more dispersed, electricity storage is now available at reasonable cost and scale, while customers are becoming more flexible and responsive. So-called smart grid technology, alongside smart metering, may also provide a way to ensure the needs of connected customers are met at a lower cost than simply using conventional reinforcement. Going forward, the system operator role will become more important to ensure that all these technologies work together to reduce overall system cost.
- **Digitalisation**: the huge and ever increasing volume of data that is produced by the energy system, including the networks, must be used to maximise efficiency and to effect the transition to net zero at least cost.
- **Whole systems thinking**: more needs to be done to ensure coherent planning across all energy vectors, by establishing clear principles, removing barriers to cooperation and ensuring incentives are aligned.
- **Legitimacy**: whatever the merits of the present debate about network returns and the effectiveness of regulation, progress must be made to restore legitimacy. Customers must be confident that higher returns are only available when they've been earned, and that they benefit fairly from this in both the short and long run. This is the only route through which policy uncertainty can be addressed, to benefit of customers and investors alike.

That significant work is already underway in all of these areas is a demonstration of the flexibility of the present arrangements and helps to illustrate why the prevailing arrangements have been successful.

The current arrangements

In order to assess the merits of a proposed change, we need to begin with an understanding of where we are today.

The existing model has **privately owned networks** delivering the **policy objectives set by Ministers** scrutinized by Parliament under **independent economic regulation** determined at arm's length from politicians by Ofgem. Further **checks and balances** are provided by the Competition and Markets Authority, which acts as independent appeal body for regulatory licence modification appeals. The entire system is underpinned by primary legislation that places '***the interests of existing and future customers***' at the heart of all decision making.[5]

Key properties of the existing system

The existing system creates a governance and delivery model with important strengths.

- **Flexibility**: the existing arrangements are sufficiently flexible that they can adapt easily to new policy challenges and objectives. The primary legislation has been changed multiple times. Ofgem develops its approach to regulation at every price control review. No aspect of existing policy is fixed.
- **Accountability, checks and balances, no conflict of interest**: the clear separation of roles – policy maker, regulator, operator, owner, arbiter – creates a high degree of clarity and transparency. Accountability is clearly defined and there is a requirement to report frequently on performance. There is little scope for information to be hidden. No entity within the system sets its own targets.
- **Powerful incentives**: the main purpose of economic regulation is to design incentive arrangements in a way that rewards the regulated entity for achieving desired policy outcomes, e.g. better reliability, lower cost, more responsive service, efficient integration of low carbon technologies. When this regulatory design principle is combined with the profit incentives that arise from private ownership then powerful incentives can be provided for better performance, and this better performance can be embedded in future price controls.

There may presently be controversy around the outcomes delivered by recent regulatory price control rounds. For example, recent papers published by Citizens Advice and others have suggested that there have been errors in past regulatory determinations. Whatever the merits of these papers, the existing approach to regulation is already digesting all aspects of this debate and contemplating what action is needed, as it has in the past when issues have arisen. When it became clear that differential incentives to reduce operating expenditures versus capital expenditures were distorting behaviour, those incentives were equalised and the

[5] See for example the Electricity Act 1989, Section 3A. Also the Gas Act 1986, Section 4AA.

concern was addressed. When the concern arose that incentives to reduce cost may lead companies to reduce reliability, a specific incentive to deliver reliability was introduced. When there was a desire for companies to focus on a better direct customer experience specific incentives were introduced and that concern was addressed too. These experiences, along with the way the present controversy is being appraised and acted on as necessary, demonstrate that all the evidence needed to assess price control effectiveness and Ofgem acts on that evidence. The existing system has proven that it can adapt as challenges emerge.

Performance record

The existing arrangements have been in place since 1990, providing almost three decades of data on performance, and how that performance compares to the arrangements that prevailed pre-privatisation. In a nutshell, costs have fallen enormously, while reliability has improved.

- **Cost**: The costs of GB's energy networks have fallen substantially since privatisation: GB consumers benefited from substantial efficiency gains in the 1990 to 2010 period, with network costs down by 50%.[6]
- **Reliability:** Electricity networks have grown steadily more reliable, and gas networks have remained extremely robust: There was a 30% reduction in the number and duration of power cuts between 1990 and 2008. Performance has continued to improve under RIIO with customer interruptions and customer minutes lost decreasing by 9% and 12% respectively between 2014/15 and 2015/16. The average gas customer will experience an unplanned interruption once every 140 years.[7]
- **Investment:** On aggregate consumers have paid over £80bn in investment on networks since privatisation, with a further £40bn needed over the RIIO 1 price control. This 50% real terms increase in investment since 1990.[8]

The cost reductions and reliability improvements have been achieved despite facing the initial challenges of decarbonisation. To illustrate, the networks have so far connected 45 GW of renewable capacity, a figure that is growing rapidly.[9]

It is also worth noting the improvement in performance that occurred in the period immediately following privatisation. Appraisals made approximately a decade into the privatisation experiment found year on year reductions in cost that averaged between 6.5% and 9.0%, signalling the very rapid removal of slack that had accumulated over the years prior to privatisation.[10]

Consequences for our appraisal of BEH

Three decades of strong performance, in particular in respect of rapid productivity improvement coupled with improved reliability, is inconsistent with the picture of

6 "GB Energy Networks: an analysis of delivery since 1990", KPMG, September 2017.

7 Ibid.

8 Ibid.

9 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/811974/Renewables_June_2019.pdf

10 See Section 4 of this report.

failure that is painted by BEH. While the track record of the network companies (and indeed Ofgem) is not flawless over that period, and there have been many lessons learned along the way, the fundamentals show us that there is a lot to lose by changing the current model. In our view BEH would only be worthy of adoption if there was strong reason to believe that it would be even better at meeting its stated objectives. Otherwise the inevitable cost and delay of major reform, and the associated risks of delivery failure, should lead us to adopt a cautionary stance that favours the status quo, given its proven effectiveness.

Past UK experience with nationalised networks

Contemporaneous reports into the performance of the then nationalised industries are all highly critical, in respect of efficiency, productivity, pricing policies, investment performance and the delivery of wider social objectives. There are three primary sources.

- Pryke[11] described performance as '*third rate, though with some evidence here and there of first class standards*'.
- The National Economic Development Office (NEDO) [12] concluded that '*it is doubtful whether ... [the criteria for control of nationalised industries] ... have made a material contribution to improving the allocation and effective use of resources*'.
- Molyneux and Thompson[13] concluded that '*continued reform of the regulatory framework is required if the inefficiencies identified in our study … are to be eliminated*.

The build-up of inefficiency reported by studies conducted at the time are mirrored in the record of rapid improvement that has been seen in the decade following privatisation (as already noted above) and beyond. Elimination of slack on this scale implies a high level of inefficiency within the network organisations before they were privatised.

This poor performance was driven by a weak institutional framework and a weak regulatory framework. Vague legislation did not constitute a set of clear over-arching objectives; and the guidance provided by the White Papers was not followed through, not least by the government itself who often used the corporations as instruments of macro-economic policy. Consequently, the basis for a clear accountability framework was missing, which created a vacuum within which responsibility was absent, and inefficient, rent-seeking behaviour could flourish within a self-regulated monopoly. This potent mix was supported by the absence of transparency and scrutiny, facilitated by the state as the policy-maker, owner, manager and regulator of the corporations.

[11] Pryke, R. (1981), The Nationalised Industries: Policies and Performance since 1968, Oxford: Martin Robertson

[12] National Economic Development Office (1976), A Study of UK Nationalised Industries, London: HMSO.

[13] Molyneux, R. and D. Thompson, Nationalised Industry Performance: Still Third-Rate?, Fiscal Studies, Vol. 8, No. 1 (February 1987), pp. 48-82

Consequences for our appraisal of BEH

While the fundamental performance of the networks has been strong under the current model, it was demonstrably weak under the nationalised model that preceded it and this was known and reported on at the time. It is noted that the BEH reforms are intended to achieve a very different looking industry model to that which preceded the privatisation programmes. But having this intention does not guarantee that the effect would be as achieved. It would be necessary to design institutions and arrangements around them which would guard against these historical concerns and that, in our view, is easier said than done.

Based on the past performance of nationalised industries in the UK BEH's central policy of taking the networks back into public ownership creates clear risks in respect of the efficient delivery of net zero on time. The lessons of the past suggest that such a move would be likely to hamper delivery.

BEH's wider proposals

A much wider set of policy proposals would accompany ownership change. While the stated policy objectives of BEH may be far from radical, this wider set of changes are.

- A **National Energy Agency** (NEA) would be created, into which would be put certain policy making functions taken from BEIS, certain regulatory functions taken from Ofgem and the transmission grids (electricity and gas) presently owned by National Grid, Scottish Power and SSE.
- **Regional Energy Agencies** (REAs) would take over from the existing electricity and gas distribution networks. These REAs would also take on responsibility for decarbonising heat and electricity, fuel poverty and aspects of regional industrial strategy.
- Consumers would be encouraged to set up **Municipal Energy Agencies** (MEAs) and **Local Energy Communities** (LECs) that would devolve from the relevant REA. MEAs and LECs could own and operate the local grid serving, for example, a city, borough or parish, or even down to an individual housing estate.

Having reviewed these new entities and structures, in our view a range of additional concerns arise.

- **Delay, disruption and uncertainty:** The BEH proposals include a total change in ownership across the entire sector and a wholesale revision of roles, responsibilities and accountabilities, which would create a new set of operational relationships between relevant parties. It would take time to create and establish these new arrangements in the first instance, and potentially much longer for them to become fully effective. It may also take time for the private sector to understand its revised role in decarbonisation.
  - It is tempting to believe that some delay will be of little consequence, as 2050 is still far away. But the latest research on achieving net zero, for example from the CCC and UKERC warns us not to fall into this trap. Even

seemingly modest delays can make achieving net zero far more challenging, increase, costs and delay the achievement of benefits.

- **Disruption to innovation:** we consider BEH would slow innovation and make it less effective, further weakening efficiency and hampering progress towards decarbonisation. Public ownership may reduce the extent to which long and uncertain payback periods hamper innovation, a wide range of other aspects of BEH would lead to slower innovation, including the fragmentation of the labour pool, lost scale, weak access to finance, loss of locational clusters, weakened international links and a lack of commercial focus.
- **Uncertain access to funding:** with the energy networks under public ownership the energy transition will be competing with other core central government departments for scarce funds and may be crowded out in spending rounds. The BEH proposals introduce the risk of a funding constraint emerging, whereas under the existing model (as long as returns to investors are fair) there is essentially no limit to the quantum of funds available.
- **Geographic fragmentation and lost scale economies:** encouraging the creation of MEAs and LECs would fragment the operation of the energy networks, a sector that is characterised by strong economies of scale.
  - To give a feel for what impact on cost the proposed creation of MEAs and LECs might have we have examined the example set out on page 9 of BEH, which shows Yorkshire operating as an REA and Leeds operating as an MEA. Based on academic evidence on scale economies, overall estimated cost increases may be between 7% and 18%.
- **A postcode lottery for costs and reliability:** cost reflective charging would underpin the new BEH framework. As MEA and LECs devolve from the REA, the current model of socialised and shared cost would be disrupted, creating the potential for a postcode lottery in respect of charges and reliability.
- **Confused roles, conflicts of interest and weak checks and balances:** Having a single body (the NEA) that makes policy for itself, self-regulates and also regulates others, in addition to being directly responsible for delivery, is far from best practice and contrasts directly with the highly effective separation of accountability that characterises the current arrangements.
  - There are obvious incentive problems and conflicts of interest.
  - There would be no checks and balances in the system.
  - Rather than enhancing democratic accountability, this aspect of the proposals seems certain to harm it.
  - Our review of past experience of nationalised industries reveals evidence of all of these concerns.

1 INTRODUCTION

Frontier Economics has been commissioned by the Energy Networks Association (ENA) to provide our independent views on aspects of a recently issued policy paper, Bringing Energy Home (BEH).[14]

We were asked to comment specifically on:

- whether we considered that the policies outlined in BEH would be likely to achieve their stated objectives efficiently or otherwise;
- if not, then why not; and
- whether the balance of evidence suggested that the existing arrangements were likely to be better able to achieve BEH's objectives.

This report provides our answers to those questions. The views expressed in this paper are our own.

We have adopted a structured and evidence based approach to addressing these question.

- We have identified the generic features of institutional and ownership arrangements for monopoly networks that in our view are likely to lead to better outcomes.
- We have explored the extent to which we find these features present or lacking in the existing arrangements and reviewed what the evidence tells us about the performance of this existing system.
- Since returning energy networks to state ownership is a key element of BEH's package of proposals, we have repeated this process for the pre-privatisation period, when energy networks were state owned, drawing on the findings from authoritative studies published at the time.
- Lastly, we have explored BEH's wider set of proposals, identifying a range of potential effects that would arise from their implementation. We then provide a qualitative appraisal of whether these would be likely to help or hinder efforts towards net zero.

While at each stage we have tried to be as clear as possible around our approach, the evidence we have relied on, and why we have drawn the conclusions that we do, we note that a number of aspects of our review is necessarily **qualitative**. BEH provides a high level overview of how energy networks would be reorganised, but (entirely reasonably) it does not provide exhaustive detail. A full CBA is, in our view, not possible at this stage and we have not attempted to produce one. Instead we have tried to develop a clear methodology for exploring what the evidence tells us about the balance of risks between the existing arrangements and BEH.

The remainder of this report is structured as followed:

- In **Section 2** we provide an overview of the **decarbonisation challenge** that the energy sector as a whole, including the energy networks, must rise to. We

[14] "Bringing Energy Home, Labour's proposals for publicly owned energy networks", Labour 2019 https://www.labour.org.uk/wp-content/uploads/2019/03/Bringing-Energy-Home-2019.pdf

provide our assessment of the properties that an effective set of institutional arrangements should have to ensure this challenge is met as efficiently as possible.

- In **Section 3** we provide an **overview of the prevailing arrangements** that have been in place since privation, assess their properties and comment on the strong track of performance that these arrangements have stimulated.
- In **Section 4** we review the h**istorical performance and past experience with nationalised industries in the UK**. We present evidence from contemporaneous assessments that revealed generally weak performance, and explore the reasons why performance was weak.
- In **Section 5** we set out and **review the wider set of policy proposals contained within BEH**, and explain why these wider proposals would be likely to harm the efficient delivery of net zero.

Annexes provide an overview of how the legislation put in place at privatisation has changed over time, and provide further details of the track record of delivery of the privatised networks over almost three decades.

2 THE CHALLENGE TO BE MET

BEH sets out four objectives for its proposals:

- deliver better value for the public
- accelerate and coordinate the investments needed to roll out renewable and low carbon energy;
- provide democratic control over nationally strategic infrastructure; and
- ensure decentralisation occurs equitably.

These objectives of better value for money, decarbonisation, democratic control and equitable de-centralisation are already (explicitly or implicitly) embedded into the current system of ownership and control of the networks. And the networks companies, under the existing model, are already actively pursuing their delivery.

The challenge that BEH sets itself is that its proposals will be more effective will achieve these objectives. Central to the proposals is the transfer of network assets from private ownership to public ownership. But BEH also proposes a wide range of other important changes to how energy supply is organised in the UK.

The key question for consideration, and the primary focus of this paper, is whether the evidence suggests that the proposal sets out in BEH are likely to be better or worse at achieving desired policy outcomes than the existing arrangements. In essence, will the framework proposed by BEH lead to the more efficient delivery of net zero?

In the rest of this section we set out a flavour of the practical challenges that need to be met, irrespective of the policy framework.

2.1 What needs to be done?

2.1.1 Decarbonisation……

Greenhouse gas emissions as a result of human activity are causing climate change. The United Nations has described Climate Change as '*the defining issue of our time*' and around the globe policy makers are taking increasing steps to slow greenhouse gas emissions and move towards economies that generate no net emission at all. The short hand for this is net zero.

The UK has recently passed legislation committing to become net zero by 2050, the first major economy to make such a commitment. It also has a carbon budget, as advised by the CCC, that requires UK emissions in 2030 to be 57% below 1990 levels. In addition, the Scottish Government has set its own target to achieve net zero by 2045, along with a commitment to prohibit the sale of conventionally fuelled vehicles by 2032.

Labour has set out more ambitious targets to increase the deployment of low carbon technologies, so as to ensure that 60% of the UK's total energy supply comes from renewable sources by 2030.[15] This policy means "going faster" than prevailing UK policy. To provide context, the energy system wide renewables

[15] https://www.labour.org.uk/wp-content/uploads/2018/09/Achieving-6025-by-2030-final-version.pdf.

target for 2020 is just 15%, hence the Labour party proposes an approximate quadrupling of renewable energy use. Although it is not central to this report, there may be some debate around whether setting a target for renewable use is optimal. Many low carbon options would not qualify as renewable and hence may be crowded out under a renewables target, even though they may be cheap and could contribute significantly to a net zero target.

2.1.2 …. requires fundamental changes to the scale, operation and topology of the networks….

Achieving net zero, regardless of the speed of transition, will require a wide range of important changes to be made. In addition to changing how we generate electricity, changes will be needed in how we heat our homes and how we move people and goods. This will involve the widespread electrification of activities that presently consume fossil fuels (such as vehicles), and/or adopting another solution at scale, such as hydrogen or the widespread use of other carbon neutral alternative fuels.

There will be many changes for network users. But there will also be major adaptation needed by the networks to meet the new and different set of demands that will be placed on them.

For example, in respect of electricity networks:

- Demand will significantly increase, albeit by an uncertain amount, as at least some space and water heating and transport demand will be electrified;
- There will be the need to accommodate even more intermittent renewable energy, at small scale (behind the meter) and at utility scale, while maintaining continuous supplies;
- There will be a need to make more use of flexible resources to minimise the cost of expanding network capacity, including:
  - storage; and
  - flexible demand.

In respect of gas networks:

- There is profound uncertainty over the role that gas networks will play and what demands may be placed on them, but there is a consensus that gas networks will play a key role in transitioning the UK to a net zero economy and will be needed in some capacity in all future pathways;
- The gas network will therefore need to be maintained and invested in safely and efficiently, but only where this drives long term value for customers;
- They will need to be ready to accept a wider range of alternative sources of gas, injecting at new locations;
- This may include adapting the gas network to transport an entirely different commodity, e.g. hydrogen; and
- They will need to be ready to respond to new gas flows, as demand and import patterns may change markedly.

There will be more data available than ever before to support these changes, but this data will need to be harnessed to unlock benefits throughout the value chain.[16]

2.1.3 ….and needs to be delivered at least cost to customers

The costs associated with these major structural changes are also very large. The CCC has estimated that meeting net zero will require an annual investment of 1-2% of GDP.[17] With UK GDP presently at around £2 trillion per annum[18], the sums implied are significant and will need to be sustained over decades.

Networks will need to play their part as key facilitators of the transition, investing material sums in very long lived assets. And as set out in above, they will need to make these investments in the face of considerable uncertainty. The combination of significant uncertainty and the need to incur very large costs give rise to the following risks:

- An overly conservative approach to risk that results in failing to invest in network capacity that turns out to be needed, meaning net zero is not achieved on time.
- An overly exuberant approach to risk that results in investing in too much network capacity that turns out not to be needed, meaning that the cost of transition is higher than it needs to be.
- Backing the wrong long term solution, leading to building assets that turn out not to be needed.

The challenge of decarbonisation must be met. But the key question is how to meet that challenge as efficiently as possible, in order to ensure that customers' interests are protected and value for money is achieved. The history of nationalisation and privatisation tells us very clearly that achieving big outcomes at least cost under uncertainty is far easier said than done. That said, that history gives clear pointers as to what conditions need to be in place to meet this challenge.

2.2 What conditions will support efficient decarbonisation?

Given that the major investments that will be made will be made under conditions of significant uncertainty rather than perfect foresight, it is essential that the institutional and economic architecture supports high-quality decision-making, geared toward achieving decarbonisation at least-cost. This architecture would include the following key features:

- **Institutional:**
  - **Clarity over the over-arching objectives**, supported by effective guidance from government as to how those objectives should be achieved;

[16] https://es.catapult.org.uk/news/energy-data-taskforce-report/

[17] See for example slide 3 here. https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Chris-Stark-Presentation.pdf

[18] https://www.ons.gov.uk/economy/grossdomesticproductgdp

- A **clear accountability framework** that covers all the key organisations in the system, so that the high level objectives are clearly the responsibility of particular entities, for example:
  - The state that makes the policy
  - The regulator that converts the policy into a set of targets, rules, and incentives
  - The company that operates the networks subject to the rules set by the regulator
- Open information and consultation systems to enable all stakeholders to assess the performance of each of the key agents against their objectives to promote challenge and legitimacy

- **Economic:**
  - A **well understood system of payments and penalties** (incentives) for performance against the outcomes that each organisation within the system is required to deliver:
    - These incentives should be well-designed and well-calibrated to focus the management of the organisations on achieving the right balanced outcomes across the right range of relevant priorities.
    - The incentives should also be designed that they expose the right parties to risks that they can manage.
- **Technical:**
  - Optimisation of **scale economies** in the system, and avoidance of unnecessary fragmentation.
  - Enabling **effective coordination** among a large number of parties in order to ensure that energy needs can be met continuously over time. Achieving net zero efficiently is likely to require far more than this day-to-day operation, to ensure that the decarbonisation solutions adopted are efficient overall, not just cost minimising from some individual entity. Whole systems thinking and decision making will be key.

The history of the energy sector since 1948 provides some important insights into how these different ingredients have combined together to drive outcomes, which can provide lessons for the future. We first consider the arrangements that have prevailed since the electricity and gas industries were privatised and restructured over 30 years ago. Then, in Section 4 we review the experience of nationalisation between 1948 and privatisation, making use of the contemporary assessments and analysis. We then draw together some conclusions against which to assess whether the BEH is likely to achieve significantly better outcomes than the current system.

3 CURRENT ARRANGEMENTS

At present the UK energy market is fully liberalised[19] and privately owned[20]. The process began with the Energy Act 1983, which allowed private producers to sell electricity to Area Boards (the predecessors of the electricity DNOs in England and Wales). A full privatisation programme followed through the 1980s and 1990s, covering all aspects of the electricity and gas supply value chain, supported primarily by the Gas Act 1986 and the Electricity Act 1989. These two Acts remain key pieces of legislation, although both have been amended to respond to new challenges as they have emerged.

In this section we present an overview of the current arrangements. While our review is brief, it is relevant as it clarifies the key drivers of the outcomes we have observed over the past three decades. This section is structured as follows:

- An overview of the separation of roles and responsibilities that accompanied privatisation and restructuring;
- The flexibility of the regime to adjust to different challenges;
- The role of the regulatory framework;
- The role of operators and their owners;
- The transparency with which the system operates; and
- The outcomes that the model has delivered.

3.1 Separation and identification of roles and responsibilities

A fundamental change that occurred with privatisation was what might be described as the unbundling of accountability across the key agents in the system:

- the government sets the legal and regulatory framework within which the other stakeholders operate;
- the regulator sets regulatory rules for prices and outputs consistent with the legislative framework and then resets those rules at infrequent intervals and on a forward-looking basis;
- the owners of the companies put in place the right management and set of management incentives to deliver shareholder returns within the regulatory framework; and
- the management, to whom operational control is devolved, take responsibility for the investment and operating decisions of the business within this regulatory and commercial environment.

The separation of roles promoted both efficiency and accountability. It promoted efficiency because management would be left to manage the business to deliver shareholder returns within a clear set of regulatory rules. This search for profit is

[19] In the sense that elements of the overall supply task where there is scope for competitive provision have been opened up to competition and are no longer subject to monopoly provision.

[20] Although we do note that some GB suppliers, such as EDF are owned by companies that are themselves state owned. There are also some small suppliers that are council owned, e.g. Bristol Energy.

intended to reveal efficiency improvements that would not otherwise be revealed, information which can then be used to set future price controls.

It promoted accountability because the responsibilities of each stakeholder are clear and the tension between the objectives of the shareholder, manager and regulator encourages a mutually reinforcing, disciplining behaviour on all three. In contrast, as we discuss in Section 4, the conflation of these roles under the umbrella of the state between 1948 and the 1980s led to confusion around objectives, blurred or missing accountability, a weakening of the necessary discipline to achieve positive outcomes, and ultimately costly outcomes for customers.

Specifically, the key entities that together regulate and undertake the supply of electricity and gas, within this unbundled governance model, include:

- **The Secretary of State/Department**: the Department for Business, Energy and Industrial Strategy (BEIS) is responsible for setting energy and related environmental policy, under the leadership of the Secretary of State and other Ministers. The relevant legislation gives the Secretary of State the principal objective of 'carrying out their respective functions under this Part is to protect the interests of existing and future consumers', The stated objective of the Department, according to its latest strategy document, is to 'Ensure the UK has a reliable, low cost and clean energy system'. [21]
- **Ofgem/The Authority**: Ofgem is the Office of Gas and Electricity Markets. It is a non-ministerial government department and it shares the same principal objective as the Secretary of State. The Gas and Electricity Markets Authority (GEMA or The Authority) is Ofgem's governing body, comprised of executive and non-executive directors. Ofgem plays a critical role in shaping what is required of networks and the revenues they will be allowed to receive, through the setting of price controls. These price controls set out what each company is expected to deliver, and their allowed revenues over a pre-determined period ahead. The design of a new price control is conducted alongside a lengthy, open consultation process allowing any party that wishes to make a submission to express their view on Ofgem's proposals (both in respect of high level direction and in respect of the fine detail).
- **The Licenced Companies**: unless a specific exemption is sought, any party wishing to participate in the energy supply chain requires a licence, not least owing to the safety risks involved, but also because of the need for many parties to work in concert to ensure that supply and demand are balanced continuously. The energy networks are key participants in the sector, transporting electricity and gas from producers to consumers. The licences held by the networks place a vast range of requirements and obligations on them, setting out how they should operate their networks (e.g. technical standards) and organise themselves (e.g. the requirement to ensure adequate resources are available at all times) and requiring that networks adhere to the

[21] https://www.gov.uk/government/publications/department-for-business-energy-and-industrial-strategy-single-departmental-plan/department-for-business-energy-and-industrial-strategy-single-departmental-plan-june-2019.

relevant industry codes (more on this below), that they cooperate with Ofgem etc..

Since all energy networks are currently held by investors rather than the state (whether publicly listed or not), standard company law provisions also apply (e.g. as set out in the Companies Act 2006). Hence the directors of companies have the standard set of obligations and duties placed upon them by this legislation, including the need to act within the powers as set out in the relevant company articles of association and to promote the success of the company. This is important, as it provides the primary way in which Ofgem can steer companies to deliver good societal outcomes, i.e. by ensuring that the companies long term financial performance is tied to the successful delivery of consumer preferences and desired policy outcomes. Again, more on this below.

- **The CMA**: as prescribed in the Gas Act 1986 and the Electricity Act 1989, the Competition and Markets Authority (CMA) is the body responsible for hearing appeals against licence modifications. Where a company considers that Ofgem has taken a decision that is inconsistent with its powers, duties and obligations, it has the right to bring an appeal. This creates an important check and balance on Ofgem's powers, increases investor confidence and lowers long run costs for customers. Importantly, appeal arrangements are also symmetric, meaning that customer representatives (Citizens Advice) and affected third parties (e.g. energy retailers) may also bring appeals. Hence, if there is a belief that the price control determinations are too generous, the original decision can appealed and re-considered by an independent body before it is implemented. At present the appeal arrangements are focused (i.e. the appellant can select elements of Ofgem's decision on which to appeal, it is not necessary to appeal the entire determination) and merits based (i.e. the CMA will to a reasonable extent reconsider points of principle and judgements, rather than just checking that, for example, due process has been followed).

In addition to primary legislation, there is also an important role for industry codes. There are 12 such codes, that define (in much more detail than the legalisation) the terms under which industry participants can access the electricity and gas networks and the obligations and requirements on different parties.[22] The existence of these codes reflect the complexity of the sector, arising from the need for real time balancing (particularly in the case of electricity), safety concerns and the critical importance of energy security, given that access to reliable energy is critical to every aspect of a modern economy. The entire system will only function if a large number of entities cooperate continuously over time all the time.

3.2 Flexibility to meet ongoing challenges

Within the current governance arrangements there is considerable flexibility to meet the challenges of the time. Over the years, the government in its role as policymaker, has made a wide range of important adaptions to the main legislation to ensure that it remains fit for purpose as the world has changed and challenges has emerged, in particular as environmental concerns have moved front and centre

[22] https://www.ofgem.gov.uk/licences-industry-codes-and-standards/industry-codes

of energy policy debate. An indication of the extent of this change is provided in Annex A, which illustrates the evolution of the regulators' duties over time.

Furthermore, the regulators have also adjusted their regulatory rules applied to the companies over time – the RIIO system of price control is virtually unrecognisable to the early RPI-X price controls in the early 1990s, for example.

What is important, as we discuss below, is that these significant changes have been affected within a transparent system, in that government has required parliament to approve changes to the primary legislation, and the regulators' actions have been disciplined by the availability of appeal mechanisms and judicial review. These checks and balances are an important ingredient of the legitimacy of the system, and have not been an impediment to major change in the sector over the past 30 years.

In the light of this, it is difficult to argue, as BEH does, that the current framework is unable to meet today's policy needs. The current framework provides policy makers and regulators with every legislative and administrative tool they may need to pursue any policy they desire. If a new Labour Government wished to make policies more supportive of renewables, it could do so within the existing structure and without any structural upheaval. There is no reason to suppose that the existing framework creates any kind of barrier to going faster.

For example, BEH is critical of the speed with which the transition is proceeding, and implies that the networks may be to blame. But, the speed is set by the policy and the policy is set by the Secretary of State, not the companies. If prevailing arrangements are not moving as fast as policy makers would like, this is first and foremost a question of the decarbonisation targets set by government and the support policies aimed at incentivising the use of renewables and other low carbon technologies. The Secretary of State could put in place different policies to accelerate the transition to net zero if they so wish, and then instruct Ofgem to implement that policy. The current ownership model of the network companies is irrelevant to the ability of the policy makers to set policy.

Equally, the activities of the network companies are determined by Ofgem's regulations, which will in turn be shaped by Government policy. If Ofgem is instructed to accelerate renewable roll out, and decides that it wants faster connections, or for the networks to invest in order to create capacity ahead of time, then this can be regulated for. Importantly, where companies fail to deliver to what is asked, Ofgem has the ability regulate so as to allow it to reduce their rewards accordingly. In cases of more extreme failure, where a licence obligation is breached, Ofgem has enforcement powers.

3.3 Regulation to promote the right outcomes

A crucial element of the current framework is the application of incentive-based regulation by a regulator that operates at arm's length from day-to-day ministerial control. The regulator is the interface between the policy of the state and the operational strategies of the network operators. The purpose of economic regulation is to align those strategies to achieving the policies of the government.

Ofgem must take the policies and targets set by policy makers and then develop regulatory rules that are designed to meet those targets at an efficient long run cost for customers.

In respect of setting and meeting targets, over time, Ofgem has added more "outputs" to its regulatory settlements, in order to ensure that network companies are delivering for customers and other stakeholders. Where delivery is not at target, company returns will be lowered.

In respect of long run efficiency, a stable commercial framework and high powered incentives have been key ingredients to the past success of the UK regulatory model in this regard. This approach has seen companies respond to strong performance incentives by lowering cost and improving the quality and reliability of supply dramatically over time. While customers "pay" for this outperformance in the short term, any improvement in performance can be captured at the next regulatory review to the benefit of customers in perpetuity thereafter.

The key ingredients of a price control settlement (determined through a complex and detailed process) are:

- Cost allowances largely based on benchmarking of business plans and future costs, which have the effect of penalising operators who are inefficient;
- A return on capital determined in a transparent way; and
- A mechanism that enables the sharing of unexpected efficiency savings, that also ensures operators take the hit of cost overruns.

Notwithstanding the exhaustive process, the outcomes of a regulatory regime can be controversial. Where there is a perception that outperformance is too easily earned, and that profits are "money for nothing", over time the legitimacy of the regime will suffer. High powered regulation must go hand in hand therefore with well calibrated targets to ensure legitimacy.

There may presently be controversy around the outcomes delivered by recent regulatory price control rounds. For example, recent papers published by Citizens Advice and others have suggested that there have been errors in past regulatory determinations. Whatever the merits of these papers, the existing approach to regulation is already digesting all aspects of this debate and contemplating what action is needed, as it has in the past when issues have arisen. For example, when it became clear that differential incentives to reduce operating expenditures versus capital expenditures were distorting behaviour, those incentives were equalised and the concern was addressed. When the concern arose that incentives to reduce cost may lead companies to reduce reliability, a specific incentive was introduced and the concern was addressed. When there was a desire for companies to focus on a better direct customer experience incentives were introduced to incentivise that and the concern was addressed. These experiences, along with the way the present controversy is being appraised and acted on as necessary, demonstrate that all the evidence needed to assess price control effectiveness is available and that Ofgem is open to scrutiny and external discipline. When new information or criticism of existing practice emerges, the existing system is able to adapt.

Whilst it is tempting to think of such episodes as evidence of failure, learning by doing within an extremely transparent regulatory environment under the present system has led to ongoing benefits for customers. The efficiency savings that reveal themselves under the incentive based system get passed onto to customers at the next price control review. In contrast, as we shall discuss further in the context of performance under nationalisation, the growing creep of excess returns being taken as inefficiency within the corporations led to systematic over-charging of customers for decades, a phenomenon that wasn't revealed until the sector was privatised and restructured.

In the light of regulatory flexibility and learning by doing that exists currently, it is clear that BEH's assertion that the regulatory regime acts as a block to change is not consistent with the evidence. Ofgem's track record of effecting major change does not support this contention. For example Ofgem:

- undertook a major reform of its network regulation to change from RPI-X regulation to its present RIIO model;
- has transformed energy trading arrangements significantly over time, moving from the England and Wales Pool to bilateral arrangements (NETA and subsequently BETTA);
- is currently reforming the network charging, in the light changes in energy use;
- has been responsible for overseeing the roll out of smart meters and the creation of bespoke regulatory arrangements for smart DCC; and
- following the creation of the capacity market, Ofgem has overseen its implementation.

These are all major changes, and provide no basis to suggest that changes to regulation cannot be made and remade as are necessary.

In summary, a critical and challenging independent regulator ensures that outputs are delivered and provides downward pressure on costs, and upwards pressure on quality, within a long term, flexible, commercial framework has been critical in ensuring policy goals have been met. Moreover, it is entirely appropriate that regulators come under intense scrutiny for their role in aligning the commercial strategies of the operators to the policies of the government, and there has been little absence of that discipline on Ofgem's conduct over the years.

3.4 The role of shareholders who are independent of the state

If the regulator sits between the state as policymaker and the business to whom the regulations must be applied; then the management of the network operator must adhere to the rules that the regulator lays down, whilst ensuring that it operates efficiently so that the financial interests of its owners are met through earning a reasonable return.

Private ownership and commercial incentives play an important role in making the present arrangements work. In our view, this contrasts starkly with one of the key underlying assumptions of BEH.

> *'Private ownership raises the question of whose interests these networks are being run to serve. Needless to say, achieving the highest possible return on investment does not naturally align with meeting the public interest of an energy system that is green, secure and affordable.' [BEH page 3]*

As just described, the entire purpose of economic regulation is to align the interests of the operator and customer, by designing incentive mechanisms that reward companies for delivering the outcomes customers value. When regulation functions as intended, private interest is not an obstacle to delivery but an essential ingredient, just as it is in competitive markets. Few would assert that private ownership would act as an obstacle to meeting customer needs in a competitive market. Again, market mechanisms ensure that the private interest is aligned with meeting customer needs, because in a competitive market the customer can take their business elsewhere if their needs are not met. While this threat is not available to customers of a monopoly business, a similar effect can be achieved by the economic regulator acting on customers' behalf.

Regulatory incentives in combination with private ownership have created a strong focus on delivering against the targets set by regulators as efficiently as possible to ensure that the shareholders earn a return. Over time, as these efficiency savings are returned to customers. This has been unambiguously good for customers compared to situations where the operators are not challenged by the regulatory regime to reveal cost efficiencies.

3.5 Open consultations and checks and balances

BEH has indicated that part of the motivation for the proposals is to improve transparency. Yet, the existing system is characterised by a high degree of transparency at each stage of the process, and clear lines of accountability with each party subject to appropriate checks and balances:

- Policy decisions are taken by Ministers and must be passed through Parliament.
- Ofgem is responsible for embodying policy decisions in its regulations. The consultation process that accompanies such a design programme is open to all and is extensive. Ofgem also actively encourages stakeholder participation. To provide an indication:
  - consultation on the RIIO-2 round of price controls began in July 2017 with an Open Letter.
  - this was followed by:
    - a framework consultation on the overarching approach; and
    - a suite of sector specific consultations setting out how Ofgem plans to implement its high level framework within each of gas distribution and transmission.
  - Ofgem will publish at least two further detailed summaries of its planned price controls – a Draft Determination and a Final Determination, before the process is concluded.

- Ofgem has so far published separate papers on:
  - the detail of how it plans to undertake benchmarking;
  - what is expects to see from network operators following the move to legislate for net zero by 2050;
  - details of how it will regulate the ESO;
  - how it will assess financeability;
  - Ofgem's approach to stakeholder engagement (the letter launching this engagement programme begins '*We want to hear from anyone interested in our RIIO-2 framework consultation*'[23]); and
  - As appendices to its main consultations, papers on the cost of capital, productivity, a review of the RIIO-1 process so far, plus a range of other papers.
- Ofgem has created a Consumer Challenge Group to act as a 'critical friend' to Ofgem. The staged objective of this group is to '*ensure that the price control settlement is in the best interests of existing and future consumers*'.[24]
- Ofgem is running an extensive programme of workshops and seminars on its forming price control.
  - To date there have been more than 20 GD2 workshops, with all materials presented uploaded onto the Ofgem website.[25]
  - Ofgem has also run many transmission focused worskhops in support of ET2 and GT2.[26]

- The companies that are responsible for delivery are required under their licence to provide a huge range of information to Ofgem, over and above what they are required to submit in their annual company accounts.
  - Ofgem requires each company to develop a business plan as part of each price control review.
    - These plans are highly detailed (typically running to many hundred pages) and are publicly available for review.
    - All aspects of each company's plan must be set out, including detailed costings. These costings will be subject to specific scrutiny from Ofgem and will be extensively benchmarked.
    - All company business plans must be supported by extensive stakeholder engagement.

[23] https://www.ofgem.gov.uk/system/files/docs/2017/10/riio2stakeholder_engagement_plan_0.pdf

[24] https://www.ofgem.gov.uk/network-regulation-riio-model/current-network-price-controls-riio-1/riio-1-forums-seminars-and-working-groups/consumer-challenge-group

[25] https://www.ofgem.gov.uk/publications-and-updates/riio-gd2-working-groups

[26] https://www.ofgem.gov.uk/publications-and-updates/riio-et2-working-groups
https://www.ofgem.gov.uk/publications-and-updates/riio-gt2-working-groups

- Ofgem provided clear guidance on what it expects companies to do in order to ensure that their plans are supported by customers.[27]
- Companies in their business plans will need to show robust stakeholder evidence along with an explanation of how this evidence has been acted on in their plan. Failure to do so would lead to their plan being deemed non-compliant with the Ofgem guidance, leading to a financial penalty.
  - Stakeholder evidence must cover all relevant groups, including the general consumer.
- Each company has been required to establish an independent Customer Engagement Group (CEG) to provide a detailed challenge forum for the companies' business plans.
- Companies will be required to hold "open hearings" once business plans have been submitted, chaired by the head of their CEG.
- The CEG for each company will write a report setting out its views on the merits of the business, to be submitted to Ofgem.

□ During a price control period, companies are required to provide Ofgem with a highly detailed annual reporting pack, setting out a granular breakdown of costs and performance. Ofgem publishes a summary report based on this data annually.

□ Ofgem has the power to request further data from companies should it need to, and companies, under the terms of their licence, are obliged to cooperate.

■ As noted above, price control decisions are subject to merit based review, through the CMA. A selection of independent CMA panel members lead such reviews, supported by the CMA staff. Appeal rights are symmetric, i.e. affect third parties and consumer representatives may bring appeals. Consequently, Ofgem can be held to account for its decisions, should appellants take the view that errors have been made.

It is difficult to see how there could be a perception that the governance and operation of the sector is not subject to extensive scrutiny, that it is beyond the control of stakeholders or policy makers, or that it is difficult to seek to influence the direction of networks should stakeholder have views to share.

3.6 Assessment

Returning to the conditions we identified as necessary for the efficient attainment of net zero, it is clear that the conditions to do so are already in place and work well, although there may be room for improvement in some areas.

[27] https://www.ofgem.gov.uk/system/files/docs/2018/04/riio-2_enhanced_stakeholder_engagement_guidance_v13_final.pdf

- **Institutional:**
  - There is, generally, **clarity over the over-arching objectives**, supported by effective guidance from government as to how those objectives should be achieved;
  - The **accountability framework is clear**. Policy is set by Ministers and confirmed by elected representatives. Ofgem sets the regulations and third party appeal rights are symmetric. Management of the network operators seek to meet their regulatory targets and wider requirements, whilst seeking to ensure that their owners earn appropriate returns on their investment.
  - As far as transparency is concerned, **stakeholders can exert influence on all aspects of the development and execution of energy and related environmental policy**. There may presently be controversy around the outcomes delivered by recent regulatory price control rounds. However, the existing approach to regulation is already digesting all aspects of this debate and contemplating what action is needed. This demonstrates that all the evidence needed to assess price control effectiveness is available and that Ofgem is open to arguments.
- **Economic:**
  - Network companies are **strongly exposed to their performance** through the existing price control framework, and are exposed to a range of delivery risks. They therefore have every incentive to seek efficient delivery and innovation, and to avoid unnecessary investments.
  - The activity of companies is steered by the **effective regulatory arrangements** created by Ofgem, a regulatory office that devotes very significant resource to developing network regulation. Ofgem has relatively recently concluded a major review of its regulatory arrangements for networks, leading to its adoption of the RIIO framework. This broad framework is very largely reconsidered afresh at each period price control, when it is applied to each of the four network sectors, to ensure it remains fit for purpose and that lessons are learned. The outputs networks are asked to deliver are unambiguous and can evolve over time.
- **Technical**
  - **Scale economies** are achieved by the present ownership structure.
  - **Coordination** is achieved in the main, through the clarity achieved by focused regulation and existing industry codes.
    - However, there may be a gap in respect of the extent to which networks are encouraged to take a whole systems perspective. We note that this is already emerging as a key theme for the RIIO-2 price controls, so there is reason to expect any gap to be filled.

These ingredients have led to outcomes that have been positive for customers (certainly far more positive than under the previous nationalised arrangements, as we shall discuss in the next section).

As we set out Annex B, in respect of networks, the combination of private ownership and arm's length economic regulation has worked very well in GB.

- **Cost**: The costs of GB's energy networks have fallen substantially since privatisation: GB consumers benefited from substantial efficiency gains in the 1990 to 2010 period, with network costs down by 50%.[28]
- **Reliability:** Electricity networks have grown steadily more reliable, and gas networks have remained extremely robust: There was a 30% reduction in the number and duration of power cuts between 1990 and 2008. Performance has continued to improve under RIIO with customer interruptions and customer minutes lost decreasing by 9% and 12% respectively between 2014/15 and 2015/16. The average gas customer will experience an unplanned interruption once every 140 years.[29]
- **Investment:** On aggregate consumers have paid over £80bn in investment on networks since privatisation, with a further £40bn needed over the RIIO 1 price control. This 50% real terms increase in investment since 1990.[30]

The cost reductions and reliability improvements have been achieved despite facing the initial challenges of decarbonisation. To illustrate, the networks have so far connected 45 GW of renewable capacity, a figure that is growing rapidly.[31]

It is also worth noting the improvement in performance that occurred in the period immediately following privatisation. Appraisals made approximately a decade into the privatisation experiment found year on year reductions in cost that averaged between 6.5% and 9%, signalling the very rapid removal of slack that had accumulated over the years prior to privatisation.[32]

While we note again the present controversy around the outcomes delivered by recent regulatory price control rounds, these are sizeable achievements. From a high level sweep of the performance of the sector since privatisation, there seems to be no compelling case for change.

In summary, given all of the above, there is not a strong prima facie case for change, in particular not for radical change, but for the continued focus on incremental improvement in regulation that comes from learning by doing. We see no reason to believe that any aspect of the existing arrangements should act as a block to net zero. On the contrary, the existing model appears well able to meet that challenge.

28 "GB Energy Networks: an analysis of delivery since 1990", KPMG, September 2017.

29 Ibid.

30 Ibid.

31 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/811974/Renewables_June_2019.pdf

32 See Section 4 of this report.

4 PAST UK EXPERIENCE WITH NATIONALISATION

In this section we review the experience of nationalisation between the 1940s and the 1980s. We do so recognising that the current proposals set out in BEH are not a return to the Morrisonian model of public enterprise (see below), but nevertheless it is clear that important lessons can be learned from the institutional and economic architecture of the model that are relevant for the current debate.

4.1 Original motivations for the post-war nationalisation programme

Nationalisation was a response to the view that private markets would fail to deliver efficient outcomes, in that there would be problems of excess returns (and over-charging), inadequate or inefficient investment, co-ordination failures, and a failure to address externalities.

The electricity industry (nationalised in 1948) and the gas industry (in 1949) were structured on the basis of the model that Herbert Morrison developed in the 1930s. This "Morrisonian" model led to the creation of public corporations which – it was assumed – would be tasked with maximising welfare directly – through prices that reflected marginal costs, and investment plans that reflected the required rate of return (adjusted for social benefits). Supporting this assumption was the prevailing post-war optimism that corporations that were led and managed by clear-sighted, objective people with the relevant expertise under a clear set of objectives (and operating at arm's length from ministerial control) would be able to achieve greater levels of economic efficiency and fairness than diffuse or chaotic market structures and private monopolies.

4.2 Outcomes

The three primary sources of authority on the performance of the nationalised industries are the National Economic Development Office (NEDO, 1976) report[33]; Pryke's (1981)[34] comprehensive analysis of the performance of all the major public corporations between 1968 and 1978; and Molyneux and Thompson's (1987)[35] updating of that study.

The two earlier works, assessing the performance of the nationalised corporations in respect of productivity, efficiency, pricing policies, investment performance, and meeting of wider social objectives, were highly critical. Pryke pithily described performance as '*third rate, though with some evidence here and there of first class standards*' In its review, focusing particularly on government's stewardship of the corporations, NEDO concluded that '*it is doubtful whether ... [the criteria for control*

[33] National Economic Development Office (1976), A Study of UK Nationalised Industries, London: HMSO.

[34] Pryke, R. (1981), The Nationalised Industries: Policies and Performance since 1968, Oxford: Martin Robertson

[35] Molyneux, R. and D. Thompson, Nationalised Industry Performance: Still Third-Rate?, Fiscal Studies, Vol. 8, No. 1 (February 1987), pp. 48-82

of nationalised industries] ... have made a material contribution to improving the allocation and effective use of resources'.

Molyneux and Thompson's assessment of performance after 1978 concluded that there had been an upturn in performance since 1978, but that there was significant scope for improvement, both in respect of productivity performance and pricing policies. They concluded that '*continued reform of the regulatory framework is required if the inefficiencies identified in our study … are to be eliminated'*.

As far as the electricity industry specifically is concerned, all the studies concluded that it had shown steady productivity growth, but with total factor productivity (TFP) growing far less rapidly than labour productivity. A significant body of contemporary evidence concluded that whilst the assets were managed reasonably efficiently, there was over-investment in the sector, undermining the dynamic efficiency of the industry. For example, the efficiency audit of the industry conducted by the Monopolies and Mergers Commission[36] (MMC), found that the Central Electricity Generating Board (CEGB) was operating the power stations efficiently, but that its excessive investment was "against the public interest". This echoed Pryke's earlier analysis which found that the ratio of production to capacity had fallen considerably over time. Jones (1986)[37] concluded that even though the CEGB's investment appraisal processes had improved since the MMC report, they were still inadequate.

These inefficiencies fully revealed themselves very shortly after the privatisation and re-structuring of the electricity sector. Newbery[38] notes that In the five years after 1990:

- labour productivity in the former CEGB doubled;
- nuclear output increased 28% overall with no increase in capacity, and nearly 50% from the more modern AGRs;
- gas-fired generation rose from almost nothing to 15% of output, and to 30% in 1997;
- fossil fuel cost/kWh fell 45% in real terms;
- nuclear fuel cost/kWh fell 60% in real terms; and
- CO2/kWh fell 28%, and SO2 and NOx fell by over 40%.

Newbery and Pollitt (1997)[39] estimated the costs and benefits of restructuring and privatising the CEGB, and found that even if there were to be no further improvements, and ignoring the environmental benefits, the gains achieved and projected up to 1996 were equivalent to a permanent cost reduction of about 5% of generation costs. In present value terms that is equivalent to about 40% on the current cost value of the assets concerned, and about 100% on the privatisation sales price. They suggested that environmental benefits might double this figure.

[36] Monopolies and Mergers Commission (1981), Central Electricity Generating Board, HC 315, London: HMSO.

[37] Jones, I. (1986), 'The application of risk analysis to the appraisal of optimal investment in the electricity supply industry', Journal of Applied Econ

[38] David M Newbery (1999), The UK Experience: Privatization with Market Power, Department of Applied Economics Cambridge, UK

[39] Newbery, D.M. and M.G. Pollitt (1997), 'The Restructuring and Privatisation of the CEGB- Was it worth it', Journal of Industrial Economics, XLV (3), 269-303

As far as the network activities in the electricity sector are concerned, as their investments and operations were more incremental than the production activities, they attracted less focus during the period they were nationalised. However, the sheer scale of the cost-cutting in both transmission and distribution in the years immediately after privatisation (without any diminution in the reliability or safety of the networks, indeed both improved) was testament to a growing stock of inefficiency that had accumulated over the previous decades.

The figure below shows the change in operating expenditures (RUOE) and operating productivity; and the change in total costs (RUOC) and productivity including capital inputs, which illustrates the magnitude of the inefficiency that was stripped out of the sector in the years immediately after privatisation. This productivity performance was tracked by the path of prices, which by 2004/5 had halved in real terms relative to 1990 in the distribution sector.

Figure 1 Productivity performance of the energy networks post-privatisation

Company / Sector	Type of Measure	Period	Overall Change	Annual Average Rate of Change
Electricity distribution (12 Regional Electricity Companies, England & Wales)	RUOE	1990/91 to 1997/98	16.6% to 53.6% [36.8%]	2.6% to 10.4% [6.5%]
Electricity distribution* (12 Regional Electricity Companies, England & Wales)	Productivity growth (excl. capital inputs)	1990 to 1998		9.0%
National Grid Company	RUOE	1990/01 to 1997/98	38.50%	6.80%
Electricity distribution*	RUOC	1990/91 to 1997/98	14.5% to 40.8% [Average 28%]	2.2% to 7.2% [Average 4.7%]
Electricity distribution (12 Regional Electricity Companies of England and Wales)	TFP	1990 to 1998		6.0%
National Grid Company	RUOC	1990/91 to 1997/98	27.2%	4.4%

Source: Sources: ORR / Europe Economics (2000), except (*) Frontier Economics estimates

4.3 Reasons for the poor performance of the nationalised industries

The reasons for the poor performance of the nationalised industries fall into two broad categories:

- **Institutional:** an absence of clear over-arching objectives, supported by effective guidance from government, necessary to underpin a clear accountability framework; and
- **Economic:** the absence of an incentive model that focused the efforts of the managers of the nationalised corporations.

We discuss each in turn.

Weak institutional framework

The corporations were given very little guidance on the types of policies that they were to follow. The various powers and duties established in legislation usually provided a financial duty to break even, a requirement not to discriminate (show undue preference) in pricing, and general duties to act economically and efficiently. This vagueness of the nationalisation statutes on the question of economic and financial objectives was frequently commented upon during the period of nationalisation. (e.g. Webb 1973)[40].

Three White Papers (1961, 1967 and 1978) represented the Government's attempts to develop a framework to guide the decisions of the public enterprises. The first White Paper gave little guidance, and consequently corporations retained significant discretion over its activities subject to meeting a financial target set by Ministers. No detailed economic or social objectives were specified.

In contrast, the 1967 White Paper specified detailed guidelines for the pricing and investment policies that management were to follow, combined with a process for the Prices and Incomes Board to monitor outcomes. However, as noted by Heald (1980)[41] and Molyneux and Thompson (1987), the framework over-determined the financial instruments (one of the pricing, investment and financial target rules would be either redundant or inconsistent); and there was a relative lack of importance attached to the achievement of productive efficiency.

As Molyneux and Thompson note: '*The institutional framework provided for ministerial intervention in decision-making in ways which blurred ultimate responsibility for particular actions*'. Both Pryke and NEDO concluded that this absence of clear responsibility for outcomes conflicted with the achievement of efficiency. Furthermore, the effectiveness of financial targets as an incentive to the achievement of productive efficiency was substantially vitiated in the early 1970s by government counter-inflation policies which required the public corporations to hold down price increases. Subsidies were paid to corporations in compensation. The result was that financial targets became largely irrelevant, as did the

[40] Webb, M. G. (1973). The Economics of Nationalised Industries

[41] Heald, D. The Economic and Financial Control of U.K. Nationalised Industries, The Economic Journal, Vol. 90, No. 358 (Jun., 1980), pp. 243-265

requirement that the level of prices charged should be based on long-run marginal costs.

The 1978 White Paper was published against a backdrop of macro-economic crises and government deficit and debt issues. Consequently, the financial target – set by government – became the prime instrument of policy, pricing and investment rules became of secondary importance, and "non-commercial" objectives were substantially relegated in importance. In the light of growing concerns relating to the efficiency performance of the public enterprises, the government introduced efficiency audits in 1980.

In summary, the vague legislation did not constitute a set of clear over-arching objectives; and the guidance provided by the White Paper was not followed through, not least by the government itself who often used the corporations as instruments of macro-economic policy. Consequently, the basis for a clear accountability framework was missing, which created a vacuum within which responsibility was absent, and inefficient, rent-seeking behaviour could flourish. This was potent mix was supported by the absence of transparency and scrutiny, facilitated by the state as the policy-maker, owner, manager and regulator of the corporations.

Weak economic regulation

The other cause of the poor performance of nationalised industries, partly related to the first, but also a cause in its own right, is that another assumption – common throughout much of the period up to the 1980s – turned out to be false. This was the assumption that if the corporations that were led and managed by clear-sighted, objective people with the relevant expertise then they would achieve economic efficiency and fairness.

That this assumption turned out to be false is due to a number of factors.

First, the absence of clear guidance from government was accompanied by the lack of a clear accountability framework over what was expected of the managers of the corporations. This lack of an accountability framework naturally led to a reward system that was not related to measurable, public interest outcomes.

Second, given the monopoly rights bestowed on the corporations (which consequently includes a monopoly over inside-information), managers were increasingly able to pursue their own objectives, which were not always (or often) aligned with economic efficiency. The economic literature gives many examples of this rent-seeking behaviour such as, for example, scale maximisation (rather than welfare maximisation) reflecting the status or enhanced career prospects that scale can provide to the managers of the business; direct and indirect means of increasing remuneration such as plush offices, company cars, etc.; and managerial slack, or as Hicks (1936) memorably said '*the greatest monopoly profits are a quiet life*'. These well-known problems associated with monopoly were allowed to flourish within the self-regulatory environment of the nationalised corporation. The absence of the disciplining force of an independent regulatory framework that aligned the objectives of the managers of the corporations to the (unclear) public interest objectives was a key driver of the creeping inefficiency in the sector.

Thirdly, the growing economic literature around the limits of knowledge and the inability to strike complete contracts for all states of the world suggest that whilst in-house expertise is valuable for meeting current levels of demand using the current vintages and technologies of assets, it is not sufficient when assessing new investments, technologies and innovations. Innovation flourishes in a diverse environment (markets often provide such diversity) and investment appraisal needs to be tested against commercial benchmarks. The echo chamber within the CEGB functioned – unrestrained by commercial discipline – was not likely to lead to commercially driven innovations and investment decisions, and indeed led to significant over-investment in capacity, and in the wrong type of capacity. After 1990, the market determined the fuel mix, and signalled the end of the expensive coal and nuclear options.

4.4 Summary

In summary, the lack of clarity and consistency over the high-level objectives of the corporations was amplified by the use of the nationalised industries as instruments of macro-economic policy, creating further confusion over the goals of the corporations. This fed into an ill-defined accountability framework for the managers of the businesses, which coupled with the well-known problems of rent-seeking, managerial slack and loss of discipline in self-regulated monopoly businesses led to poor performance.

The experience of nationalisation is best summarised in two quotes. First, from Waschke (1977)[42] writing on the UK experience from a German perspective:

> *'On the whole the British experiments show that the nationalisation of industries is no means for solving financial, economic or social problems nor can it guarantee jobs. It does not alter the conflict of interest between labour, management and consumers in spite of consumer councils and some labour representatives in some of the Boards. The conflict between economic requirements and social obligations again and again creates new problems which paralyse the decision making process.'*

This gloomy assessment of nationalisation stands in contrast to an assessment of the first 10 years of privatisation, liberalisation and incentive-based regulation offered by Newbery:

> *'Privatising electricity would have a sizeable [favourable] impact on the national debt and the short run public sector borrowing requirement…. while privatising BT and British Gas had been relatively simple as they were not restructured, the idea of transferring public monopolies to private ownership had been so strongly criticised that liberalisation was essential. Fortunately, the Government failed to appreciate just how hard unbundling the industry would be before it made the political commitment to restructuring and privatisation. The final result, if far from perfect, was a great improvement on what went before, and was a remarkable achievement that demonstrated what*

[42] Waschke, Hildegard (1977) : The development and impact of nationalisation in Britain, Intereconomics, ISSN 0020-5346, Verlag Weltarchiv, Hamburg, Vol. 12, Iss. 5/6, pp. 153-157

was possible to the rest of the world, and certainly encouraged the passage of the EU Electricity Directive.'

The lesson for any reform is clear: it is not sufficient to restructure and change the ownership of the sector. It must also be accompanied by clarity of objectives and a clear accountability framework against which to monitor and reward or penalise the achievement of those objectives. As discussed in Section 3, under the privatisation model, the unbundling of accountability and responsibility was a key driver in determining the efficiency outcomes:

- the government set the legal and regulatory framework within which the other stakeholders operate;
- the regulator sets regulatory rules for prices and outputs consistent with the legislative framework and then resets those rules at infrequent intervals and on a forward-looking basis;
- the owners put in place the right management and set of management incentives to deliver shareholder returns within the regulatory framework; and
- the management, to whom operational control is devolved, who must take responsibility for the investment and operating decisions of the business within this regulatory and commercial environment.

The separation of roles promoted both efficiency and accountability, and led to positive outcomes for customers. In contrast, the conflation of these roles under nationalisation led to a weakening of accountability and commercial discipline and ultimately costly outcomes for customers.

The lesson from the comparative assessment of the earlier nationalised model and the current model is that any new system of nationalisation will need to ensure that these reinforcing disciplines remain active, or else there is a serious danger that either the key outcomes will not be achieved, or if they are, they will be achieved very inefficiently.

5 APPRAISAL OF THE DETAIL OF BEH

BEH presents a set of reforms that goes well beyond simply renationalising the energy networks. A raft of further changes are proposed and the likely effect of these requires exploration. We present our findings on these wider aspects of BEH below.

5.1 Key findings

The main issues that arise following our review of BEH are as follows.

- **Delay, disruption and uncertainty:** The BEH proposals are fundamental and wide ranging. They include a total change in ownership across the entire sector and a wholesale revision of roles, responsibilities and accountabilities, which would create a new set of operational relationships between relevant parties. It would take time to create and establish these new arrangements in the first instance, and potentially much longer for them to become fully effective. It may also take time for the private sector to understand its new role in decarbonisation under the BEH proposals. This will lead to a delay, disruption and uncertainty that would slow progress towards the transition to a net zero carbon economy. It is tempting to believe that some delay will be of little consequence, as 2050 is still far away. But the latest research on achieving net zero, for example from the CCC and UKERC warns us not to fall into this trap. Even seemingly modest delays can make achieving net zero far more challenging, increase, costs and delay the achievement of benefits.
- **Disruption to innovation:** on balance, we consider BEH would slow innovation and make it less effective, further weakening efficiency outcomes and hampering progress towards decarbonisation. While public ownership may reduce the extent to which long and uncertain payback periods hamper innovation, a wide range of other aspects of BEH would lead to slower innovation, including the fragmentation of the labour pool and lost scale, weak access to finance, loss of locational clusters, weakened international links and a lack of commercial focus in decision making.
- **Uncertain access to funding:** Accelerating the transition and assigning new roles to the networks (e.g. leading the delivery of EVs and storage) will require an increase in funding. If the energy networks were under public ownership then the energy transition will be competing with other core central government departments for scarce funds and may be crowded out in spending rounds. In effect, the BEH proposals introduce the risk of a funding constraint emerging, in contrast to the existing model where (as long as returns to investors are fair) there is essentially no limit to the quantum of funding available.
- **Fragmentation and lost scale economies:** encouraging the creation of MEAs and LECs would fragment the operation of the energy networks, a sector that is characterised by strong economies of scale. To give a feel for what impact on cost the proposed creation of MEAs and LECs might have we have examined the example set out on page 9 of BEH, which shows Yorkshire operating as an REA and Leeds operating as an MEA. Based on academic

evidence on scale economies, overall estimated cost increases may be between 7% and 18%. This is unfortunate as one of the main hypothesised benefits of public ownership is its ability create greater synergies and coordination among parties that may reduce cost. This aspect of BEH's proposals would markedly reduce the prospect of such benefits being achieved in practice.

- **A postcode lottery for costs and reliability:** BEH indicates that cost reflective charging is likely to be the principle that would underpin the new BEH framework. As MEA and LECs devolve from the REA, the current model of socialised and shared cost would be disrupted, creating the potential for a postcode lottery in respect of charges and reliability. This would be contrary to the stated objective of ensuring equitable decentralisation.
- **Confused roles, conflicts of interest and weak checks and balances:** Having a single body (the NEA) that makes policy for itself, self-regulates and also regulates others, in addition to being directly responsible for delivery, is far from best practice and contrasts directly with the highly effective separation of accountability that characterises the current arrangements.
  - There are immediate and obvious incentive problems and conflicts of interest that arise from having policy, regulation and delivery combined in one entity.
  - There would be no checks and balances in the system and a general lack of scrutiny, a formulation that is likely to lead to satisficing behaviour to the detriment of customers.
  - Rather than enhancing democratic accountability, this aspect of the proposals seems certain to harm it.
  - Our review of past experience of nationalised industries reveals evidence of all of these concerns.

At the end of Section 3, we provided an overview of how the present ownership and governance arrangements operate so as to foster good performance. We identified institutional, economic and technical aspects as relevant. It is worth returning to the three elements we set out there.

- **Institutional:**
  - There is a lack of **clarity in respect of the objectives** of the NEA and REAs in particular. Each would have a number of conflicting objectives with latitude to decide for themselves which was most important;
  - There would be a weak **accountability framework** principally arising from the proposal to merge policy, regulation, ownership and delivery within one organisation.
  - There is a **risk that transparency would be reduced**. While BEH indicates that there would be a requirement on all entities to publish information on their performance, the merging of roles into one body can be expected to limit information revelation. The wider set of governance arrangements considered as part of BEH would need to prove highly

effective to offset this tendency if transparency was to be maintained at current levels.

- **Economic:**
  - While the new network companies would have an obligation to be efficient, past experience with nationalised companies in the UK tells us that this is rarely enough to ensure that efficiency is actually delivered. There is no evidence within BEH around how the NEA, REAs, MEAs and LECs would be provided with a commercial framework within which to operate, and hence every reason to believe that **increased inefficiency** would follow.
  - Whereas under the current model the activity of companies is steered by the effective regulatory arrangements created at arm's length by Ofgem, **under BEH the sector would be self-regulating**, setting its own targets and deciding its own level of funding. This absence of external scrutiny and checks and balances will not lead to an effective regulatory and commercial environment.
- **Technical**
  - **Scale economies** would be reduced by the proposed fragmentation of the REAs.
  - One of the main hypothesised benefits of state ownership is the scope for improvement in coordination (as in the original conception of the Morrisonian model). However **BEH will likely fail to achieve these coordination benefits owing to the envisaged fragmentation**.

In short, many of the ingredients that have led to positive outcomes under the existing arrangements will be removed or disrupted.

Based on our review, there is nothing in the BEH proposals that suggests we should have a high level of confidence (or indeed any degree of confidence) that they will meet the enormous challenge of achieving net zero on time and at reasonable cost. In fact given what we have learned from the history of how utility businesses have been owned and regulated in the UK, these proposals carry with them a very significant risk of being less effective – more costly and greater risk of delay – than the current system. The model that is proposed is entirely unproven, and the issues with it fundamental. In contrast, the existing system has delivered material benefits for consumers and wider stakeholders over almost three decades.

5.2 Key features of the BEH proposals

While the stated policy objectives of BEH may be far from radical, this wider set of changes are, and would lead to many important changes to the prevailing arrangements.

- A **National Energy Agency** (NEA) would be created, into which would be put:
  - Policy making functions taken from BEIS, including responsibility for regional climate targets and skills and workforce planning;

- Regulatory functions taken from Ofgem, as this new entity would take over many of the network regulation tasks currently performed by Ofgem;
- The transmission grids (electricity and gas) presently owned by National Grid, Scottish Power and SSE.

- **Regional Energy Agencies** (REAs) would take over from the existing electricity and gas distribution networks. These REAs would also take on responsibility for:
  - decarbonising heat and electricity;
  - fuel poverty; and
  - aspects of industrial strategy.
- Consumers would be encouraged to set up **Municipal Energy Agencies** (MEAs) and **Local Energy Communities** (LECs) that would devolve from the relevant REA. MEAs and LECs could own and operate the local grid serving, for example, a city, borough or parish, or even down to an individual housing estate.

5.3 Significant change will cause delay, disruption and uncertainty

The BEH proposals are fundamental and wide ranging. They include a total change in ownership across the entire sector and a wide revision of roles, responsibilities and accountabilities, which would create a new set of operational relationships between relevant parties. It would take time to create and establish these new arrangements in the first instance, and potentially much longer for them to become fully effective. It may also take time for the private sector to understand their role in decarbonisation under the BEH proposals. This will lead to a delay, disruption and uncertainty that would slow progress towards the transition to a net zero carbon economy.

This creates a hurdle that BEH must clear before it would be sound to adopt the proposals, i.e. we would need to be confident that the acceleration in progress or improvements in efficiency that would arise from adopting BEH would be sufficiently large to offset the set up costs.

- **Delay – preparing the legislative framework**: a new Government pursuing the policies set out in BEH would need to prepare a Bill for debate and approval by each House of Parliament. This would need to set out the legislative framework for the purchase of the existing companies, their transfer to new companies (the NEA, the REA), the provisions necessary for MEAs and LECs to come into being and to provide all these new entities with the envisaged set of powers, duties and obligations. Passing this legislation would take time. While legislation can in principle be passed quickly through all necessary stages, the typical time taken for a Bill to be passed will vary widely depending on the support for the bill (and its contentiousness) and large bills can be introduced at the beginning of the session and only passed at the end of the

session (a year later).[43] This time frame depends on whether it is consulted on before introduction to the legislative programme, the degree of pre-legislative scrutiny (both of which would delay introduction to Parliament) and the potential for a Bill to be amended in the second House and have to move between the two Houses before agreement is reached.

- **Delay – bedding in new roles and responsibilities**: BEH is a relatively short document that provides few details in many areas important areas. However, clearly a major change is envisaged in the roles that will be played by different entities and in their organisation. For example, while there is presently a clear separation in key roles (with BEIS setting policy, Ofgem responsible for designing regulations consistent with policy and the companies responsible for actual delivery) many of these will be redrawn should BEH be enacted. The NEA will now set key aspects of policy, regulate itself and others, maintain and deliver transmission infrastructure and be required to provide apparently open ended support to REAs, MEAs and LECs. This will require fairly major organisational change, and further delay before new arrangements are effective is inevitable.
- **Uncertainty – the role of the private sector**: BEH appears to envisage that in a number of areas the NEA and REA would take over direct provision of new infrastructure, with EV charging infrastructure and storage highlighted. It is unclear whether the REA would be required or permitted to spread its activity into other areas, e.g. flexibility services, home insulation deployment. It is unclear whether it is anticipated that the NEA and REAs (or MEAs and LECs where relevant) will be the only parties permitted to build such infrastructure. Nevertheless, the presence of a state owned monopoly provided rolling out such infrastructure is likely to have a chilling effect on private sector investment. This chilling effect will be felt even before BEH is implemented. If investors perceive that it is likely that the policies set out in BEH could be adopted, then any prospective private provision of this infrastructure may have its business case undermined and may not proceed, at least until potential policy/regulatory risks have been resolved. If BEH were implemented, then again there may be no case for a private investor to supply such infrastructure if there is the possibility that it will face competition from similar infrastructure rolled out by the NEA/REA/MEA/LECs. In essence, the competitive sector may be crowded out from participation unless it is supplying a state owned body.
- **Disruption – staffing the new institutions**: BEH envisages that the staff working for the existing networks will be transferred to the new entities on creation under TUPE regulations. It notes that 'senior executives and directors role will be re-advertised on dramatically reduced salaries'. It seems reasonable to assume that this would lead to a large turnover of senior staff at all network organisations, and there may be question around the ability of the networks to ensure that new executives and directors are suitably qualified and experienced. Even if suitable candidates can be found under these different terms, there will be further delay arising from this turnover, which would be greatly exacerbated if recruitment proved challenging.

[43] Cabinet Office, Legislative process: taking a Bill through Parliament. https://www.gov.uk/guidance/legislative-process-taking-a-bill-through-parliament

- **Disruption – creating newly merged/demerged entities**: The NEA will need to take on and re-organise staff from four transmission companies, Ofgem and BEIS, at a time when (as noted above) there may be senior staff turnover. The REAs will be busy consolidating their ownership of the existing DNOs with the local GDNs – noting that the areas of operation of the GDNs do not match well those of the DNOs. This lack of consistency in geography served will bring an additional complication that will need to be resolved.[44] Similarly, there may be a need to process requests for the creation of MEAs and LECs. All of this will take time to execute., integrate and become effective.

It is clearly hard to quantify the cost and delay that would arise from making these changes, but given the scale of the change envisaged and the size and complexity of the energy networks, it is reasonable to presume that delays would be material and costs high.

Predicting the length of time to implement the relevant legislative and the subsequent organisational changes under Bringing Energy Home would be highly speculative. However, large changes to national infrastructure ownership and the delegations of responsibility have been brought before Parliament before and there are lessons to learn from similarly disruptive organisational change.

Case studies

Below we provide three concrete examples of how major reforms can take time – years – to implement and become fully effective. Even seemingly arcane changes to arrangements, that do little to alter the physical equipment installed or how it operates, can also be costly and time consuming.

[44] In a similar vein, we note that BEH is silent on what would happen to the IDNOs, IGTs, OFTOs and (should any be created) CATOs under BEH. Would these assets be adopted and integrated into the relevant REA/MEA/LEC and if so under what terms?

Reforming the England & Wales Electricity Pool

The Electricity Pool was a centralised market arrangement through which electricity was traded following privatisation in 1990. Generators above a de minimis threshold were required to submit a schedule of bids to NGC, the party responsible for optimising dispatch, issuing dispatch instructions and balancing the system. NGC would also calculate the Pool prices at which that power should be bought and sold.

Over time a consensus emerged that certain aspects of the way the Pool operated may be contributing to the exercise of market power and may be leading to wholesale power prices that were higher than they needed to be. Calls for reform grew, leading to a request from the Minister for Science Energy and Industry to Offer (the predecessor body to Ofgem) to consider how trading arrangements might be reformed, issued in October 1997.

Just over a year later, Offer published a Framework Document setting out the steps it would take to reform trading arrangements.[45] This set out at a high level the envisaged decentralised bilateral trading arrangements that would replace the centralised Pool. A range of further consultation papers followed, as the detailed framework was developed, consulted upon and decided.

The replacement bilateral trading arrangements were finally implemented by the Department and Ofgem in March 2001, at a direct cost of £39mn.[46] However, this was only a small fraction of the total costs of replacing the Pool, with an estimated £580mn spent by market participants on revised operating procedures and new IT systems. The entire programme therefore required an elapsed time to implementation of 41 months, and a cost (in money of the day) of over £600mn.

[45] https://www.ofgem.gov.uk/ofgem-publications/79067/review-electricity-trading-arrangements.pdf

[46] https://www.nao.org.uk/wp-content/uploads/2003/05/0203624.pdf. Paragraph 4.

London Underground public-private partnership

In March 1998, it was announced that the London Underground tube network was to go into a public-private partnership (PPP). The idea was that private companies could bid to upgrade the infrastructure, providing the funds for necessary work without full privatisation. London Underground signed 30-year contracts with Tube Lines Ltd and Metronet consortiums to undertake investment in the network, and signalled a big change to the investment approach on these networks.

The primary obstacle to a successful PPP was the complexity of the issue. The contact negotiations were due to be concluded and signed off in July 2000; in reality they weren't signed until almost three years later in April 2003[47]. The lengthy contract negotiations almost inevitably led to overly complex contracts.

The complexity of the contracts were only the start: there was a complex layer of management structures which were difficult to disentangle at best, and uncooperative at worst[48]. As a result decision-making was slow and ineffective. On top of this, the scale and complexity of the London Underground system quickly led to a series of unforeseen cost overruns that became difficult to manage. By 2010 both Metronet and Tube Lines Ltd had fallen foul of these cost increases and collapsed, leading to London Underground stepping in and buying out the companies.

The House of Commons Transport Committee wrote a special report on the London Underground and the PPP agreements in 2008. The poor management and ill-thought contracts led to a scathing review, in which they claimed: "A contractual arrangement which fails to incentivise efficiency in the private sector and at the same time fails to deter poor planning, lack of forethought and gold plating in the public sector is one which is pretty much useless."[49]

The cost implications of the agreement were large. Due to complex contracts, ineffective management and a large, complicated network; the cost to the taxpayer was huge. The direct cost to the UK government difficult to assess: some estimated it to be not less than £2.5 billion (the taxpayer was liable for £1.7 billion from Metronet's collapse alone[50]), but according to some estimates possibly far more, in the region of £20-30 billion[51].

47 House of Commons Library, London Underground PPP: A background, L. Butcher, January 2012, Page 6

48 House of Commons Transport Committee, Update on the London Underground and the Public-Private Partnership agreements, March 2010, Page 13 https://publications.parliament.uk/pa/cm200910/cmselect/cmtran/100/100.pdf

49 House of Commons Transport Committee, The London Underground and the Public-Private Partnership agreements, March 2008, Page 9, https://publications.parliament.uk/pa/cm200708/cmselect/cmtran/461/461.pdf

50 House of Commons Transport Committee, Update on the London Underground and the Public-Private Partnership agreements, March 2010, Page 5, https://publications.parliament.uk/pa/cm200910/cmselect/cmtran/100/100.pdf

51 '*The Blunders of our Governments*', I. Crewe and A. King, 2013, Page 221.

Privatising BT

The **privatisation of British Telecom (BT)** through the Telecommunications Act 1984 was the Bill that spent more time (320 hours) in the commons than any measure since the War, even though it was brought forward by a government with clear majority in the House. Due to various changes in government passing the Bill in 1984 was the culmination of the Act's initial introduction in 1981. It was also only in 1997 that the Government gave up its Special Share in BT and BT considered itself to be fully privatised.[52] Plans for the **privatisation of the energy market** were initially published in 1988 for the replacement of board areas by regional electricity companies in 1990. The transition to "full competition" in electricity retail began, region-by-region, in late 1998. By May 1999 all regional markets had been opened to competition[53], but all residual retail regulation was only removed in 2002.[54]

The effective outcomes of legislative change, such as creating competition in the telecommunications market or introducing regulators can take years to actualise. Although a Bill could technically be passed in a year (or less) it can be lengthy to effect all necessary changes (only in 1991 was a White Paper issued that effectively ended the telecommunications duopoly).

Privatisation often results in breakups of large monopolies which takes time to implement in order to not disrupt service delivery, such as the **Postal Services** Act 2011 resulting in the three-way split of Royal Mail between October 2013 and October 2015. This was so that it was separate from the Post Office, transferred some responsibilities to the government and Ofcom was made the regulator.[55] It would not be unreasonable to think that consolidating such bodies would equally take a long time to enact.

The consequences of delay

It is tempting to believe that some delay will be of little consequence, as 2050 is still far away. But the latest research on achieving net zero warns us not to fall into this trap.

For a start, the scale of work needed to decarbonise is very extensive. To illustrate, decarbonising heat will require the retrofitting of approximately 20,000 homes a week, every week for 20 to 25 years.[56] This is already a very substantial challenge, but each year of delay ramp up the difficulty of that programme. To illustrate, there are approximately 25m homes in the UK, so if we take the UKERC figure of 20,000 per week every week, every existing home will be retrofitted in 24 years. If we delay the start by just one week, such that we now need to complete the work in 23 years, the required weekly rate increases to 20,900. The total volume of work is clearly the same either way, but the work would need to be completed 4.3% faster even if the effective delay is only 12 months. A delay of 5 years (i.e. the

[52] https://www.btplc.com/Thegroup/BTsHistory/Privatisationinfosheetissue2.pdf

[53] https://www.ofgem.gov.uk/sites/default/files/docs/1999/12/reviews-of-public-electricity-suppliers-1998-to-2000---spcr---02-12_0.pdf

[54] https://www.ofgem.gov.uk/ofgem-publications/38550/3775-dcmr04july.pdf

[55] House of Commons Briefing Paper CBP-8325, May 2018, Page 50

[56] http://www.nea.org.uk/wp-content/uploads/2017/09/Heat-Decarbonisation-Report-2017.pdf. See page 4.

retrofit programme must be completed in 19 years) the weekly rate increase to 25,300. The work would then need to be completed 26.3% faster than if it was completed in 24 years, placing ever more significant pressure on supply chains and bringing into question whether the programme would remain feasible.

Delay would also prove costly in other areas where decarbonisation is required. Recent work by the CCC noted that, according to their research, decarbonisation of transportation would generate direct cost savings from 2030, hence earlier phase out was directly beneficial. In respect of cars and vans alone the CCC noted:

> *'Electric vehicles are likely to be cost saving compared to petrol and diesel vehicles by 2030. On this basis, the cumulative costs of passenger transport in the UK from 2018 to 2050 may be lower if the end to sales of cars and vans with petrol and diesel engines is brought forward to 2030, compared to 2040.'*[57]

By applying a discount rate of 3.5% to the underlying CCC data, we can see a £10bn difference was expected to arise between the 2030 phase out pathway, and a slower 2040 phase out.[58] This analysis clearly supports the Scottish commitment to phase out conventional cars by 2032. And it provides an indication of the quantum of costs that would arise in the event of the networks not being ready to accommodate EVs. We also note that this analysis ignores a much wider set of benefits that were noted by the CCC but not quantified.

> *'The scenario would also bring significant co-benefits through improved air quality and reduced noise from the deployment of zero emission vehicles and could create further economic opportunities in the UK. Measures to improve walking and cycling have associated health benefits and logistics measures contribute to reduced congestion. There is potential for electric vehicles to provide electricity back to the grid at times of high demand, reducing the need for extra storage or back-up capacity.'*[59]

Any attempt to quantify what effective delay may arise if the BEH proposals were implemented is clearly very challenging. But these examples from current research show that the implications of even seemingly modest delays may be profound. The risk that net zero deadlines might be missed would increase, costs would increase and potential benefits realised later.

5.4 Slowing innovation

Within its pages, BEH asserts in various places that MEAs and LECs will promote innovation.

> *'A network of MEAs will promote peer-to-peer skill-sharing and collective innovation.' [BEH page 15]*

[57] "Net Zero Technical Report", CCC, May 2019. https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf See page 155.

[58] This estimate is derived using the data that underlies Figure 5.5 of the CCC Net Zero report. The data can be downloaded here. https://www.theccc.org.uk/publication/net-zero-technical-report/#supporting-charts-and-data

[59] Ibid.

> *'A network of LECs will promote peer-to-peer skill-sharing and collective innovation.' [BEH page 17]*

However, there is no evidence provided as to exactly how, i.e. through what mechanisms, this will be achieved. Given the central importance of fostering innovation in respect of reducing long run costs, improving service performance and supporting the net zero transition, we have considered whether the wide ranging set of measures proposed by BEH would be likely to accelerate or harm innovation. Our analysis has identified many more risks to future innovation than opportunities. We anticipate that the BEH proposals are, on balance of risks, more likely to slow rather than stimulate innovation.

Frontier has advised extensively on the conditions that are necessary to foster and accelerate innovation.[60] That work, drawing on the available academic literature, has identified five fundamental conditions that should be in place for innovation to thrive.

- **Skills and talents.**[61] The technical expertise required to deliver innovation requires a pool of talent and expertise. It can take time to build this up in an organisation, and organisational capacity for innovation can be lost quickly, if not maintained.
- **Finance.** Innovation projects have long payback periods and some of the benefits can be difficult for private investors to capture. Public investment (e.g. the Low Carbon Networks Fund) or mechanisms that allow investors to capture the benefits of their investments (e.g. patents) are therefore often introduced. Given the long payback periods, stable policy and regulatory frameworks are also important.
- **Scale.** There are often significant scale economies associated with the development and deployment of innovative technologies.[62] In its Net Zero report, the Committee on Climate Change is clear on the importance of deployment of innovative technologies "at scale" to drive down costs.[63]
- **Locational clusters.** Innovation generally thrives in locational clusters (e.g. Silicon Valley). This is because physical colocation increases the rate at which ideas are shared, and also increases the size of the talent pool.
- **Openness.** There is evidence that industries with international links (e.g. through export market) can have higher levels of productivity.
- **Incentives.** Clearly, in addition to the above criteria, more innovation will flow when there is a commercial incentive to do so. Such incentives are provided readily in competitive markets, where innovation may lead to cheaper costs of production and/or higher quality or improved functionality any of which would improve the commercial position of the company making such innovations and lead to higher profits. In regulated sectors incentives for innovation may require

[60] This includes evaluating policies for the spending of innovation grants to businesses, the drivers of rural growth, the role of standards in helping drive productivity and clustering in the creative industries. An example of this work can be seen here: https://es.catapult.org.uk/wp-content/uploads/2019/04/2019-03-29-RDI-WP6-Report-FINAL.pdf

[61] See for example, "Fixing the foundations: creating a more prosperous nation", HMT, 2015, chart iii

[62] "Scale and Innovation During Two U.S. Breakthrough Eras", Nicholas, HBS, October 2015.

[63] Committee on Climate Change, Net Zero - The UK's contribution to stopping global warming, May 2019, Page 184 https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

specific arrangements, as the process of regulatory cost scrutiny at regular price controls may diminish incentives to innovate.

How then may BEH's proposals change the circumstances relating to each of these five fundamental conditions? We think that there are three key ways.

- **Instability/dislocation created by material change and new ownership**: The BEH proposals are fundamental and wide ranging. They include a total change in ownership across the entire sector and a wide revision of roles, responsibilities and accountabilities, which would create a new set of operational relationships between relevant parties. It would take time to create and establish these new arrangements in the first instance, and potentially much longer for them to become fully effective. This creates the following risks to innovation:
  - Proposals to re-advertise jobs a range of senior roles may cause the loss of key staff able to drive innovation and may limit the ability of new entities to hire suitably skilled individuals.
  - In the presence of uncertainty created by the potential adoption of the BEH policies, investments in risky innovation will become less attractive to existing networks. This may slow innovation in the short term.
  - A delay of some months/years before roles are clear and direction could lead to further delay.
  - Delays of this kind could result in skilled staff moving elsewhere.
- **A move towards greater geographic fragmentation and localisation**: Under BEH, REAs would become geographically fragmented into MEAs and LECs As we describe below, this will lead to lost scale economies. That effect will likely be magnified as a result of slowing innovation owing to the negative risks that will arise from loss of scale.
  - Smaller organisations will have access to smaller pools of experts, which will inhibit innovation.
  - Innovation is risky. It can be costly and there is no certainty that any given project will prove successful Smaller organisations are likely to have more limited financial resources with which to pursue any particular innovation or to undertake a portfolio of innovation which might manage that risk.
  - Lost scale economies will reduce efficiency generally, and this is likely to also affect the efficiency with which innovation is undertaken.
  - Increased localisation, through MEAs and LECs, will reduce opportunities for innovation hubs to evolve naturally, meaning that they will be absent, or specific additional expenditure will be needed to foster their creation.
  - Smaller organisations will find it hard to keep track of and engage with international developments.
- **The long term impact of public ownership**: we consider that a move to public ownership will give rise to three potential additional risk factors, one positive and two negative.

- Under public ownership, long and uncertain payback periods may be less of a barrier to innovation, at least as long as there is a genuine focus on the long term by politicians and policy makers.
- However, the particular innovation projects won't be market tested (or tested by regulatory scrutiny). There will therefore be no commercial pressure placed on which projects to pursue, in which order or in respect of how much resource it is optimal to invest in innovation. Prioritisation won't necessarily depend on achievement of outcomes (or achievement of outcomes at least cost). Thus, while more innovation may be pursued, there is an increased risk that it is not well targets, executed inefficiently and may not bring about desired outcomes.
- At present many energy networks are owned by international investors, many owning a wide range of similar assets in other countries. This ownership model will naturally foster a wider international collaboration around innovation, by creating strong links with other innovators. These natural links and alliances will be broken.

We provide a summary of our findings below. We have identified nine ways in which we expect BEH to change the conditions necessary to foster innovation. Of those nine, eight are negative risk factors, while just one is positive.

Figure 2 Summary of potential impact of *Bringing Energy Home* on innovation

	Instability around the transition to new ownership	A move to greater localisation	Long term impact of public ownership
Skills and talents	**Risk –** even a temporary slow down in innovation investment could result in skilled staff moving elsewhere	**Risk –** local organisations will tend to have a smaller pool of experts available to them	
Finance	**Risk –** even a temporary slow down in innovation investment could result in skilled staff moving elsewhere	**Risk –** investment in innovation is inherently risky. These risks may be more difficult for smaller organisation to manage or absorb.	**Opportunity** – under public ownership, long payback periods may pose less of a barrier (assuming that a political focus on short term outcomes does not drive decisions)
Scale		**Risk** – LECs and regional carbon targets are likely to reduce scope for economies of scale	
Locational clusters		**Risk –** Greater localisation will reduce the opportunities for creating innovation hubs	
Openness		**Risk** – The transaction costs of interacting with international bodies will be higher for smaller organisations	**Risk** – A move away from international ownership risks reducing the exchange of ideas
Incentives			**Risk** – Innovation projects won't be market tested or subject to commercial pressures

Source: Frontier Economics

Based on this appraisal, we consider it likely that adopting BEH would create underlying circumstances that, all other things equal, will inhibit rather than promote innovation.

5.5 Limited access to funding could slow progress towards net zero and harm network resilience

Accelerating the transition and assigning new roles to the networks (e.g. leading the delivery of EVs and storage) will require an increase in funding. BEH is unclear on whether the networks, if transferred to public ownership, would be expected to be largely self-funded, through charges to consumers (as is the case at present) or whether the networks would receive some level of funding from general taxation. The nearest BEH comes to explaining how this would work is:

> *'Pricing will be fully transparent and reflect only the cost of delivering energy - not dividends, executive salaries, or excessive interest payments.[BEH page 17]'*

The clear desire to keep energy bills low makes it likely that at least some level of ongoing funding from the state would be required. If so, then the energy transition will be competing with other core central government departments for scarce funds and may be crowded out in spending rounds. Otherwise additional state borrowing will be needed, leading to higher borrowing and/or higher taxes.

The networks will require ongoing funding from somewhere to cover day-to-day operations, network renewal and any reinforcement investments. And the new entities created under the BEH proposals are likely to be spending more cash than the existing networks would if the prevailing arrangements were to continue. Why? Because NEA and REAs will require further incremental funding to:

- overcome any increase in costs arising from loss of scale and the creation of new operational interfaces (see Section 0);
- allow them to fulfil the new roles that they are taking on compared to the existing networks, i.e. the provision of EV charging infrastructure and investment in storage; and
- facilitate the desired acceleration of the energy transition, which will require more accelerated action on the part of network, and hence greater expenditure.

It is helpful to provide a sense of the scale of funding that will be necessary, for example:

- there is currently £66bn invested in the energy networks (see Figure 3) that will need to be financed.
- It is also worth noting that the increase in depreciation lifetime for electricity distribution networks will result in their RAV doubling over the coming years even if there is no underlying increase in investment. At a minimum then, the state is likely to find itself financing around £100bn of assets annually.
- The networks are currently spending over £7bn per year (see Figure 4), the cost of which would need to be met annually, either recovered from customers, borrowing or state funding.

- There is then the uncertain additional cost of adapting the networks such that they are able to support net zero. This is clearly difficult to quantify with any degree of accuracy, but various estimates have been produced and they all suggest that the sums involved are sizeable.
  - A 2016 study by KPMG for the ENA explored a number of scenarios for decarbonising the heating sector and identified incremental costs of at least £100bn by 2050.
  - A 2014 study for the CCC by Element Energy with Imperial College and Grid Scientific found that delivering an electricity network capable of supporting a low carbon network by 2030 would create a range of sizeable incremental costs. An incremental £9bn could need to be spent on interconnectors and the main transmission and as much as £30bn on upgrading the distribution network (the NIC also reports a similar figure for distribution network reinforcement). Note that these cost estimates would not capture the cost of the sizeable acceleration in renewable deployment envisaged by Labour, or the cost of going net zero by 2050.

Figure 3 Average Regulated Asset Value (RAV) by sector during RIIO-1

Sector	RIIO-1 average RAV (£ bln)
Electricity Distribution (ED)	26,212.1
Electricity Transmission (ET)	16,173.7
Gas Distribution (GD)	18,323.1
Gas Transmission (GT)	5,519.1
Total	**66,228.1**

Source: Regulatory Financial Performance annex to RIIO-1 annual reports 2017-18, March 2019, https://www.ofgem.gov.uk/publications-and-updates/regulatory-financial-performance-annex-riio-1-annual-reports-2017-18

Figure 4 Total network expenditure by sector – actual and forecast

Totex (£ mln, 2016/17 prices)	Actuals 2016	Actuals 2017	Actuals 2018	Forecast 2019	Forecast 2020	Forecast 2021
ED	3,204	3,302	3,254	3,245	3,226	3,142
ET	2,005	1,844	1,604	1,648	2,090	2,033
GD	1,839	1,827	1,777	1,952	1,964	1,874
GT	220	263	358	398	325	250
Total	**7,268**	**7,236**	**6,994**	**7,243**	**7,604**	**7,299**

Source: Regulatory Financial Performance annex to RIIO-1 annual reports 2017-18, March 2019, https://www.ofgem.gov.uk/publications-and-updates/regulatory-financial-performance-annex-riio-1-annual-reports-2017-18

We can also place these in the context of existing central and local government expenditure. Recent Government expenditure by department is set out in Figure 5.

Figure 5 Annual government public spending, by department

Government department spending (£ billion)	2013-14	2014-15	2015-16	2016-17	2017-18
Work and Pensions	171	175	180	179	184
Health and Social Care	128	135	166	148	165
Education	82	88	82	90	96
Business, Energy and Industrial Strategy	13	19	113	16	86
Defence	41	43	47	40	53
HM Revenue and Customs	46	46	47	46	46
Scotland	31	33	33	34	36
Transport	7	18	20	20	23
Local Government	28	25	23	21	22
Northern Ireland	19	20	20	20	20
Wales	15	16	14	15	16
Home Office	13	14	13	14	14
Cabinet Office	9	11	11	10	12
International Development	10	10	10	10	11
Housing and Communities	6	7	6	8	9
Justice	8	7	8	8	8
Digital, Culture, Media and Sport	6	7	6	7	7
Sum of other departments*	3	-54	-35	-36	6
Total spending	635	621	764	650	813

Source: UK Public Spending statistical release, HM Treasury, February 2019, https://www.gov.uk/government/statistics/public-spending-statistics-release-february-2019
(*) Sum of other departments is negative in three years which reflects HM Treasury's income from financial sector interventions, see Box 2.A, Chapter 2, PESA 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726871/PESA_2018_Accessible.pdf

Expenditure on networks is small compared to, for example, the sums spent on health and education. But it is large relative to other important expenditure areas. For example:

- Current total annual network expenditure of over £7bn is around £500m larger than the total budget for the Department for Digital, Culture, Media and Sport and equal to around 150% of the total annual budget for Highways England[64].
- Should expenditure increase as a result of an acceleration in the rate of progress towards net zero, then this may result in annual expenditure flows in line with the annual expenditure of the Department of Justice, Housing and Communities and International Development.

[64] Department for Transport Annual Report and Accounts 2017-2018, Figure 7, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/741685/dft-annual-report-18-tagged.pdf

There would clearly be difficult choices to be made around spending priorities for the public purse.

In contrast, the networks have invested considerable sums since privatisation. Indeed, the rates of investment have been considerably higher than was the case under state ownership. For example, recent work commissioned by SSE highlighted how electricity distribution networks have invested far more while in private hands than they did while state owned, and how this translated into rapid improvements in performance.[65]

At present there is no meaningful constraint on the sums that are available to be invested in the energy networks, provided that private investors are confident that returns on invested capital can be expected to remain fair. Under BEH, there is now a new risk that a funding constraint could apply in future and this creates an additional risk around the ability to deliver net zero in an efficient and timely way.

5.6 The geographic fragmentation of the sector will increase cost

Energy networks are natural monopolies.[66] The BEH proposal to allow and encourage the creation of MEAs that would own and operate their local distribution grid would lead to geographic fragmentation that would increase cost. This would be in addition to any increases in cost arising from the transition to a net zero carbon economy.

A sector is a natural monopoly when it is more efficient for one provider to provide the service rather than more than one. Energy networks are natural monopolies because of the very large fixed and common costs associated with building and maintaining the networks of pipes and wires. The duplication of those costs by enabling multiple networks to be built in the same streets, town, region, would be very inefficient and costly for customers. Instead, it is more efficient for customers to benefit from the economies of scale available by maximising the utilisation of the sole network across as many customers as possible. The natural monopoly nature of energy networks is recognised around the world, through the monopoly provision of energy network infrastructure in any given geography.

Scale then – and achieving minimum efficient scale – is an important element of keeping costs down.

In this context BEH's proposals to allow and encourage the creation of MEAs will lead to the geographic fragmentation of the existing energy network into smaller autonomous units. This will lead to increased costs and lower levels of efficiency. While the NEA and REAs envisaged will largely replicate the service regions (and hence scale of operation) of the existing transmission and distribution companies, MEAs would lead to a reduction in scale and hence lost scale efficiencies. The MEAs would be relatively small entities themselves, but each new MEA would lead

[65] https://sse.com/media/623270/NERA-Economic-Consulting-Comparison-of-public-and-private-eletricity-networks.pdf. See page 8, Figure 2.1.

[66] It is worth noting that this is one of the reasons that networks are prohibited from owning generation. There would be a natural concern among potential competitors that the monopoly network may favour its own generation projects rather than those of independent competitors. The ownership of generation by networks is one of the measures proposed in BEH and would create another conflict of interest.

to a loss of scale form the REA that the MEA devolved from. In addition to the simple loss of scale, it would also create a new interface where presently one does not exist. This would create operational challenges and new costs.

What scale of operation is envisaged for MEAs?

> *'An MEA can be set up at scales as small as a parish council, or as large as a city like Manchester or Glasgow.' [BEH page 14].*

MEAs would range in size, but could therefore be very small. The available evidence suggests that even the larger MEA's (e.g. running distribution and supply for a city the size of Leeds, an example given on page 9 of BEH) are likely to be operating at a scale where higher cost to serve is more or less inevitable.

Another reason for the existence of scale economies in network provision is the meshed nature of many energy networks. While some boundaries between networks are inevitable, the proposal to allow MEA to be created within the service region of an REA will lead to new interfaces along administrative boundaries, separating networks that have hitherto been planned and operated as one coherent whole.

If an existing network is subdivided, it is likely that the smooth operation of the resulting split grids will depend a great deal on the smooth operation of their new neighbour(s). There will be a need for the flow of real time information and, ideally, co-planning of decision making on the grid. Decisions on how to configure and reinforce the grid run by one company may cause knock on changes in power flows in the other grid. As a result what might be efficient for one operator may lead to higher costs to serve for a neighbour and higher costs overall.

While it may be reasonable to presume that a new MEA devolved from an existing REA would be able to find ways to ensure efficient operation and planning, making this happens would not be costless. By creating a new boundary between two distinct entities, we would create a new set of transaction costs that would increase overall cost to serve. And if coordination was less than perfect, then the failure to co-optimise across both grids could give rise to further costs to serve relative to a more coherent counterfactual.

Evidence on scale efficiencies from academic work

The academic literature strongly supports the existence of scale economies in the network sector, a result that holds across a very wide range of scales of operation, including at the scale of the present DNOs and GDNS. To provide some specific examples:

- Burns and Weyman-Jones (1994) found scale elasticities of 0.565 (in their unrestricted model) and 0.721 in a more parsimonious model when estimating the cost efficiency of the England and Wales DNOs over the period 1980 to 1993. (To understand how to interpret these figures, a scale elasticity of 0.7 would imply that for each 1% increase in all network outputs, costs would

increase by only 0.7%. Hence, all other things equal, a larger entity will have lower costs per unit or per customer than a smaller company.)[67]

- A follow on paper by Burns and Weyman-Jones (1996) fitted a wider range of models on the same data, and found scale elasticities ranging between 0.669 and 0.861.[68]
- Growitsch, Jamasb and Pollitt (2011) estimated cost functions for electrical networks from the UK, Ireland, Netherlands, Finland, Norway, Sweden and Italy. They found that their models '*shows evidence of significant economies of scale in electricity distribution networks*' and '*that large utilities are technically more efficient even when quality is controlled for, indicating that larger firms can supply a given level of QoS at lower cost*'.[69]
- Filippini (2006) analysed data on 39 publicly owned electricity networks over the period 1988 to 1991 and found that '*Economies of both scale and utilization appear to exist in the distribution of electricity, both for small-, medium- and large-sized utilities.*'[70]
- Work by Frontier Economics on behalf of Ofgem at RIIO-ED1 also found scale elasticities of 0.812 and 0.817 across the 14 GB licences across two preferred totex models.[71]
- Ofgem's top down totex model at RIIO-ED1 implied a scale elasticity of 0.7373.
- While most empirical academic work has focused on electricity distribution identical logic also holds for gas. For example Ofgem's totex model at RIIO-GD1 implies a scale elasticity of 0.7467.

The finding of economies of scale therefore holds:

- Across different network types;
- At all relevant scales of operation;
- Across different geographies; and
- Has been found across studies looking at data from the 1980s through to much more recent evidence.

To give a feel for what impact on cost the proposed creation of MEAs and LECs might have, we give an illustrative estimation based on the example in BEH. The proposal outlined on page 9 of BEH shows Yorkshire[72] operating as an REA and Leeds operating as an MEA. Using the above scale elasticities, we can estimate the potential cost increase of separating Leeds from the rest of Yorkshire, versus

67 "Productive efficiency and the regulator review of regional electricity companies in the UK", Burns and Weyman-Jones, 1994.

68 "Cost functions and cost efficiency in electricity distribution: a stochastic frontier approach", Burns and Weyman-Jones, 1996/.

69 "Quality of service, efficiency and scale in network industries: an analysis of European electricity distribution", Growitsch, Jamasb and Pollitt, 2009.

70 "Economies of scale and utilization in the Swiss electric power distribution industry", Filippini, 2006.

71 https://www.ofgem.gov.uk/publications-and-updates/frontier-economics-total-cost-benchmarking-riio-ed1-%E2%80%93-volume-1

72 This illustrative example uses the NUTS 1 region, as defined by the UK statistical authority, of Yorkshire and the Humber, which has a population of 5.14m. The population of Leeds is 789k.

the alternative of maintaining Yorkshire as one entity. The overall estimated cost increases are between 7% and 18%[73].

5.7 Ensuring bills are fair and equitable

A key objective of BEH is around fairness and avoiding the risk of inequality in outcomes arising from decentralisation. However, if one MEA decides to embark on a large solar installation and network build-out programme, while the MEA next door does nothing – who pays? Does the funding all come from the taxpayer via central government or is it charged directly to customers in the area? As noted above, the principle suggested in BEH is cost reflectivity. But this may lead to numerous complications.

Above we have explored the issue of limits on available capital if some funding is required from central government. But a further set of complex issues are likely to arise if the networks are self-funding and follow cost reflective principles, owing to the envisaged nested structure of these entities, i.e. the MEA would be embedded within an REA, an LEC would be embedded within an REA or MEA and so on.

To illustrate the problem, consider what charges should be levied to households served by an LEC. The LEC will incur some costs directly, in maintaining and operating its distribution grid, and potentially in installing and running some small scale local generation.

These will, presumably, need to be funded by the individuals served by the LEC. This immediately gives rise to a risk for the group of individuals served by the LEC. If their local distribution plant breaks down or running the system proves more expensive than anticipated, the community served by the LEC will be stuck with the cost, whereas at present customers are largely insulated from such effects (e.g. through fixed regulatory allowances, through the pooling of risks in larger companies serving many customers and through the average of charges across customers – nobody is hard charged if their nearest substation requires major work). By creating smaller entities serving small numbers of customers we may focus risk on small numbers of individuals. Allocating risks in this way may require more careful analysis than is present in BEH, in order to ensure that participants in an LEC are educated as to the risks they may take on.

But there are risks running the other way too – from the smaller entity back to customers of the larger entity they devolve from. The MEAs and LECs most likely to be created are those that have lowest average cost to serve (because for example the local geography makes network operation particularly straightforward and cost effective in that location). To illustrate, serving urban areas is generally cheaper on a per customer basis, as many customers can be served with relatively few network assets, whereas in rural areas more network is needed to serve fewer customers. Under existing charging methodologies there is considerable averaging across customer types, but this would be much harder to achieve if customers in different geographies were now served by entirely different entities (i.e. the legacy REA and a new MEA or LEC). The risk then is that “cheap” areas

[73] The range depends on which scale elasticities are used: in this example we have taken the highest and lowest elasticities: 0.861 and 0.669 – both estimated by Burns and Weyman-Jones (1996)

devolve themselves from the local REA, leaving higher costs to be borne by those customers that remain with the REA.

It is also unclear what would constitute a mandate for the creation of an MEA/LEC. Would inhabitants of a proposed MEA area have the ability to "opt out", or would the choice be forced on them? The ability to opt out could again give rise to a "death spiral" of opt outs if costs to serve of the MEA ended up higher than the alternative local provider.

Further complications will arise if neighbouring networks rely on one another, e.g. if security of supply to a city that devolves into an MEA is only assured if it can rely on grid support from the surrounding area, run by the legacy REA. What contribution to the costs of the REA should be made by those served by the MEA?

Few such issues arise at present, as DNOs and GDNs are large and boundaries between them reflect sensible operational splits. But in future we may have administrative boundaries placed arbitrarily within networks that are highly meshed. If many regions devolved we may end up with the need to create a web of complex "transfer prices" in order to ensure that charges are fair. Who will design and oversee these charges? The task would be complex and potentially contentious. Inevitably, simplifications and shortcuts will follow, with the potential for something of a postcode lottery of costs to service (and also potentially standards of service).

5.8 Confused roles, conflicts of interest and weak checks and balances

Under the present institutional and governance arrangements, roles are clear. Policy is set by Ministers. Ofgem develops a regulatory regime to meet the policy. The companies are responsible for delivery. The CMA provides a needed check and balance. There is clarity of accountability at each stage and there are no conflicts of interest.

A number of aspects of BEH will lead to blurred accountability, confused roles and weak checks and balances. We explore a number of these below.

A self-regulating entity that sets its own policy

The envisaged remit of the NEA is extremely large and wide ranging. It would appear that the NEA will:

- Take over policy making in at least some aspects, in particular in respect of setting climate targets;
- Take over a number of the roles presently held by Ofgem (which would presumably cease to exist, at least in its present form). Including publishing information on the performance of REAs/MEAs/LECs; and
- Own and operate the transmission grids.

Having a single body that makes policy for itself, self-regulates and also regulates others, in addition to being directly responsible for delivery, seems far from best practice. There are immediate and obvious incentive problems and conflicts of

interest that arise from having policy, regulation and delivery combined in one entity. There are no checks and balances in the system and a general lack of scrutiny, a formulation that is likely to lead to satisficing behaviour to the detriment of customers. This can be directly contrasted with the existing arrangements, where there is clarity of role and accountability.

We note as an aside that, on the face of it, this proposal is inconsistent with the EC's Electricity and Gas directives (2009/72/EC and 2009/73/EC) which require an appointed National Regulatory Authority to be '*legally distinct and functionally independent from any other public or private entity*'.[74]

NEA will translate national carbon targets into regional targets

At present the UK does not subdivide its national targets into regional targets. The process through which the NEA would attempt this highly challenging task is not specified, but could be very important. It would also represent a considerable centralisation of power into the self-regulating NEA.

Why contentious? REAs that take on more of the decarbonisation burden (i.e. that are given targets higher than the national average of 60% renewable deployment) may well incur higher costs than REAs that take on less. So who pays?

- Is it the directly connected customers of the REA that rolls out the technologies?
- Or will customers from across the country pay? And if so who determines any cross subsidies from one REA to another?
- This process would be contentious and it is not clear what rights of appeal exist.

Within this framework, REAs will have an incentive to downplay their ability to deploy low carbon technologies, in order to seek a more manageable delivery target and to limit the extent to which they impose costs on their customers.

- How will the NEA monitor REA submissions to the central target setting process to ensure they are accurate?
- What appeal rights do REAs have if they disagree with the decisions of the NEA?

Even absent these incentive problems, the task of centrally determining where to roll out low carbon technologies would be extremely challenging. Costly errors are almost inevitable. Renewable generation and low carbon technologies are deployed across the country on the basis of very many individuals decisions taken by developers, companies, households, local councils etc. Each of these parties will need to consider for themselves the economics of investing in a low carbon at that particular locale, within the prevailing framework of charges and subsidies. And each party will bear the resulting risks of their own decision.

By relying on market forces, guided by wider policy measures and objectives, to govern roll out, efficiency is strongly incentivised and risks allocated to the appropriate party. Under BEH, the NEA will need to decide all of this centrally. This places a very significant informational burden on the NEA, to understand relative attractiveness of building all manner of low carbon technologies at scale in

[74] See Chapter IX of 2009/72/EC and Chapter XIII of 2009/73/EC.

different locations across the country, in order to optimise deployment. Given the challenging nature of this role, error is almost certain, and this will lead to setting targets inappropriately and inefficient costs of deployment.

We note that one of the arguments in favour of greater state involvement is its ability to coordinate action effectively, more effectively than when many smaller parties are involved. While this argument may have merit, it's force is severely diluted here by the proposed fragmentation of the sector into many parties under BEH.

Ensuring costs are affordable

Both the NEA and the REA would have responsibility for ensuring that energy costs are affordable. It is clear that what is intended is a strong focus on what has become known as fuel poverty[75], and potentially also generally on the cost of energy to homes and businesses. However, the mechanism through which affordability may be assured is unclear.

Whether energy bills are affordable depends (obviously) on the combination of the cost of meeting energy needs and on household incomes. The NEA or the REA may have some ability to control the first of these, but this control would not be complete. Although the NEA and the REA can help to shape the cost, by attempting to ensure efficiency of delivery and by changing the speed of decarbonisation (we assume it would be unacceptable for standards of service or reliability to suffer), costs will at best only partially influenceable. If the cost of supplying energy increases in future (and given the challenges that will be faced in decarbonising this is close to certain), then affordability issues will become more prevalent and acute.

While NEA and REAs may have some ability to manage cost increases, they clearly have no control at all over the household incomes of those experiencing fuel poverty.

So what powers might the NEA/REAs need in order to '*ensure*" affordability as BEH demands? There is a relatively small set of potential options.

- Spend less in order to reduce cost. But this will slow the transition, so we presume it would be ruled out.
- Seek subsidy from Government, leading to higher taxes or higher borrowing.
- Subsidise bills for certain fuel poor customers, by making others pay more.

How will the NEA and REA decide between these options? A clear framework would be needed to guide decisions taken in this area.

[75] The Government's definition of fuel poverty, along with statistics on the prevalence of fuel poverty, can be found here. https://www.gov.uk/government/collections/fuel-poverty-statistics

Skills and capacity building

Under BEH, the NEA would be responsible for '*future skills and workforce planning as part of capacity building responsibility*'. The NEA would also '*provide resources and training to REAs, MEAs and LECs*'.[76]

At present, workforce planning is a task for which each network is responsible. The standard licence conditions require each licenced network to ensure that it has available at all times all the resources necessary to meet its obligations. Networks must decide whether to grow their own, hire already skilled people from the wider labour market, or subcontract to service companies that may have the needed skills. Whatever approach they adopt, this obligation cannot be avoided and the risk of taking inefficient decisions sits squarely with the networks. For example, consider a situation where one of the network fails to plan appropriately for the long term and hence finds itself short of key resources. It may then need to pay over the odds to a subcontractor. The majority of any excess cost versus more efficient peers (that planned better) will be borne by the company under the current regulatory arrangements.

In essence, accountability and responsibility for workforce planning is devolved to the parties that can do both something about it and will be exposed to the financial consequences of their decisions.

Under BEH, accountability clearly rests with the NEA, but there would be no commercial pressure on the decisions that the NEA may takes.

- The NEA would be responsible for workforce planning for itself (in its capacity as owner and operator of both transmission networks) and a wide range of other parties, including REAs, MEAs and LECs.
- The NEA would need to try to gather information from each of these bodies from across the country on their present resources and their current and future resource needs, not just on its own needs.
- It is not clear how the NEA would vet these submissions.
  - The incentives of the REA/MEA/LEC would be to overstate their needs, so as to ensure that they are well resourced, rather than signing up to make the most of more scarce resources.
  - What checks and balances would exist to address this?
  - If the NEA did seek to limit resources, how would it decide how to "ration" the allocation of resources it allocated to the REA/MEA/LECs? What appeal rights would exist? What would the REA/MEA/LECs do if the NEA cannot provide the resources needed?
- If the NEA gets its wrong (e.g. it hires too many people) who pays?

As an aside, it is also worth noting that there may be limits to what the NEA is able to achieve in respect of expanding the workforce. There is a recognised shortage of STEM candidates entering the job market and a many companies have reported

[76] BEH page 10.

an inability to hire candidates as they would like.[77] The material acceleration in renewable deployment may not come cheap.

An active role in industrial strategy

BEH envisages that the REAs would play a role that goes beyond the focused delivery of regional energy infrastructure to support decarbonisation.

> *'The new REAs will, inter alia: …. Be empowered to take an active role in regional industrial strategy, using their procurement and planning powers to create jobs and economic activity.' [BEH page 13)*

Firstly, it is not clear why an energy network company should be expected to take an active role in industrial policy. If there is an energy need to be met, then the focus of the energy network should be on meeting that need, along with others placed on it, at lowest long run cost.

There are clearly risks that arise as the objectives of the networks become more multifaceted and blurred. Should the network start to invest ahead of need, in order to creates jobs either directly or through stimulating demand in their region? Who would monitor what each region was doing and what networks as a whole were doing, and whether this was reasonable? How can the risk of regional level lobbying and agency capture be mitigated? Generally, how should this objective be balanced against the need to ensure affordability?

Representation and accountability

One of the primary objectives within BEH is around representation and accountability, the desire to bring more democratic oversight into energy networks.

> *'it is imperative that energy networks be run transparently, in the public interest with democratic control and oversight.' [BEH page 7].*

We have already set out the numerous aspects of the existing arrangements that create opportunities for effective scrutiny of the whole sequence of decisions (from policy formation to final delivery) and for wide participation, including participation by interested individuals. It is in our view wrong to suggest that any aspect of network performance is outside the control of democratic representatives and/or independent regulators, or that there is a lack of transparency over what networks are asked to do and how well they do it.

BEH proposes to replace very many aspects of the current arrangements, reformulating the scope of important entities by merging the functions of a number of entities that are today distinct. We have described above the important concerns that arise from the lack of clarity over responsivity, from the confused allocation of roles and from losing the separation between functions. This can be expected to lead to reduced ability to monitor decisions and to hold decision makers to account versus the status quo. It may be that the steps BEH proposes to modify governance arrangements around the new entities to be created can overcome the

[77] See for example Section 3 of House of Commons Science and Technology Committee, Thirteenth Report of Session 2016-17. https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/991/991.pdf

weakening of oversight that will come from these structural deficiencies, but this cannot be guaranteed.

ANNEX A EVOLUTION OF THE DUTIES OF THE SECRETARY OF STATE AND OF GEMA

The statutory duties – or to be precise the principal objective and general duties of the Secretary of State and of GEMA – while being directionally consistent over time, have changed considerably over time as the needs of policy makers have changed. The intention of what follows is not to present an exhaustive analysis of all changes made to the key legislation, but to highlight that under the existing framework policy objectives have changed, by having their focus shifted, by modifying the relative priority of competing objectives and by adding new concerns to those that have always existed as new problems have emerged. There is therefore enormous flexibility for policy makers to require Ofgem, and hence the regulated networks pursue and achieve whatever outcomes are desired.

- The original form of the Electricity Act 1989 set out five duties in the first two subsections of the Act.
  - (1) The Secretary of State and the Director shall each have a duty to exercise the functions assigned or transferred to him by this Part in the manner which he considers is best calculated—
    - (a) to secure that all reasonable demands for electricity are satisfied;
    - (b) to secure that licence holders are able to finance the carrying on of the activities which they are authorised by their licences to carry on; and
    - (c) subject to subsection (2) below, to promote competition in the generation and supply of electricity.
  - (2)The Secretary of State and the Director shall each have a duty to exercise the functions assigned or transferred to him by this Part in the manner which he considers is best calculated to secure—
    - (a) that the prices charged to tariff customers by public electricity suppliers for electricity supplied in pursuance of section 16(1) below to premises in any area of Scotland specified in an order made by the Secretary of State are in accordance with tariffs which do not distinguish (whether directly or indirectly) between different parts of that area; and
    - (b) that public electricity suppliers are not thereby disadvantaged in competing with persons authorised by a licence or exemption to supply electricity to such premises.[78]
- There was no specific guidance on whether some of these objectives were more important than others or on how any trade-offs should be made when any of these five come into conflict with one another.
- There were then, subject to the provisions of first two subsections, five further duties as prescribed in subsection 3 of the Act, with the clear implication that these five were secondary to the first five:

[78] http://www.legislation.gov.uk/ukpga/1989/29/section/3/enacted

- (a) to protect the interests of consumers of electricity supplied by persons authorised by licences to supply electricity in respect of—
  - (i) the prices charged and the other terms of supply;
  - (ii) the continuity of supply; and
  - (iii) the quality of the electricity supply services provided;
  - (b) to promote efficiency and economy on the part of persons authorised by licences to supply or transmit electricity and the efficient use of electricity supplied to consumers;
  - (c) to promote research into, and the development and use of, new techniques by or on behalf of persons authorised by a licence to generate, transmit or supply electricity;
  - (d) to protect the public from dangers arising from the generation, transmission or supply of electricity; and
  - (e) to secure the establishment and maintenance of machinery for promoting the health and safety of persons employed in the generation, transmission or supply of electricity;

- Finally, subsections 4 and 5 required the Secretary of State and the Director to take into account the interests 'consumers of electricity in rural areas', and of consumers 'who are disabled or of pensionable age'.
- Much has changed since then, with the online version of the Act listing 31 textual amendments and 13 modifications.
- The Secretary of State now has a clear primary objective 'to protect the interests of existing and future consumers'.
  - The change to create a primary objective was made first.
  - The duty to protect both 'existing and future consumers' was added later in 2009, to provide a statutory footing for policy and regulation to take appropriate account of long run interests, not just the here and now.
- Further changes clarified explicitly what was meant by 'the interests of consumer'. In particular:
  - 'the reduction of electricity-supply emissions of targeted greenhouse gases' was added in 2010, reflecting the increasing prominence of environmental concerns;[79] and
  - the need to take account of the EC's Electricity Directive was also written into the legislation.[80]
- Further groups of consumers with particular interests to be protected were also identified, with specific mention of 'chronically sick' and 'individuals on low incomes' added to the disabled, pensioners and rural customers.

[79] Subsection 3A 1(A) (a).

[80] Subsection 3A 1(A) (c)

ANNEX B PERFORMANCE UNDER THE PREVAILING ARRANGEMENTS

Below we provide examples of the performance record of the GB energy networks, drawing on published reports and available public evidence.

Costs and productivity

- '*The costs of GB's energy networks have fallen substantially since privatisation: GB consumers benefited from substantial efficiency gains in the 1990 to 2010 period, with network costs down by 50%. Even with the urgent network investment required since then (as Britain decarbonises), costs are still much lower in real terms than pre-privatisation.*' [81]
- Ofgem's recently published an analysis of the productivity of the energy networks that showed that they outperformed the wider UK economy by around 1% per year in the 30 years since privatisation.[82]

Investment

- *'on aggregate consumers have paid over £80bn in investment on networks since privatisation, with a further £40bn needed over the RIIO 1 price control. This 50% real terms increase in investment since 1990'.*[83]
- '*In every regulatory period following privatisation, capex per customer [for the electricity distribution networks] has been higher than in the 10 years prior to privatisation*'.[84]

Reliability

- '*Electricity networks have grown steadily more reliable, and gas networks have remained extremely robust: There was a 30% reduction in the number and duration of power cuts between 1990 and 2008. Performance has continued to improve under RIIO with customer interruptions and customer minutes lost decreasing by 9% and 12% respectively between 2014/15 and 2015/16. The average gas customer will experience an unplanned interruption once every 140 years.*'[85]

Connecting renewables

- The cost reductions noted above have been achieved despite the connection of a very large volume of renewable generation.

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81 "GB Energy Networks: an analysis of delivery since 1990", KPMG, September 2017.

82 "Productivity growth in electricity and gas networks since 1990", Ajayi, Anaya and Pollitt ,December 2018.

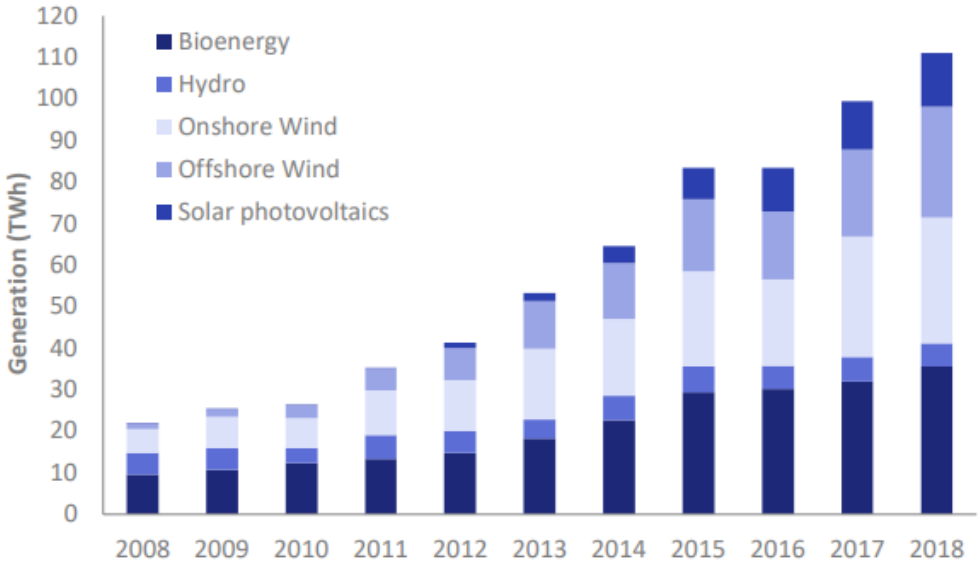
83 KPMG..

84 "A comparison of the performance and efficiency of public- and privately-owned energy networks", NERA, June 2019

85 KPMG.

- The networks have so far connected **45 GW of renewable capacity**, a figure that is growing rapidly.[86]
- **Renewable generation** has vastly increased over the last decade, with a third of 2018's total electricity generation being produced by renewable sources (111.1 TWh out of 333.9 TWh).[87]

Figure 6 Renewable electricity generation



Source: BEIS, UK Energy Statistics 2018 and Q4 2018.

[86] BEIS, June 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/811974/Renewables_June_2019.pdf

[87] BEIS, UK Energy Statistics 2018 and Q4 2018, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791297/Press_Notice_March_2019.pdf

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