22 JANUARY 2021

# GB SYSTEM OPERATOR REVIEW

REPORT PREPARED FOR OFGEM

## Table of contents

## Executive summary

The energy market in Great Britain ("GB") is currently undergoing a period of transition, driven by efforts to tackle climate change, which has led to a rapid increase in the share of generation from intermittent renewable sources. As part of these efforts, the UK Government has committed to achieving Net Zero carbon emissions by 2050.

The increased reliance on intermittent generation has meant that the task of maintaining the integrity of the electricity system on a second-by-second basis is becoming increasingly challenging. Moreover, achieving Net Zero by 2050 is very likely to require significant volumes of new network investment, which will need to be planned and co-ordinated carefully to achieve the best value for consumers. The declining role of natural gas as an energy source will also need to be carefully managed during this period.

The system operators ("SOs") of both the electricity and gas sectors have historically played a pivotal role in managing the energy networks in GB. In electricity, the SO role is undertaken by National Grid Electricity System Operator ("NG ESO"), which is legally separated from National Grid Electricity Transmission ("NGET"). NGET owns the electricity transmission network in England and Wales. In gas, the SO role is undertaken by the Gas SO ("GSO"), which is fully integrated within National Grid Gas Transmission ("NGGT").

In the past, the role was focused on managing the networks on an operational basis. In recent years, as the roll out of renewable electricity generation has accelerated and the demand for gas has declined, the role and nature of activities undertaken by the SO has expanded to include aspects of planning the networks and market-based functions. As the UK moves towards Net Zero, the role of the SO in both sectors is likely to become increasingly complex. As such, the Office of Gas and Electricity Markets ("Ofgem") and other stakeholders are concerned that the current arrangements may lead to possible conflicts of interest between the SO role and National Grid's other activities as a transmission asset owner.

In this context, Ofgem is reviewing the current SO arrangements and is considering whether other arrangements may result in a more optimal delivery of the Net Zero target. As part of this review, Ofgem has commissioned FTI Consulting to:

(1) assess the magnitude of the potential conflicts of interest in the current SO arrangements; and

(2) explore options for alternative SO arrangements.

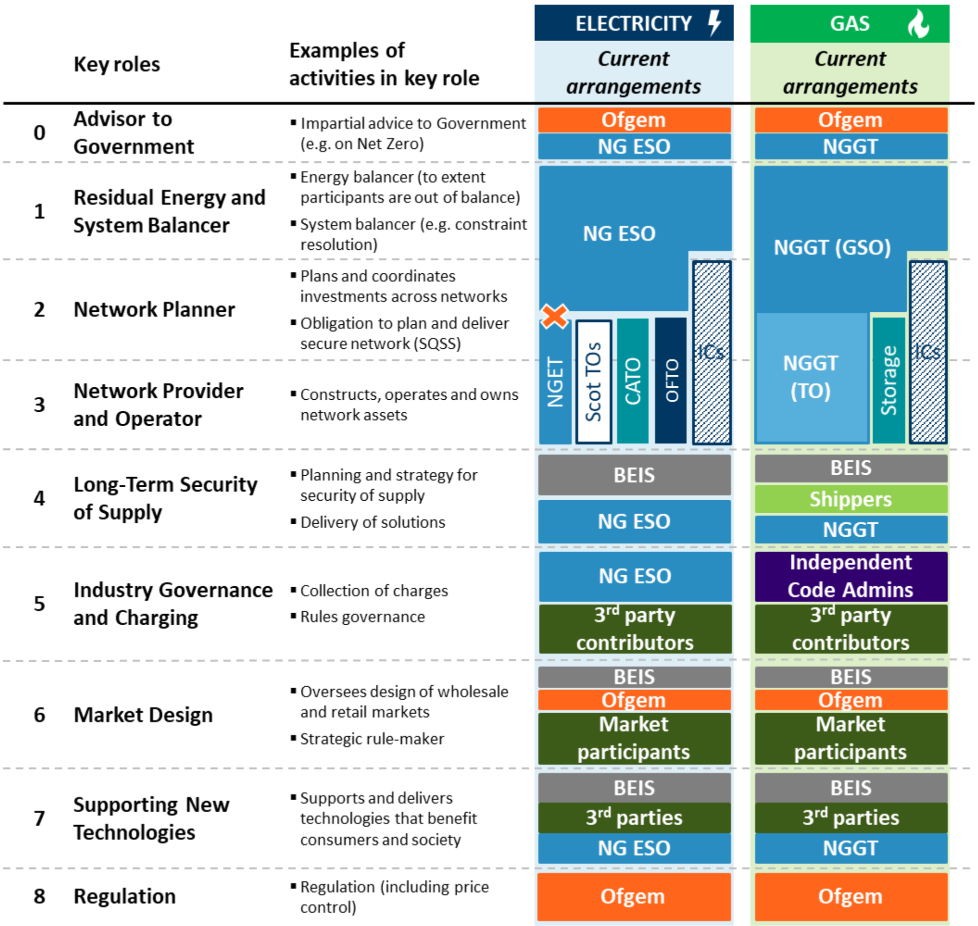
### Potential conflicts of interest in the current roles of the system operator

Both NG ESO and the GSO within NGGT occupy a central role in their respective energy networks. Energy networks are complex and there are many ways to categorise the various roles market participants undertake in the system as a whole. To create a framework for our analysis in this report, we have delineated nine key activities common to both the electricity and gas networks that are currently carried out by different parties:

- **Advisor to Government.** Provides impartial advice to Government.
- **Residual Energy and System Balancer.** Ensures the network as a whole remains balanced within certain operational tolerances.
- **Network Planner.** Co-ordinates and decides on investments in the network.
- **Network Provider and Operator.** Constructs, operates and owns network assets.
- **Long-term Security of Supply.** Ensures that there is sufficient supply to meet demand (up to an agreed security standard).
- **Industry Governance and Charging.** Responsible for administering industry codes and collecting network charges.
- **Market Design.** Develops operational rules and trading arrangements in the wholesale and retail markets.
- **Supporting New Technologies**. Advocates, co-ordinates investment for, and delivers new technologies for the benefit of consumers.
- **Regulation**. Monitors energy markets, including the companies that operate it, to ensure they are functioning in the interests of consumers.

The figure below summarises the main parties responsible for each of these roles in both the electricity and gas sectors.

**Figure ES-1: Summary of current SO arrangements in electricity and gas**




*Source: FTI analysis.*
*Notes: Competitively Appointed Transmission Owner ("CATO"); Offshore Transmission Owner ("OFTO"); Interconnector ("IC"); Department for Business, Energy & Industrial Strategy ("BEIS").*

As previously discussed, under the current SO arrangements NG ESO is legally separate from NGET, but remains part of the wider National Grid Group plc. By contrast, the GSO and Gas TO ("GTO") functions are fully integrated within NGGT. Ofgem and other stakeholders are concerned that these arrangements create scope for several potential conflicts of interest that could lead to suboptimal, and therefore potential costly, outcomes for customers in the transition to Net Zero.

These potential conflicts can be summarised as follows:

- **Perception of lack of independence.** Advice given to Government by National Grid entities may be perceived to be in National Grid's self-interest, or to not be in the best interests of consumers. For example, there may be a perception of bias towards advocating solutions to Government that are in some way beneficial to National Grid's other businesses (for example, its transmission or interconnector businesses), which could undermine the value of such advice - even in the absence of any actual bias.
- **Possible asset ownership bias.** As the SOs could have a role in planning the future of the energy system, an SO may be able to take decisions regarding investment in transmission infrastructure that allow Transmission Owners ("TOs") within the National Grid plc group (in both electricity and gas) to spend more on transmission assets than they otherwise would be.
- **Possible bias in competitive procurement.** There may be a perception of bias against third party bidders in any competitive procurement of transmission solutions. If the SO is responsible for running the competition (as is currently envisaged) then there may be a risk that third-party bidders are discouraged from participating. In turn, this might dilute the competitive pressure in transmission that is being developed to reduce costs to customers.
- **Other potential conflicts of interest.** There may be other potential conflicts of interest in the operation of the Capacity Market, market design, and support for specific new technologies.

### Assessment of the magnitude of potential conflicts in SO arrangements

To assess the possible magnitude of the potential conflicts of interest described above, we consider the net benefit to consumers of removing the theoretical conflicts in **both electricity and gas**.

Our overarching assumption is that removing the potential conflicts identified above requires a full unbundling of the SO from the TO. We assume that the maximum net benefits that can be obtained from fully unbundling the SO and TO are equal to the potential costs to customers arising from these possible conflicts (or perception of conflicts) in the current SO arrangements.

While taking actions to remove the potential conflicts may bring benefits to consumers, **certain costs will also be incurred**. We attempt to quantify these costs, in order to calculate the net benefits to consumers of fully unbundling the SO and TO.

We estimate these net benefits for the period between 2022, the start of the RIIO-2 period,[1] and 2050, the deadline by which the UK Government has committed to achieving Net Zero emissions.

Given the significant time period involved, and the inherent uncertainty of estimating these effects, we present our results as upper and lower bounds over a range of scenarios.

*Approach to assessing the magnitude of the potential asset ownership bias*

To estimate the possible magnitude of the potential cost to customers of asset ownership bias in both electricity and gas, we:

(1) forecast to 2050 the total expenditure on the transmission network, over several possible scenarios; then

(2) assume some proportion of this expenditure is 'overspend' as a result of asset ownership bias that might not otherwise have been incurred if the SO was fully unbundled from the TO.

*Approach to assessing the magnitude of the potential bias in competitive procurement*

To estimate the possible magnitude of the potential bias in competitive procurement in electricity, we:

(1) forecast the total value of transmission assets that could be procured via a competitive process;

(2) estimate the likely cost savings that could result from competitive procurement, as a proportion of the total value of assets procured; then

(3) assume some proportion of these cost savings may not be realised, unless the SO was fully unbundled from the TO.

We assume that, in line with current Ofgem policy, competitive procurement of gas transmission will not occur.

1 'RIIO' stands for Revenue using Incentives to deliver Innovation and Outputs and is the name given to the framework Ofgem uses to set price controls in the GB energy sector. RIIO-2 refers to the second round of price controls set under this framework.

*Approach to valuing the cost to consumers of removing potential conflicts*

We would expect several costs to be incurred in unbundling the SO. These include the costs of implementing separation, and the loss of any operational synergies that may exist between the SO and TO functions.

The **implementation costs** of separation are the direct costs associated with unbundling the SO from the TO. This could involve one-off upfront costs, such as the purchase of a new building, or ongoing costs, such as the cost of hiring staff to perform roles that need to be duplicated across both the SO and TO (finance, human resources, etc.).

In electricity, some level of implementation cost has already been incurred in legally separating NG ESO. However, there are likely to be further costs that would be incurred in moving to a fully unbundled ISO.

There may also be **operational synergies** associated with the integration of the SO and TO, which might be reduced if they are unbundled. These operational synergies revolve around the SO's role as the Residual Energy and System Balancer. It is possible, in some circumstances, to co-optimise between commercial balancing actions that would typically be undertaken by an SO and short-term asset optimisation actions taken by the TO. For example, rather than incurring a cost to resolve network congestion in the balancing market, it may be less expensive to incur additional wear and tear on transmission assets by flexing voltage tolerances for a short period of time. In the gas market, a similar analogy is that it might be preferable to reschedule compressor maintenance (at additional cost) rather than incur cost in, say, capacity buy backs.

While it might be possible to contractualise this interface between the SO and TO, full unbundling may create additional friction in achieving these synergies, resulting in higher costs for consumers.

These operational synergies have arguably already been impacted upon in electricity as a result of the legal separation of NG ESO from NGET in 2019, so we only estimate their value in the gas sector.

*Net benefits of fully unbundling the SO*

Based on the scenarios considered and our estimate of the potential conflicts that we have quantified, we estimate that the net benefits of eliminating those potential conflicts, are likely to be materially larger in electricity than in gas. Indeed, we estimate the net benefit to consumers of removing the potential conflicts is between **£0.4 billion and £4.8 billion** in **electricity**. This compares to a range between a **£0.8 billion net disbenefit** and **£0.4 billion net benefit** in gas. These are illustrated in the tables below.

**Table ES-1: Estimated net impact on consumers from unbundling of NG ESO**

| Items | Minimum<br>*£ billion* | Maximum<br>*£ billion* |
|---|---|---|
| Removing potential asset ownership bias | 0.21 | 2.87 |
| Removing potential bias in competitive procurement | 0.27 | 1.95 |
| Loss of operational synergies | n/a | n/a |
| Implementation costs of separation | (0.10) | (0.05) |
| **Net impact on consumers** | **0.38** | **4.77** |

*Note: Positive values reflect a positive impact on consumers, negative values reflect a cost to be borne by consumers.*
*Sources: FTI analysis.*

**Table ES-2: Estimated net impact on consumers from unbundling of the GSO**

| Items | Minimum<br>*£ billion* | Maximum<br>*£ billion* |
|---|---|---|
| Removing potential asset ownership bias | 0.04 | 0.74 |
| Removing potential bias in competitive procurement | n/a | n/a |
| Loss of operational synergies | (0.43) | 0.04 |
| Implementation costs of separation | (0.41) | (0.35) |
| **Net impact on consumers** | **(0.80)** | **0.44** |

*Note: Positive values reflect a positive impact on consumers, negative values reflect a cost to be borne by consumers.*
*Sources: FTI analysis.*

Based on our findings above, we consider that there may be a relatively stronger case for change for the SO arrangements in electricity than in gas. This is due to the following reasons:

- there is expected to be significantly greater investment in the electricity transmission network than the natural gas transmission network. Hence, any bias by the SO will have a significantly more material adverse effect on electricity customers than on gas customers;
- competition in transmission is currently only anticipated in the electricity network; and
- there are lower costs associated with fully unbundling NG ESO as operational synergies have already been lost and some implementation costs have already been incurred in the move to legal separation.

In contrast, the case for change in the gas sector appears more marginal, and may also depend on:

- potential benefits we have not quantified, such as the value of an unbundled SO taking on a wider range of roles, including supporting new technologies, market design and providing advice to Government, as well as any value of a combined Electricity and GSO; and
- the time taken to fully unbundle the GSO from NGGT, which is likely to be longer than fully unbundling the Electricity SO ("ESO").[2]

It is worth emphasizing that our analysis of the gas transmission network considers the case for change in the SO arrangements for natural gas transmission only. We have not considered the case for change in the event of a decision to change the use of the transmission network to allow the conveyance of hydrogen gas instead. The costs associated with such a change are likely to be highly material and we would therefore suggest revisiting the issue of GSO independence if policy were to move in this direction.

[2] There is a risk that unbundling the ESO and GSO at the same time may delay the potential benefits to consumers from unbundling the ESO.

### Assessment of high-level options for the SO

Having estimated the possible magnitude of the potential conflicts of interest in the SO arrangements, we assess alternative models for SO arrangements, including models with a fully unbundled Independent System Operator ("ISO"). We have performed a qualitative assessment of various theoretical SO models using a range of criteria.

The high-level options we consider in this part of our assessment are:

- **Strengthen Legal Separation (for electricity only)**. Enhancing the current legal separation of NG ESO from National Grid by implementing additional restrictions on NG ESO's behaviour. However, this would not go as far as to fully unbundle ownership of NG ESO from the rest of National Grid.
- **ISO (Planning / Strategy only).** An ISO that is fully separated in ownership from the rest of National Grid, which would only undertake roles related to planning and strategy. Specifically, the role of planning the network would be performed by the ISO, while the role of balancing would be reintegrated within NGET.[3]
- **ISO (Full).** An ISO that is fully separated in ownership from the rest of National Grid, which undertakes both planning and balancing activities.
- **ISO (Combined).** A single ISO performing the activities under the ISO (Full) model, but with combined responsibilities across electricity and gas.

With regard to the option of strengthening legal separation, our main conclusion is that, if policy makers believe conflicts of interest do exist because of the joint ownership of the SO and TO functions by National Grid, then it seems unlikely that this option will fully address such concerns as it will still have the same ultimate owner.

[3] The ISO would also take on the other roles NG ESO is currently responsible for, including providing impartial advice to Government, ensuring long-term security of supply, and administering industry codes and charging regimes.

We also conclude that the ISO (Planning / Strategy only) model may have some advantages as it potentially allows the synergies between SO balancing and TO asset optimisation to realised more fully. However:

- this synergy is limited and likely to reduce over time. It only applies to the onshore England & Wales network owned by NGET (not Scotland or offshore which are owned by separate TOs) and, as competition in transmission evolves, transmission ownership might reasonably be expected to become more fragmented – thereby eroding the potential synergy benefit further; and
- this model may limit the effectiveness of the ISO's other strategic roles (for example, providing advice to Government and network planning), as the ISO may not have easy access to operational balancing information, which assists in strategic decision-making.

Given the growing importance of the SO's strategic roles (which gave rise to the review in the first place), it therefore seems to us that the ISO (Full) model for the electricity sector may therefore be preferred over the ISO (Planning / Strategy) model.

By contrast, given our findings in the cost benefit analysis, there may well be a case for not changing the gas SO arrangements until policy objectives regarding the use of hydrogen become clearer. Given these costs and likely implementation difficulties, it seems to us that the merits of moving at this stage to a combined gas and electricity ISO model appear relatively low.

Finally, we should emphasize that the optimal set of SO arrangements may also depend on several specific design options. For example, whether the SO is for-profit or not-for-profit, and whether it is privately or government owned is likely to impact on the overall benefits to customers arising from a transition to an ISO. We have not considered these detailed design options here, as we have been instructed by Ofgem that they are outside the scope of this report.

# 1. Introduction

1.1 In common with many energy markets in the world, the GB energy market is undergoing a period of transition, driven by concerns over climate change, in which the share of generation from renewable intermittent sources is increasing rapidly. The GB market is increasingly moving away from a historical reliance on large, centralised thermal power generation and price insensitive consumption towards a greater diversity of supply. Alongside this, technological changes are enabling increasing flexibility and controllability of energy demand and better storage. At the same time, the UK Government has committed to achieving Net Zero carbon emissions by 2050.

1.2 These changes will significantly impact how both the electricity and gas networks in GB are managed on a day-to-day operational basis and over a longer-term planning and investment horizon. For example, the rise in new intermittent sources of electricity generation and the decline in large controllable thermal generation means that the task of maintaining the integrity of the electricity system on a second-by-second basis is becoming increasingly challenging. Equally, the rise of new sources of renewable electricity generation necessary to achieve Net Zero by 2050, sited on both on the transmission and distribution networks, means that there will be a need for significant volumes of new network investment. These investments will need to be planned and co-ordinated carefully if Net Zero is to be achieved efficiently. The declining role of natural gas as a source of energy for GB will also need to be carefully managed in the transition period. Finally, the energy system as a whole may become increasingly interlinked, including along vectors such as heat and transport, further increasing the complexity of future network planning.

1.3 The SOs of both the electricity and gas sectors have historically played a pivotal role in the energy networks in GB, focused on managing the networks on an operational basis and ensuring that the secure delivery of electricity and gas to end users was maintained continuously. In recent years, as the roll out of renewable electricity generation has accelerated and the demand for gas has declined, the role and nature of activities undertaken by the SO has expanded to include aspects of planning the networks and some market-based functions.

1.4 By virtue of its technical characteristics, the main SO role in gas and electricity can only be undertaken by a single entity. Currently, in the electricity sector, the SO role is undertaken by NG ESO which is a legally separated entity of National Grid. The owner of the electricity transmission network in England and Wales is NGET. In the gas sector, the GSO function is an integrated entity within NGGT. As the sector regulator, Ofgem regulates both SOs and periodically sets the amount of revenue NG ESO, NGET and NGGT are allowed to recover from consumers to cover their costs.

1.5 Given the challenges of moving to Net Zero by 2050, and the increasing complexity and importance of the SO, Ofgem and other stakeholders have expressed concerns that the current ownership arrangements might lead to possible conflicts of interest between the SO role and the other activities undertaken by National Grid (notably its transmission asset owner activities). Ofgem is specifically concerned that these conflicts could lead to suboptimal, and therefore potential costly, outcomes for customers in the transition to Net Zero.

1.6 In this context, Ofgem is reviewing the current SO arrangements and exploring whether alternative arrangements might result in a more optimal delivery of the Net Zero target and better outcomes for consumers and society.

1.7 To support this review, Ofgem has commissioned FTI Consulting to assess the possible value at stake that might arise from potential conflicts of interest in the current SO arrangements, and to explore options for alternative SO arrangements. This report sets out our findings.

### Restrictions

1.8 This report has been prepared solely for the benefit of Ofgem for the purpose described in this introduction. In all other respects, this report is confidential. It should not be used by any other party for any purpose or reproduced or circulated, in whole or in part, by any party without the prior written consent of FTI Consulting.

1.9 FTI Consulting accepts no liability or duty of care to any person other than Ofgem for the content of the report and disclaims all responsibility for the consequences of any person other than Ofgem acting or refraining to act in reliance on the report or for any decisions made or not made which are based upon the report.

### Limitations to the scope of our work

1.10 This report contains information obtained or derived from a variety of sources. FTI Consulting has not sought to establish the reliability of those sources or verified the information provided.

1.11 No representation or warranty of any kind (whether express or implied) is given by FTI Consulting to any person (except to Ofgem under the relevant terms of our engagement) as to the accuracy or completeness of this report.

1.12 This report is based on information available to FTI Consulting at the time of writing of the report and does not take into account any new information which becomes known to us after the date of the report. We accept no responsibility for updating the report or informing any recipient of the report of any such new information.

### Structure of this report

1.13 The remainder of this report is structured as follows:

- **Section 2** sets out key roles and activities in the GB energy sector and identifies the potential conflicts of interest in the current set of arrangements.
- **Section 3** describes the methodology we have used to estimate the magnitude of the potential conflicts of interest in the current arrangements.
- **Section 4** assesses the potential (net) value of implementing SO arrangements that eliminate current potential conflicts of interest, whilst also considering potential costs.
- **Section 5** considers the options for alternative models of SO arrangements and assesses them qualitatively according to pre-determined criteria.

1.14 This report also includes the following appendices:

- **Appendix 1** provides further details on our modelling approach.
- **Appendix 2** describes the potential value of eliminating current potential conflicts of interest assuming a high volume of hydrogen demand.

# 2. System operation in GB and areas of potential conflicts of interest

2.1 The first elements of the GB SO role were borne out of the need to manage, in operational timescales, the national energy networks of the country. In electricity, this role emerged in the 1930s with the creation of the high voltage bulk transmission grid.[4] For the gas system, the role emerged following the creation of the high-pressure gas transmission network, the National Transmission System ("NTS"), in the 1970s. Since then, the scope and nature of the SO has naturally evolved and, in each sector, the SO now undertakes a broad range of activities. Moreover, given the Net Zero challenge, it seems highly probable that the nature of activities and roles will evolve further. In particular, given the position of each SO at the centre of its respective energy network, it is possible that both SOs will take on greater responsibilities in a range of strategic decision-making roles.

2.2 It is this evolving role of the SO, and the possible conflict of interest given its current ownership by National Grid, that is the focus of this report. In this section, we therefore describe the activities undertaken by the SOs in each sector, then explain why Ofgem and other stakeholders might have concerns given the current ownership structure. In turn we:

- provide, by way of context, a **brief history** of the SO roles in both the gas and electricity sectors;
- describe the **current roles** of the SOs and other key stakeholders in the overall management of each sector and consider how these might evolve over time; and
- explain how the current scope of activities of the SOs and the current ownership give rise to the concerns of Ofgem and other key stakeholders regarding **potential conflicts of interest** that could, in turn, lead to suboptimal (and therefore costly) outcomes for customers in the transition to Net Zero.

---

4 National Grid, History of electricity transmission in Britain. The first time the grid was operated at a national level was in 1937.

### History of the electricity and gas SO

2.3 NG ESO is the SO of the GB electricity market. Throughout the RIIO-1 period, the SO's costs have been subject to Ofgem's price control regulation.

2.4 Before 2005, separate SOs were responsible for the operation of the transmission networks in England and Wales, the north of Scotland, and the south of Scotland.[5] A full GB-wide electricity SO ("GB SO") was first appointed in 2005, as part of the new British Electricity Trading and Transmission Arrangements ("BETTA"), which formed a single, competitive wholesale electricity trading market in Great Britain.[6] National Grid (at the time, National Grid Company plc) was appointed the GB SO.[7] The new BETTA also gave rise to the System Operator – Transmission Owner Code ("STC"), which governs the high-level relationship between the SO and TOs.[8]

2.5 The primary role of the GB SO was traditionally to balance the transmission system in real-time and contracting with users for connection and use of the transmission system. However, this role expanded over time. In 2013, the Electricity Market Reform ("EMR") created the Capacity Market[9] and designated the ESO to administer key elements of the auction.[10] In 2015, following Ofgem's Integrated Transmission Planning and Regulation ("ITPR") project, the ESO began taking a greater role in planning GB transmission infrastructure, by publishing the annual Network Options Assessment ("NOA").[11,12]

5 Ofgem (2005) BETTA User Guide, page 7.

6 Ofgem (2005) BETTA User Guide, page 5.

7 National Grid Company plc was previously the SO for England and Wales, a position it held since before privatisation.

8 Ofgem - System Operator - Transmission Owner Code.

9 Department of Energy & Climate Change (2012) Electricity Market Reform: policy overview.

10 NG ESO – EMR Delivery Body – Capacity Market.

11 Ofgem (2015) Integrated Transmission Planning and Regulation (ITPR) project - final conclusions.

12 In addition to these, the ESO now has responsibility for administering key parts of the Contracts for Difference ("CfD") regime and produces Electricity Capacity Reports for BEIS.

2.6 In 2017, the decision was made to legally separate the GB ESO from NGET.[13] This was completed in 2019, forming NG ESO.[14]

2.7 Before 2011, the GB SO was incentivised via a single target on its Incentivised Balancing Cost ("IBC"), which covered all balancing activities. This target was set ex-ante as part of National Grid's overall business plans, which were submitted in its price control negotiations.[15] From 2011, this was replaced with separate targets for different balancing activities, which were set ex-ante using forecasting models and adjusted using ex-post information.[16] In 2018, Ofgem adopted an 'evaluative scorecard' approach to incentivising the GB SO, removing cost targets.[17] For the RIIO-2 period (from April 2021 onwards), NG ESO will be remunerated on a separate price control, independent from NGET, although the 'evaluative scorecard' approach to incentivisation is expected to remain.[18]

2.8 The GB GSO, by contrast, has been fully integrated within NGGT throughout its history. An equivalent code to the STC does not exist in the GB gas market. As part of NGGT's price control, the integrated GSO is subject to a number of incentives intended to mimic the commercial pressures of a competitive market.[19] This is similar to the approach used to incentivise GB ESO's balancing costs pre-2011, in which a fixed ex-ante cost allowance covered all balancing activities. This broad framework is expected to be maintained in the RIIO-2 period.[20]

---

13 Ofgem (2017) Future Arrangements for the ESO - Response to Consultation on SO Separation.

14 NG ESO - Our new legally separate company.

15 Ofgem (2011) NGET System Operator Incentives from 1 April 2011 – final proposals.

16 Ofgem (2011) NGET System Operator Incentives from 1 April 2011 – final proposals.

17 Ofgem (2017) The ESO Regulatory and Incentives Framework from April 2018 – Final Decision.

18 Ofgem (2019) RIIO-2 financial methodology and roles framework for the ESO.

19 NGGT - System Operator incentives.

20 Ofgem (2018) RIIO-2 Framework Decision.

### Current roles of the system operator and other key stakeholders

2.9 In both electricity and gas, the SO is one of several critical stakeholders that have responsibilities for managing their respective energy networks as well as the overall market in each sector. In this subsection, we set out the key roles and describe the involvement of the SOs and other key stakeholders. Where relevant, we set out how this role is expected to evolve as the UK moves towards Net Zero.

2.10 While many categorisations are possible, we have delineated between nine different activities in the sector that serve as a framework for our analysis in this report. They are:

- **Advisor to Government.** Provides impartial advice to Government.
- **Residual Energy and System Balancer.** Ensures the network as a whole remains balanced within certain operational tolerances.
- **Network Planner.** Co-ordinates and decides on investments in the network.
- **Network Provider and Operator.** Constructs, operates and owns network assets.
- **Long-term Security of Supply.** Ensures that there is sufficient supply to meet demand (up to an agreed security standard).
- **Industry Governance and Charging.** Responsible for administering industry codes and standards and collecting network charges.
- **Market Design.** Develops operational rules and trading arrangements in the wholesale and retail markets.
- **Supporting New Technologies**. Advocates, co-ordinates investment for, and delivers new technologies for the benefit of consumers.
- **Regulation**. Monitors energy markets, including the companies that operate it, to ensure they are functioning in the interests of consumers.

2.11 These roles and the parties responsible for fulfilling them are summarised in the figure below. In the remainder of this subsection we describe each activity and the entities that currently have responsibility for it.

### Figure 2-1: Summary of current SO arrangements in electricity and gas

| | Key roles | Examples of activities in key role | ELECTRICITY – Current arrangements | GAS – Current arrangements |
|---|---|---|---|---|
| 0 | Advisor to Government | ▪ Impartial advice to Government (e.g. on Net Zero) | Ofgem<br>NG ESO | Ofgem<br>NGGT |
| 1 | Residual Energy and System Balancer | ▪ Energy balancer (to extent participants are out of balance)<br>▪ System balancer (e.g. constraint resolution) | NG ESO | NGGT (GSO) |
| 2 | Network Planner | ▪ Plans and coordinates investments across networks<br>▪ Obligation to plan and deliver secure network (SQSS) | NG ESO<br>ICs | NGGT (GSO)<br>ICs |
| 3 | Network Provider and Operator | ▪ Constructs, operates and owns network assets | NGET<br>Scot TOs<br>CATO<br>OFTO<br>ICs | NGGT (TO)<br>Storage<br>ICs |
| 4 | Long-Term Security of Supply | ▪ Planning and strategy for security of supply<br>▪ Delivery of solutions | BEIS<br>NG ESO | BEIS<br>Shippers<br>NGGT |
| 5 | Industry Governance and Charging | ▪ Collection of charges<br>▪ Rules governance | NG ESO<br>3rd party contributors | Independent Code Admins<br>3rd party contributors |
| 6 | Market Design | ▪ Oversees design of wholesale and retail markets<br>▪ Strategic rule-maker | BEIS<br>Ofgem<br>Market participants | BEIS<br>Ofgem<br>Market participants |
| 7 | Supporting New Technologies | ▪ Supports and delivers technologies that benefit consumers and society | BEIS<br>3rd parties<br>NG ESO | BEIS<br>3rd parties<br>NGGT |
| 8 | Regulation | ▪ Regulation (including price control) | Ofgem | Ofgem |

2.12 We describe each of these roles, and the participants that currently fulfil them, in further detail below.

*Advisor to Government*

2.13 To assist in decision-making, government entities (such as BEIS) typically require input and advice from sector experts on key strategic and technical issues relating to the overall design of the system. The parties providing such advice would be expected to make non-binding recommendations to Government on a wide range of issues, including changes to the system that may be necessary given wider policy objectives, most notably Net Zero. For example, these could be changes to overall system needs, regulatory frameworks, or industry rules.

2.14 In both **electricity** and **gas**, Ofgem currently provides independent advice to Government, with both NG ESO and NGGT having limited formal roles. A number of other organisations may also input into the role more widely, such as the not-for-profit innovation centre, Energy Systems Catapult, and the independent statutory body, the Committee on Climate Change ("CCC").

2.15 As the UK moves towards Net Zero, the positions of both NG ESO and NGGT at the 'centre' of their respective energy systems is likely to increase the value of any advice they are able to provide. Indeed, by having key positions in several other key roles (discussed below), both NG ESO and NGGT are likely to have a unique operational perspective to offer. For example, the balancing information NG ESO has access to can directly inform Future Energy Scenarios ("FES"), which in turn may influence recommendations in the NOA. In particular, both organisations may be able to opine on the viability of specific decarbonisation technologies and how they interact with the energy network.

*Residual Energy and System Balancer*

2.16 A defining physical characteristic of both electricity and gas networks is that the volume of energy injected onto a network must equate to the volume energy that users offtake from the network. For electricity, this is true on a second-by-second basis - the production and consumption of electricity must be in balance at all times and at all locations.[21] For gas, there is significantly more tolerance, in that the volume of gas injected can exceed or be lower than the volume of gas that is offtaken for a sustained period of time,[22] with the surplus stored in or deficit drawn from the gas pipeline network.

2.17 The gas and electricity wholesale market arrangements, first developed in the late 1990s,[23] created competition in the production and sourcing of electricity and gas, and, in so doing, are considered to bring efficiency benefits to final customers through lower prices relative to centralised procurement. A key feature of the market arrangements, in both electricity and gas, is to incentivise energy market participants to balance injections and offtakes from each network so that the key physical characteristic of the energy network –physical balance – is maintained.

---

21 That is, system frequency must be maintained at 50Hz (+/- 1%) at all times.

22 The amount of gas in the network at any given time is known as the 'linepack'. 'Linepack' is allowed to vary (that is, gas can expand or be compressed) within the operational tolerances of the network.

23 Ofgem (1999) The new electricity trading arrangements: Ofgem/DTI conclusions; Ofgem (1999) The new gas trading arrangements designation.

2.18 However, to date it has not proved possible to design the wholesale market arrangements to ensure that the integrity of the network is always maintained. Despite financial incentives, participants might fail to balance injections and offtakes – hence a 'backstop' balancer is always needed to take a residual role. Moreover, the technical complexity of the network (particularly the electricity network) means that a central body is needed to manage the system to ensure that it remains balanced, and to manage the security and quality of supply on the network. The central entity that performs this residual energy balancing and system management role is the SO.

2.19 In **electricity**, the Electricity National Control Centre ("ENCC"), part of NG ESO, operates the National Electricity Transmission System ("NETS") in real-time, in line with the balancing responsibilities outlined above. The ENCC is supported by the wider NG ESO entity, which is responsible for ensuring process and workforce resilience, both currently and in the long term.[24,25] NG ESO as a whole is also responsible for providing information to market participants to facilitate informed decision-making, and for ensuring efficiency in the operation of the system.

2.20 In **gas**, this role is currently performed by the Gas National Control Centre ("GNCC"), which operates the gas Natural Transmission System ("NTS") in real-time as part of the GSO. The GSO is wholly integrated within NGGT. As far as possible, the GB wholesale gas market aims to incentivise gas shippers to balance the market. NGGT's role in balancing is therefore very much on a residual basis. Similar to NG ESO, NGGT has an obligation to provide transmission operational data on the gas network to *"reduce market uncertainty, ensure equal access to information, and increase information transparency"*.[26]

2.21 In **electricity**, as the share of generation from intermittent sources continues to increase, this role is likely to become more challenging. NG ESO may have to intervene more often to ensure the network remains balanced within operating limits. A similar trend is likely in **gas**. Following the increased electrification of transport and heating, demand for gas is likely to fall. This may mean NGGT will need to intervene more frequently to ensure system integrity.

---

24 This allows the ENCC to efficiently respond to system disturbances and incidents (for example, network faults, loss of infeed, blackouts, etc.).

25 For example, through continued development of the System Operability Framework. See NG ESO, System Operability Framework.

26 National Grid, Gas Transmission – Transmission operational data.

*Network Planner*

2.22 Energy networks need to evolve to meet the changing nature of demand and supply. Given the meshed and interrelated nature of the networks, investment (and retirements) in network assets need to be planned and co-ordinated across the network. This activity includes recommending investment options (including performing long-term forecasts to identify system needs to be met via those options) and performing the detailed planning to deliver transmission investment (e.g. design, routing, consenting, etc.).

2.23 In **electricity**, the Network Planner role is currently shared between NG ESO, NGET, and Scottish TOs for the GB onshore network.[27] Currently, NG ESO recommends preferred transmission investment options via the NOA and performs long-term forecasts by publishing FES. The annual NOA document recommends which network reinforcement projects should receive investment in the coming year.[28] The most recent NOA recommended £203 million of investment in the network for the 2020/21 financial year.[29]

2.24 A key input into the NOA is the Electricity Ten Year Statement ("ETYS"), also published by NG ESO, which helps inform electricity system needs. NG ESO also has a role in co-ordinating between TOs to optimise short and long-term outage plans.

---

27 Offshore Transmission Owners ("OFTOs") and interconnectors play a minor role in planning as well, insofar as they may consider options for and design their own assets. If they are appointed in the future, Competitively Appointed Transmission Owners ("CATOs") will also share this role, though at this time, the exact details are still evolving.

28 In addition to which projects should be delayed, halted, or stopped outright.

29 NG ESO (2020) NOA 2019/20.

2.25 Detailed planning is performed by NGET and the Scottish TOs.[30] The TOs are decision-makers[31] for transmission planning in their respective geographic areas and are not legally obligated to comply with NG ESO's recommendations. Indeed, TOs are legally obligated to plan and deliver a secure network, for example, under the Security and Quality of Supply Standard ("SQSS"). The TOs develop and maintain Transmission Investment Plans, which describe transmission investments for each coming financial year.[32]

2.26 In **gas**, by contrast, both the recommendation and detailed planning functions of the Network Planner role are performed within the same, integrated entity. NGGT conducts an annual planning cycle,[33] for which the primary input is the FES discussed above. At the start of each planning cycle, NGGT undertakes an analysis of network capability, using information from the FES, distribution network operators ("DNOs") and shippers. This determines the ability of the NTS, in its current state, to accommodate expected supply and demand patterns. NGGT then reconsiders the planned projects from the previous investment plan, to verify whether they are still required, given the network capability analysis.

2.27 NGGT then considers if new investments, in addition to those already identified, are necessary to ensure network capability. The planning cycle concludes with the publication of the Gas Ten Year Statement ("GTYS").[34]

2.28 Going forward, Ofgem is likely to support the introduction of competition in onshore electricity transmission. Indeed, Ofgem considers there are *"significant benefits to consumers in introducing competition into the delivery of new, separable, and high value onshore electricity transmission projects"*.[35] Though the required legislation is yet to be finalised, the ESO's part in Network Planning may expand to include playing a role in operating the competitive process for some onshore transmission projects.

---

30 OFTOs and interconnectors perform the detailed planning of their own proposed assets, but do not necessarily respond to NG ESO recommendations from the NOA.

31 Although Ofgem oversees TO business plans through price controls and the Strategic Wider Works process.

32 NG ESO (2019) STC Section D.

33 NGGT (2019) Transmission Planning Code.

34 Gas storage companies and gas interconnectors arguably play a minor role in planning as, similarly to OFTOs and interconnectors in electricity, they may perform the detailed planning of their own assets.

35 Ofgem (2018) Update on competition in onshore electricity transmission.

2.29 By contrast, in gas, the evolution of the Network Planner role is less clear. If, for example, the declining demand for gas leads to a reduced need for the NTS, NGGT's Network Planner role may evolve into one overseeing the gradual decommissioning of the network. On the other hand, if new technologies like hydrogen become widespread, significant expansion or adaptation of the NTS, potentially overseen by NGGT (or another entity), may be necessary.

*Network Provider and Operator*

2.30 National energy networks comprise a large volume of complex and varied machinery and equipment. After investment decisions have been made, these networks need to be constructed and integrated with the existing network. The network as a whole requires constant maintenance, to ensure it remains in good working order and remains safe. Parties responsible for construction, and subsequent operation and maintenance of the network, are typically the owners of the network as well.

2.31 Parties performing this Network Provider role therefore take on construction, operation, and ownership of network assets. In GB, parties performing this role often benefit from Ofgem's transmission network price controls, which set their allowed revenues.[36] An assessment of the total value of assets owned, the Regulatory Asset Base ("RAB"), is a key ingredient in setting these revenues.

2.32 In **electricity**, this role is currently performed by NGET (for England and Wales), and the Scottish TOs (for Scotland).[37,38] In **gas**, this role is performed by NGGT.[39]

*Long-Term Security of Supply*

2.33 A key objective of energy markets as a whole is to ensure there is a sufficient supply of energy (either electricity or gas) to meet all levels of demand. This is referred to as the security of supply. In the short term, ensuring the security of supply falls under the remit of the Residual Energy and System Balancer.

---

36 Merchant interconnectors are the exception to this and do not earn a regulated return.

37 OFTOs (for offshore GB transmission assets) and interconnectors (for assets connecting different price zones) arguably perform this role as well, insofar as they are the owners of their specific asset classes.

38 As above, if they are appointed in the future, CATOs will also take on this role.

39 Gas storage companies and gas interconnectors take a minor responsibility in this role as owners of their specific asset classes.

2.34 Ensuring the security of supply over the long term, in **electricity**, typically involves encouraging a sufficient level of generation capacity to be built to meet long-term demand. For example, the relevant activities to ensure this include:

- setting security of supply standards, including determining the minimum available generation capacity in excess of expected peak demand that should be maintained (sometimes referred to as the "capacity margin"); and
- delivering solutions to ensure this minimum capacity is maintained.

2.35 In **electricity**, NG ESO operates the Capacity Market, which is a mechanism for ensuring there is sufficient generation capacity to meet consumer demand during periods of system stress.

2.36 In **gas**, this is more likely to involve the monitoring of gas sources relative to forecasted demand and ensuring the diversity of supply.[40]

2.37 Furthermore, both NGGT and gas shippers help to deliver security of supply by ensuring gas can be transported through the NTS to satisfy consumer demand. NGGT operates and maintains the NTS, and publishes outlook reports on the availability of gas supplies ahead of each winter.[41] Gas shippers are responsible for buying gas from producers and selling it on to suppliers, making use of the NTS to transport gas to where it is required.

2.38 For **both electricity and gas**, BEIS currently sets security of supply standards and reports to Government on the availability of electricity and gas for meeting consumer demand, for example, through the Statutory Security of Supply Report.

### *Industry Governance and Charging*

2.39 Energy markets are highly complex and involve a large number of market participants that interact with each other, with the ultimate goal of meeting the energy demands of consumers. A series of clear and consistent rules is therefore required to codify the relationships between these market participants and govern their operation. Licensees in both sectors are required to *"maintain, become party to, or comply with"* the relevant industry codes as per their licence obligations.[42] Licensees are also typically required to comply with certain technical standards.

---

40 The majority of gas in GB comes from the North Sea, imports from Norway and mainland Europe, and liquefied natural gas imports from around the world.

41 Ofgem, Gas security of supply.

42 Ofgem, Industry codes.

2.40 These rules, or codes, must be written, maintained, and updated to ensure they are fit for purpose. To that end, Code Administrators serve as the main points of contact for each code, and provide support to any stakeholders with an interest in modifying a given code.

2.41 A central entity is also required to collect charges from participants on the network and distribute them, such that market participants are fairly remunerated for the services they provide.

2.42 In **electricity,** the main codes related to the transmission system, that is, the Grid Code, the Balancing and Settlement Code ("BSC"), the Connection and Use of Settlement Code ("CUSC"), and the STC, are administered by NG ESO (or, in the case of the BSC, by Elexon, a subsidiary of the National Grid Group).[43] In addition, the Quality of Service Guaranteed Standards cover requirements related to specific service areas, including supply restoration, connections and voltage quality.

2.43 A number of other entities take responsibility for code administration in **gas**, such as the Joint Office of Gas Transporters, for the Uniform Network Code ("UNC"), Germserv, for the Independent Gas Transporter Network Codes ("IGT"), and Electralink, for the Supply Point Administration Agreement ("SPAA").[44] The Joint Office of Gas Transporters is jointly operated by all gas transporters, which includes NGGT. In addition, the Gas Industry Standards ("GIS"), govern the common product specifications for gas carrying assets and associated specialist network tools to ensure consistency and minimise complexity among those charged with transporting gas. The GIS is jointly upheld and maintained by NGGT and the gas transporters under the Technical Standards Forum ("TSF").

2.44 For the electricity and gas sectors, NG ESO and NGGT respectively are responsible for collecting transmission network and balancing charges.

### *Market Design*

2.45 The design of an energy market (electricity or gas) is characterised by the operational rules and trading arrangements that govern how market participants interact with each other, and determine the revenues received or amounts paid by each participant. These rules and arrangements are intended such that the combined actions of all participant acting individually yields market outcomes that are as close as possible to the designer's desired outcome.

---

43 A number of other codes are administered by other parties. For a full list, see Ofgem, Industry codes.

44 For the full list of gas sector codes, see Ofgem, Industry codes.

2.46 In both the GB electricity and gas sectors, BEIS and Ofgem have a role in dictating desired outcomes in the design of the market. Ofgem has a key role in triggering reviews of rules and trading arrangements that have led to the current market design, for example, through the New Electricity Trading Arrangements (“NETA”), BETTA, and the New Gas Trading Arrangements (“NGTA”).

2.47 The role of Market Design as a whole, however, is a largely collaborative effort between all participants. For example, in 2012, Ofgem conducted the Electricity Balancing Significant Code Review (“EBSCR”), to review electricity balancing arrangements.[45] During this process all stakeholders (including TOs, power exchanges, traders, etc.) were able to contribute via consultation responses and attending workshops hosted by Ofgem.[46]

2.48 Moving forward, the SO may take a more active role in driving change in wholesale and balancing market arrangements, and in the design of the Capacity Market. Indeed, this would be similar to arrangements in the US, in which the ISOs take a greater role in Market Design relative to the current GB approach.

*Supporting New Technologies*

2.49 New technologies are likely to be rapidly developed to support the transition of energy markets to their desired low carbon state. There are likely several parties that will advocate, co-ordinate investment for, and deliver new technologies for the benefit consumers. As the UK moves towards Net Zero, this role is likely to grow in importance.

2.50 In both **electricity** and **gas**, BEIS and any third party developing these new technologies occupy this role. NG ESO and NGGT may also take minor roles in this area, as they may need to consider how to integrate any new technologies into their respective networks.

2.51 This role is likely to overlap with the Advisor to Government role as the UK moves towards Net Zero. Stakeholders are likely to develop innovative technologies, and the SOs in both electricity and gas may be well placed to comment on their impact on the energy system as a whole, including on the implications for system costs and resilience. For example, as stakeholders develop hydrogen-based technologies, NGGT may be well placed to comment on their likely effect on the gas network. NG ESO, in turn, may be well placed to advise on the electrification of heat and the development of heat pumps.

---

45 Ofgem, Electricity Balancing Significant Code Review.

46 NG ESO and the GSO within NGGT in particular have a role in designing and procuring balancing services.

*Regulation*

2.52 Some participants in energy market, notably energy networks, have substantial market power, typically due to their positions as natural monopolies. More generally, due to their size and complexity, electricity and gas markets may not always function in the best interests of existing and future energy consumers. An industry regulator is therefore required to monitor the system as a whole and set rules to encourage market outcomes that mimic competition.

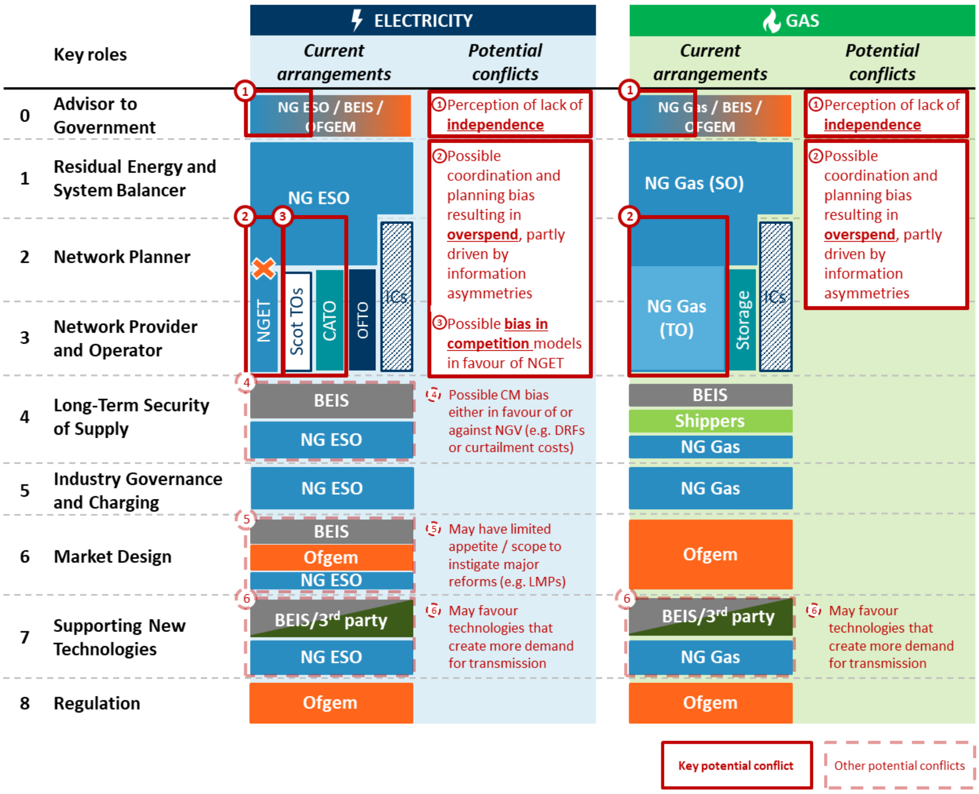
2.53 The regulator's role includes setting price controls, determining licence conditions for relevant market participants, and conducting investigations of market segments or companies where it believes licence conditions may have been breached. Ofgem is the independent regulator of the GB **electricity and gas** sectors.

### Potential conflicts of interest

2.54 Under the current SO arrangements, NG ESO is legally separate from NGET but is still part of the wider National Grid Group plc, and the gas SO and TO functions are fully integrated within NGGT. A number of industry stakeholders, including Ofgem, are concerned that this may create scope for several conflicts of interest as the SO entities carry out their current roles or if they took on additional roles under different SO arrangements.

2.55 The figure below summarises these potential conflicts.

**Figure 2-2: Summary of potential conflicts of interest in SO arrangements**




2.56 We describe each of these potential conflicts below, and in the remainder of this subsection:

- **Perception of lack of independence.** Advice given to Government by National Grid entities may be perceived to be in National Grid's self-interest or be perceived to not be in the best interests of consumers.
- **Possible asset ownership bias.** TOs within the National Grid plc group (in both electricity and gas) may be able to spend more on transmission assets than they otherwise would.
- **Possible bias in competitive procurement.** There may be a perception of bias against third party bidders in any competitive procurement of transmission, which may discourage third party bidders and, in turn, dilute the competitive pressure in transmission that is being developed to reduce costs to customers.

- **Other potential conflicts of interest.** There may be other potential conflicts of interest in the operation of the Capacity Market, market design, and support for specific new technologies. These are inherently uncertain and more difficult to quantify.

*Lack of independence in advice to Government*

2.57 Both NG ESO and NGGT may be perceived to be insufficiently independent in their current roles as Advisors to Government. In particular, stakeholders may be concerned that NG ESO and NGGT may make recommendations to Government that might serve the interests of National Grid's shareholders over and above the interests of consumers. This may impact the extent to which advice given is valued by Government or Ofgem.

2.58 For example, there may be a bias, or a perception of a bias, towards advocating asset-based solutions to Government that would be owned by National Grid's transmission businesses. In this context, it is worth noting that even the perception of such a bias, even if not actual bias, could undermine the value and weight placed on any advice from the SO entity. If policy makers perceive a given suggestion to be biased, they may delay taking actions that might result in an improvement in consumer welfare.

2.59 In the context of meeting the Net Zero challenge, this may be of growing importance. Ofgem considers both SOs to be at the 'centre' of their respective energy networks and, together with Government, and may look to use the technical and operational expertise of the SOs to assist in decision-making. The perception of non-impartiality of the SOs may therefore delay or constrain decision-making.

*Asset ownership bias*

2.60 Currently, both NG ESO and the GSO within NGGT undertake the role of Residual Energy and System Balancer, and also have some role in Network Planning. At the same time, both NG ESO and NGGT are part of the same wider organisation as the entities that are Network Providers; NG ESO through the wider National Grid plc, which owns NGET, and the GSO through being directly integrated with its GTO operations in NGGT. Both SOs therefore have an interest in other entities that benefit from owning and operating transmission assets.

2.61 As such, both SOs may have an incentive and the ability to recommend an evolution of the network that necessitates a greater expenditure on transmission than would otherwise be necessary, as this would increase the RAB and the returns for the entities in the Network Provider role. This may result in an overspend on network assets (sometimes known as 'gold plating') to the detriment of consumers who pay for them. This may also manifest as a preference for transmission asset solutions for any given need and an unwillingness to consider more innovative solutions that may reduce the need for transmission assets.

2.62 If, in the context of meeting the Net Zero target, the SOs take a greater role in Network Planning, the extent of this potential conflict may increase.

*Bias in competitive procurement*

2.63 The GB electricity sector is soon expected to move towards competitive appointment of onshore transmission owners.[47] This would involve competitions to provide assets to satisfy certain pre-identified system needs. An SO performing the Network Planner role is likely to be responsible for identifying the needs that are suitable for competition, administering the competitions, and selecting the preferred solution to meet any given system need.

2.64 The joint ownership between NG ESO and NGET, through the National Grid Group, creates a risk that NG ESO may be biased in favour of NGET's solutions over any potential competitors', since the National Grid Group as a whole will benefit from any additional transmission assets built by NGET. For example, it might have an incentive to identify systems needs that are suitable for competition in Scotland, where the transmission assets are not owned by NGET, which would therefore not impact on the evolution of the transmission asset base in England & Wales (where it is currently the monopoly provider of transmission). Equally, in assessing competitions, there may be a risk that it favours its own sister company's bids relative to competitors.

2.65 In practice, the risk of bias and the impact of this is likely to be more subtle. For example, the perception of a potential bias in the assessment of bids may deter potential competitors from entering competitions. This may reduce the benefits of introducing competitive procurement, which could lead to less cost efficiencies being realised, to the detriment of consumers.

47 Ofgem, Competition in onshore transmission.

2.66 The risk of perception of bias may also induce the SO to act perversely, which might also harm customers. For example, it may be that, in an effort to demonstrate the independence of its evaluation process to all stakeholders, the SO (perhaps even subconsciously) discriminates against NGET bids in a competition to favour rival bidders. Somewhat perversely, therefore, it may be that a better solution, from a customer perspective, offered by NGET is passed over in favour of a rival bidder's less beneficial solution because of the current ownership structure of the SO.

2.67 This conflict of interest does not arise in gas, as the competitive procurement of transmission infrastructure seen in electricity is not expected to be implemented in gas. If competitive procurement of gas transmission were to be implemented (for example, if a new gas transmission system needed to be constructed to accommodate hydrogen as a substitute for natural gas), then this may need to be reconsidered.

*Other potential conflicts of interest*

2.68 There may also be other conflicts of interest related to the other roles held by NG ESO and NGGT. The magnitudes of these conflicts are of greater uncertainty than the key conflicts identified above and are difficult to quantify. As such, we do not attempt to estimate them in later sections of this report.

**Bias in the operation of the GB Capacity Market**

2.69 In its role as operator of the Capacity Market, NG ESO calculates the de-rating factors for interconnectors participating in the Capacity Market. Some of these interconnectors are owned by National Grid Ventures ("NGV"), a subsidiary of the wider National Grid Group.

2.70 The level of the de-rating factor (set by NG ESO) directly impacts the revenues earned by interconnectors. Furthermore, the approach to setting the de-rating factor is complex and opaque.[48] Hence, there is a risk that NG ESO may be perceived to be biased in favour of (in order to earn a greater financial return), or against (to burnish its credentials as an 'independent' entity) NGV interconnectors through its treatment of its de-rating factors.

---

48 The approach involves: (1) a forecasting model under several scenarios which estimates a wide range of de-rating factors and is not open to stakeholder scrutiny; then (2) closed-door discussions between a BEIS-sponsored panel of technical experts, BEIS, Ofgem, and NG ESO to determine a point estimate. Sources: Ofgem (2018) Consolidated version of the Capacity Market Rules, Schedule 3A; BEIS (2018) Panel of Technical Experts Report – Independent Report on NG's Electricity Capacity Report 2018. For a more detailed critique, see FTI Consulting (2019) Securely Connected, Section 4.

2.71 In either case, this would cause a cost to consumers – either through needing to procure additional capacity in the CM or by increasing the risks to security of supply.

2.72 NG ESO is also in a position to determine which interconnectors are curtailed (typically due to a lack of grid availability). This, in turn, triggers compensation for the interconnectors. Ofgem and other stakeholders may perceive NG ESO to be biased in how and when NG ESO chooses to curtail NGV's interconnectors.

**Market design bias**

2.73 NG ESO and GSO may have less incentive to recommend market design changes that may reduce the need for transmission, to the benefit of consumers, as this would reduce the financial returns earned by National Grid Group.

2.74 For example, market design changes that strengthen locational signals to encourage more efficient siting decisions of generators and demand are likely to be less favoured by network owners as, by design, the measures will reduce the need for network assets.[49]

**Supporting new technologies**

2.75 Both NG ESO and NGGT may favour technologies that create more demand for transmission or may not support new technologies that reduce the need for transmission. For example, NGGT is likely to be a strong supporter of hydrogen as an alternative to natural gas. This is because the cost to adapt the GB natural gas network to transport a high level of hydrogen is likely to be substantial. NGGT could benefit financially from this increased expenditure. The magnitude of this conflict is inherently difficult to quantify due to the uncertain nature of new technologies.

---

49 For example, the wholesale electricity market design in the US incorporates a regime known as Locational Marginal Pricing ("LMPs") which allows for different wholesale electricity prices at each node of the network. This encourages generators and load to consider carefully siting decisions. The transmission charging regime in the UK attempts to perform a similar role but, by virtue of the lack of dynamic pricing, is less effective and therefore is likely to increase the need for transmission relative to the US approach.

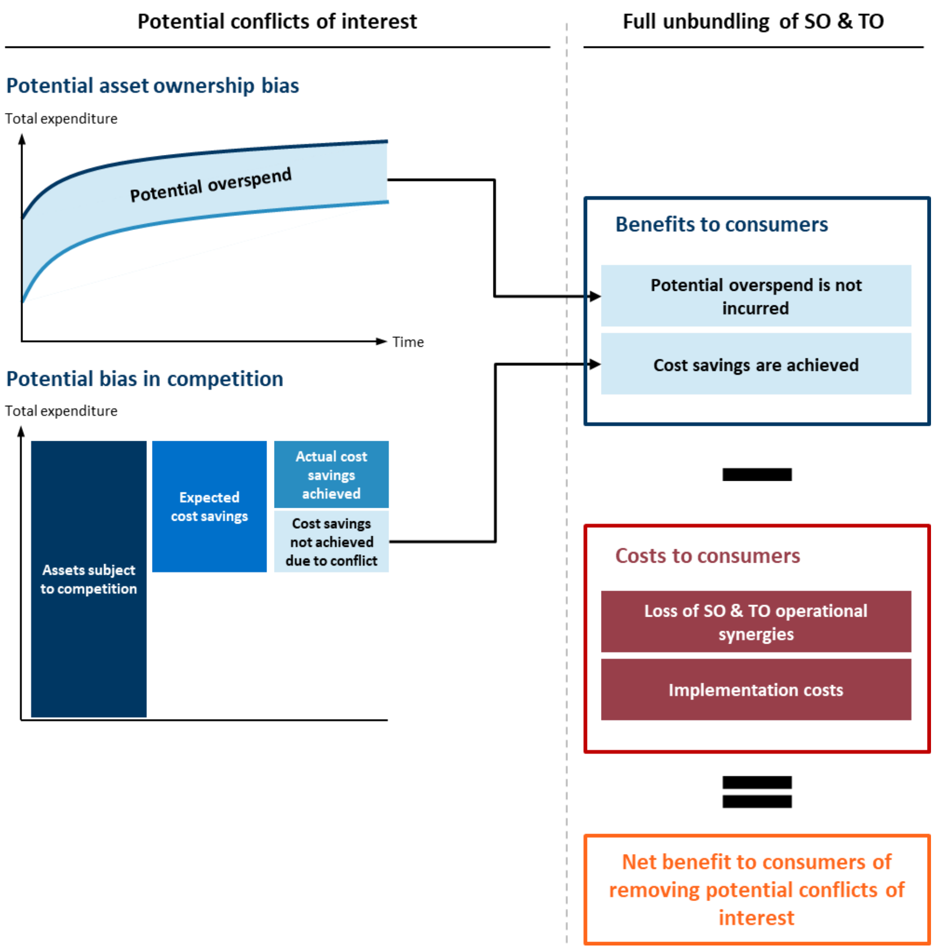
Equally, the 'virtual hub' approach of the GB gas market, known as National Balancing Point, is likely to increase the need for gas transmission assets relative to markets designs that adopt a more granular locational approach. For further details on 'virtual hubs', see FTI Consulting (2015) Conceptual design for a virtual gas hub.

# 3. Methodology to assess the magnitude of potential conflicts of interest

3.1 To assess the possible magnitude of the two quantifiable potential conflicts of interest described above, we consider the net benefit to consumers of removing those theoretical conflicts in **both electricity and gas**.

3.2 The figure below summarises our overall approach, which is discussed in further detail in the remainder of this section.

**Figure 3-1: Summary of approach to calculating magnitude of potential conflicts**



3.3 As shown in the figure above, the quantifiable benefits to consumers of fully unbundling the SO in both electricity and gas are formed of:

- the potential 'overspend' on the transmission network; and
- the cost savings that may not be achieved when competitively procuring new transmission assets due to the perception of 'incumbency advantage'.[50]

3.4 We have calculated the costs to consumers as the sum of:

- any loss in operational synergies between the SO and TO following full unbundling; and
- any implementation costs incurred in unbundling.

3.5 The remainder of this section summarises the methodology we have used to assess the magnitude, in theory, of the potential conflicts of interest described above. It describes, for both sectors, our:

- overarching assumption;
- approach to calculating the theoretical value of the potential asset ownership bias;
- approach to calculating the theoretical value of the potential competitive procurement bias; and
- approach to considering the cost of removing these potential conflicts.

### Overarching assumption

3.6 Our overarching assumption is that **removing the potential conflicts identified above requires a full unbundling of the SO from the TO.** This has the effect, primarily, of preventing a given entity from simultaneously:

(1) having access to the operational information driving transmission needs and the ability to recommend future transmission expenditure; and

(2) benefiting from owning and operating transmission assets.

---

50 This is only applicable to the electricity network, as we assume no competitive procurement of gas transmission.

3.7 While full unbundling removes potential conflicts (or the perception thereof), to the benefit of consumers, so too is it likely to incur significant costs, which we consider in our calculations. Together, these give the potential net benefit to consumers of full unbundling due to the removal of the theoretical conflicts of interest, or the perception of those conflicts, identified above.

3.8 We assume that, **the maximum net benefits that can be obtained from fully unbundling the SO and TO are equal to the potential costs to customers arising from these possible conflicts (or perception of conflicts) in the current SO arrangements**. We estimate these net benefits for the period between 2022, the start of the RIIO-2 period, and 2050, the deadline by which the UK Government has committed to achieving Net Zero.

3.9 In practice, there are a variety of possible SO models, with varying degrees of separation from their respective TO entities. It may not be possible for any of the SO models to capture fully the net benefit of removing the potential conflicts specified above. For example, any given SO organisation may remain biased towards transmission assets, as opposed to non-network solutions, due to familiarity with these assets or, say, inherent conservativism of the organisation. At this stage of the report, we simply discuss the maximum net benefits obtainable from eliminating these conflicts.

3.10 We do not attempt to estimate the value of the potential (or perceived) lack of independence in advice given to Government, as this is strictly qualitative in nature.

### Approach to valuing the potential asset ownership bias

3.11 To estimate the potential overspend on the transmission network due to the potential asset ownership bias between 2022 and 2050, the first key input is the likely expenditure on the network over that period. We have assumed that, after the RIIO-2 period, **expenditure on both networks will change at a constant rate**.[51][52]

3.12 It is difficult to determine that rate of change with a high degree of certainty, so we have considered a range of estimates that reflect likely future states of the world for both the electricity and gas networks.

---

51 Assuming a constant rate of change is a simplification intended to account for the inherent uncertainty of forecasting potential expenditure as far as 2050.

52 Our analysis is based on the RIIO2 Business Plans published by NGET and NGGT, and pre-dates the publications of Ofgem’s Draft Determinations and Final Determinations for RIIO-2.

3.13 The second key input is the **proportion of this expenditure that is 'overspend'** – that is expenditure that might otherwise not have been incurred if the SO was fully unbundled from the TO. This proportion is, of course, difficult to determine with any degree of confidence. Therefore, informed by discussions with Ofgem, we have assumed a wide range of potential proportions.

3.14 We assume that fully unbundling the SO from the TO will remove the overspend. By construction, therefore, the **value of the potential overspend** is **equal to the benefit to consumers from removing this potential conflict.** This, in turn, measures the magnitude of the potential conflict.

### Approach to valuing the potential bias in competitive procurement

3.15 To estimate the potential effect of independent entities being discouraged from entering competitions for new transmission, the first key input is the **total value** of transmission assets that are likely to be **procured via this competitive process**. This has largely been informed by Ofgem, who are driving reforms to allow for competition in onshore transmission.[53]

3.16 We then consider the likely **cost savings that result from competitive procurement**. The key input in this case is the reduction in transmission asset expenditure that could be achieved. We have estimated this with reference to our experience with competitive transmission in other jurisdictions.

3.17 Finally, we consider the extent to which these **savings may not be achieved**, due to perceptions of a conflict of interest. As with the proportion of asset 'overspend', this is difficult to determine with any certainty. Therefore, informed by discussions with Ofgem, we have made a wide range of assumptions.

3.18 We assume that unbundling the SO from the TO will allow this proportion of cost savings to be achieved. By construction therefore, the value of the savings that may not be achieved is **equal to the benefit to consumers from removing this potential conflict**, which in turn measures the **magnitude of the potential conflict**.

### Costs of removing potential conflicts

3.19 We would expect several costs to be incurred in unbundling the SO. These include the costs of implementing separation and loss of operational synergies that may exist between the SO and TO functions.

53 Ofgem, Competition in onshore transmission.

3.20 The costs of implementing separation are the **direct costs associated with unbundling the SO entity** from the TO. This could involve one-off upfront costs, such as the purchase of a new building, or ongoing costs, such as hiring new corporate staff like human resources, finance, or legal. This may also include the ongoing costs of roles that need to be duplicated across both the SO and TO, or the cost of roles dedicated to interfacing between the two entities. Since unbundling is likely to be a directive from Ofgem, it is likely these costs will be recovered from consumers. We estimate these costs with reference to the implementation costs already incurred in the legal separation of NG ESO from NGET.

3.21 There may be **operational synergies associated with the integration of the SO and TO**. These are likely to be lost if the SO is unbundled and is therefore an indirect cost of removing the potential conflicts identified. We discuss these synergies in further detail in Section 4 below.

# 4. Assessment of magnitude of potential conflicts in SO arrangements

4.1 We estimate the magnitude of the two quantifiable conflicts of interest under several specified scenarios. Our calculations suggest that the net benefit of eliminating those potential conflicts, are likely to be materially larger in electricity than in gas. Indeed, we estimate the net benefit to consumers of removing the potential conflicts is between **£0.4 billion and £4.8 billion** in **electricity**. This compares to a range between a **£0.8 billion net disbenefit** and **£0.4 billion net benefit** in gas.

4.2 In the remainder of this section, we discuss our net benefit calculations for electricity and gas separately. We then summarise our conclusions and identify potential areas of further investigation.

### Electricity

4.3 Using the methodology described in Section 3 above, we have assessed the potential costs to customers arising from the theoretical conflicts of interest in the current NG ESO arrangements may be between **£0.4 billion** and **£4.8 billion** on a present value basis, over the 2022 to 2050 period, although there may be additional benefits from removing conflicts that we have not quantified. This is summarised in the table below.

**Table 4-1: Estimated net impact on consumers from unbundling of NG ESO**

| **Items** | **Minimum** *£ billion* | **Maximum** *£ billion* |
|---|---|---|
| Removing potential asset ownership bias | 0.21 | 2.87 |
| Removing potential bias in competitive procurement | 0.27 | 1.95 |
| Loss of operational synergies | n/a | n/a |
| Implementation costs of separation | (0.10) | (0.05) |
| **Net impact on consumers** | **0.38** | **4.77** |

*Note: Positive values reflect a positive impact on consumers, negative values reflect a cost to be borne by consumers.*
*Sources: FTI analysis.*

4.4 We find that the benefits to customers from fully unbundling the SO in electricity are likely to be significantly more material that in the gas sector for two main reasons:

(1) first, there is likely to be a need to significantly expand the electricity transmission network over the period to 2050. By comparison, the future scenarios assume relatively lower expenditure on the gas transmission network and have not considered the potential impact of hydrogen on the network. Therefore, any distortion that imposes a cost to customers arising from the potential conflict of interest is likely to be of greater materiality in electricity; and

(2) second, as NG ESO has already been legally separated from the main National Grid business, a large portion of the costs needed to create a fully unbundled SO are likely to have already been incurred, relative to the gas regime in which the GSO is still a fully integrated part of the NGG.

*Benefits in electricity*

4.5 There may be relatively larger benefits to consumers from unbundling NG ESO, due to the:

(1) higher expenditure expected on the electricity transmission network (related to the potential asset ownership bias); and

(2) scope for competitive procurement of electricity transmission assets (related to the potential bias in competitive procurement).

**Higher expenditure on the electricity transmission network**

4.6 As the UK moves towards Net Zero, it seems highly likely that there will be a continued need for additional electricity transmission assets from now until 2050. This may be driven by a combination of factors, including (but not limited to) the rising share of renewables generation (in particular offshore wind), growing distribution-level upflows of electricity, rising volume of nuclear generation, and the increased interconnection with other jurisdictions. Equally, it seems likely that demand for electricity will increase over time as the electrification of sectors that have historically used other sources of energy accelerates (such as the electrification of transport).

4.7 Clearly, it is difficult to forecast this growth over such a long period of time. We have made the simplifying assumption that expenditure on electricity transmission will rise between **1.0% per annum** and **3.5% per annum** from now until 2050.[54]

4.8 NGET's total expenditure in the financial year ending 2026 is expected to be £1.3 billion.[55] We therefore estimate total expenditure on electricity transmission assets from 2022 to 2050 will total between **£27.2 billion** and **£34.6 billion** on a present value basis.[56]

4.9 As explained in Section 2 above, Ofgem and other stakeholders believe there may be a potential asset ownership bias in NG ESO's current arrangements. This may result in a theoretical overspend on transmission assets, relative to a scenario in which NG ESO was fully unbundled. It is difficult to determine the proportion of forecast total expenditure that may theoretically be 'overspend' with any degree of confidence. Therefore, informed by discussions with Ofgem, we have assumed it may be between **1%** and **10%**.

4.10 This gives an estimated theoretical benefit of **between £0.2 billion and £2.9 billion** (in present value terms) for removing the potential NG ESO **asset ownership bias**.[57]

**Scope for competitive procurement**

4.11 In addition to NGET's expenditure, we have assumed transmission projects to meet system needs identified by NG ESO will be put out to competitive tender, in line with Ofgem's plans for competitive onshore transmission.[58] The expected value of these projects from 2022 to 2050 is not clear, so, informed by Ofgem, we have assumed an average of between £0.5 billion and £1.0 billion per annum.[59] We therefore estimate transmission projects worth a total of between **£9.7 billion** and **£19.5 billion** to be competitively procured between 2022 to 2050.

---

54 Sources: NG ESO (2019) Future Energy Scenarios 2019 and NGET (2019) RIIO-2 business plan 2021-26. See Appendix 1 for further details.

55 NGET (2019) RIIO-2 business plan 2021-26.

56 For further details, see Appendix 1.

57 For further details, see Appendix 1.

58 Ofgem, Competition in onshore transmission.

59 The £0.5 billion per annum assumption is informed by discussions with Ofgem. The £1.0 billion per annum assumption is sourced from Ofgem (2020) Ofgem update on early model competition.

4.12 As explained above, a key rationale for competitive procurement is to encourage innovation and cost efficiency in the delivery of assets that would not otherwise occur. This is likely to result in cost savings for consumers. While it is not possible to predict this with a high level of uncertainty, we can make assumptions based, in part, on our experience with competitive transmission in other jurisdictions. We have therefore assumed cost savings of between **11%** and **20%** of the asset's initial estimated cost.[60] This may result in benefits to consumers from competitive procurement of **between £1.1 billion and £3.9 billion**.

4.13 As explained in Section 2 above, the potential bias in competitive procurement may result in the perception of incumbent advantage in the competitions. This may discourage independent (that is, non-NGET) bidders from entering, which, in turn, may dilute the competitive pressure on the cost of delivering the assets.

4.14 Of course, it is not possible to determine the size of this effect with any degree of certainty. However, from our experience of competitive transmission in other jurisdictions,[61] we understand that bidders are sometimes wary of incumbency advantage and are aware of instances where potential bidders have elected to pull out of a competitive process because of this concern. Informed by discussions with Ofgem, we have therefore assumed between **25% and 50%** of the expected cost savings from competitive procurement may not be realised on account of the risk of dilution of competitive pressure.

4.15 This gives an estimated benefit of between **£0.3 billion** to **£1.9 billion** to GB consumers from removing the potential **bias in competitive procurement**.

*Costs in electricity*

4.16 There may also be relatively lower costs to consumers from fully unbundling NG ESO, as:

(1) the operational synergies between the TO and SO in electricity have already been lost due to legal separation; and

(2) some of the implementation costs of full unbundling may have already been incurred during legal separation.

---

60 11% based on Yahoo Finance (2014) AESO awards Alberta PowerLine Limited Partnership with Fort McMurray West 500 kV Transmission Project. 20% based on CEPA (2016) Evaluation of OFTO Tender Round 2 and 3 Benefits.

61 And in other regulated sectors, for example, fibre broadband.

### Operational synergies

4.17 There are various actions that can be taken by the SO or by TOs, in theory, to balance the electricity network. These include:

- commercial actions taken by the SO (and the relevant counterparties) via the Ancillary Services market; and
- short-term asset optimisation actions taken by a TO.

4.18 The Ancillary Services market in GB is made up of a number of commercial services that the SO procures from energy market participants to help balance the network. These include, for example, Short-Term Operating Reserve ("STOR"), used for energy balancing, and Enhanced Frequency Response, one of many services used for system balancing.[62] The cost of procuring these Ancillary Services is borne, in the first instance, by the SO and subsequently recovered from customers.

4.19 Short-term asset optimisations are actions taken by a TO to modify the operation of their transmission assets. For example, a TO could flex voltage tolerances on specific assets within their network or amend specific circuit ratings, to help keep the frequency of the system as a whole within defined limits. A TO could also shorten or reschedule planned outages (e.g. by rescheduling maintenance) to help maintain balance in the system. The TO is likely to incur costs to perform these actions. For example, shortening planned outages may require additional overtime payments to be made to engineering staff.

4.20 Even though both the SO and TOs can take actions to balance the network and are likely to bear the costs of their own actions, any incentive on balancing is likely to be levied on the SO. This means that the share of balancing performed by either body is likely to depend on the extent to which they are integrated within the same entity.

4.21 If the SO and TO are fully integrated, the combined entity is likely to take the most cost-effective action to balance the network, as this would result in the greatest performance under any given balancing incentive regime. It would be convenient, for example, for the control room to request that planned maintenance be rescheduled at short notice. The combined entity might be willing for the TO to incur that cost if it was less than the cost of a commercial action on the part of the SO. This ability to optimise over SO and TO actions can be considered to be operational synergies.

62 Ofgem (2007) Review Electricity and Gas System Operator Role, Functions and Incentives, Appendices 5 – 13. National Grid ESO, List of all balancing services.

4.22 If instead the SO and TO are separated entities (legally or otherwise), the TO might not be willing to take short-term asset optimisation actions to assist the SO in balancing, unless it is compensated for doing so. As explained above, this is because these actions incur a cost that the TO may not recover through its price control. If, for a given imbalance, an operational action would have been the lowest cost solution, but the TO is unwilling to take it because it is not compensated, or if it that compensation results in a higher cost for consumers, consumers will bear the higher costs resulting in disbenefit. It may be possible to contractualise this relationship in such a way that the TO is compensated for these services, but this is likely to be difficult. These disbenefits represent the loss of operational synergies resulting from the separation of the SO from the TO.

4.23 In the case of NG ESO, which was legally separated from NGET in 2019, these operational synergies have already been lost. Therefore, the full unbundling of NG ESO is not likely to incur this cost.

**Implementation costs**

4.24 Some level of implementation cost has already been incurred in legally separating NG ESO. Legal separation involved:[63]

- **Separation of governance.** NG ESO is governed by a separate Board of Directors
- **Employee separation.** All ESO staff are employed by NG ESO (as opposed to NGET), with managers and executives incentivised on ESO metrics.
- **Physical separation.** NG ESO staff are located in a physically separate location from NGET staff.
- **Shared services.** Some corporate functions (e.g. Human Resources, Finance) remain shared between NG ESO and NGET.
- **Culture and branding**. NG ESO has adopted distinct branding from NGET.

[63] Ofgem (2017) Future Arrangements for the ESO: Response to Consultation on SO Separation.

4.25 These resulted in both **upfront** costs (for example, in developing a physically separate part of the National Grid headquarters to serve as NG ESO's headquarters) and **ongoing** costs (for example, an additional regulatory capability within NG ESO):[64]

- Upfront costs incurred were approximately £49.3 million.
- Ongoing costs were about £9.1 million per year.

4.26 We would expect some additional costs to be incurred in moving to a fully unbundled ISO. We have assumed that these costs will be in the order of £50 million to £100 million in present value terms.

4.27 We also assume these costs will be split between upfront costs and ongoing costs in the same proportion as the implementation costs of legal separation. On a present value basis, over the period 2022 to 2050, the ongoing costs of legal separation were a total of around £177.3 million between 2022 and 2050.[65] Therefore the costs of legal separation, if applied to the 2022 to 2050 consist of:

- upfront costs of £49.3 million (around 22% of the total); and
- ongoing costs of £177.3 million (around 78% of the total).

4.28 Applying these proportions to the assumed costs of moving to a fully unbundled ISO results in:

- upfront costs of £10.9 million to £21.8 million; and
- ongoing costs of £39.1 million to £78.2 million.[66]

### Gas

4.29 Using the same methodology, the theoretical conflicts of interest in the current GSO arrangements may be between a **£0.8 <u>dis</u>benefit** and a **£0.4 net benefit** to consumers on a present value basis, over the 2022 to 2050 period. This is summarised in the table below. This is significantly lower than the potential net benefits from unbundling in electricity, as the:

(1) benefits to consumers of unbundling are relatively lower; and

64 Ofgem (2018) Notice on National Grid's allowances for the costs of implementing ESO Separation.

65 For further details see Appendix 1.

66 Or, between £2 million and £4 million per year.

(2) costs of unbundling are relatively higher.

**Table 4-2: Estimated net impact on consumers from unbundling of the GSO**

| Items | Minimum *£ billion* | Maximum *£ billion* |
|---|---|---|
| Removing potential asset ownership bias | 0.04 | 0.74 |
| Removing potential bias in competitive procurement | n/a | n/a |
| Loss of operational synergies | (0.43) | 0.04 |
| Implementation costs of separation | (0.41) | (0.35) |
| **Net impact on consumers** | **(0.80)** | **0.44** |

*Note: Positive values reflect a positive impact on consumers, negative values reflect a cost to be borne by consumers.*
*Sources: FTI analysis.*

4.30 These estimates also do not account for a future scenario in which hydrogen plays a significant role in achieving Net Zero, by serving as a substitute for natural gas. We recognise that the development of hydrogen as a fuel source may have a significant impact on the energy sector, and is a potential enabler of Net Zero.[67] However assessing its potential impact on the energy sector, and in particular on the gas network, is complex. We therefore consider it separately.

4.31 Our estimates also do not consider the benefits of a combined Electricity and Gas SO. This is discussed in further detail below.

*Benefits in gas*

4.32 There may be relatively smaller theoretical benefits to consumers from unbundling the GSO from NGGT, as:[68]

(1) the total expenditure on the gas transmission network between 2022 and 2050 is expected to be relatively low, which means any potential (or perceived) bias has a smaller impact; and

67 NG ESO (2019) Future Energy Scenarios 2019.

68 This assumes a large-scale expansion of the NTS will not occur.

(2) new transmission assets for the NTS are not expected to be competitively tendered between 2022 and 2050, which means there is no potential bias in competitive procurement.[69]

4.33 As the UK moves towards Net Zero, demand for natural gas is expected to fall, driven by the increasing electrification of heat and transport.[70] This may have the effect of reducing the need for new gas transmission assets and expenditure on the gas network. As the extent of this decline is uncertain, we assume it could be:

- gradual, at a rate of 1.0% per annum; or
- rapid, dropping to just £300 million p.a. to cover operational and replacement expenditure.

4.34 NGGT's total expenditure in the financial year ending 2026 is expected to be £0.6 billion.[71] We therefore estimate expenditure from 2022 to 2050 will total between **£6.7 billion** and **£10.0 billion** on a present value basis.[72]

4.35 As with electricity, some proportion of this expenditure may in theory be overspend, relative to a scenario in which the GSO is fully unbundled from NGGT. This proportion is difficult to determine with certainty, so, as with our assumptions on electricity, we have assumed it is between **1%** and **10%**.

4.36 This gives an estimated benefit of between **£0.04 billion** and **£0.7 billion** from removing the GSO's potential **asset ownership bias**.[73]

*Costs in gas*

4.37 The costs to consumers of unbundling the GSO from NGGT appear to be relatively higher than in electricity, as:

(1) there are potentially operational synergies between the SO and TO in gas that may, in part, be lost following unbundling; and

(2) the implementation costs of unbundling the GSO may be significant.

---

69 We have assumed that competitive procurement of gas transmission will not occur. If this were to change, we would have to reconsider the calculations presented below.

70 Or, potentially, new sources of energy that replace the role of natural gas, such as hydrogen.

71 NGGT (2019) RIIO-2 business plan 2021-26.

72 For further details, see Appendix 1.

73 For further details, see Appendix 1.

**Material loss of operational synergies**

4.38 Similar to electricity, there are various actions that can be taken by NGGT to balance the gas network. These include:

- commercial actions taken by the GSO, which adjust shipper flows of gas across the network; and
- short-term asset optimisation actions taken by the GTO.

4.39 Commercial actions taken by the GSO include:

- locational trades undertaken; and
- capacity buybacks, in which shippers are invited to bid for the GSO to buy back the capacity produced at specific entry and exit points.

4.40 Locational trades are undertaken to buy and sell volumes of gas on the market at specific entry and exit points. This effectively interrupts or increases the flow of gas on particular points of the network. Locational trades are bilateral transactions between the GSO and shippers. Capacity buybacks involve the GSO buying entry capacity from shippers at specific entry and exit points. This has the effect of restricting the volume of gas being injected and the volume of entry capacity available for use by shippers at that point.

4.41 The cost of locational trades, being transactions for volumes of gas, are incurred by the GSO and passed on to consumers via the prevailing regulatory settlement. They have a direct effect on consumers. By contrast, capacity buybacks have an indirect effect on consumers.[74] This indirect impact arises because, by restricting the volume of entry capacity, a capacity buyback effectively shifts the supply curve for gas upwards. The National Balancing Point (“NBP”) price, which is the wholesale price of gas, rises as a result. This increase may be priced into forward contracts for gas and is thereby spread across all gas procured in the market.

4.42 Short-term asset optimisation actions taken by the GTO involve amendments to its operations. For example, it might delay the planned maintenance of a compressor to reduce the likelihood of a constraint. The GTO bears the costs of these operational actions.

[74] This is in addition to the direct effect of paying shippers for their entry capacity.

4.43 The current incentive scheme covering the balancing of the gas network is levied on the GSO. This is the Capacity Constraint Mechanism ("CCM") scheme, which sets a target value for the amount the GSO is expected to spend on constraint management, and allows it to retain a certain amount of money based on the actual amount spent. This is despite the GSO and the GTO bearing their own costs for any of the actions identified above.

4.44 Under the current arrangements, in which the GSO and GTO are fully integrated, the combined entity has an incentive to optimise over GSO commercial actions and GTO operational actions to select the lowest cost action to correct any given imbalance. It could, on occasion, be convenient for the GSO to request planned maintenance to be rescheduled at short notice, which could assist with balancing. The combined entity might be willing for the GTO to incur this additional cost, if this cost was less than the potential reward to the GSO under its balancing incentive for minimising commercial actions. While the GTO is willing to take these short-term operational actions, the GSO is required to take fewer, more costly, commercial actions to balance the network. This reflects the operational synergies of the two bodies while they are integrated within NGGT.

4.45 If the GSO is fully unbundled from NGGT, the GTO may be less willing to incur additional expenditure to aid the GSO, unless it is compensated. A contractual interface between the GTO and the GSO would be required which, while theoretically possible, may cause frictions that in turn reduce the volume of short-term operational actions taken. These frictions may lead the GSO to take more commercial actions to balance the system than would otherwise be the case. Further, the costs of these actions continue to be passed on to consumers via the entities' respective regulatory settlements. The reduction in GTO operational actions represents a benefit to consumers, but the potential increase in GSO commercial actions is a cost. This reflects a loss of operational synergies.

4.46 To estimate the value of the loss of operational synergies, we make assumptions over the total expenditure on each of the actions discussed above and consider how they may change with full unbundling of the GSO.

4.47 In the RIIO-1 period, we assume NGGT spent a total of £16 million per year on short-term operational actions.[75] Following full unbundling, we assume total expenditure on these actions will fall by 50% to £8 million, as the GTO is likely to be less responsive to the GSO's requests.

---

75 This compares to NGGT's proposed RIIO-2 total asset management costs of £66.3 million per year. See NGGT RIIO-2 Business Plan.

4.48 To account for the reduced volume of GTO operational actions, we expect the unbundled GSO to take more commercial actions to balance the system. We assume the number of commercial balancing actions taken to increase from an average of 0.4 per year to 3 per year.[76] It is worth noting that as the demand for gas falls over the coming period and assuming the current gas market design of a single virtual gas hub spanning the entirety of the GB gas network continues, then the task of maintaining gas balance will become more challenging (and, as a consequence, more costly). This is because it is more likely that (the lower) GB gas demand will be met by gas delivered at fewer entry points which are likely to be more geographically concentrated, rather than the current system where gas tends to be injected into the NTS from a relatively geographically dispersed number of entry points.

4.49 We assume the following costs to consumers for both locational trades and capacity buybacks:

- **Locational trades:** £78,000 per action.
- **Capacity buybacks:** between £3.5 million and £11.6 million per action.

4.50 The cost of a capacity buyback includes the effect of the action on wholesale gas prices, which, as explained above, is in an indirect cost to consumers. It is therefore significantly higher than the cost of a locational trade.

4.51 We estimate these costs with reference to a case study of a real-world oversupply event at Milford Haven in 2016.[77] In the actual event, the GSO used a locational trade to correct the imbalance, which allows us to observe its cost directly. We estimate the cost of capacity buyback by supposing such an action was used to resolve the same imbalance and considering the direct cost and indirect effect on the NBP wholesale price.

4.52 In addition, we assume the current CCM incentive on NGGT will be removed, since it would no longer have an active role in balancing. We assume this may lead to a cost saving of £12 million per year for consumers.[78]

---

76 This compares to the five commercial actions that have thus far been taken in the 2020 calendar year. Source: NGGT (2020) Gas Operational Forum May 2020. These commercial actions appear to have been taken as a result of low demand during the Covid-19 pandemic, which could be a proxy for low gas demand in the future.

77 We discuss this event, and the calculations we performed, in Appendix 1.

78 Ofgem (2018) RIIO-2 Sector Methodology Annex: Gas Transmission.

4.53 Taken together, the removal of operational synergies may result in a net benefit for consumers, if the costs of commercial actions are relatively low, or a net loss for consumers, if the costs of commercial actions are relatively high. This is illustrated in the table below.

**Table 4-3: Loss of operational synergies in gas**

| **Items** | **Integrated NGGT** | **Gas ISO (low case)** | **Gas ISO (high case)** |
|---|---|---|---|
| **Short-term asset optimisation** | | | |
| TOTEX on asset optimisation *(£m)* | 16.0 | 8.0 | 8.0 |
| Sharing factor | 56% | 56% | 56% |
| **Total cost** *(£m)* | **8.9** | **4.5** | **4.5** |
| | | | |
| **Locational trades** | | | |
| Cost per action *(£m)* | 0.078 | 0.078 | 0.078 |
| Number of actions | 2 | 15 | 15 |
| **Total cost** *(£m)* | **0.2** | **1.2** | **1.2** |
| | | | |
| **Capacity buybacks** | | | |
| Cost per action *(£m)* | - | 11.6 | 3.5 |
| Number of actions | - | 15 | 15 |
| **Total cost** *(£m)* | **-** | **174.0** | **52.5** |
| | | | |
| **Cost of CCM incentive** *(£m)* | **60.0** | **-** | **-** |
| | | | |
| **Total cost to consumers over RIIO-2 period** *(£m)* | **69.1** | **179.6** | **58.1** |
| | | | |
| **Effect on consumers of unbundling** | | | |
| Value for RIIO-2 period *(£m)* | | (110.6) | 10.9 |
| Value per year *(£m)* | | (22.1) | 2.2 |
| **Present value** *(2022 to 2050, £m)* | | **(430.8)** | **42.6** |

*Sources: FTI analysis*

**High implementation costs relative to benefits**

4.54 We would expect full unbundling of the GSO to incur a significant level of implementation costs. We estimate the implementation costs of full unbundling with reference to:

- the implementation cost incurred to legally separate NG ESO from NGET; and
- our estimates of the implementation cost required to move from a legally separate NG ESO to a fully unbundled electricity ISO.

4.55 The implementation cost of legally separating NG ESO from NGET was formed of:

- **One-off upfront costs**, for example, implementing a new, separate IT system or relocating GSO staff to a different building. When NG ESO was legally separated from NGET, this cost was about £49.3 million.[79]
- **Ongoing compliance costs**, for example, hiring new human resources staff or legal staff for the GSO. When NG ESO was legally separated from NGET, this cost was about £9.1 million per year.[80] On a present value basis, we estimate this cost will total about £177 million between 2022 and 2050.[81]

4.56 We assume costs of a similar nature will be incurred in gas.

4.57 As discussed above, we have assumed that the implementation cost of fully unbundling the legally separate electricity SO will be in the order of between £50 million and £100 million on a present value basis. We assume costs of a similar nature will be incurred in gas.

79 Ofgem (2018) Notice on National Grid's allowances for the costs of implementing ESO Separation.

80 Ofgem (2018) Notice on National Grid's allowances for the costs of implementing ESO Separation.

81 For further details see Appendix 1.

4.58 In practice, the implementation costs of full unbundling in gas are likely to be greater than those incurred in electricity. In electricity, some degree of separation already existed prior to legal separation, as a result of the established relationship between the GB SO and third party TOs (namely, the Scottish TOs). Therefore, a reasonable amount of the legal and regulatory architecture was already in place to allow the transition to the legally separate SO. Most obviously, there was already the STC, which codified the high-level relationship between the ESO and TOs. This probably made it relatively easier to legally separate NG ESO. As no equivalent exists in the gas sector, we would expect the process of unbundling the GSO from NGGT to be costlier, and to take longer. We assume therefore that it may be 25% more costly to fully unbundle the GSO from NGGT. On a present value basis, we estimate a **total cost to consumers of between £346 million to £408 million** from 2022 to 2050, as shown in the table below.

**Table 4-4: Estimated implementation costs of unbundling the GSO**

| **Items** | **Low case** *£ million* | **High case** *£ million* |
|---|---|---|
| Full integration to legal separation | | |
| *of which are upfront costs* | (49.3) | (49.3) |
| *of which are ongoing costs* | (177.0) | (177.0) |
| Legal separation to full unbundling | (100.0) | (50.0) |
| **Total implementation costs of unbundling ESO** | **(326.6)** | **(276.6)** |
| 25% additional cost for GSO unbundling | (81.6) | (69.1) |
| **Total implementation costs of unbundling GSO** | **(408.2)** | **(345.7)** |

*Note: Positive values reflect a positive impact on consumers, negative values reflect a cost to be borne by consumers.*
*Sources: Ofgem (2018) Notice on National Grid's allowances for the costs of implementing ESO Separation, FTI analysis.*

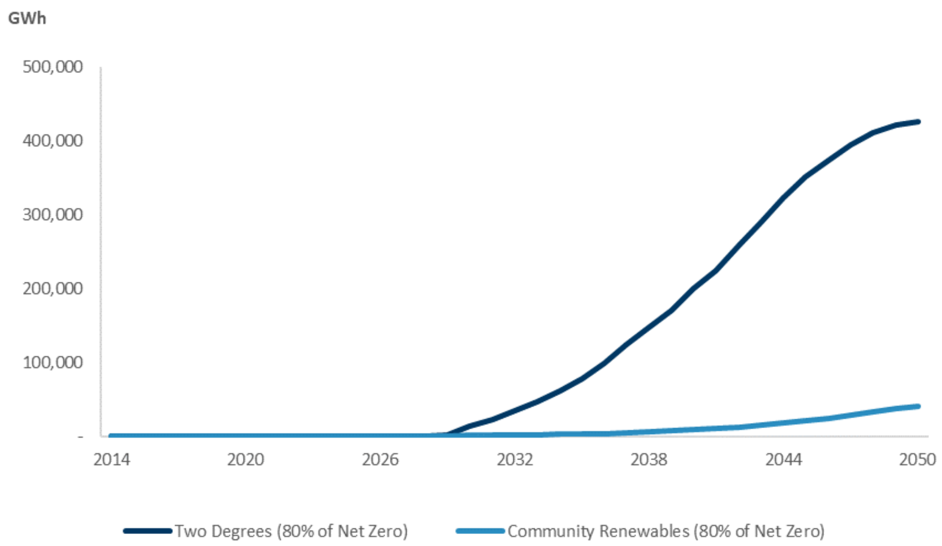
4.59 In addition to the costs identified in the table above, there may be further costs in the form of submitting a safety case to the Health and Safety Executive ("HSE"), as fully unbundling the GSO may constitute a significant enough change that a safety case may have to be submitted. This may incur some additional one-off administrative and ongoing costs, which we have not estimated in this report.

*Hydrogen*

4.60 As the role to be played by hydrogen is currently highly uncertain, we do not estimate the size of potential conflicts in the gas network based on predictions dependent on hydrogen.

4.61 The figure below presents the forecasted combined demand for electricity and gas used to produce hydrogen under two of the FES published by NG ESO.[82] Under both scenarios, the UK achieves 80% of its Net Zero target.

**Figure 4-1: Combined demand for electricity and gas to produce hydrogen by FES 2019 scenarios**




*Source: FTI analysis, based on data from NG ESO (2019) Future Energy Scenarios 2019.*

82 Electricity can be used to produce hydrogen via electrolysis. Gas can be used to produce hydrogen via methane reforming.

4.62 As shown in the figure above, the extent of the role played by hydrogen in the UK's pursuit of Net Zero is highly uncertain. If the demand for hydrogen is high and its production is relatively centralised (requiring transportation to demand centres), significant expenditure may be required to adapt the NTS to facilitate its transportation. Indeed, it may be necessary to build an entirely new network. Under a fully integrated GTO and GSO, this expenditure may be subject to the same potential asset ownership bias identified above. If instead a new network was competitively tendered,[83] a fully integrated GSO within NGGT may give rise to a potential bias in competitive procurement. All else held equal, this may increase the benefits of unbundling the GSO.

4.63 However, if the demand for hydrogen is low and its production is relatively decentralised, there may not be a significant need to adapt the NTS to facilitate its transportation. Under this scenario, the expenditure on the gas network is likely to remain low.

4.64 Given the uncertainties associated with hydrogen, we have not considered it in the context of estimating the magnitude of the potential conflicts of interest in the current SO arrangements. However, for completeness, we present a possible range of the asset ownership bias due to a hydrogen transmission network in Appendix 2 below.

4.65 However, it should be noted the role of hydrogen in achieving Net Zero may depend on a variety of 'whole system' factors, independent of the transmission network. For example, achieving Net Zero may require the use of hydrogen boilers and hydrogen powered vehicles to be widespread.[84] These may feature their own technological and commercial challenges. It is not clear that the GSO, whether or not it is independent, will be best placed to opine on these issues.

4.66 If a GSO was independent, policymakers may place greater value on its advice on the likely development path of hydrogen. However, this is a strictly qualitative benefit, and it is ultimately for policymakers to determine if full unbundling is the best way to obtain more independent advice, and whether its value is greater than the potential future disbenefits to consumers.[85]

---

83 In the same way a CATO regime may develop in electricity.

84 NG ESO (2019) Future Energy Scenarios 2019.

85 Caused by the loss of operational synergies between the SO and TO, and costs of implementing a Gas ISO.

*Combined Electricity and Gas SO*

4.67 There may be additional benefits to consumers from a combined electricity and gas SO (a 'combined SO'). This combined SO may be the result of unbundling NG ESO from the NG Group and the GSO from NGGT, then combining the resultant entity into one that operates across both sectors.

4.68 These benefits are likely to be qualitative in nature, and we therefore have not quantified them. They would, however, be in addition to the potential benefits identified above.

4.69 A combined SO would be able to co-optimise network planning across the electricity and gas system. If a combined SO was able to make use of information on both the electricity and gas networks and was able to plan for additional electricity or gas transmission (or decommissioning thereof), it might be able to select the least cost option for consumers. We understand from stakeholders that, under the current arrangements, this level of information sharing does not currently occur.[86]

4.70 For example, suppose a combined SO was able to foresee a large future increase in electricity demand (due to, say, rapid electrification of residential heating). Having access to information on both the gas and electricity sectors, the combined SO may be able to generate synergies and cost savings for consumers from the simultaneous decommissioning of gas transmission while increasing electricity transmission.

4.71 A combined SO may also result in a more co-ordinated response during times of system stress. For example, some stakeholders have explained that during the 'Beast from the East' event in 2018, there were occasions when NG ESO and the GSO within NGGT were instructing plants to perform conflicting actions.[87] A combined SO would remove the risk of these co-ordination issues.

4.72 A combined SO may also be better placed to advise on cross sector technologies. Some stakeholders have highlighted that the co-ordination of a combined SO is likely to benefit the adoption of new technologies, such as hydrogen and heat pumps.[88]

---

86 Stakeholder feedback obtained by Ofgem.

87 Stakeholder feedback obtained by Ofgem.

88 Stakeholder feedback obtained by Ofgem.

### Conclusions from our quantitative assessment.

4.73 Based on our findings above, we consider that there may be a relatively stronger case for change of the SO arrangements in electricity than in gas. This is because:

- expenditure on the electricity network is expected to be materially greater than on gas; and
- there are lower costs associated with unbundling the ESO, as operational synergies have already been lost and some implementation costs have already been incurred as a result of legal separation.

4.74 The case for change in gas appears, by contrast, to be more marginal, and may depend on benefits we have not quantified, such as the value of an independent Advisor to Government and any value of a combined Electricity and Gas SO. It may also take much longer to unbundle the GSO from NGGT, given the potential regulatory and operational complexities that would need to be resolved, delaying any benefits to consumers.

4.75 If a particular concern of policy makers is that there would be a risk of not receiving impartial advice from the (integrated) GSO, then a potential ‘work around’ may be to task a fully independent ESO to advise on gas matters also. A fully unbundled NG ESO could establish a separate department charged with providing independent advice to regulators and Government on the gas network. This advice could include, for example, the extent to which hydrogen could replace natural gas as an energy source.

4.76 This might not be a ’first best outcome’, when viewed through this particular lens, as there may be a risk of attracting the appropriate expertise in the gas sector to work in the ESO. Nonetheless, it would have the benefit of providing impartial advice, yet not incur the potential costs we have identified in moving to a fully independent GSO.

4.77 Furthermore, there seems to us no particular reason why Ofgem cannot revisit the GSO arrangements once the future role of hydrogen becomes clearer.

# 5. Assessment of high-level options for SO arrangements

5.1 In this section, we assess several high-level options for SO arrangements that could mitigate the potential conflicts of interest identified in Section 2 above. We undertake a qualitative assessment of these arrangements, which considers the relative strengths and weaknesses of each option against the Status Quo.

### High-level options for System Operator arrangements

5.2 The high-level options that we consider in this part of our assessment are:

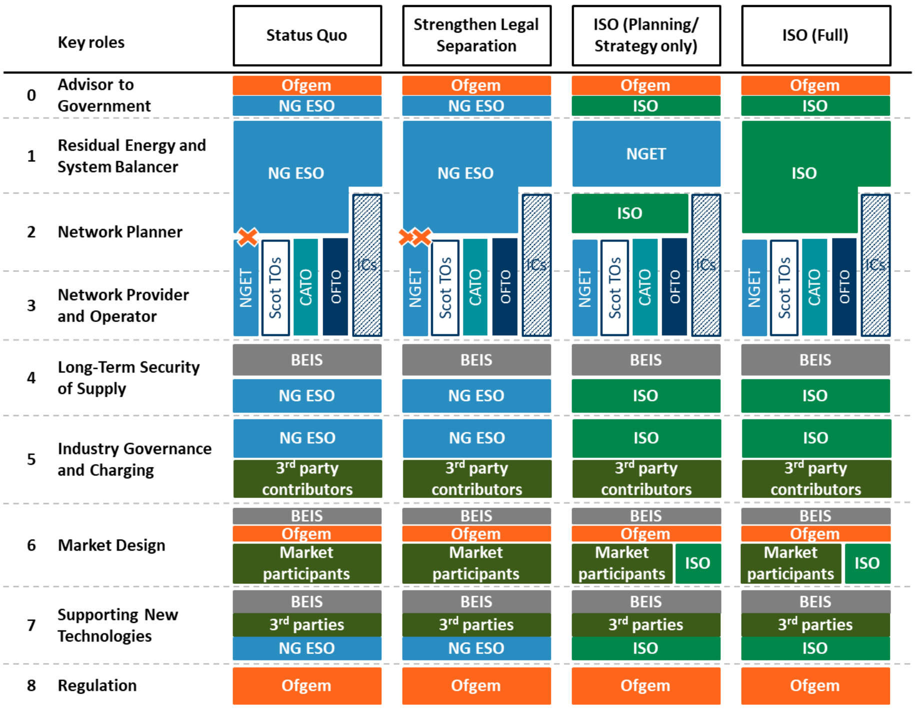
- **Strengthen Legal Separation** – enhancing the current system of legal separation in electricity. This could be through implementing additional obligations on the ESO to further mitigate the potential conflicts of interest that may not have been addressed in the existing arrangements. However, this would not go as far as to fully separate ownership of the ESO from the rest of National Grid. Additionally, we only consider this option for electricity and do not consider legal separation (in any form) for gas. Specific measures for this option may include:
    - stronger restrictions on NG ESO's use of shared services provided centrally by National Grid Group;
    - stronger restrictions on day-to-day governance interactions with National Grid Group and other National Grid entities (e.g. National Grid Ventures);
    - changes to the NG ESO board's role and structure to increase the role of the independent directors; and
    - removal of any scope for 'dual fuel' employees to exist.

- **ISO (Planning / Strategy only)** – establishing an ISO that is fully separated in ownership from the rest of National Grid, which would only take up roles related to planning and strategy. The roles the ISO would perform, as defined in Section 2 above, are those of Advisor to Government, Network Planner, Long-term Security of Supply, Industry Governance and Charging and Market Design. The ISO would not perform the role of Residual Energy and System Balancer. Under this option, the balancing role would be performed by the relevant TO arm of National Grid.[89] We consider this option separately for both electricity and gas.
- **ISO (Full)** – establishing an ISO that is fully separated in ownership from the rest of National Grid. In contrast to the previous 'ISO (Planning / Strategy only)' model, the ISO would also perform the Residual Energy and System Balancer role. We consider this option separately for both electricity and gas.
- **ISO (Combined)** – establishing a single ISO entity that is fully separated in ownership from the rest of National Grid and performs the roles of the 'ISO (Full)' model in both electricity and gas. We consider this option once, rather than separately for both electricity and gas.

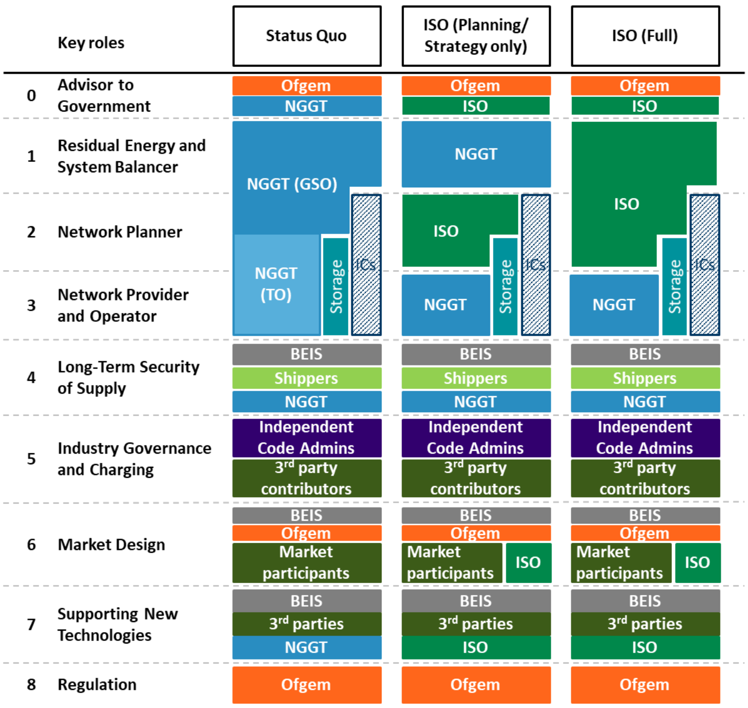
5.3 The roles and responsibilities of different stakeholders for each of the key energy sector roles set out in Section 2 under the high-level options above are set out below.

[89] NGET in electricity and the GTO within NGGT for gas.

## Figure 5-1: Proposed roles under options for SO arrangements in electricity




## Figure 5-2: Proposed roles under options for SO arrangements in gas



### Criteria for qualitative assessment

5.4 We assess these options on the following criteria:

- **Efficiency.** The extent to which a set of SO arrangements promotes outcomes that reflect those in competitive markets and whether the system, as a whole, is likely to incur costs efficiently on an ongoing basis. This may include, for example, the ability of a set of arrangements to facilitate secure and efficient day to day system operation or to promote outcomes that deliver Net Zero at lowest cost to consumers. As set out in the previous section, the key benefits of removing potential conflicts that we have quantified are cost savings from more efficient planning decisions and competitive outcomes in procurement.
- **Simplicity.** The ease with which market participants can engage with a given set of SO arrangements. Simpler arrangements are likely to reduce the regulatory burden on regulators and stakeholders. Simpler arrangements are also likely to be easier for a regulator to monitor and increase the predictability of regulatory behaviour and decision-making.
- **Transparency and credibility.** The ability to provide useful and unbiased information to market participants and other key stakeholders. This includes the provision of impartial strategic advice to Government, Ofgem and the industry on a wide range of issues, including decarbonisation. This criterion also takes account of the extent to which the SO is perceived to be credible in its role by market participants.
- **Co-ordination and adaptability.** The ability to act as a strategic co-ordinator across stakeholders in the energy system[90] and to remain relevant and effective in response to changing energy system needs throughout the transition to Net Zero. This is likely to translate to an ability to future-proof the energy system, by providing robust assessments of energy system infrastructure needs and facilitating effective system planning and network development.
- **Ease of implementation.** The likely complexity and cost associated with transitioning to a given set of arrangements from the Status Quo.

5.5 Our assessment is qualitative and aims to capture the relative strengths and weaknesses of these high-level options against each other, as well as highlight likely differences in outcomes when the same model is applied to different sectors (for instance, a full ISO in gas compared to a full ISO in electricity).

---

90 This could extend to Distribution System Operators and Distribution Network Operators.

5.6 In addition, we recognise that there may be uncertainties around the relative strengths and weaknesses of certain models. In some cases, this could be because the assessment of a particular model on a given criterion depends on a detailed design choice. For instance, the extent to which an ‘ISO (full)’ model promotes cost efficiency could depend, to some extent, on whether the ISO is motivated by monetary incentives. We have not considered these detailed design choices in this report, as we have been instructed by Ofgem that this is outside the scope of the report. Where relevant, we have highlighted these uncertainties in our assessment.

5.7 Finally, our assessment does not make a judgement on the relative importance of different criteria against one another. Equally, our assessment does not imply that each criterion is of equal importance in the context of deciding the most appropriate SO arrangements. It is likely that policymakers will have to weigh up the relative importance of different criteria and consider the relevant trade-offs when considering the most suitable option for future SO arrangements.

### Assessment of options

5.8 Our assessment is summarised below.

**Figure 5-3: Qualitative assessment of high-level options in electricity**

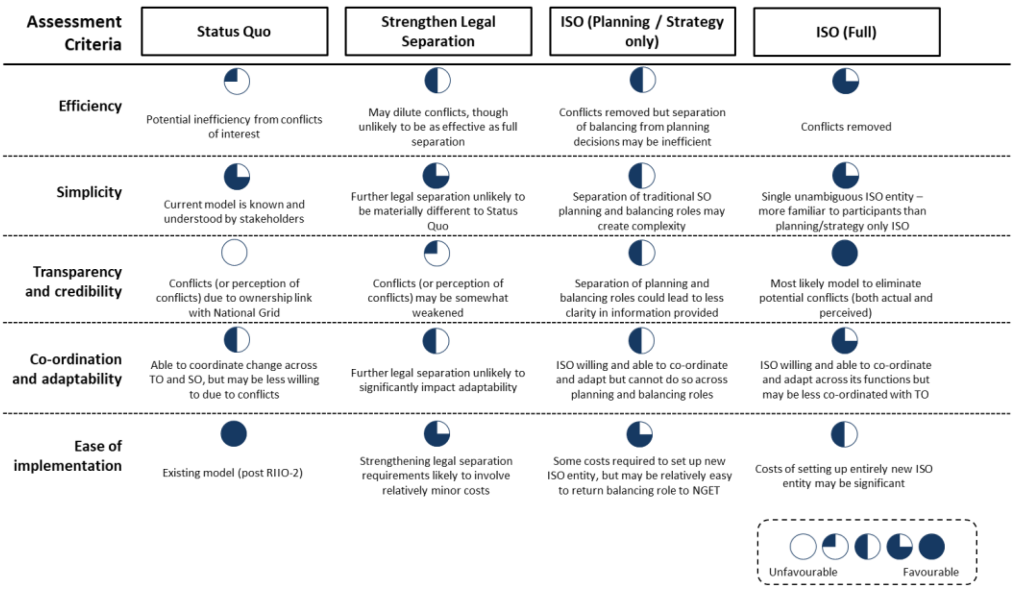
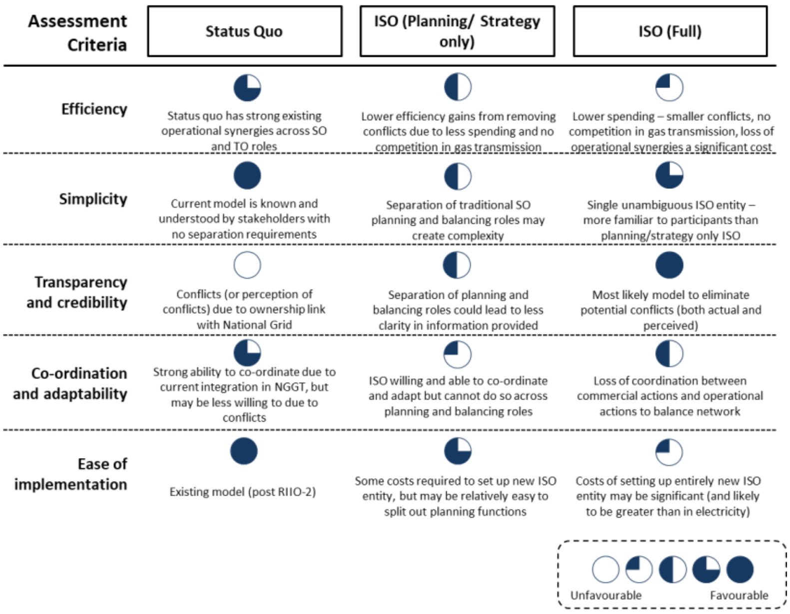


**Figure 5-4: Qualitative assessment of high-level options in gas**



| Assessment Criteria | Status Quo | ISO (Planning/ Strategy only) | ISO (Full) |
|---|---|---|---|
| Efficiency | Status quo has strong existing operational synergies across SO and TO roles | Lower efficiency gains from removing conflicts due to less spending and no competition in gas transmission | Lower spending – smaller conflicts, no competition in gas transmission, loss of operational synergies a significant cost |
| Simplicity | Current model is known and understood by stakeholders with no separation requirements | Separation of traditional SO planning and balancing roles may create complexity | Single unambiguous ISO entity – more familiar to participants than planning/strategy only ISO |
| Transparency and credibility | Conflicts (or perception of conflicts) due to ownership link with National Grid | Separation of planning and balancing roles could lead to less clarity in information provided | Most likely model to eliminate potential conflicts (both actual and perceived) |
| Co-ordination and adaptability | Strong ability to co-ordinate due to current integration in NGGT, but may be less willing to due to conflicts | ISO willing and able to co-ordinate and adapt but cannot do so across planning and balancing roles | Loss of coordination between commercial actions and operational actions to balance network |
| Ease of implementation | Existing model (post RIIO-2) | Some costs required to set up new ISO entity, but may be relatively easy to split out planning functions | Costs of setting up entirely new ISO entity may be significant (and likely to be greater than in electricity) |



5.9 Our assessment reflects a number of the key features of each of the high-level options, which we explain in further detail below.

*Status Quo*

5.10 Our assessment considers the high-level options for SO arrangements in both electricity and gas with reference to the Status Quo.[91] However, the material difference in the Status Quo for SO arrangements between the two sectors results in differences in how each option performs in our assessment in electricity and gas. This has implications, for example, for the impact on **efficiency** and **ease of implementation** of additional separation.

5.11 In electricity, our assessment of options takes into account the current legal separation regime for electricity. By contrast, in gas, our assessment acknowledges the current fully integrated nature of NGGT. As such, the impact on **efficiency** of moving to ISO models in gas reflect, for instance, the potential loss of existing operational synergies when separating functions from NGGT. These synergies are likely to be comparatively more material than in the electricity sector, where the current legal separation regime means they have already been lost.

[91] Specifically, we consider the Status Quo to be the SO arrangements that would be in place at the end of the RIIO-2 price control period, without any further changes.

5.12 Furthermore, the future trajectory of the market and of regulatory policy in the two sectors also has an impact on our assessment. We have, for example, taken account of differences in the expected future level of spending on new infrastructure and the fact that competitive procurement of new infrastructure is expected in electricity but not in gas.

5.13 The impact of these differences in the Status Quo between electricity and gas on our assessment will be discussed in more detail when we address each of the models specifically.

*Strengthen Legal Separation*

**Overview of assessment:**

- Some (but limited) potential to improve efficiency by reducing potential conflicts relative to the Status Quo.
- Impact on efficiency and other criteria likely to be limited as changes to the legal separation regime do not fundamentally address the ownership link between the SO and the TO entities.
- Legal separation is likely to be less effective than a fully independent SO model in changing stakeholder perceptions of the independence of the SO entity.
- Likely to be the easiest option to implement and relatively simple for stakeholders to engage with.

5.14 To the extent that the current SO arrangements give rise to potential conflicts of interest that impact customers adversely, strengthening the current legal separation regime in electricity may help address these potential conflicts. By partially mitigating the impact of the potential conflicts, this option might reduce the potential cost to customers identified in Section 2 above and, in turn, improve overall **efficiency** relative to the Status Quo. Due to its similarity to the Status Quo, it is also likely to be **easier to implement** and **simpler** for stakeholders to engage with, but has a limited impact on the other criteria.

**Changes to the legal separation regime do not fundamentally address the link in ownership between the SO and the TO entities**

5.15 As set out in Section 2, potential conflicts of interest may arise from the SO entity having the incentive and ability to act in favour of TO entities that sit within the ownership structure of its wider group.

5.16 The current legal separation regime for NG ESO restricts how it can act in favour of NGET compared to full integration. A strengthening of the legal separation regime may further restrict NG ESO and reduce potential conflicts (or the perception thereof). For instance, it may facilitate more effective competition for infrastructure by further restricting the perception of incumbency advantage in procurement competitions, with a potentially positive impact on **efficiency**.

5.17 However, since legal separation does not break the ownership relationship between NG ESO and the wider National Grid plc, strengthening legal separation may not remove the incentive for NG ESO to act in the group's wider interests as effectively as full ownership separation.

5.18 To the extent that any incentive to act in favour of the SO entity's own wider group would still exist, a legal separation regime would need to fully restrict NG ESO's capacity to act in its wider group's interests in order to address potential conflicts of interest. Creating legal separation arrangements that are effective to this extent could be extremely challenging.

**Legal separation is likely to be less effective in changing stakeholder perceptions of the independence of the SO entity**

5.19 Furthermore, irrespective of the impact of the legal separation regime on NG ESO's ability and incentive to act in its wider group's interest, the fact that NG ESO would remain part of the wider National Grid plc means that stakeholders could still perceive NG ESO to be influenced by its parent company, which could allow the potential conflicts of interest (or perception thereof) to persist.

5.20 For instance, third party bidders may be unwilling to enter a competition for procurement of new infrastructure that is administered by NG ESO in the belief that the competition will not be run fairly. If this is the case, the competition itself is likely to be less effective and bring fewer benefits for consumers, even if (in practice) NG ESO administered the process in an entirely impartial way, limiting the potential **efficiency** benefits of the model compared to a fully independent SO.

5.21 In addition, the perception of the independence of the SO entity is particularly important as it is envisaged that the SO will be performing roles that require it to provide impartial advice to stakeholders or use its judgment, such as the Network Planner and Advisor to Government roles. Credibility and the impartial nature of the SO, both perceived and actual, is likely to be valuable in these roles.

5.22 By retaining an ownership link with the wider National Grid plc, it seems more likely that the SO entity's impartiality and credibility could be called into question compared to a fully independent SO, limiting the extent to which **transparency and credibility** can be improved by enhancing the legal separation arrangements. By contrast, the ISO options are likely to create more stakeholder confidence in the SO entity's impartiality and ability to act independently.

5.23 While additional restrictions may make it more difficult for NG ESO to act on any potential conflicts of interest, they ultimately are not likely to remove the scope for those potential concerns over conflicts to exist. They are likely, however, to incur additional administrative costs on both Ofgem and NG ESO in monitoring and compliance.

*ISO (Planning / Strategy only)*

**Overview of assessment**

- Facilitates efficiency and co-ordination benefits from operational synergies in balancing. SO is able to optimise and co-ordinate across both commercial actions and short-term operational actions to balance the network and can be incentivised to select the most cost-effective action.
- Perception of the SO's independence in strategic decision-making roles is enhanced through full ownership unbundling.
- However, the SO's effectiveness in these strategic decision-making roles may be adversely affected by not having access to informational synergies that come with performing the balancing role.
- The model is relatively untested globally and unfamiliar to stakeholders.

5.24 The ISO (Planning / Strategy only) model would separate strategic decision-making roles (Advisor to Government, Network Planner, Long-term Security of Supply, Market Design, and Supporting New Technologies) from the operational role of Residual Energy and System Balancer. As such, this model makes a key trade-off between two types of synergies in the energy system, with corresponding impacts on the **efficiency** and **co-ordination and adaptability** of the model.

5.25 As previously mentioned, the different ownership structures in the Status Quo in the electricity and gas sectors mean that the overall impacts are likely to differ between the two sectors.

**Consumers may benefit from operational synergies in balancing**

5.26 Under the ISO (Planning / Strategy) model, National Grid would benefit from the operational synergies in balancing described in Section 4 above. The TO entity (NGET in electricity and the GTO within NGGT in gas) would be able to optimise and co-ordinate across both control room commercial actions and TO short-term operational actions to balance the network, and could potentially be incentivised to select the action with the lowest cost to consumers. This provides benefits both in terms of **efficiency** and in **co-ordination and adaptability** across these two functions.

5.27 In gas, these operational synergies between the TO taking operational actions and the SO taking commercial actions to ensure the network remains balanced would be retained when moving from the Status Quo.

5.28 In electricity, these operational synergies were lost with legal separation, so regaining them may provide an additional benefit to consumers. However, this benefit would only apply to the transmission network in England and Wales, since the networks in Scotland are owned by other, non-National Grid entities. In addition, this benefit is likely to erode over time, as new transmission is increasingly competitively tendered and owned by CATOs.

**Informational synergies in strategic decision-making roles may be lost**

5.29 Under an ISO (Planning / Strategy only) model, the ISO would potentially be unable to benefit fully from the informational synergies between balancing and other strategic decision-making roles. Under the Status Quo arrangements, information from control rooms can be used to inform strategic decision-making in areas such as network planning recommendations or for advice provided to Government, potentially enhancing **efficiency** and **co-ordination and planning**. For example, in electricity, NG ESO can use information from the ENCC on common points of congestion to inform network reinforcement recommendations in the NOA. Indeed, NG ESO is intending to make greater use of ENCC information in the NOA process.[92] This may also be applicable in gas, where common points of faults or congestion may be used to inform network planning.

92 NG ESO (2020) Forward Plan 2020-21.

5.30 By being outside of the National Grid plc umbrella, the ISO could lose easy access to this information. While information sharing could, in theory, still be provided through a formalised process, this may create frictions. There is also a risk that stakeholders may have concerns over the **transparency and credibility** of that information. For instance, NGET or NGGT may be perceived to be able to influence the ISO's decisions, advice or recommendations provided in its strategic decision-making roles by being selective in the information provided to the ISO.

5.31 This influence (perceived or actual) may mean that, in the context of competitive transmission in electricity, the perception of incumbency advantage under the current arrangements is not entirely removed. This, in turn, may result in less **efficient** competition and reduced cost savings for consumers. However, this would not apply in gas, where we have assumed no competitive transmission.

**SO model may be complex and costly to set up, with uncertain efficiency effects**

5.32 The relative magnitude of the impacts on **efficiency** and **co-ordination and planning** of the two synergies described above is highly uncertain. Thus, the impact of this SO model on **efficiency** is uncertain.

5.33 However, the ISO (Planning / Strategy only) model would involve separating the SO in such a manner that is likely to be unfamiliar to stakeholders. Indeed, this model is relatively untested in other jurisdictions.[93] This model could therefore be perceived as less **simple** than the current arrangements and could also make the model less **easy to implement**.

93 Models where balancing roles are combined with more strategic decision-making roles in the same unbundled SO (similar to the ISO (full) model) are seen in other jurisdictions, such as the United States.

*ISO (Full)*

**Overview of assessment:**

- Full ownership unbundling is likely to maximise the perception of the SO's independence and credibility across its roles.
- Captures the informational synergies between balancing and strategic decision-making roles by combining them in the same SO entity.
- However, operational synergies from being integrated with TOs may be lost. The impact of this is likely to be greater in gas, where GSO and NGGT are currently fully integrated.
- May be costly to implement, particularly in gas, where there is currently no separation.

5.34 An ISO (Full) model would involve an independent, newly formed organisation taking on all of the roles currently being performed by a National Grid SO entity.

**Different trade-offs in synergies compared to the ISO (Planning / Strategy only) model**

5.35 The trade-offs inherent in an ISO (Planning / Strategy only) model would be of a different nature to those under the ISO (Full) model. The ISO (Full) model would capture the benefits from informational synergies (improving **efficiency** and **co-ordination and planning**), since the ISO would perform both balancing and planning activities. This could also be perceived as being **simpler** by stakeholders.

5.36 However, operational synergies between the TO and SO in balancing are not likely to be fully captured, as there may be contractual frictions in making use of TO operational actions to balance the system. The impact compared to the Status Quo differs between gas and electricity, since NG ESO is already legally separate (thus operational synergies have already been lost), while the GSO remains fully integrated within NGGT.

5.37 Whether the ISO (Full) model is likely to be more or less efficient than the ISO (Planning / Strategy) model depends on the relative sizes of the informational synergies and operational synergies. It is unclear which of these two effects dominate and therefore it is not clear which of the two models is more efficient.

**Full ownership separation is likely to maximise the perception of the SO's independence**

5.38 If all SO functions were fully separated from the National Grid Group, this model could be perceived by stakeholders as the most **transparent and credible**. This may increase the value placed by Government on recommendations and advice provided by the SO, even more so than under the ISO (Planning / Strategy only) model.[94]

5.39 Compared to the ISO (Planning / Strategy only) model, the actual or perceived risk that the ISO's strategic decision-making is adversely affected by the quality of balancing information being received is also likely to be removed, further enhancing the **transparency and credibility** of the ISO's decisions.

5.40 This may also result in improvements in **efficiency.** If the ISO is perceived to be more independent in its Network Planner role, then any potential perception of incumbency advantage in the context of competitive procurement of electricity transmission may be avoided. Competition may become more effective, which could result in new infrastructure being procured more **efficiently**.

5.41 Furthermore, the ISO (Full) model may be perceived to be relatively **simple,** as stakeholder interactions on any given issue are likely to be with a single SO entity. This is similar to the Status Quo in electricity with the already legally separated ESO. In gas, the model of a separated SO entity may be a material shift from the current integrated NGGT arrangements, which stakeholders would have to adapt to.

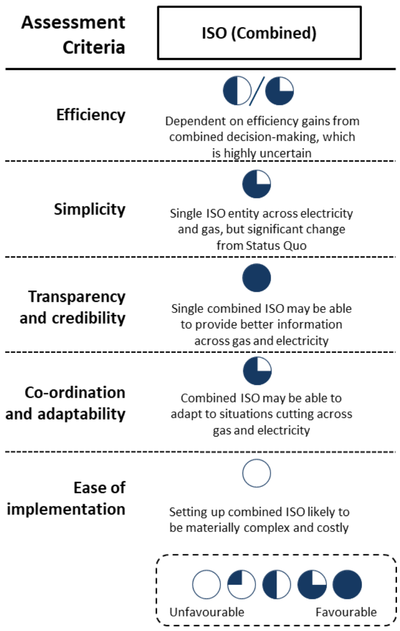
*ISO (Combined)*

5.42 Our assessment of the ISO (Combined) option is summarised in the figure below.

---

94 The key difference being that entity would no longer be owned by National Grid Group.

**Figure 5-5: Qualitative assessment of ISO (combined) option**




5.43 An ISO with combined responsibilities across electricity and gas may bring additional benefits, relative to having a fully unbundled but separate SO in each of the sectors. In principle, a combined ISO could potentially facilitate enhanced **co-ordination and adaptability**, management of **risk** and synergies that generate **efficiency** across the two sectors. However, the scale of the impact in each of these areas remains uncertain. This appears to have been separately acknowledged by stakeholders that Ofgem has recently engaged with.[95]

5.44 We understand that Ofgem has received feedback from stakeholders on the potential benefits of a combined ISO. These benefits include those relating to **increased co-ordination**:

- in developing the heat network;
- in meeting the Net Zero target as a whole;
- during emergencies, such as extreme cold weather events;[96] and
- of technical vocabulary across the sectors.

95 Stakeholder feedback obtained by Ofgem.

96 Stakeholders cited conflicting messaging to generation plants during the 'Beast from the East' in 2018. Source: Stakeholder feedback obtained by Ofgem.

5.45 However, a combined ISO is highly likely to be the least **easy to implement**, as it would combine the costs of establishing ISOs in both electricity and gas.

5.46 The decision to create a combined ISO could also potentially introduce dependencies on the timing of implementing the unbundling of the SO between the gas and electricity sectors. This could delay the realisation of benefits to consumers. For instance, it may take relatively longer to unbundle the GSO from NGGT due to their current fully integrated nature, compared to fully unbundling the ESO. Therefore, if the implementation of the ISO in electricity was delayed by the time needed to unbundle the GSO in gas, electricity customers may not experience the associated benefits of full unbundling of the electricity ISO as promptly as they could have otherwise.

### Conclusions on assessment

5.47 As stated above, our assessment does not make a judgement on the relative importance of different criteria against each other, and it will be up to policymakers to decide on the most appropriate set of SO arrangements given the criteria they consider to be the most important, and any inherent uncertainties.

5.48 Nevertheless, if policymakers believe conflicts of interest do exist, **strengthening legal separation** seems unlikely to be an effective option. This is because strengthening the legal separation of NG ESO does not fundamentally address the link in ownership between the SO and TO entities. It is therefore **not likely to change stakeholder perceptions of the independence of the SO entity**.

5.49 The choice between the remaining ISO models may be a question of which criteria and SO roles are prioritised by policymakers.

5.50 For example, if policymakers consider **efficiency in balancing** to be the greatest priority, then the **ISO (Planning / Strategy only) model** may be preferred. This is because, under this model, operational synergies in the SO's balancing role are retained. However, this model is **complex**, and it may **hinder potential informational synergies** that could improve the SO's effectiveness in its strategic decision-making functions. Such a model is also relatively untested around the world and, therefore, its impact on the market is even more uncertain.

5.51 If policymakers are instead **most concerned** with an ISO's **strategic decision-making roles** (Network Planner, Advisor to Government, Market Design, Long-Term Security of Supply, and Supporting New Technologies), then the **ISO (Full) model** may be preferred. This model gives an ISO access to balancing information that can enhance its ability to carry out the strategic decision-making roles more effectively and bring about more efficient outcomes. It may also remove any disincentive to actively share that information with stakeholders, allowing for **greater transparency and credibility**. This model may also allow the ISO to better **co-ordinate and adapt** across its balancing and strategic decision-making functions. Given the growing importance of the SO's strategic roles (which gave rise to the review in the first place), the ISO (Full) model may be preferred over the ISO (Planning / Strategy) model.

5.52 The **ISO (Combined) model** may have further informational synergies in planning, by enabling the SO to co-optimise across both sectors. However, the degree of this **efficiency benefit** is currently **highly uncertain**. It is also likely to be the **most difficult model to implement**. As such, the case for an ISO (Combined) model might not be currently justified.

# Appendix 1 **Magnitude of potential conflicts – further details**

A1.1 This appendix provides further details of the methodology and assumptions used to estimate the magnitude of potential conflicts in Section 4 above.

### Present value assumptions

A1.2 Our calculations estimate the size of potential conflicts from the year ending 31 March 2022 ("FY2022") to the year ending 31 March 2050 ("FY2050"). This represents the 'modelling period'. FY2022 is a convenient starting point, as it is the start of the RIIO-2 price control for both electricity and gas transmission.[97]

A1.3 Where relevant, we calculate the present value of the potential conflicts as at 31 March 2021. We use an annual **discount rate** of **2.88%**.[98]

### Electricity

A1.4 This sub-section describes in further detail our approach to estimate the total benefits of removing the potential asset-ownership bias and bias in competitive procurement, in the current NG ESO arrangements. Operational synergies between NG ESO and NGET have already been lost due to legal separation, so we do not estimate them here. Our analysis is based on the RIIO-2 Business Plans published by NGET, and pre-dates the publications of Ofgem's Draft Determinations and Final Determinations for RIIO-2.

*Potential asset-ownership bias*

A1.5 To assess the size of the potential asset ownership bias, we estimate the:

(1) TOTEX of NGET each year from FY2022 to FY2050; and

(2) proportion of that spend that may represent an overspend, due to the potential asset ownership bias.

---

97 Ofgem - 2021 price control review.

98 Ofgem (2019) RIIO-2 Sector Specific Methodology – Finance.

A1.6 We estimate NGET's TOTEX over the modelling period in two parts:

(1) the RIIO-2 period, from FY2022 to FY2026; and

(2) beyond RIIO-2, from FY2027 to FY2050.

A1.7 We assume TOTEX in the RIIO-2 period will be as per NGET's RIIO-2 Business Plan, with a 10% cost allowance reduction applied. We understand that Ofgem typically sets regulatory cost allowances at an average of 10% below business plan costs. This is illustrated in the table below.

**Table A1-1: Estimated NGET TOTEX during RIIO-2 period**

| | FY2022 | FY2023 | FY2024 | FY2025 | FY2026 |
|---|---|---|---|---|---|
| NGET TOTEX as per Business Plan (£ million) | 1,510 | 1,602 | 1,427 | 1,290 | 1,278 |
| *Cost reduction* | *10%* | *10%* | *10%* | *10%* | *10%* |
| **Estimated allowed NGET TOTEX** (£ million) | **1,359** | **1,441** | **1,284** | **1,161** | **1,150** |

*Sources: FTI analysis; NGET (2019) RIIO-2 business plan.*

A1.8 Beyond RIIO-2, we assume NGET's average annual TOTEX from the RIIO-2 period will increase by a per annum average growth rate. We estimate NGET's TOTEX over three different cases for this growth rate:[99]

- **High case: 3.5% per annum.** This is based on the growth rate of NGET's estimated Regulatory Asset Value ("RAV") over the RIIO-2 period. This scenario reflects an electricity network that continues to rapidly evolve (in respect of investments in reliability, security, innovation, etc.) after RIIO-2.
- **Mid case: 2.0% per annum.** This is based on the cumulative annual growth in peak electricity demand from 2018 until 2050 as per the Net Zero FES 2019 sensitivity. This scenario reflects an electricity network that is in a relatively steady state by the end of RIIO-2 and only requires additional investment to accommodate growing peak demand.

[99] At the time of writing, the FES 2020 has not been published, so we rely on FES 2019 forecasts.

- **Low case: 1.0% per annum.** This is based on the cumulative annual growth in peak electricity demand as per the 2 Degrees FES scenario. This reflects an electricity network that is in steady state and requires limited additional investment to accommodate growing peak demand.

A1.9 The table below illustrates our forecasts of NGET's allowed TOTEX over the full modelling period.

**Table A1-2: Estimated NGET TOTEX (2022 – 2050)**

| | *Index* | **Low case** *£ million* | **Mid case** *£ million* | **High case** *£ million* |
|---|---|---|---|---|
| **Allowed TOTEX in RIIO-2** *(FY2022 - FY2026)* | *{a}* | **6,395** | **6,395** | **6,395** |
| Average TOTEX p.a. in RIIO-2 | *{b} = {a} / 5 years* | 1,279 | 1,279 | 1,279 |
| *Growth rate p.a. beyond RIIO-2* | *{c}* | *1.0%* | *2.0%* | *3.5%* |
| **Total allowed TOTEX beyond RIIO-2** | *{d} = {b} x (1 + {c})$^{24\ years}$* | **34,803** | **39,752** | **48,457** |
| **Total TOTEX** *(FY2022 – FY2050)* | *{e} = {a} + {d}* | **41,198** | **46,147** | **54,852** |
| **Present value as at FY2021** | | **27,196** | **29,895** | **34,588** |

*Sources: FTI analysis; NG ESO (2019) Future Energy Scenarios 2019.*

A1.10 As explained in Section 3 above, we assume some proportion of expected TOTEX represents an 'overspend' as a result of the potential asset ownership bias, ranging from 1% to 10%. This gives the estimated size of the potential conflict, as illustrated in the table below.

**Table A1-3: Potential NGET overspend due to theoretical asset ownership bias**

| | **Low case** *£ million* | **Mid case** *£ million* | **High case** *£ million* |
|---|---|---|---|
| Present value of allowed TOTEX *(FY2022 – FY2050)* | 27,196 | 29,895 | 34,588 |
| **Estimated potential overspend on the transmission network** *(due to % overspend)* | | | |
| **1% assumed potential overspend** | **213** | **240** | **287** |
| **10% assumed potential overspend** | **2,130** | **2,400** | **2,869** |

*Source: FTI analysis.*

*Sensitivity on cost allowance reduction*

A1.11 At the time of writing, Ofgem is currently consulting on its draft determinations for the RIIO-2 price control period. We acknowledge that the 10% average cost allowance reduction we have applied above may vary from price control to price control. To account for this uncertainty, we re-estimate the value of the potential asset-ownership using a 20% cost allowance reduction. The table below illustrates this effect on NGET's estimated TOTEX during the RIIO-2 period.

**Table A1- 4: Estimated NGET TOTEX during RIIO-2 period assuming 20% disallowance**

| | FY2022 | FY2023 | FY2024 | FY2025 | FY2026 |
|---|---|---|---|---|---|
| NGET TOTEX as per Business Plan (£ million) | 1,510 | 1,602 | 1,427 | 1,290 | 1,278 |
| *Cost reduction* | *20%* | *20%* | *20%* | *20%* | *20%* |
| **Estimated allowed NGET TOTEX** (£ million) | **1,208** | **1,282** | **1,142** | **1,032** | **1,022** |

*Sources: FTI analysis; NGET (2019) RIIO-2 business plan.*

A1.12 Using a 20% cost reduction causes our estimate of the value of the potential asset ownership bias to fall from between £213 million - £2,869 million to between £189 million - £2,550 million.

*Potential bias in competitive procurement*

A1.13 To assess the size of the potential bias in competitive procurement, we estimate the:

(1) present value of projects that may be subject to competition between FY2022 and FY2050;

(2) cost savings achievable from competition; and

(3) proportion of these cost savings that may not materialise due to the potential bias.

A1.14 The table below summarises our calculations.

**Table A1-5: Potential foregone cost savings due to theoretical bias in competitive procurement**

| | Low case *£ million* | High case *£ million* |
|---|---|---|
| Value of transmission projects subject to competitive tender per annum | 500 | 1,000 |
| Present value of transmission projects subject to competitive tender (2022 – 2050) | 9,741 | 19,481 |
| Cost savings from competition | 11% | 20% |
| Cost savings lost due to perception of incumbency advantage | 25% | 50% |
| **Potential cost savings foregone** | **268** | **1,948** |

*Source: FTI analysis, based on data from: Ofgem, Competition in onshore transmission; Ofgem (2020) Ofgem update on early model competition; 11% based on Yahoo Finance (2014) AESO awards Alberta PowerLine Limited Partnership with Fort McMurray West 500 kV Transmission Project. 20% based on CEPA (2016) Evaluation of OFTO Tender Round 2 and 3 Benefits.*

### Gas

A1.15 This subsection describes in further detail our approach to estimate the net benefits of removing the potential asset ownership bias in gas transmission. We also further describe our approach to estimating the value of operational synergies between the GSO and GTO that may be lost due to unbundling. Our analysis is based on the RIIO2 Business Plans published by NGGT, and pre-dates the publications of Ofgem's Draft Determinations and Final Determinations for RIIO-2.

*Potential asset ownership bias*

A1.16 Similar to the approach in electricity, we estimate the:

(1) TOTEX of NGGT each year throughout the modelling period; and

(2) proportion of that spend that may represent an overspend, due to the potential asset ownership bias.

A1.17 We estimate NGET's TOTEX over the modelling period in two parts:

(1) the RIIO-2 period, from FY2022 to FY2026; and

(2) beyond RIIO-2, from FY2027 to FY2050.

A1.18 We assume TOTEX in the RIIO-2 period will be as per NGGT's RIIO-2 Business Plan, which is forecasted to be an average of £553 million per year from FY2022 to FY2026.[100]

A1.19 Beyond RIIO-2, we assume NGGT's average annual TOTEX from the RIIO-2 period will fall by a per annum average rate. We estimate NGGT's TOTEX over two different cases for this growth rate:

- **Gradual decline case**: **fall of 1.0% per annum.** This is based on the cumulative annual growth in gas demand from 2018 to 2050 as per the 2 Degrees FES scenario. This reflects a gradual decline in the gas network post-RIIO-2, as electricity is substituted for gas in areas like heat and transport.
- **Rapid decline case**: **fixed expenditure of around £300 million per annum from FY2027 to FY2034, followed by a decline of 1.0% per annum.** This reflects a rapid decline in expenditure on the gas network, where future expenditure is limited to operating costs and maintenance of the current network. We have assumed £300 million per annum approximates this.

A1.20 The table below illustrates our forecasts of NGGT' TOTEX between 2022 to 2050.

**Table A1-6: Estimated NGGT expenditure TOTEX (2022 – 2050)**

| | **Rapid decline case** *£ million* | **Gradual decline case** *£ million* |
|---|---|---|
| **Allowed TOTEX in RIIO-2** *(FY2022 - FY2026)* | **2,765** | **2,765** |
| Average TOTEX p.a. in RIIO-2 | 553 | 553 |
| Change beyond RIIO-2 | £300m p.a. until FY2034<br>Decline by 1.0% p.a. after | Decline by 1.0% p.a. |
| **Total allowed TOTEX beyond RIIO-2** | **6,846** | **11,792** |
| **Total TOTEX** *(FY2022 – FY2050)* | **9,611** | **14,557** |
| **Present value as at FY2021** | **6,829** | **9,951** |

*Source: FTI analysis; NGGT (2019) RIIO-2 business plan.*

100 NGGT (2019) RIIO-2 business plan 2021-26.

A1.21 As explained in Section 3 above, we assume some proportion of expected TOTEX represents an 'overspend' as a result of the potential asset-ownership bias, ranging from 1% to 10%. This gives the estimated size of the potential conflict, as illustrated in the table below.

**Table A1- 7: Potential NGGT overspend due to theoretical asset ownership bias**

| | **Rapid decline case** *£ million* | **Gradual decline case** *£ million* |
|---|---|---|
| Present value of allowed TOTEX *(FY2022 – FY2050)* | 6,829 | 9,951 |
| **Estimated potential overspend on the transmission network** *(based on % overspend)* | | |
| **1% assumed overspend** | **43** | **74** |
| **10% assumed overspend** | **429** | **741** |

*Source: FTI analysis.*

*Loss of operational synergies*

A1.22 As discussed in Section 4 above, we consider that full unbundling of the GSO will lead to a loss in operational synergies. This is because the GSO may take a higher number of commercial actions to balance the network. We estimate the cost of each type of commercial action (locational trades and capacity buybacks) with reference to a real-world oversupply event at Milford Haven in 2016.

A1.23 On 5 September 2016, linepack was forecast to be low at the start of the day due to significant undersupply. The market responded and increased supply during the day, However, with the effect compounded by demand falling away, this resulted in an oversupply of gas in a specific part of the network.

A1.24 We set out two analyses below to calculate the cost to consumers for resolving this oversupply situation:

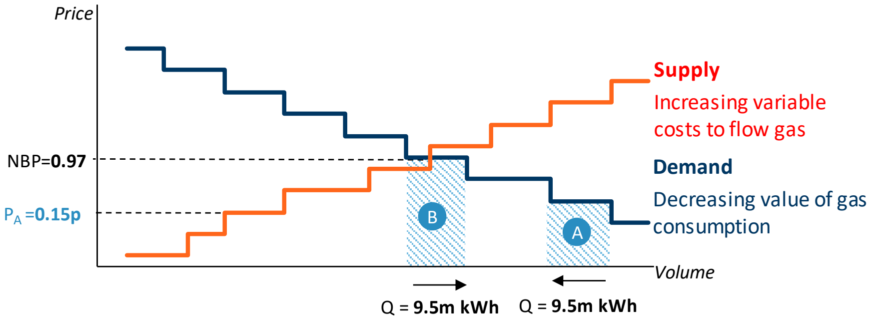
(1) estimating the cost of locational trades used to manage the constraint; and

(2) estimating the theoretical cost if capacity buybacks were used instead.

**1) Actual cost: Locational trades**

A1.25 In the actual event, NGGT managed to resolve the constraint using locational actions, with gas sold at a discount at an exit point. The quantity sold (Q) was 9.5 GWh at a locational sell price ($P_A$) of 0.15p/kWh.[101,102] The NBP price on that day was 0.97p/kWh.[103]

**Figure A1-1: Locational trade action to resolve oversupply**




*Source: FTI analysis.*

A1.26 This resulted in two effects:

(1) First, NGGT was paid (Q x $P_A$): 9.5 GWh x 0.15p/kWh = £14,000 (Area A on above chart); and

(2) Second, NGGT pays (Q x NBP): 9.5 GWh x 0.97p/kWh = £92,000 (Area B on above chart).

A1.27 This is a theoretical estimate as NGGT did not undertake a locational buy. However, we have assumed that NGGT would have been required to undertake a locational buy, potentially on a future gas day.

A1.28 The direct cost of the locational trade was **£92,000 less £14,000 = £78,000**

**2) Theoretical cost: Capacity buybacks**

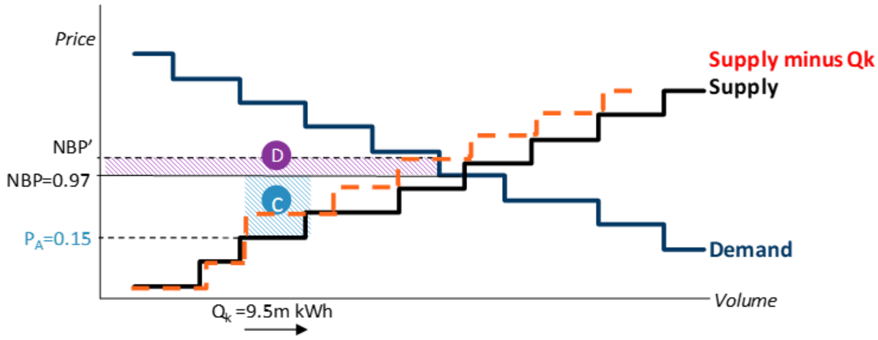
A1.29 In the alternative scenario, NGGT could also have undertaken a buyback action.

101 NGGT (2017) Our Performance for 2016/17.

102 Sell price of 4.38p/therm converted to p/kWh. Source: NGGT (2016) OCM Market Update.

103 Monthly average of 28.36p/therm converted to p/kWh. Source: Ofgem, Gas prices: Day-ahead contracts – monthly average.

**Figure A1-2: Capacity buyback action to resolve oversupply**




*Source: FTI analysis.*

A1.30 This would have resulted in two effects:

(1) NGGT would have incurred a cost of buyback {Q x (NBP - $P_A$)} = £78,000. [104] This corresponds to Area C in the above chart; and

(2) the impact on consumers from an NBP price change:

**Table A1-8: Impact on consumer from NBP price change**

| Items | Low | High |
|---|---|---|
| Estimated ΔNBP (p/kWh) | 0.1 | 0.5 |
| Demand (TWh) | 3.4 | 2.3 |
| **Cost to consumers (£ million)** | **3.4** | **11.5** |

*Sources: FTI analysis.*

A1.31 We have considered that 0.5p/kWh is a reasonable assumption for the upper limit of the NBP price increase as this corresponds to the last buyback action undertaken by NGGT (in 2006).[105,] We assume a 0.1p/kWh change for the lower bound.[106]

---

104 It is possible that NGGT would have to incur a higher cost, as it would have to buyback a larger quantity. This is because NGGT might be required to buyback all allocated but unused capacity rights.

105 ICIS (2006) National Grid issues Terminal Flow Advice warning. On the day of the buyback, gas System Average Prices increased by 0.5p/kWh. The total end of day demand on 5th September 2016 (following the Milford Haven event) was 2.3 TWh.

106 We assume a price elasticity of demand of around -0.4, so if the NBP price only increases by 0.1p/kWh, demand is 3.4 TWh.

A1.32 An increase in the NBP price would affect the whole market volume. This is because the clearing price in the NBP sets the price for all volume procured by shippers.

A1.33 The total cost of a hypothetical buyback action therefore would be a sum of the two effects, resulting in a total cost of between approximately £3.5m and £11.6m (the sum of the results from effect (1) and effect (2)). This reflects two types of cost to consumers as described above – the direct cost from buying back the entry capacity and the indirect cost caused by the NBP price increasing as a result of supply restrictions.

A1.34 There are a few reasons to believe that the cost of a buyback action would be higher if it were to occur. First, the quantity of capacity required to be purchased by NGGT might be significantly larger if the constrained flow is below the capacity purchased by shippers. Second, constraints tend to occur on high demand days. Third, higher NBP prices may spill over to the electricity sector resulting in higher electricity prices.

# Appendix 2 **Potential asset ownership bias for hydrogen transmission**

A2.1 The extent of the role played by hydrogen in the UK's pursuit of Net Zero is uncertain. As discussed in Section 4 above, the two FES 2019 scenarios that achieve 80% of the UK's Net Zero Target by 2050 diverge significantly in their forecasts related to hydrogen.

A2.2 Nevertheless, for completeness, in this appendix we present a possible calculation of the magnitude of the potential asset ownership bias in a hydrogen network, if the current GSO arrangements for NGGT persist. To be clear, this assumes:

- the demand for hydrogen will be high, as the UK moves to Net Zero;
- the production of hydrogen is relatively 'centralised', which therefore requires transportation to centres of demand;
- significant adaptations to the NTS are necessary to transport hydrogen (or, a new transmission system needs to be constructed – we treat the two as interchangeable);
- the GSO remains fully integrated within NGGT, as per current arrangements; and
- the GTO constructs the hydrogen transmission system on a non-competitive basis, in the same way it currently plans and expands the NTS.

A2.3 These factors combined mean that, by construction, the estimate we present in this appendix should be considered an upper bound.

A2.4 We mimic the approach described in Section 3 above:

(1) We first **forecast the expenditure** required to adapt the NTS for a large volume of hydrogen.

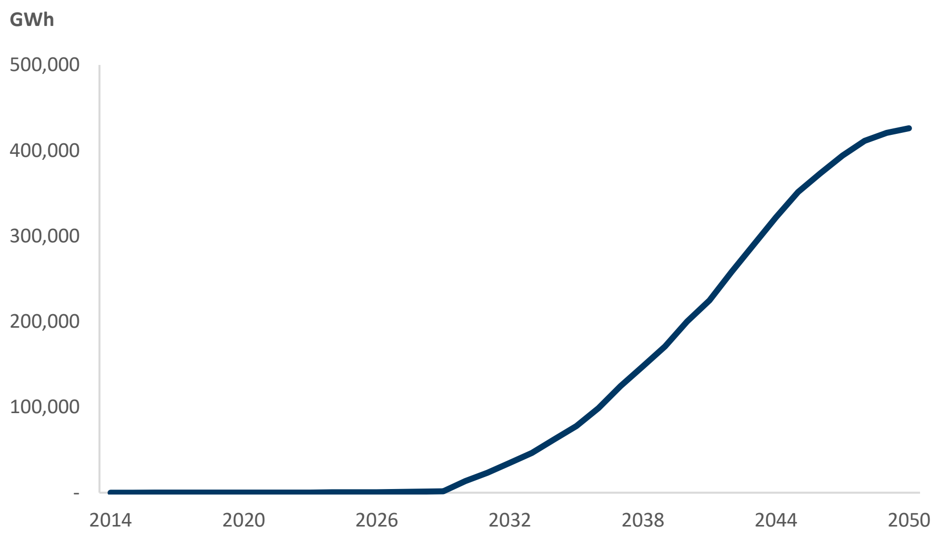
(2) We then **assume some proportion of this expenditure is 'overspend'** that might not otherwise have been incurred if the GSO was fully unbundled from NGGT.

### Calculation of potential asset ownership bias

A2.5 To forecast the expenditure to adapt the NTS for hydrogen, we assume a fixed £ per MWh of energy used to produce hydrogen.

A2.6 We use the combined demand for electricity and gas to produce hydrogen as a proxy for the demand for hydrogen. We assume that, from now until 2050, this will be as per the Two Degrees FES 2019 scenario. This scenario forecasts (by far) the highest level of hydrogen demand among all four scenarios. The Two Degrees scenario predicts the combined demand for electricity and gas to produce hydrogen will grow from 202 GWh in 2022 to over 425,000 GWh in 2050. This is illustrated in the figure below.

**Figure A2-1: Combined demand for electricity and gas to produce hydrogen (2 Degrees – FES 2019)**




*Source: FTI analysis, based on data from NG ESO (2019) Future Energy Scenarios 2019.*

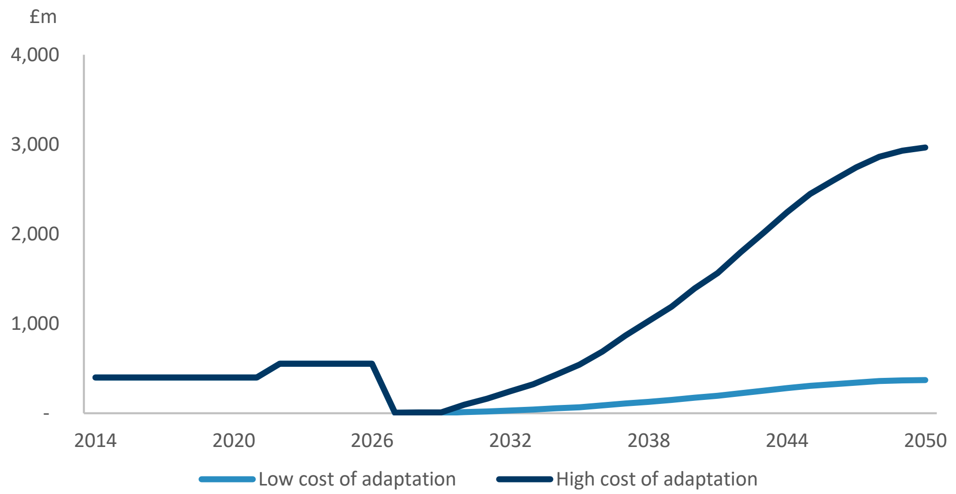
A2.7 The cost of converting the NTS for hydrogen is uncertain and difficult to forecast. We assume a range of between £0.87 per MWh and £6.97 per MWh of energy used to produce hydrogen.[107] This range can be used to give an estimate of total expenditure, which we use for the 2027 to 2050 period only.

107 Converted from a range of €1 per MWh and €8 per MWh. Source: GRTgaz (2019) Technical and economic conditions for injecting hydrogen into natural gas networks.

A2.8 For the 2022 to 2026 period, we forecast total expenditure will be equal to NGGT's RIIO-2 business plan, which mimics the approach used in Section 4 above.

A2.9 The figure below presents the estimated total expenditure to adapt the NTS for the level of hydrogen predicted by the 2 Degrees scenario.

**Figure A2-2: Range of expenditure required to adapt the NTS for hydrogen (2 Degrees – FES 2019)**




*Sources: FTI analysis, based on data from GRTgaz (2019) Technical and economic conditions for injecting hydrogen into natural gas networks; NG ESO (2019) Future Energy Scenarios 2019.*

A2.10 Our calculations suggest the total cost of adapting the NTS for hydrogen from 2022 and 2050 could be between **£4.6 billion and £18.9 billion** on a present value basis.

A2.11 As in Section 4 above, we assume a proportion of this expenditure may in theory be overspend, which would not be incurred if the GSO was fully unbundled from NGGT. We apply a range of between **1% and 10%** to the range of total cost. This gives an estimated benefit of **£0.02 billion and £1.6 billion** of removing the GSO's potential asset ownership bias.

## Glossary

| | |
|---|---|
| AESO | Alberta Electricity System Operator |
| BEIS | Department for Business, Energy & Industrial Strategy |
| BETTA | British Electricity Trading and Transmission Arrangements |
| BSC | Balancing and Settlement Code |
| CAA | Civil Aviation Authority |
| CATO | Competitively Appointed Transmission Owner |
| CCC | Committee on Climate Change |
| CCM | Capacity Constraint Mechanism |
| CfD | Contracts for Difference |
| Combined SO | Combined electricity and gas system operator |
| CMA | Competition and Markets Authority |
| CUSC | Connection and Use of Settlement Code |
| DNO | Distribution Network Operator |
| EBSCR | Electricity Balancing Significant Code Review |
| EMR | Electricity Market Reform |
| ENCC | Electricity National Control Centre |
| ESO | Electricity System Operator |
| ETYS | Electricity Ten Year Statement |
| EUR | European Euro |
| FES | Future Energy Scenarios |
| FTI Consulting | FTI Consulting LLP |
| FY2022 | The financial year ending 31 March 2022 |
| FY2050 | The financial year ending 31 March 2050 |

| | |
|---|---|
| GB | Great Britain |
| GBP | British Pounds. |
| GB SO | Great Britain System Operator |
| GIS | Gas Industry Standards |
| GNCC | Gas National Control Centre |
| GSO | Gas System Operator |
| GTO | Gas Transmission Owner |
| GTYS | Gas Ten Year Statement |
| HSE | Health and Safety Executive |
| IBC | Incentivised Balancing Cost |
| IGT | Independent Gas Transporter Network Codes |
| I-SEM | Integrated Single Electricity Market |
| ISO | Independent System Operator |
| ITPR | Integrated Transmission Planning and Regulation |
| LMP | Locational Marginal Pricing |
| MISO | Midwest Independent System Operator |
| NBP | National Balancing Point |
| NATS | National Air Traffic Services |
| NETA | New Electricity Trading Arrangements |
| NETS | National Electricity Transmission System |
| NGTA | New Gas Trading Arrangements |
| NG ESO | National Grid Electricity System Operator |
| NGET | National Grid Electricity Transmission |
| NGGT | National Grid Gas Transmission |
| NGV | National Grid Ventures |
| NOA | Network Options Assessment |
| NTS | National Transmission System |

| | |
|---|---|
| SPAA | Supply Point Administration Agreement |
| SQSS | Security and Quality of Supply Standard |
| STOR | Short-Term Operating Reserve |
| Ofgem | Office of Gas and Electricity Markets |
| OFTO | Offshore Transmission Owner |
| RAB | Regulatory Asset Base |
| RAV | Regulatory Asset Value |
| RIIO | Revenue = Incentives + Innovation + Outputs |
| TO | Transmission Owner |
| TSF | Technical Standards Forum |
| UNC | Uniform Network Code |
| STC | System Operator – Transmission Owner Code |
| SO | System Operator |
| UK | United Kingdom |
| US | United States of America |
| USD | United States Dollars |