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Do current regulatory frameworks in the EU support innovation and security of supply in electricity and gas infrastructure?

Country Report – United Kingdom

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Assessment of the NRF and the regulatory practice of the electricity and gas sector in the UK

The NRF and regulatory practices for electricity and gas in the UK have many similarities, for this reason in this summary no distinction is made between electricity and gas.

The NRF in the UK

Transmission system operation (the SO) and transmission ownership (the TO) roles are separated in the UK. There are various conditions on TOs in the *Standard Licence Conditions, which* are specific to security of supply. There are limited duties on Ofgem to encourage innovation in terms of the statutory framework, however the duty to encourage innovation is likely implicit in the more general duties on Ofgem to ensure that it secures the efficient and economic execution of activities by licensees.

The main mechanism to ensure the delivery of appropriate investment in the transmission network is through the RIIO (Revenue= Incentives + Innovation + Outputs) model. RIIO-T1 price control decisions are built on a traditional RPI-X model. The SOs and TOs submit business plans to the NRA for assessment and approval. In particular Ofgem's criteria and methodology for outputs assesses the proposed investment projects in a TO's business plan in terms of Reliability, Wider Works, and Innovation.

The regulatory practice in the UK

Key elements identified that encourage innovation are:

- *Network Innovation Allowance*: this allowance funds smaller technical, commercial or operational projects on the network;
- *Network Innovation Competition:* funding innovation projects which help all network operators understand what they need to do to provide environmental benefits, cost reductions and security of supply.

Key elements identified that encourage security of supply and innovation are:

- An outputs-driven framework with incentive mechanisms for delivery against a set of broad parameters;
- *Re-openers* which are specific circumstances where TOs can request Ofgem to review of costs in light of certain specified events;
- *Revenue Drivers:* the gas TSO is funded to provide baseline levels of. If there is demand for additional capacity, it automatically receives additional funding to support its investment in delivering that capacity;
- *Strategic Wider Works Mechanism (SWW)*, which allows TOs to bring forward large projects, not allocated funding as part of the RIIO price control.

Stakeholders have a positive opinion on the investment climate for innovative projects and there are no indications that the NRF results in barriers for investments in security of supply projects.

The NRF is considered quite clear and accommodating to new investments, including security of supply investments.

Options for improvement

A distinguishing characteristic of the NRF in the UK is its emphasis on innovation. Stakeholders have a positive view on the effects of the funding mechanisms for innovation. However, to the best of our knowledge, the effect of the funding mechanisms on investment levels and outputs has not been evaluated. The insights from such an evaluation could benefit both regulatory practices in the UK as well as in other Member States that consider the implementation of similar mechanisms.

1. INTRODUCTION

The present Country Report is a deliverable of the study "Do current regulatory frameworks in the EU support innovation and security of supply in electricity and gas infrastructure?".

The key objective of the study is to analyse how the existing national regulatory frameworks (NRFs) in the EU guide and incentivise the electricity and gas transmission project promoters to undertake investments. The focus of the study is both on investments in new innovative technologies and investments to increase security of supply. The main objective of the study is to map how the regulatory frameworks in the MSs support such investments and how do these frameworks ensure that the necessary investments are made.

This Country Report provides an overview of both the current legal frameworks and their implementation practice related to investments in gas and electricity transmission infrastructure. As part of this analysis, selected specific infrastructure projects in electricity and gas are discussed. Based on this research, options for improvement are formulated, both relating to the implementation practice and to legal changes.

The Country Report is based on previous study deliverables and analysis. It is divided into two main sections, Section 2 which relates to electricity, and Section 3 which relates to gas. Each of these sections examines the legal framework (Section 2.1 for electricity and Section 3.1 for gas), including specific rights and duties of relevant parties, such as TSOs and NRAs (hereafter also referred to as stakeholders), mechanisms for the financing of investment projects and the regulatory rules regarding innovation and security of supply in particular. Having studied the legal regulatory framework, Section 2.2 for electricity and Section 3.2 for gas examine the regulatory practice in the UK, drawing specifically on stakeholder interviews, and paying particular attention to the regulatory practice related to innovation and security of supply. The functioning of the legal framework and the regulatory practice are illustrated by selected specific projects in the UK. Lastly, options for improvement of the regulatory practice and the regulatory framework are discussed in Section 2.3 for electricity and Section 3.3 for gas.

These options for improvement are taken from a long list of best practises that the project team has compiled based on the analysis of regulatory frameworks in all Member States. We acknowledge that we have not carried out a full analysis of all the costs and benefits of the suggested options. Therefore, some of these options are conditional and there might be reasons that we did not take into consideration not to implement them.

The focus of this report is not primarily on R&D investments and projects, but rather on "innovative" transmission infrastructure related investments. In order to define what "innovative" is in the context of this report, we have introduced the notion of "typological investments" (see Annex I and II). The goal of selecting "typological investments", which, in our understanding, are categories of investments, was to make the discussion concrete and the investments comparable across countries. The term "typological investment" relates to technical solutions that TSOs can adopt to provide the transmission capacities needed to cover the transmission demand of grid users.

Thus, a typological investment is meant to be a type of solution that can be implemented, in principle, by any TSO in situations in which these solutions are appropriate to provide the desired benefit. Hence, typological investments are not specific to a concrete location or a particular TSO. Annex I provides a list of typological investments in the electricity sector, whereas Annex II provides the same for gas.

Ultimately, these technical solutions contribute to fulfilling the objective to improve or maintain the level of security of supply. It has to be noted that the degree of innovativeness of typological investments can be quite diverse, ranging from construction of conventional assets like AC overhead lines or pipelines with conventional materials and construction methods down to novel concepts of system automation and operation based on recent R&D achievements. Innovation aims at providing the desired level of transmission capacity – determined by the objectives of security of supply (see above) – in a way that is in some way superior to the conventional way, e.g.:

i. by immediately reducing overall cost as compared to a conventional solution;
ii. by prospectively reducing overall cost in the future, subject however to a "learning curve" as to the cost level of the innovative solution;

iii. by accelerating the process of transmission capacity expansion and thus reducing social welfare loss caused by temporarily insufficient transmission capacities; or
iv. by providing improvements with respect to other criteria that are often difficult to monetarise, like environmental or public acceptance aspects.

Innovative investments, especially those whose benefits fall into category ii., iii. and iv. named above, can face certain barriers and market failures. We have identified five categories of innovative projects, which might encounter potential regulatory barriers (see also Annex III for more explanation):

a. Capital intensive projects resulting in uncertain future OPEX gains (efficiency improvements / cost reductions) are not incentivised by the regulatory framework;
b. Projects with potential significant benefits, which would benefit primarily the wider society and where the concerned TSOs are not incentivised;
c. A roll out and investment in smart grids substituting planned physical investments may provide a reduction in the regulated asset base, but might not be realised due to an increase in tariffs or regulatory disincentives;
d. Projects with few or no commercial benefits to justify the investment, but with positive social impacts;
e. Projects, which result in a lower TSO TOTEX, but bring about a shift in the CAPEX/OPEX ratio, which is not incentivised by the regulatory framework.

Our understanding of innovative investments and typological investments, and the categorisation of investment projects in relation to possible regulatory barriers are the basis for the research done in the context of the analysis of the implementation practice in this report.

2. ELECTRICITY

2.1. Legal analysis of the NRF in the UK

2.1.1. Overview of the regulatory framework of the UK– legal rules

For the purposes of the Legal Framework in GB, "transmission" is defined as 275kV or above (for England and Wales) and 132kV or above (for Scotland).

Electricity: Great Britain (GB)

The Electricity Act 1989, the "1989 Act" (which has been heavily amended since its commencement) is the principal piece of primary legislation governing the Legal Framework for electricity in GB. Ofgem[1], the independent economic regulator of the GB electricity industry, derives its primary duties, objectives and powers from the 1989 Act. Both the regulator and the Secretary of State (minister of government) have duties and objectives derived from this Act. These duties and powers (as relevant to transmission network development) include:-

- The principal objective in respect of their functions is to protect the interests of existing and future consumers in relation to electricity conveyed by distribution systems or transmission systems.[2] This includes the interests of existing and future consumers as a whole in respect of their interests in the security of electricity supply.[3] Wherever appropriate, the Secretary of State or Ofgem will carry out their objectives through the promotion of effective competition in the electricity market (including specifically activities relating to transmission or the provision/use of interconnectors);[4]
- The Secretary of State/Ofgem are also required to carry out their functions in a way best calculated to ensure all licensees are able to finance the activities for which they are licenced (which will include transmission development)[5], the promotion of efficiency and economy on the part of licensees[6], and to secure a diverse and viable long-term energy supply.[7]

The 1989 Act sets up the licensing regime for the electricity market in GB. Ofgem, as regulator, administers this regime. Licensable activities include interconnection, generation, transmission, distribution and supply. There are restrictions on the same person holding multiple different types of licence, in compliance with the Third Package.[8] Each activity has a separate licence and associated standard conditions.[9]

While Ofgem has a central role in the regulation and continuing development of the GB framework, there is scope for direct intervention by the Secretary of State. For example, there are powers available to government to give specific directions to any licensee for the preservation of security of supply.[10]

Ofgem's role involves the issuing of licences for the activities mentioned above, monitoring compliance with those licences, engaging in economic regulation (price control) of the transmission network licensees through the RIIO-T1[11] model, as well as develops various initiatives, programmes and interventions to secure the achievement of its statutory objectives.[12] These interventions and initiatives are often executed through the leveraging of

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1 The Office of Gas and Electricity Markets ("Ofgem"), was created by the Utilities Act 2000, which merged the functions of the previous Director Generals of Gas Supply and Electricity Supply. The 2000 Act sets out the establishment and governance arrangements of the new regulator (such as Board composition etc.). The 2000 Act also modified the Electricity Act 1989 and the Gas Act 1986 to reflect the new regulatory arrangements.

2 Section 3A(1) of the 1989 Act.

3 Section 3A(1A) of the 1989 Act.

4 Section 3A(1B) of the 1989 Act.

5 Section 3A(2)(b) of the 1989 Act.

6 Section 3A(5)(a) of the 1989 Act.

7 Section 3A(5)(c) of the 1989 Act.

8 Section 6 of the 1989 Act.

9 https://www.ofgem.gov.uk/licences-codes-and-standards/licences/licence-conditions.

10 Section 96 of the 1989 Act.

11 RIIO (Revenue=Incentives+ Innovation+ Outputs). RIIO is Ofgem's framework for setting price controls for network companies. It is fundamentally based on traditional RPI-X price cap regulation but has evolved to incorporate new features and incentives.

12 Explained in further detail below.

existing statutory and regulatory powers (for example by introducing a new licence condition on licensees). Government can and does make interventions in the framework, and these can often be through new statutory duties to be carried out by Ofgem.[13] Broadly, however, obligations on transmission system owners and the system operator are largely executed through the imposition of licence conditions through the Transmission Licence Standard Conditions.

2.1.2. Specific legal rights and duties

Role of the TSO

Transmission system operation (the SO) and transmission ownership (the TO) roles are separated in the UK, although the SO role for GB is carried out by a business unit of one of the TOs. There are three Transmission Owners (TOs), in the GB onshore electricity framework:-

- National Grid (NGET): England and Wales;
- ScottishPower Energy Networks (SPEN): Central Scotland;
- Scottish Hydro Electricity Transmission (SHET): North of Scotland;
- Whilst separate companies own the networks and are responsible for the maintenance, renewal and development of the networks they own, NGET is tasked with the Transmission System Operator (SO) role for the National Electricity Transmission Network (NETS) in GB *as a whole* and does this through a distinct business unit within the NGET group, carrying out day-to-day system operation, including balancing of the system and constraint management. As mentioned NGET also owns part of the GB transmission network, again through a business unit within the group, although this arrangement is changing;[14]
- All of the transmission system owners are permitted to carry out their activities through licences issued by Ofgem, who also maintains, develops and monitors compliance with these licences and associated Standard Licence Conditions (SLCs). There are also general statutory duties on transmission licence holders to develop and maintain an efficient, co-ordinated and economical system of transmission and to facilitate competition in supply and generation.[15] There are various conditions on TOs in the SLCs which are specific to security of supply, including:-
- **Condition B12:** Obligation for SO and TOs to be party to and comply with the System Operator-Transmission Owner Code (STC), which defines the high level relationship between the system owners and operator and is administered by the SO on behalf of all parties to it. A key objective of the STC is the protection of the security and quality of supply of the NETS.[16] Examples of obligations on TOs under the STC are various obligations to plan and coordinate works in cooperation with the SO.[17] An example of an obligation on the SO, is to prepare the Electricity Ten Year Statement (as it is required to do under its licence, see more below) in consultation with the TOs.[18]
- **Condition C17/D3:** Obligation on SO[19] and TOs[20] to plan and develop their transmission system in line with the requirements of the National Electricity Transmission System Security and Quality of Supply Standard[21] (SQSS). While the requirement to comply with the SQSS is a licence condition, the coordination and administration of the SQSS is an industry-led process based on voluntary cooperation and coordination between the TOs and the SO.[22] The obligations set out in the SQSS are of a high level technical nature which TOs and the SO must comply with (such as technical and design standards/criteria including voltage limits under section 6 of the

[13] See for example the Electricity Market Reform (EMR) policy, much of which was introduced through the Energy Act 2013. This introduced the Capacity Market (CM) and Contracts for Difference (CfD) mechanisms. Both of these mechanisms are delivered by National Grid (the UK Transmission System Operator), through a subsidiary, the EMR Delivery Body.

[14] Note, that Ofgem has mandated greater separation of the owner/operator units within National Grid. NGESO (the System Operator) will be a separate legal entity within the National Grid group from April 2019. Transition activities are underway.

[15] See Section 9(2) of the 1989 Act.

[16] See Condition B12(3)(d) of the Transmission Licence Standard Conditions.

[17] Generally, see Section D, of the STC.

[18] See Section D, Part 1(4) of the STC.

[19] See Condition C17 of the Transmission Licence Standard Conditions.

[20] See Condition D3 of the Transmission Licence Standard Conditions.

[21] The SQSS sets out sets out a coordinated set of criteria and methodologies (for example cost-benefit techniques and weather related operation) that transmission licensees shall use in the planning and operation of the NETS in GB.

[22] See the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS) Industry Governance Framework, at section 2.

SQSS). In this sense, adherence to these technical standards promotes security of supply in the transmission network by ensuring reliable and consistent operation. The SQSS should be read in conjunction with the Grid Code and the STC, as both of these documents build on the requirements of the SQSS;

- **Condition C14:** Obligation for the SO to prepare the Grid Code, the technical code for connection and development of the NETS. Promotion of security and efficiency of the NETS is a key objective of the Grid Code.[23] The Grid Code sets out the operating procedures and principles governing the relationship between NGET and all users of the NETS (be they Generators, DC Converter owners, Suppliers or Non-Embedded Customers). The Grid Code specifies day-to-day procedures for both planning and operational purposes and covers both normal and exceptional circumstances. The Grid Code provides more detail on technical and operational criteria between users of the NGET and the SO;
- **Condition C4/C5/C6:** The SO must develop charging methodologies for the connection and use of the NETS. Methodologies are subject to approval by Ofgem. Such charges support the operation and development of the NETS;
- Licensees (both SO and TOs), as a condition of their licence, are required to comply with the requirements of Regulatory Instructions and Guidance (RIGs) as published by Ofgem. RIGs are the primary means by which Ofgem directs licensees to collect and provide the information, such as business plans, the regulator needs to perform its functions in relation to the price control (for more, see Section 2.1.1 above on the role of the NRA). The licence conditions set out the scope and content that can be included in RIGs issued by Ofgem;[24]
- In support of security of electricity supply and identification of appropriate investment in the NETS, NGET, as the SO, is required[25] to prepare an annual statement on the capabilities and future requirements of the NETS in GB. This is done with input from all the TOs, and is known as the Electricity Ten Year Statement (ETYS). Previously prepared as a single document, the ETYS is published along with 'sister' documents that together fulfil NGET's requirement to publish this information. These include the Network Options Assessment (NOA), which recommends options for TOs on when and what to invest in, in order to support the future of the NETS. NGET is required under a licence condition to publish this NOA.[26] The other GB TOs feed into the development of this document, providing information about their networks. Together, these documents feed into the Community-wide Ten Year Network Development Plan, which is prepared pursuant to Regulation (EC) 714/2009.

Finally, the System Operability Framework (SOF) provides a holistic view and ongoing technical assessment of requirements for medium and long term operability of the NETS.

Undertaking of investments

TSOs are required to carry out any investment projects to deliver on their legal/regulatory duties as more fully described above in this Section 2.1.2. TSOs are also required to develop business plans, which deliver on those duties through Ofgem's price control process, the details of which are more fully described in Section 2.1.3, below.

Institutional or procedural constraints on the performance of these roles

The statutory duties, powers and associated licencing regime set out in the answers above, do tend to act as a constraint on the performance of specific roles, whether this is from Ofgem or the regulated network companies. This is particularly prevalent when duties conflict with each other. For example, the requirement for Ofgem to wherever possible encourage the development of competition in the network to deliver objectives, may conflict with other objectives and duties in certain circumstances.

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23 See Condition C14(1)(b)(iii) of the Transmission Licence Standard Conditions.

24 Condition B15 of the Transmission Licence Standard Conditions sets out the requirement to comply with RIGs. In addition, there are a number of obligations on the licensee to have in place various systems and processes to comply with requests for information from the regulator.

25 Through Condition C11 of the Transmission Licence Standard Conditions.

26 See SLC C27.

In order to execute changes or implement specific policies within the legal framework, Ofgem will often be required to do so in accordance with any governance mechanisms to execute such change. An example of this would be the modification of licence conditions. The process for this often requires consultation, statutory notice periods, and may be appealed by licensees or third parties to the UK's Competition and Markets Authority, or ultimately the courts.[27]

In addition, some policies cannot be fully implemented without making changes to the various industry codes that serve to manage balancing and settlement, connection to the network and customer switching in GB. Often the process of amending those codes is elaborate and time consuming causing delays in the implementation of change.

Planning processes and legislation associated with the obtaining of appropriate planning consents (e.g. environmental, aviation, health and safety), can clearly act as a legal constraint on the development of the transmission network in any particular project. Any project promoter will need to develop such projects in line with the requirements of the legal framework, as a whole, and this will include planning processes.

Additionally, general requirements relating to aspects of public law (such as the requirement to consult, to follow any defined processes and governance set out in the regulatory framework) will also act as general constraining factors on the ability and speed at which Ofgem can act within the regulatory framework.

2.1.3. Mechanism for financing of investment projects

Ofgem has a number of funding mechanisms, which have an influence on the development of the transmission network. Some mechanisms are general (covering transmission and more), while others are more specific to transmission. We set these out in turn, below.

RIIO-T1

Ofgem's primary mechanism to ensure the delivery of appropriate investment in the transmission network is through the RIIO (Revenue= Incentives + Innovation + Outputs) model. There are RIIO price controls for distribution and transmission. The current price control for transmission is RIIO-T1 and is effective from 2013- 2021, setting limits on what SO and TOs can charge for development and operation of the NETS.

RIIO-T1 price control decisions are carried out for both SO and the three TOs in GB. They are built on traditional a RPI-X model (where allowed revenue is capped at RPI minus expected efficiency savings, plus a factor for allowed investment). The SO and TOs submit business plans to Ofgem for assessment and approval in line with the framework.[28] In particular Ofgem criteria and methodology for outputs specifically assesses the proposed investment projects in a TO's business plan in terms of Reliability, Wider Works, and Innovation.[29]

Overall revenues that TOs can recover are limited through a cap, implemented via a licence condition on TOs[30], on the maximum revenue that may be recovered through the TO's Transmission Network Charges. A similar condition operates in respect of SO revenue restrictions for NGET.[31] Both conditions contain the detailed formula by which revenue maximum revenue is calculated for the year. The variable inputs (such as Corporate Debt

[27] The licence modification process, and governance surrounding appeals to the Competition and Markets Authority for electricity is found at Section 11 and 11A-15A of the 1989 Act.

[28] The criteria used by Ofgem in their initial assessments of business plans can be found at pp18-23 of Supplementary Annex RIIO-T1 and GD1 Overview papers to Ofgem's Consultation on strategy for the next transmission and gas distribution price controls.

[29] See Initial Assessment of Business Plans at pages 17-20, for an example of assessment of such outputs in the contexts of National Grid Electricity Transmission.

[30] See, for example, Standard Special Condition 3A (and more widely, Chapter 3) of the Special Conditions to National Grid Electricity Transmission's Electricity Transmission Licence. Special conditions also exist for the other GB TOs including SP Transmission and SHETL (although note that consolidated public versions of the special conditions are not formal public register documents and cannot be relied on as they can sometimes have changes pending).

[31] See Standard Special Condition 4A (and more widely, Chapter 4) of the Special Conditions to National Grid Electricity Transmission's Electricity Transmission Licence.

Expenditure) are updated through an ongoing Annual Iteration Process, with such iterations being executed through Directions[32] issued by Ofgem to TOs/SOs under the Special Conditions.

In essence, TOs propose projects as part of their business plan, Ofgem scrutinises and approves the investment plan, setting the maximum recoverable revenues that TOs can charge to deliver the approved plan. TOs then fund this by preparing a statement[33] setting out their charges (one for each TO) that is to be consistent with the revenue caps that Ofgem set, and which is ultimately approved by Ofgem.[34] In this way, development of the transmission network is ultimately paid by end-user customers, as the retail charge for electricity includes transmission charges as a cost component of this.

The RIIO model (and its predecessors) has been developed and expanded over successive price control periods. RIIO-T1 now has a number of features that build on the previous approach. Key elements identified that encourage security of supply and innovation are:

- Outputs-driven framework with incentive mechanisms for delivery against a set of broad parameters. For example, the RIIO decisions implement safety and reliability incentives with appropriate penalty provisions for under-performance as well as a framework for compensation payments to customers for interruptions to supply (6/12 hour payments in place), thereby providing incentives for securing supply to customers;
- Allowed revenues are capped but mechanisms are in place, which allow for potential uncertainties identified in SO/TO business plans. These are tightly defined, and include incentive arrangements that set percentages of under/over recovery of revenues that SO/TOs absorb and what levels of additional cost/savings are passed on to consumers. A key element is the defined 're-opener' mechanisms, which are specific circumstances where TOs can request Ofgem to review of costs in light of certain specified events. For example, for RIIO-T1 categories include the possibility of re-openers for SO spend on IT security enhancement (which supports security of supply), and also the ability to apply for a revenue adjustment mechanism for innovation projects, that enables companies to apply for additional funding within the price control period for the rollout of initiatives with demonstrable and cost effective low carbon or environmental benefits;
- **Network Innovation Allowance (NIA):** The NIA is a set allowance that each RIIO network licensee receives as part of their overall revenue allowance as determined in the RIIO price control. These funds are allowed to fund smaller technical, commercial or operational projects on the network that have potential to deliver financial benefits to the licensee or customers. Licensees can also use funds to prepare submissions for the Network Innovation Competition (below). NGET's innovation allowance is governed in accordance with its Special Conditions.[35] Ofgem also issues an NIA Governance Document which contains all of the regulations for the administration and governance of the NIA;
- **Network Innovation Competition** (NIC): Part of the RIIO price control, the electricity NIC is an annual opportunity for electricity network companies to compete for funding for the development and demonstration of new technologies, operating and commercial arrangements. Funding will be provided for the best innovation projects, which help all network operators, understand what they need to do to provide environmental benefits, cost reductions and security of supply as GB moves to a low carbon economy. Up to £70m per annum is available through the Electricity NIC. NGET funds eligible projects by means of its transmission network charges, under governance arrangements provided for in NGET's Special Conditions.[36] An expert panel assists Ofgem in the assessment of project proposals. The latest example of the expert panel's assessment of specific projects is available here. Case studies of recent NIC projects can be found in a brochure published by Ofgem. A relevant project on the transmission network includes SP Energy Networks' testing of a new type of solid-state transformer on the GB network.

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32 For example, see Standard Special Condition 5B of the Special Conditions to National Grid Electricity Transmission's Electricity Transmission Licence.

33 For example, see Scottish and Southern Electricity Networks' Transmission Charges Statements for the Scottish Hydro Electric Transmission area.

34 Charging statements are prepared in accordance with the Special Conditions of Transmission Owner Licences (e.g. Special Condition 8C).

35 See Special Condition 3H of the NGET's Electricity Transmission Special Conditions.

36 See Special Condition 3I of the NGET's Electricity Transmission Special Conditions.

There are several other mechanisms in Ofgem's 'toolbox', which help support security of supply/innovation in transmission development:

- **Strategic Wider Works Mechanism** (SWW): This allows TOs to bring forward large projects not allocated funding as part of the RIIO price control. Here Ofgem consider the need and funding for these projects during the price control period, so that delivery of these outputs can be brought forward in a timely manner. Costs are recovered from customers through grid use and connection charges. This process interacts with the annual NOAs (explained above) which are compiled by National Grid in collaboration with the other TOs. An example is the Kintyre-Hunterston reinforcement in Scotland, a joint project between the two Scottish TOs.

SWW has traditionally used TO-managed delivery for these projects by the incumbent network owner. As a development of the SWW process, Ofgem will look at introducing competition into the process, and is consulting on its future approach in 2018. Two proposals are:

1. **Competition Proxy**, where Ofgem will set TO allowed revenue for a specific project in line with the outcome Ofgem considers would have resulted from an efficient competition for the construction, financing and operation of the project. An example of a project (which Ofgem has issued a 'minded-to' decision to approve) that is proposed to be delivered under this model is the Hinkley-Seabank[37] transmission project;
2. **SPV Model,** where Ofgem will require that the TO tenders out the design, build and operation of a project through a special-purpose vehicle owned by the TO.

Ofgem strategy is focussed on introducing more competition in the development and operation of transmission assets. The two models above are mechanisms by which Ofgem seeks to deliver on these ambitions, at least temporarily. Ultimately, Ofgem will look to develop competitively appointed TOs for new and separable new projects in the onshore transmission network (the Competitively Appointed Transmission Owner framework, otherwise known as CATO[38]). Ofgem does not have the legal power to develop fully its[39] onshore CATO proposals and so the two models outlined above could be seen as stop-gaps. However, the situation is contrasted with offshore transmission, where competitive appointment for new transmission asset ownership has been in place for a number of years (more below). Ultimately, Ofgem are seeking to extend the concept of the offshore framework to future onshore assets. Note, that the primary driver for projects assessed under the SWW to date appear to have been to support new generation assets in the GB network, although this clearly has a related role in supporting security of supply objectives.

Offshore Transmission Owner:

For offshore transmission, Ofgem manages a competitive tender process for the appointment of new offshore transmission assets (OFTO). An offshore transmission licence is required for most major offshore connections to GB, and these must be obtained through a competitive process. Under the initial regime, offshore generation developers constructed assets, and transferred the right to operate and maintain the transmission assets to a separate OFTO through the competitive bidding process operated by Ofgem, where separate companies bid to operate the assets for a specified period at a defined revenue cap defined by Ofgem. In later iterations of the scheme, offshore developers have the flexibility to choose whether they or an OFTO design and construct the transmission assets. In either case, the renewables generator cannot own both the generation asset and carry the OFTO licence. OFTO appointments typically last 20 years.

The legal powers for Ofgem to operate a competitive tender process are contained within section 6C of the 1989 Act.[40] Regulations govern the tender process and a number have been issued for (so far, 5) successive tender rounds since 2009.[41] A stated objective of this policy is to encourage innovation in the development of transmission assets.

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37 Hinkley-Seabank is the project proposed by National Grid to deliver the required transmission system infrastructure for the construction and operation of the Hinkley Point-C nuclear power station.

38 Competitively Appointed Transmission Operator.

39 The current legislative framework only allows competitive allocation of transmission licences for offshore transmission. There is currently draft legislation is ready to be progressed through parliament and has been subject to pre-legislative scrutiny, but is delayed notably due to the demands that Brexit will have on the timetable for parliament.

40 A power that was introduced through modification of the Act through the Energy Act 2004.

41 Previous Regulations have been made in 2009, 2010 and 2013. Current regulations are 2015.

Interconnector development:

Under the present regulatory regime based on EU and GB requirements, there are two general routes for interconnector investment. (i) Companies can opt for a regulated application to Ofgem where a project is approved and revenue is protected/restricted through a Cap and Floor regime to the price they can receive for the energy supplied. Through the cap and floor approach, developers identify, propose and build interconnectors and there is a cap and floor mechanism to regulate how much money a developer can earn once in operation. Cap and floor regime duration is 25 years, and actual revenues earned are assessed against the cap and floor levels every 5 years, with the ability for interconnectors to request within-period adjustments. This approach is intended to be a risk sharing mechanism between customers and developers. (ii) Alternatively companies can build such assets outside of the regulated route, but do so entirely at risk without regulatory backstop.[42] The majority of Projects of Common Interest would likely fall under the cap and floor regime.[43]

Innovation Link (Regulatory Sandbox):

Ofgem provides a service (known as the Innovation Link) which allows businesses access to advice and assistance on innovation or other propositions that don't 'fit' with the regulatory model. A single point of contact is provided for feedback, and a 'sandbox' where applicants can trial services and products that cannot operate within the existing framework. While projects to date have focussed more on the area of consumer/retail, transmission projects are not necessarily outside of scope for support.

Relevant project types

While generally the mechanisms above are designed to capture and accommodate a wide variety of projects, certain mechanisms are aimed at more specific categories of project. For example, the general RIIO price control framework covers a wide variety of potential development projects, and since the requirements are outputs (or outcomes) based the specific category of project to deliver on that output will be for TSOs to determine in their business planning activities, but will be subject to Ofgem scrutiny through the price control process.

The Strategic Wider Works mechanism again can accommodate a variety of categories of projects but will typically be larger, specific projects, which are identified as a need outside of the RIIO price control period. Typically, these projects have been reinforcements to the transmission network, particularly to cater for new renewables development. A list of current projects, which are currently being considered by Ofgem under this mechanism, is available here.

2.1.4. Regulatory rules with respect to innovation

Specific duties of the TSO aimed at encouraging innovation

Duties, including any, which are applicable to innovation (or indirectly support innovation), are more fully described at question (i), above. TSOs will also have role in delivering/participating in mechanisms, which support the development of innovation.

Specific duties of the NRA aimed at encouraging innovation

There are limited duties on Ofgem to encourage innovation in terms of the statutory framework, however the duty to encourage innovation is likely implicit in the more general duties on Ofgem to ensure that it secures the efficient and economic execution of activities by licensees. As a result, many of the mechanisms, outlined in Section 2.1.3, are aimed specifically at promoting innovation.

2.1.5. Regulatory rules with respect to security of supply

Specific duties of the TSO aiming at safeguarding security of supply

Duties, including those applicable to security of supply, are more fully described in Section 2.1.2 above. TSOs will also have role in delivering/participating in mechanisms, which support

[42] For more information, see Ofgem, Cap and Floor Regime: Unlocking investment in electricity interconnectors.

[43] See page 9 of https://www.ofgem.gov.uk/ofgem-publications/90534/regulatoryregimesingb.pdf.

security of supply objectives. These specific mechanisms, and the TSOs role in them, are more fully explained in Section 2.1.3.

Specific duties of the NRA with respect to security of supply

See Section 2.1.1, above, with regard to the legal powers and duties available to Ofgem in terms of security of supply. Ofgem exercises these duties largely through the mechanisms more widely described Section 2.1.3 above.

2.2. Regulatory practice

2.2.1. Overview over regulatory practice in the UK

Information about the general regulatory framework in the UK

The RIIO framework is fundamentally based on traditional price cap regulation but has evolved to incorporate new features and incentives. In contrast to the framework in most other Member States one of the objectives of the framework is to encourage innovation. The framework puts emphasis on incentives and outputs but compared to the regulatory practice in other Member States with an output-based framework the regulator reviews the inputs (or business plans) in a more detailed way and there is an extensive consultation process.

Main regulatory barriers

No specific regulatory barriers were mentioned by stakeholders.

2.2.2. Regulatory practice related to innovation

Innovation projects

The Network Innovation Allowance, the Network Innovation Competition and Innovation roll-out mechanism are funding instruments for innovative projects.

The projects funded under the Network Innovation Allowance and Network Innovation Competition partly are mainly aimed at comparatively smaller projects, many of them could be considered R&D projects in the terminology used in this study. Many projects can be grouped under the category ‘Improvement of approaches to curative congestion management providing the possibility to operate systems closer to their technical limits and/or to improve security of supply’ and ‘Investment into components contributing to ancillary services provision (reactive power / voltage control, short-circuit power, momentary power reserves and black-start capability)’ in the list of ‘typological investments’ used in this study (see Annex 2).

Additionally, there are other elements of the price control which facilitate innovation, such as sharing factors (i.e. although simplified, if costs can be reduced the benefit is shared between the TSO and consumers), which drives more innovative approaches to TSO obligations such as new infrastructure build. Those ‘other elements’ provide the funding for implementation of other innovations mentioned in the list of ‘typological investments’.

Adequacy of the NRF relating to its support for innovative investments

In the regulatory framework in the UK, specific funding is available for innovative projects. There is not necessarily a barrier for TSOs, which prevents them from doing specific innovative projects.

2.2.3. Regulatory practice related to security of supply

Security of supply projects

The TO licence contains criteria regarding security of supply. Standards are not fixed and can change over time.

The TSO also has an obligation to undertake an annual Network Options Assessment report. This report contains a CBA of proposed investments, including proposed system reinforcements, which are assessed against a number of criteria.

Adequacy of the NRF relating to its support for security of supply investments

In general, TSOs are able to do the investments they want to do. The NRF is considered quite clear and accommodating to new investments. Stakeholders also note that the security of supply is at a high level.

2.2.4. Illustrative specific projects

The projects below are considered examples of innovative and security of supply projects. They illustrate how innovative and security of supply projects are successfully incentivised by the NRF. The first two projects, Deeside and the Power Potential project, are funded through the Network Innovation Competition. The following two projects can also be considered innovative, but they also have a strong security of supply component.

The Deeside Project

Description and aim

The Deeside Project of National Grid will convert a 400 kV substation into an evaluation facility where assets associated with electricity networks can be tested off-grid, 24 hours, seven days a week.[44]

Financial mechanisms

National Grid secured £12m of funding in 2015 through the Network Innovation Competition. National Grid contributed £14m of investment to the project.

Power Potential project

Description and aim

In this project, National Grid will create and trial a new reactive power market for distributed energy resources.[45]

Financial mechanisms

The project is funded under the Network Innovation Competition.

Viking Link (PCI):

Description and aim

Viking Link is a DKR11bn (1.48bn) joint project, proposed by Energinet and National Grid. The cable will stretch from Denmark to Bicker Fen in Lincolnshire (UK) through the Exclusive Economic Zones (EEZs) of Denmark, Germany, the Netherlands and the UK. It includes a 630 km long submarine cable in the North Sea and 140 km of land cables.

Originally, the final investment decision was scheduled to take place in March 2018, but it was pushed back till further clarity is achieved with respect to UK planning consents.

Financial mechanisms

A regulated route under the 'cap and floor' regime is applicable to the interconnector. Through the cap and floor approach, developers identify, propose and build interconnectors and there is a cap and floor mechanism to regulate how much money a developer can earn once in operation.

Approval process and financial mechanisms

Ofgem approved £53.2m of additional Allowed Expenditure for the Beauly Mossford project in April 2014 under the Strategic Wider Works Mechanism. This mechanism allowed the TOs to bring forward large investment projects where funding had not been awarded as part of the price control settlement.

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[44] More information is available on: https://www.nationalgrid.com/uk/investment-and-innovation/innovation/electricity-transmission-innovation/deeside-project.

[45] More information is available on: https://www.nationalgrid.com/uk/investment-and-innovation/innovation/system-operator-innovation/power-potential.

Hinkley - Seabank

Description and aim

Hinkley - Seabank is a proposed new transmission project to allow for the safe connection of the planned Hinkley Point C nuclear power station. The project of National Grid will also provide additional capability and relieve transmission constraints in the South West of England.

Approval process and financial mechanisms

In July 2018, Ofgem published its decision to fund delivery of the project through an alternative regulatory model (instead of the Strategic Wider Works Mechanism).[46] This 'Competition Proxy model' seeks to replicate the outcome of an efficient competitive process for the financing, construction and operation of the project. National Grid Electricity Transmission will receive a project-specific revenue allowance over the period of its construction and 25 years of operation.

Ofgem will conduct a Project Assessment in 2018, which will determine the efficient costs that National Grid can recover from energy consumers for delivery of the project.

2.3. Options for improvement

2.3.1. Options to improve regulatory practice

The above discussion shows that the NRF is well-designed and functional for security of supply projects.

A distinguishing characteristic of the NRF is the emphasis on innovation. Stakeholders have a positive view on the effects of the funding mechanisms for innovation. However, to the best of our knowledge, there is no formal evaluation of the impact of the innovative projects of the TSOs available. Such a formal evaluation could both benefit stakeholders in the UK as well as other Member States that are inspired by the NRF in the UK and consider to implement similar incentives for innovation.

2.3.2. National law mechanism(s) for implementing options

Not applicable.

2.3.3. Impact assessment

Not applicable.

[46] https://www.ofgem.gov.uk/system/files/docs/2018/07/hinkley_seabank_project_decision_on_delivery_model.pdf.

3. GAS

3.1. Legal analysis of the NRF in the UK

3.1.1. Overview of the regulatory framework of the UK– legal rules

The Gas Act 1986, the "1986 Act" is the principal piece of primary legislation governing the Legal Framework for gas in GB. Ofgem[47], the independent economic regulator of the GB gas industry, derives its primary duties, objectives and powers from the 1986 Act. Many of these broadly mirror that of the framework for electricity. Both the regulator and the Secretary of State (minister of government) have duties and objectives derived from this Act. These duties and powers (as relevant to transmission network development) include:-

- The principal objective in respect of their functions is to protect the interests of existing and future consumers in relation to gas conveyed through pipes.[48] This includes the interests of existing and future consumers as a whole in respect of their interests in the security of the gas supply.[49] Wherever appropriate, the Secretary of State or Ofgem will carry out their objectives through the promotion of effective competition in the gas market (including specifically activities relating to the shipping, transmission or supply of gas conveyed);[50]
- The Secretary of State/Ofgem are also required to carry out their functions in a way best calculated to ensure all licensees are able to finance the activities for which they are licenced (which will include transmission development)[51], the promotion of efficiency and economy on the part of licensees[52], and to secure a diverse and viable long-term energy supply;[53]
- The 1986 Act sets up the licensing regime for the gas market in GB. Ofgem, as regulator, administers this regime. Licensable activities include interconnection, transmission, shipping and supply. Note, that these terms can be considered as equivalent to interconnection, transmission, distribution and supply respectively when compared to the electricity framework. Each activity has a separate licence and associated standard conditions.[54]

While Ofgem has a central role in the regulation and continuing development of the GB framework, there is scope for direct intervention by the Secretary of State.

It is worth noting that Ofgem's powers on gas regulation do not extend to pipelines connecting production facilities to land and onshore terminals. These are regulated via licences issued by the UK government. More information can be obtained on the Oil & Gas authority website.

3.1.2. Specific legal rights and duties

Role of TSO

National Grid Gas Plc (NGG) owns and operates the National Transmission System in GB.

NGG is permitted to carry out its activities through licences issued by Ofgem, who also maintains, develops and monitors compliance with these licences and associated Gas Transporter Standard Licence Conditions (SLCs). There are also general statutory duties on gas transmission licence holders to develop and maintain an efficient, co-ordinated and economical gas pipe-line conveyance system and to facilitate competition in supply of gas.[55] There are various conditions on TOs in the SLCs, which are specific to security of supply, including:

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47 The Office of Gas and Electricity Markets ("Ofgem"), was created by the Utilities Act 2000, which merged the functions of the previous Director Generals of Gas Supply and Electricity Supply. The 2000 Act sets out the establishment and governance arrangements of the new regulator (such as Board composition etc.). The 2000 Act also modified the Electricity Act 1989 and the Gas Act 1986 to reflect the new regulatory arrangements.

48 Section 4AA(1) of the 1986 Act.

49 Section 4AA(1A) of the 1986 Act.

50 Section 4AA(1B) of the 1986 Act.

51 Section 4AA(2) of the 1986 Act.

52 Section 4AA(5)(a) of the 1986 Act.

53 Section 4AA(5)(a) of the 1986 Act.

54 https://www.ofgem.gov.uk/licences-codes-and-standards/licences/licence-conditions.

55 See Section 9(1) and (1A) of the 1986 Act.

- **Condition 9:** Obligation for NGG to establish a Network Code and Uniform Network Code, designed to achieve a number of objectives for the operation of the pipe-line system, but particularly to promote the provision of reasonable economic incentives for suppliers to secure that domestic customer supply security standards are satisfied in respect of the availability of gas to their domestic customers;[56]
- **Condition 16:** Obligation on NGG to plan and develop the pipe-line system to meet expectations as to the gas security standard. This sets out a technical requirement on availability and the data to be used in the calculation of peak demand in order to develop the required standard.[57]

NGG, as a condition of its licence (through the Standard Special Conditions Applicable to both NTS and DN Licensees) are required to comply with the requirements of Regulatory Instructions and Guidance (RIGs) as published by Ofgem. RIGs are the primary means by which Ofgem directs licensees to collect and provide the information, such as business plans, the regulator needs to perform its functions in relation to the price control (for more, see the answer to question 3 on the role of the NRA). The licence conditions set out the scope and content that can be included in RIGs issued by Ofgem.[58]

Undertaking of investments

TSOs are required to carry out any investment projects to deliver on their legal/regulatory duties as more fully described above in Section 3.1.2. TSOs are also required to develop business plans, which deliver on those duties through Ofgem's price control process.

Here we explain the mechanisms Ofgem uses in order to facilitate the development of the transmission network. In particular, we focus on mechanisms aimed at encouraging financing of projects that support security of supply and innovation.

Institutional or procedural constraints on the performance of these roles

The statutory duties, powers and associated licencing regime set out in the answers above, do tend to act as a constraint on the performance of specific roles, whether this is from Ofgem or the regulated network companies. This is particularly prevalent when duties conflict with each other. For example, the requirement for Ofgem to wherever possible encourage the development of competition in the network to deliver objectives, may conflict with other objectives and duties in certain circumstances.

In order to execute changes or implement specific policies within the legal framework, Ofgem will often be required to do so in accordance with any governance mechanisms to execute such change. An example of this would be the modification of licence conditions. The process for this often requires consultation, statutory notice periods, and may be appealed by licensees or third parties to the UK's Competition and Markets Authority, or ultimately the courts.[59]

In addition, some policies cannot be fully implemented without making changes to the various industry codes that serve to manage the operation of, and downstream activity within, the GB transmission system. Often the process of amending those codes is elaborate and time consuming causing delays in the implementation of change.

Planning processes and legislation associated with the obtaining of appropriate planning consents (e.g. environmental, aviation, health and safety) can clearly act as a legal constraint on the development of the transmission network in any particular project. Any project promoter will need to develop such projects in line with the requirements of the legal framework, as a whole, and this will include planning processes.

Additionally, general requirements relating to aspects of public law (such as the requirement to consult, to follow any defined processes and governance set out in the regulatory framework)

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56 See Condition 9(e) of the Gas Transporter Standard Licence Conditions.
57 See Condition 16(1) and (2) of the Gas Transporter Standard Licence Conditions.
58 Standard Special Condition A40 of the Standard Special Conditions Applicable to both NTS and DN sets out the requirement to comply with RIGs. In addition, there are a number of obligations on the licensee to have in place various systems and processes to comply with requests for information from the regulator.
59 The licence modification process, and governance surrounding appeals to the Competition and Markets Authority for electricity is found at Section 11 and 11A-15A of the 1989 Act.

will also act as general constraining factors on the ability and speed at which Ofgem can act within the regulatory framework.

3.1.3. Mechanism for financing of investment projects

Ofgem's primary mechanism to ensure the delivery of appropriate investment in the transmission network is through the RIIO (Revenue= Incentives + Innovation + Outputs) model. There are RIIO price controls for distribution and transmission (i.e. shipping and transportation). The current price control for gas transmission is RIIO-T1 and is effective from 2013- 2021, setting limits on what NGG can charge for development and operation of the NTS. Note, that the RIIO-T1 determination for National Grid covers both its electricity and gas transmission operations.

RIIO-T1 price control determinations in respect of gas are carried out for NGG in respect of the national transmission system. They are built on traditional a RPI-X model (where allowed revenue is capped at RPI minus expected efficiency savings, plus a factor for allowed investment). NGG will submit a business plan to Ofgem for assessment and approval in line with the framework.[60] In particular, Ofgem criteria and methodology for outputs specifically assesses output proposals in terms of Reliability, Wider Works, and Innovation.[61] This model has been developed and expanded over successive price control periods. RIIO-T1 now has a number of features that build on the previous approach. Key elements identified that encourage security of supply and innovation are:-

- Outputs-driven framework with incentive mechanisms for delivery against a set of broad parameters. For example, the RIIO decisions implement safety and reliability incentives with appropriate penalty provisions for under-performance as well as a framework for compensation payments to customers for interruptions to supply;
- Allowed revenues are capped but mechanisms are in place, which allow for potential uncertainties identified in NGG's business plan. These are tightly defined, and include incentive arrangements that set percentages of under/over recovery of revenues that NGG will absorb and what levels of additional cost/savings are passed on to consumers. A key element is defined 're-opener' mechanisms, which are specific circumstances where NGG can request Ofgem for review of costs in light of certain specified events. For example, for RIIO-T1 categories include the possibility of re-openers for NGG spend on IT security enhancement (which supports security of supply), and also the ability to apply for a revenue adjustment mechanism for innovation projects, that enables companies to apply for additional funding within the price control period for the rollout of initiatives with demonstrable and cost effective low carbon or environmental benefits. Pipe-line diversion costs and asset health shocks are also included for gas transmission, which are not included for electricity determinations;
- **Network Innovation Allowance (NIA):** The NIA is a set allowance that each RIIO-T1 (and distribution) network licensee receives as part of their overall revenue allowance as determined in the RIIO price control. These funds are allowed to fund smaller technical, commercial or operational projects on the network that have potential to deliver financial benefits to the licensee or customers. Licensees can also use funds to prepare submissions for the Network Innovation Competition (below). NGG's innovation allowance is governed in accordance with its Special Conditions.[62] Ofgem also issues an NIA Governance Document which contains all of the regulations for the administration and governance of the NIA;
- **Network Innovation Competition** (NIC): Part of the RIIO price control, the gas NIC is an annual opportunity for gas network companies to compete for funding for the development and demonstration of new technologies, operating and commercial arrangements. Funding will be provided for the best innovation projects, which help all network operators, understand what they need to do to provide environmental benefits, cost reductions and security of supply as GB moves to a low carbon economy. Up to £20m per annum is available through the gas NIC. NGG funds eligible projects by means of its transmission network charges, under governance arrangements provider for in NGG's Special Conditions.[63]

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60 A table of criteria used by Ofgem in their initial assessment of business plans is provided at Annex 1 to this paper.

61 See Initial Assessment of Business Plans at pages 29-30, for an example of assessment of such outputs in the contexts of National Grid Gas Transmission.

62 See Special Condition 2E of NGG's Gas Transmission Special Conditions.

63 See Special Condition 2F of NGG's Gas Transmission Special Conditions.

There are other mechanisms in Ofgem's 'toolbox', which help support security of supply/innovation in transmission development. There is considerably less development in the area of gas transmission networks when compared with electricity. Relevant mechanisms for gas include:-

- **Revenue Drivers:** NGG is funded to provide baseline levels of capacity through its price control settlement under RIIO. If national transmission system customers wish to buy additional capacity (known as incremental capacity), NGG automatically receives additional funding via revenue drivers to support its investment in delivering that capacity. Revenue drivers are used to automatically adjust NGG's allowed revenue upwards in response to demand for additional capacity, which is backed by a financial user commitment. An example of a recently approved adjustment was in relation to South East quadrant exit capacity in 2012. Revenue Drivers, where agreed, are implemented by modification of NGG's Special Condition C8E;
- **Innovation Link (Regulatory Sandbox):** Ofgem provides a service (known as the Innovation Link) which allows businesses access to advice and assistance on innovation or other propositions that don't 'fit' with the regulatory model. A single point of contact is provided for feedback, and a 'sandbox' where applicants can trial services and products that cannot operate within the existing framework. While projects to date have focussed more on the area of consumer/retail, transmission projects are not necessarily outside of scope for support.

In 2014, Ofgem did not see the same degree of need for investment in additional gas interconnection as in additional electricity interconnection[64] and we have not identified any specific activities that would change this position. However, gas interconnectors are subject to licencing, regulation and oversight under the Gas Interconnector Licence: Standard Conditions. There does exist, however, regulatory obligations on gas interconnector operators to provide 'reverse flow' products (essentially reversing the direction of gas from one member state to the other), in exchange for being exempt under certain third party access requirements under EU policy. Ofgem has a role, for example, in approving the tariff proposed by an operator under such an arrangement.[65]

In terms of gas storage, Ofgem has responsibilities for ensuring compliance with the Third Package, but generally there are no specific mechanisms to encourage investment in gas storage infrastructure and the approach is therefore market driven. For more details on the current regulatory framework in gas storage, see this note from Ofgem.

As a result, we have not identified any specific mechanisms that would seek to encourage investment in gas interconnectors or gas storage.

Relevant project categories

While generally the mechanisms above are designed to capture and accommodate a wide variety of projects, certain mechanisms are aimed at more specific categories of project. For example, the general RIIO price control framework covers a wide variety of potential development projects, and since the requirements are outputs (or outcomes) based the specific category of project to deliver on that output will be for TSOs to determine in their business planning activities, but will be subject to Ofgem scrutiny through the price control process.

3.1.4. Regulatory rules with respect to innovation

Specific duties of the NRA aimed at encouraging innovation

There are limited duties on Ofgem to encourage innovation in terms of the statutory framework, however the duty to encourage innovation is likely implicit in the more general duties on Ofgem to ensure that it secures the efficient and economic execution of activities by licensees. As a result, many of the mechanisms, outlined above in Section 3.1.2 , are aimed specifically at promoting innovation.

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64 See page 15 of Ofgem's summary of the regulatory regimes it operates.

65 See Ofgem decision on the Balgzand-Bacton Line (2008): https://www.ofgem.gov.uk/sites/default/files/docs/2008/11/bbl-reverse-flow-decision-letter-081028.pdf.

Specific duties of the TSO at encouraging innovation

Duties, including those applicable to innovation, are more fully described in Section 3.1.2, above. TSOs will also have role in delivering/participating in mechanisms, which support the development of innovation. These specific mechanisms, and the TSOs role in them, are more fully explained in Section 3.1.3 above.

3.1.5. Regulatory rules with respect to security of supply

Specific duties of the TSO aiming at safeguarding security of supply

Duties, including those applicable to security of supply, are more fully described in Section 3.1.2, above. TSOs will also have role in delivering/participating in mechanisms, which support security of supply objectives. These specific mechanisms, and the TSOs role in them, are more fully explained in Section 3.1.3 above.

Specific duties of the NRA aiming at safeguarding security of supply

See Section 3.1.1 above, with regard to the legal powers and duties available to Of gem in terms of security of supply. Ofgem exercises these duties largely through the mechanisms more widely described in Section 3.1.2 above.

3.2. Regulatory practice

3.2.1. Overview over regulatory practice in the UK

Information about the general regulatory framework in the UK

The RIIO framework is fundamentally based on traditional price cap regulation but has evolved to incorporate new features and incentives. In contrast to the framework in most other Member States one of the objectives of the framework is to encourage innovation. The framework puts emphasis on incentives and outputs but compared to the regulatory practice in other Member States with an output-based framework the regulator reviews the inputs (or business plans) in a more detailed way and there is an extensive consultation process.

3.2.2. Regulatory practice related to innovation

Innovative projects

The Network Innovation Allowance and Network Innovation Competition are typically aimed at smaller value, innovative interventions.

The projects funded under the Network Innovation Allowance and Network Innovation Competition partly are mainly aimed at comparatively smaller projects, many of them could be considered R&D projects in our terminology. Some projects can be grouped under the following ‘typological investments’ (see Annex 2):

- Increased need for flexibility for market development and security of supply;
- Incentivise and facilitate upgrade of biogas to the transmission system;
- Digitalisation of operations, through e.g. drone inspections and AI, resulting in a safer and cost efficient operation.

Adequacy of the NRF relating to its support for innovative investments

Stakeholders have a positive opinion on the investment climate for innovative projects. The stakeholders pointed out that other countries are interested in copying the innovation allowance and innovation competition.

There is no formal evaluation available on the effect of the funding for innovation on outcomes. In the most recent price review.

3.2.3. Regulatory practice related to security of supply

Security of supply projects

The TO licence contains criteria regarding security of supply. Standards are not fixed and can change over time.

Adequacy of the NRF relating to its support for security of supply investments

There are no indication that there are significant barriers for investments in security of supply projects.

3.2.4. Illustrative specific projects

The projects below are considered examples of innovative and security of supply projects. They illustrate how the regulatory framework works in practise to incentivise innovative and security of supply projects. The second and third project, Project CLoCC and In Line Robotic Inspection of High Pressure Installations project, are considered innovative projects and are funded through the Network Innovation Competition mechanism. Case studies of recent NIC projects can be found in a brochure published by Ofgem in 2017 and also in 2016.

River Humber pipeline replacement ((information from the website of national grid)

Description and aim-SoS

The River Humber pipeline connects an import location for gas at Easington to the national network.

The existing pipeline crosses the River Humber in a trench on the river bed. Over time, tidal patterns have eroded the river bed covering the pipeline and work was carried out to keep it buried. For this reason, plans were developed to build a new tunnel under the River Humber, through which a replacement pipeline will be laid.

Project CLoCC (Customer Low Cost Connections)[66]

Description and aim- innovative

The project challenges the current connection process with both technical and commercial solutions that align to the needs of non-traditional gas customers, such as biomethane, small gas generators and shale. In addition, CLoCC also supports the development of exit projects such as Compressed Natural Gas (CNG) for ransport. By facilitating these new connections to the NTS from emerging markets, Nation Grid can help maximise the potential for newer forms of indigenous gas, thereby improving the nation's energy security while reducing its carbon footprint in the process.

Approval process and financial mechanisms

The project is funded (funding of £5.4m total) under the NIC mechanism.

In Line Robotic Inspection of High Pressure Installations project[67]

Description and aim- innovative

In this project, NGG (with partners) is seeking to introduce in line inspection of below ground pipework at high pressure installations (AGIs), in order to determine the true condition of these assets. This will allow for pre-emptive fault detection, more targeted planned interventions to be undertaken, thereby extending the life of assets, which remain in good condition and cost optimisation.

Approval process and financial mechanisms

The project is funded (funding of £6.3m total) under the NIC mechanism.

[66] See: Gas Ten Year Statement 2017 of National Grid, available at: https://www.nationalgrid.com/sites/default/files/documents/GTYS%202017_3.pdf.

[67] More information available at: https://www.ofgem.gov.uk/publications-and-updates/gas-nic-year-two-screening-submission-line-robotic-inspection-high-pressure-installations.

Avonmouth[68]

Description and aim

This gas pipeline was planned to replace capabilities lost with the anticipated closure of the Avonmouth LNG storage facility. Risk analysis by National Grid alongside changing demands in the South West has now demonstrated that there is no need to build the pipeline at this time.

Approval process and financial mechanisms

Allowances to replace the operational service currently provided by the LNG storage facility at Avonmouth were agreed as part of RIIO-T1. In the Mid-Period Review process, Ofgem decided to remove funding for the project.

3.3. Options for improvement

3.3.1. Options to improve regulatory practice

The above discussion shows that the NRF is well-designed and functional for security of supply projects.

A distinguishing characteristic of the NRF is the emphasis on innovation. Stakeholders have a positive view on the effects of the funding mechanisms for innovation. However, to the best of our knowledge, there is no formal evaluation of the impact of the innovative projects of the TSOs available. Such a formal evaluation could both benefit stakeholders in the UK as well as other Member States that are inspired by the NRF in the UK and consider to implement similar incentives for innovation.

3.3.2. National law mechanism(s) for implementing options

Not applicable.

3.3.3. Impact assessment

Not applicable.

[68] More information available at: https://www.ofgem.gov.uk/publications-and-updates/gas-nic-year-two-screening-submission-line-robotic-inspection-high-pressure-installations.

ANNEX I: TYPOLOGICAL INVESTMENTS – ELECTRICITY

Generally, the term typological investment relates to technical solutions that TSOs can adopt to provide the transmission capacities needed to cover the transmission demand of grid users. Thus, a typological investment is meant to be a type of solution that can be implemented, in principle, by any TSO in situations in which these solutions are appropriate to provide the desired benefit. Hence, typological investments are not specific to a concrete location or a particular TSO. In the following, we have listed a selection of typological investments for the electricity transmission sector, that are differentiated in 7 categories that can be considered innovative as compared to conventional solutions. For each of these categories we have provided a number of examples of solutions, based on our existing knowledge, a literature review and interviews. The list might not be completely comprehensive, but should give an idea of our understanding of the different types of typological investments, we are interested in.

Category	Examples of solutions
New transmission lines based on innovative technology or change of technology of existing lines	• New HVDC lines (→allow to control the power flow; less expansive for long distance transport; undergrounding less complex); • Replacement of HVAC by HVDC lines (→less complex and less expensive; more compact design); • Underground cables or GIL (→ more expensive than OHL but can help improving public acceptance and accelerate the authorisation process); • Design of overhead line poles (→can help improving public acceptance and accelerate the authorisation process); • Replacement of conventional overhead line conductors by high-temperature conductors (→more expensive than conventional ones but can allow to provide additional capacity at a lower cost level and more quickly than by building completely new lines).
Introduction of dynamic capacity rating with the aim of utilising existing transmission lines or transformers at higher levels	Spectrum of technological options ranging from a differentiation of rating levels according to fixed time intervals (e.g. seasonal or time-of-day) down to online monitoring of equipment temperature and adaptation of capacity rating in real-time operation.
Installation of power flow control components in order to better adapt power flow patterns to capacities and topology of the existing grid.	• Phase-shifting transformers; • Semiconductor-based FACTS elements (including HVDC converters).
Investment into components contributing to ancillary services provision (reactive power / voltage control, short-circuit power, momentary power reserves and black-start capability)	• Purely phase-shifting generators (→offer operational flexibility and can serve to improve cost efficiency); • FACTS elements (→ see above).
New or extended power system control and automation technology with the aim to lower the risk of disturbances threatening security of supply	• Improvements in observability and controllability based on conventional sensor and actor devices; • Wide-area measurement systems (aiming at synchronously measuring power phasor angles at the grid nodes to improve observability); • Real-time dynamic security assessment tools (aiming at observing stability phenomena beyond static voltage/current measurements).

Category	Examples of solutions
Partial automation of system operation processes aiming at better utilisation of existing grid capacities	Automatic switching of network devices (in connection with adaptive protection schemes) or of generation-side or demand-side flexibilities in case of grid component outages in order to reduce the demand for (n-1) capacity reserves.
Improvement of approaches to curative congestion management providing the possibility to operate systems closer to their technical limits and/or to improve security of supply	• Generation-side flexibilities (especially renewables); • Demand-side flexibilities (DSM/DR); • Storage components; and • Technologies coupling the electricity sector with other sectors (gas, heat, traffic).

ANNEX II: TYPOLOGICAL INVESTMENTS – GAS

Typological investments are meant to be those type of investments whose aim is to promote innovation in the gas transmission systems while ensuring or enhancing the level of security of supply of a region. Hence, by definition, they can be implemented independent of a specific TSO and location.

In the following table, we offer a resume of the typological investments for the gas transmission system we have deemed as innovative compared to "conventional" solutions.

The investments are broken down into four categories each accompanied by examples that emphasise their importance and impact on the gas system.

Category	Examples of solutions
Increased need for flexibility for market development and security of supply.	• (Power-to-gas) Usage of excess pipeline capacity as "energy" storage of excess wind or solar energy by utilizing electrolysis (an efficient utilization of the excess of electricity produced by non-programmable sources of energy); • Increase withdrawal and injection capacity in storages by incentivising investments supporting flexibility (support of gas market liquidity and security of supply level); • Allowance of higher pressure in selected pipeline/routes (increase of flexibility of the supply side).
Incentivise and facilitate upgrade of biogas to the transmission system.	• Investments in upgrade of biogas to transmission system (support of gas market liquidity and security of supply).
Digitalisation of operations, through e.g. drone inspections and artificial intelligence (AI), resulting in a safer and cost-efficient operation.	• Drone inspections and AI in combination with modern SCADA systems can serve as input to reliability based operation and maintenance (lower maintenance cost and reduction of unforeseen/unplanned shutdowns).
In order to support security of supply and add liquidity to the gas market, there is a need to build interconnectors in Europe.	• More reverse flow systems could be considered to increase flexibility in the supply routes (reduction of dependency and power of trading of the large gas suppliers); • Enhancement of available gas supply in situation of supply crisis; • possibility of arbitrage a price convergence between markets to support the development of the internal market.

ANNEX III: POTENTIAL REGULATORY BARRIERS FOR PROJECTS

Regardless of the character of a project (e.g. projects enhancing security of supply or applying innovative technologies, which this questionnaire is focussing on) there might be potential regulatory barriers for implementing projects in general but maybe also barriers for special kind of projects. To give you an impression what kind of barriers we have in mind, we have listed some examples of such barriers in the following. It should be noted that there might be different or even more or less barriers in the regulatory framework of your country.

Type	Description / Explanation
Higher TSO CAPEX but lower expected OPEX within the TSO	the investment upfront is more costly, but has a potential of lowering the operational costs in the future. However, because of its innovative and more risky character the lower OPEX is not guaranteed. If not allowed to put the costs in case of a failure in the tariffs, TSO would not invest in innovative solution.
Higher TSO CAPEX, but benefits go to the wider society, instead of the TSO	This is a situation where higher investment, including in new technologies, is needed on the part of a TSO but benefits in terms of RES integration, RES curtailment or CO2 avoidance benefit other players in the society, while the TSO is only faced with the cost increase. Projects in regulatory frameworks, which do not distribute adequately the benefits to the TSO that bears the costs and takes the risk, are less likely to happen. This could also apply to cross-border investments involving several TSOs.
Investments in smart grid elements /technology aimed at replacing planned grid investments	Investments in smart grids and other smart elements that actually reduce the need of physical construction of lines for example due to a better interactive/intelligent grid management of balancing tools (battery storage) may provide a reduction in the regulated asset base, however with a slight increase of tariffs, might not be realised.
Investments in security of supply – projects without commercial benefits	Projects that ensure security of supply will in some cases never bring enough commercial benefits such as a pipeline would be going to be used only in case of emergency. If the security of supply (e.g. diversification of the sources for gas) is not put into tariffs, a TSO is most likely not willing to invest.
Lower TSO TOTEX but shift in the CAPEX/OPEX ratio	In some member states CAPEX and OPEX are treated differently in the regulatory regimes. Depending on the incentives set by doing so, technical solutions/projects with higher CAPEX might be preferred by the TSOs even if they result in higher total costs.

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