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

Final Report

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Table of Contents

List of abbreviations

Abbreviation	
AC	Alternating Current
AI	Artificial intelligence
CAPEX	Capital expenditure
CEF	Connecting Europe Facility
CEP	Clean Energy Package
HVDC	High-voltage direct current
MS	Member States
NDP	National Development Plan
NRA	National regulatory authority
NRF	National regulatory framework
OPEX	Operating expenditure
PCI	Projects of common interest
R&D	Research and development
TSO	Transmission system operator

Executive Summary

I. Background and study objectives

The European Transmission System operators (TSOs) for electricity and gas play a central role in the energy system. Investments in transmission networks by TSOs are crucial for the integration of the European electricity and gas markets and the integration of a growing share of renewables. Transmission networks can also facilitate the integration of storage and Power-to-X technologies in the market.

The incentives for TSOs to invest are highly dependent on the National Regulatory Framework (NRF) in Member States. Traditionally, the regulation of natural monopolies such as TSOs puts a strong emphasis on the (short-term) efficiency of the network. Is this emphasis on efficiency conducive to long-term investments? Do the NRFs contribute to socially valuable investments and do they enable TSOs in meeting future challenges?

The main objective of this study was to assess how the existing regulatory framework supports and incentivises energy infrastructure investments, with a specific focus on innovative and security of supply investments.

II. Findings of the study

The roles of the TSOs, NRAs, and responsible ministries in the gas and electricity markets share many commonalities in the 26 Member States (MS) included in the study. For a large part, this is driven by EU level legislation, such as the Third Energy Package[1], the TEN-E Regulation[2], and the Security of Gas Supply Regulation[3].

There is a high level of consistency across the 26 MS regulatory frameworks included in the study in relation to security of supply. Security of supply duties are usually explicitly set out in the regulatory framework. This can be traced back to elements of the Third Package; such as the provisions referring directly to security of supply, together with congestion management requirements, and duties to promote TSO and (separately) NRA cooperation on a cross-border and regional basis as well as market integration requirements.

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[1] The following EU legislation is collectively known as the Third Package:

- Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0072&from=EN;
- Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0094:0136:en:PDF;
- Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0015:0035:EN:PDF;
- Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0036:0054:en:PDF; and
- Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0713&from=EN.

[2] Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013R0347&from=EN.

[3] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32017R1938&from=en.

NRAs and TSOs are generally satisfied with the regulatory framework when it comes to security of supply. Security of supply is seen as the core TSO business and most TS projects are perceived as security of supply projects. Neither gas nor electricity TSOs experience noticeable barriers in implementing security of supply related projects in general and NRFs are, in general, deemed adequate to support security of supply investments. However, there is still scope for some fine-tuning of the framework as discussed below.

With respect to innovation (and related concepts such as research and development, technological change and smart grids), there are substantial differences between the NRFs in the 26 MS. Countries can be split into four categories:

- In the first category of countries there are explicit references in the high-level regulatory framework (for example, in legislation) to innovation or related concepts;
- In the second category of countries, there are explicit references to innovation or related concepts at a lower level of the regulatory framework, by way of the various types of regulatory instruments. For example, tariff methodologies may explicitly encourage innovative investment or the National Development Plan (NDP) in a jurisdiction may explicitly encourage investment in innovation or new technological solutions;
- The third category of countries has references to the economic and efficient development of the network, which could be interpreted as providing a basis for innovative approaches, although not an explicit basis; and
- The fourth category of countries is where there is no evidence of support for innovative investments in the regulatory framework.

NRAs and TSOs see more room for improvement when it comes to innovation. As explained above, innovation is in many MS not explicitly incentivised or recognised in the regulatory framework. This is an issue where the gains from innovative approaches are uncertain or hard to quantify. Moreover, where innovative approaches over time would reduce the asset base or do not directly benefit the TSO, TSOs have less to gain from pursuing innovative approaches. Our analysis also shows that TSOs only pursue projects that they expect will be accepted by the regulator, while novel approaches that are not certain to be accepted often do not pass the stage of an idea. This demonstrates the importance of carefully assessing the incentives provided by the NRF.

The main regulatory barriers that were encountered (mostly for both gas and electricity) in the NRF's include:

- Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised;
- Bias towards capital expenditure (CAPEX) based solutions instead of operational expenditures (OPEX-solutions);
- No specific provision related to innovation (e.g. allowances, duties, etc.);
- TSOs are deterred from risky investments due to perceived high project risk and strict penalties for not meeting deadlines;
- Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs; and
- Lack of clarity of mandate for TSOs in certain innovative fields.

Most of these barriers can impact both innovation and security of supply investments. However, "No specific provision related to innovation (e.g. allowances, duties, etc.)" and "Lack of mandate in certain innovative fields" are specific for innovation. The barrier that is most applicable for security of supply is "Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised".

It is important to note that the understanding of the term "innovation" differs across countries and stakeholders. Interviews have provided evidence that the term "innovation" (or similar) is not only absent in most of the Member States' NRFs, but also has a Member State-specific connotation in its interpretation, especially in electricity. Moreover, even where there is a lack of explicit incentives, examples have shown there can be innovative investments although these are limited in scope.

III. Recommendations for improvement

Options for improvement at Member State level

The options for improvement for each Member State are as much as possible adapted ("tailored") to the national context and regulatory framework. In total, 40 tailored options for improvement were identified. The implementation of these recommendations generally require a change to the NRF in Member States.

The most frequently recommended options for improvement include:

- **Requirement to consider innovative solutions**
  This option for improvement is recommended to make it explicit that TSOs have a duty to consider innovative options, while innovative options chosen might be funded through tariffs, subject to NRA decision;
- **Perform Social Cost Benefit Analyses (SCBA) for larger projects**
  This option for improvement aims to ensure that wider societal benefits are taken into account in order to justify a project being built;
- **Mitigation of CAPEX bias by encouraging a balanced consideration of OPEX-based solutions**
  Encouraging investment in OPEX-based solutions may involve introducing incentives or a specific budget for OPEX-based solutions or other regulatory incentives aimed to ensure a balanced consideration of both OPEX and CAPEX when considering potential projects;
- **Consultation on National Development Plan/Investment plans and on a project level with stakeholders**
  Including a stakeholder consultation as part of the process of establishing a national development plan, an investment plan or decision-making on large projects would require the TSO to explain the alternatives considered when developing projects. This recommendation could be combined with a requirement to consider innovative technologies or approaches (and to report on considerations made) if thought desirable;
- **Requirement to consider OPEX-based options**
  A general approach to foster OPEX-based solutions in the long-term would be the introduction of an obligation to consider and report on considered OPEX-related innovative options in the network development plan or investment plan.

Table S.1. shows an overview of the recommended options per Member State. The number of options for improvement per country does not reflect the severity of the barriers or the functioning of the regulatory framework. There are also a few options for improvement that were recommended once and are very specific to the context of the Member State.

Table S.1 Overview of most recommended options for improvement

Options for improvement	Applicable countries
Requirement to consider innovative solutions	Austria, Belgium, Bulgaria, Croatia, Czechia, Germany, Greece, Hungary, Ireland, Latvia, Luxembourg, Portugal, Slovakia, Slovenia, Spain
Perform Social Cost Benefit Analysis (SCBA) for larger projects	Latvia, Poland, Bulgaria, Croatia, Denmark, Hungary, Ireland, Lithuania, Luxembourg, Poland, Slovenia, Spain
Mitigation of CAPEX bias by encouraging a balanced consideration of OPEX-based solutions	Austria, Belgium, Czechia, Denmark, Finland, Germany, Hungary, Luxembourg, Slovenia, Sweden
Consultation on National Development Plan/investment plans and on a project level with stakeholders	Bulgaria, Croatia, Germany, Luxembourg, Portugal, Slovenia, Spain
Requirement to consider OPEX-based options	Austria, Belgium, Denmark Germany, Hungary, Luxembourg, Netherlands, Poland, Slovenia

Options for improvement at EU level

This report shows that the current EU regulatory framework is largely, but not entirely, fit for purpose. Through the proposed Clean Energy Package and Governance Regulation, the EU has already taken steps to address some of the existing shortcomings. The following options for improvement identified in this report attempt to 'fine tune' the EU regulatory framework rather than suggesting a radical overhaul.

Option 1 - Requirement to consider innovative solutions

An EU-level policy guideline or recommendation setting a long-term strategy for innovation and encouraging the uptake of innovative technologies could be beneficial. This will set a basis for Member States to then develop their own policies and incentives in this area. If the policy guidance or recommendation does not achieve the desired effect, changes to the EU legislation could be considered in order to require Member States to have an innovation strategy and to require their TSOs to consider innovative solutions and new technologies.

Option 2 - Perform Social Cost-Benefit Analysis for larger projects

The European Commission may consider further improving the implementation of (for example) Article 22 of the Electricity and Gas Directives by requiring a social cost-benefit analysis to be undertaken for all non-PCI projects over a certain investment threshold (set ex-ante). It would target national projects that are not part of the current Union-wide TYNDP and thus not subject to a SCBA process at EU-level. Considerations could include: (i) a common understanding of what should be contained in a SCBA (e.g. regional benefits, public acceptance benefits, decarbonisation benefits); and (ii) putting an obligation on the TSO to explain why it does not carry out a SCBA if a project meets the non-PCI and threshold criteria. The outcome of the SCBA could be used to prioritise projects based on the net benefits that they are expected to generate.

1 Introduction

1.1 Incentives for investments in innovation and security of supply

Long-standing EU-level objectives of energy market liberalisation and integration and the more recent objectives of the EU **Energy Union strategy**, i.e. competitiveness, security of supply and sustainability, require on-going changes in both EU and Member State level legislation. Starting with the First[4] and Second[5] Energy Packages, the aim was to open up markets by breaking up monopoly structures and promoting transparency and efficiency in transmission regulation and through unbundling. The Third Energy Package[6] focussed on security of supply by reinforcing cross-border integration and introducing the legally binding network codes. It also introduced the notion that cost efficiency of the transmission system needs to be assessed, which has been done by international benchmarking or referring to a reference network. Yet, this regulatory practice has been criticised regarding its effectiveness with respect to investment incentives. The Clean Energy Package proposals published by the European Commission in November 2016 proposed numerous further steps in this area, aiming to enable the **energy transition**, whose goals have been confirmed in the Paris Agreement and in the set-up of the Energy Union. The Clean Energy Package includes eight legislative texts including: Energy Performance in Buildings Directive, Renewable Energy Directive, Energy Efficiency Directive, Governance Regulation, Electricity Directive, Electricity Regulation, Risk-Preparedness Regulation, and ACER Regulation.

Security of supply has always been a major driver of investments in transmission systems. In view of the challenges of the energy transition (higher shares of variable electricity generation) and of the possibilities of integrated markets and technologies, ensuring security of supply is becoming both more conspicuous and more complex. Possible solutions to ensure security of supply encompass, for instance, not only transmission grid expansion, but also increased cross-border trading options, innovative solutions based on new technologies or optimal use of available technologies on the market.

TSOs are the responsible parties for the transmission grids and for safeguarding security of supply and thus play a central role in enabling the energy transition. TSOs need to ensure a reliable and efficient transmission system that optimally facilitates the uptake of new renewable energy technologies across Europe. In so doing, balanced investments

[4] The First Energy Package were adopted in 1996 (electricity) and 1998 (gas).
[5] The Second Energy Package was adopted in 2003.
[6] In 2009 the Third Energy Package was adopted. The following EU legislation is collectively known as the Third Package:

- Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0072&from=EN;
- Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0094:0136:en:PDF;
- Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0015:0035:EN:PDF;
- Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0036:0054:en:PDF; and
- Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0713&from=EN.

to maintain security of supply as well as to increase the uptake of new **innovative** technologies are needed.

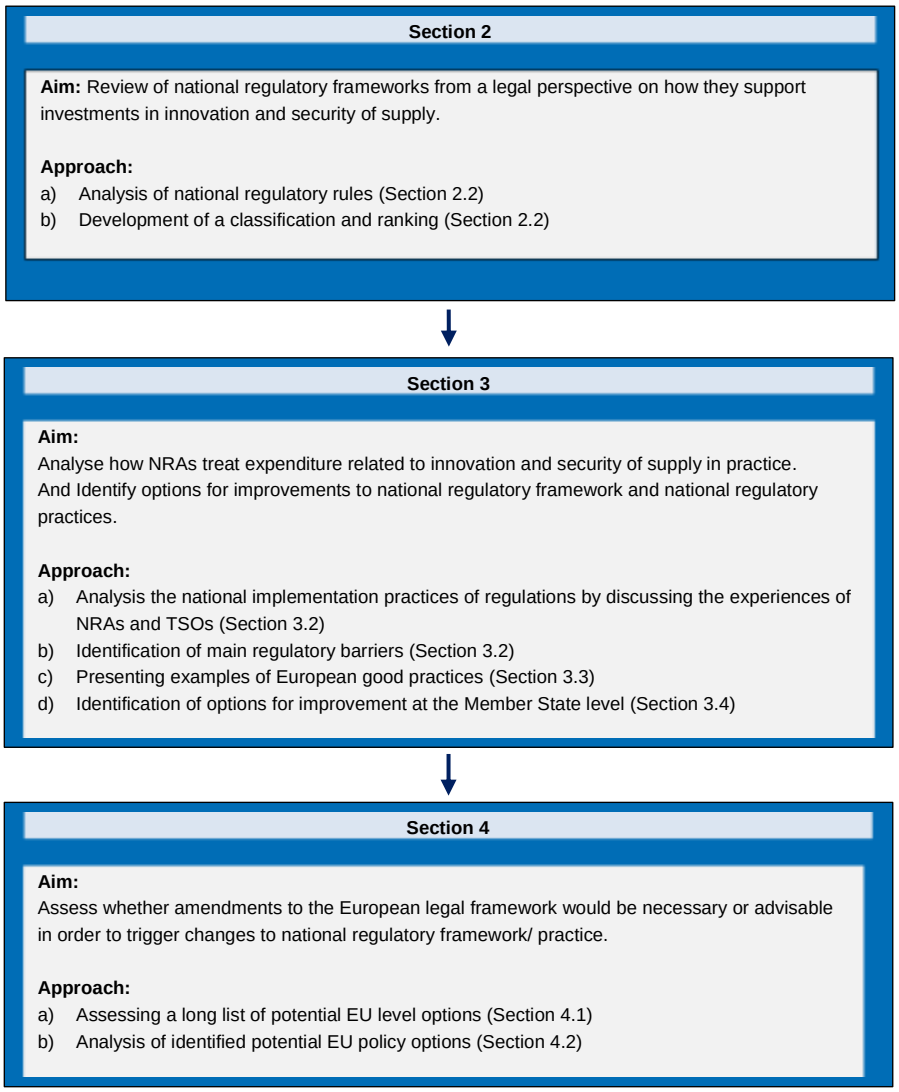
A key question is whether the regulatory frameworks relevant for gas and electricity TSOs provide sufficient incentives to invest in the uptake of new innovative infrastructure solutions as well as to safeguard security of supply. A strong emphasis on the **efficiency** of network operators, for example, might not always be conducive to providing the right incentives needed to face future challenges. Such a framework may poorly account for the new challenges of the energy transition, especially regarding security of supply and innovation. For example, in order to maintain security of supply, TSOs may need to become more forward looking in their investments, in order to anticipate potential capacity constraints because of intermittency in energy supply or demand. Similarly, deploying innovation often means more uncertainty regarding the final outcome of benefits and costs in the long run.

The scale of the investment challenge combined with increasing uncertainties about future developments and the need to deliver **secure and smart networks** makes it necessary to re-think the regulatory frameworks and their implementation. Investments in secure and reliable networks that enable more competition and market integration on a supranational level need to be incentivised by regulatory frameworks to bring benefits to consumers directly and also beyond the immediate scope of national networks.

1.2 Main objectives and methodological approach

The overall aim of the study is twofold: firstly, to assess how the national regulatory frameworks (NRFs) for energy support and incentivise energy infrastructure investments, with a specific focus on innovative and security of supply investments and secondly, to identify options for improvement of regulatory framework at a national and EU level. To this end, the legislation and implementation practice of the regulatory frameworks by EU Members States have been analysed and options for improvement for each Member State and the overall EU have been recommended. This report summarises the key findings of our analysis. Figure 1.1 provides an overview of the structure of this report.

Figure 1.1 Overview of the structure of the report



Source: Ecorys.

The first step in the study was to develop a framework consisting of a set of principles and criteria that any NRF for electricity and gas infrastructures should incorporate in order to provide appropriate incentives for innovation and security of supply. The approach taken was to first define elements of a regulatory model that are potentially relevant for innovation and security of supply. This first step was carried out through desk research. We also identified a selection of typological investments for both the electricity and natural gas transmission sectors that would allow us to have a concrete discussion with TSOs on their investments. We then developed a framework consisting of a set of principles and criteria in order to provide appropriate incentives for innovation and security of supply. The results of this exercise are described in Annex II. The principles and criteria provide a good basis for discussion, but it is not possible to directly apply these as the context of the Member State is crucial (see Section 1.5 for further discussion).

The next step in our research was to carry out an analysis of NRFs to understand what they currently require and how they support deployment of innovation and investments in security of supply. Thus, the approach included (a) an analysis of national regulatory rules, and (b) the development of a classification of these existing regulatory rules, including the identification of illustrative examples.

Realising that incentives for innovation and security of supply are determined not only by the legal framework, but also by how it is implemented in practice, we also analysed implementation practices through interviews with the National Regulatory Authorities (NRAs) and the TSOs. Hereafter, we refer to NRAs and TSOs as stakeholders.[7] Through the interviews with the stakeholders as well as building on the legal analysis, we identified the main regulatory barriers to investments for innovation and security of supply as well as good European practices to overcome these barriers.

The findings from the previous steps allowed us to identify options for improvements in national regulatory frameworks and national regulatory practices. We also assessed whether amendments to the European legal framework would be necessary or advisable in order to trigger changes to NRFs and/or national regulatory practice.

The annexes per Member State include a legal analysis of the national regulatory framework in the Member State, an overview of the regulatory practise in the Member State including barriers to innovation and security of supply, and finally an overview of potential options for improvement proposed. In addition to outlining the options for improvement we describe how these options could improve the regulatory practice and describe how national law could be amended for implementing such options. Finally, the annexes also provide an impact assessment of the proposed changes.

We have deliberately excluded Malta (which has no transmission system) and Cyprus (where the regulatory framework to implement EU requirements is still emerging) from the tables in this section. References to "**26MS**" throughout this report refer to the remaining 26 EU Member States once Malta and Cyprus have been excluded.

1.3 Definition of innovation and security of supply

To arrive at a common definition and understanding of innovation and security of supply in the context of this study we have introduced the notion of "typological investments." Typological investments are categories of investments (defined separately for electricity and gas) that can be undertaken by a TSO. They are infrastructure related, and do not cover investments in financial innovation or social innovation.

Examples of typological investments in electricity include:

- New transmission lines based on innovative technology or change in the technology of existing lines, e.g. new HVDC lines;
- Introduction of dynamic line rating with the aim of utilising existing transmission lines at higher levels;
- Installation of power flow control components to better adapt power flow patterns to capacities and topology of the existing grid, e.g. phase-shifting transformers;
- Investment into components contributing to ancillary services provision;
- New or extended power system control and automation technology, e.g. improvements in observability and controllability, wide-area measurement systems and real-time dynamic security assessment tools;
- Partial automation of system operation processes aiming at better utilisation of existing grid capacities; and
- Improvement of approaches to curative congestion management, e.g. generation and demand-side flexibilities, technologies coupling the electricity sector with other sectors (gas, heat, traffic), and storage components.

[7] The scope of the study did not include interviewing other stakeholders such a ministries, shippers, traders, end-consumers, energy intensive users, etc.

In gas, the list of examples of typological investments includes:

- Increased need for flexibility for market development and security of supply, e.g. through power to gas;
- Incentivising and facilitating upgrade of biogas to the transmission system;
- Digitalisation of operations, e.g. through drone inspections and artificial intelligence (AI); and
- Building or upgrading of interconnectors, e.g. reverse flow systems.

Security of supply related investments are technical solutions that foster efficient supply and enhancing/maintaining the required level of security of supply, see Annex II for details. The technical solutions contribute to fulfilling the objective of improving or maintaining the level of security of supply by:

- Constructing new transmission assets (lines, transformers, substations, compressors, pipelines) to provide additional transmission capacity;
- Maintaining, upgrading or replacing existing transmission assets to avoid a decrease of existing capacity or a degradation of the quality level of its provision; or
- Implementing new technology and/or operational strategies to utilise existing transmission assets closer to their technical limits.

In this study, **innovation** is not considered to be research and development (R&D) investments and projects, but rather as putting "innovative" transmission infrastructure investments into practice. A specific type of investment may very well be perceived innovative in one Member State, and not in another. This meaning of innovation is further explored in Section 3.2.1. Innovation aims at providing the desired level of transmission– determined by the objectives of security of supply – in a way that is in some way superior to the conventional way. Deployment of innovative solutions is not an aim in itself, but rather deployment of innovation is advisable if the expected benefits outweigh the costs in the longer term.

The degree of innovativeness of typological investments can be quite diverse, ranging from construction of conventional assets like Alternating Current (AC) overhead lines or pipelines with conventional materials, to novel concepts of system automation and operation based on recent R&D achievements.

1. By immediately reducing overall cost as compared to a conventional solution;
2. By prospectively reducing overall cost in the future, subject to a "learning curve" as to the cost level of the innovative solution;
3. By accelerating the process of transmission capacity expansion and thus reducing social welfare loss caused by temporarily insufficient transmission capacities; or
4. By providing improvements with respect to other criteria that are often difficult to monetarise, like environmental or public acceptance aspects.

1.4 Reading guide

The structure of the report is as follows:

- In Section 2, we review the national regulatory frameworks from a legal perspective. We present our results (2.2) for 26MS in an overview, on security of supply and innovative investments, and financing mechanisms; including a classification of existing rules and illustrative examples;
- In Section 3, we analyse the national implementation practices of regulations, by discussing the experiences of NRAs and TSOs (3.2); and presenting examples of European 'good practices' (3.3); and we also propose options for improvement at the Member State level (3.4);

- In Section 4, we identify options for improvement at the EU level by first assessing a long list of potential EU level options (4.1) and then analysing the potential EU policy option (4.2);
- The individual Member State annexes are located in Annex I. The Member State annexes provide an overview of both the current legal frameworks and their implementation practice related to investments in gas and electricity transmission infrastructure. Based on this research, options for improvement are formulated, both relating to the implementation practice and to legal changes;
- Annex II, describes the development of the key regulatory features promoting investments in innovation and security of supply;
- Annex III, list the law firms which provided the legal content; and
- Annex IV, details the classification of existing regulatory rules and illustrative examples.

1.5 General disclaimer and limitations

The legal content contained in this report (and its annexes) has been prepared by the local law firms throughout the 26 MS listed in Annex III. It reflects the factual situation in the various jurisdictions as the law stands at March 2018, using information that is publicly available. The legal content contained in this report does not constitute legal advice on any particular matter or jurisdiction. Please note that all representations of the implementation practices reflect our understanding of what has been said in the interviews and might not represent the official opinion of the institutions interviewed. Furthermore, the interviews and analysis were executed in 2018 before the adoption of the Clean Energy Package (CEP). Thus when we refer to the current regulatory framework, we refer to the situation before the adoption of the CEP with the exception of Section 4 where we discuss EU level options.

We have not been able to analyse the NRF of countries from which we have received no or only limited responses to our requests in the same depth as those from countries with detailed responses. As a result, fewer suggestions for improvement could naturally be developed in countries with less input from NRAs and TSOs. Therefore, the functioning of the regulatory framework cannot be judged by the number of options for improvement.

Furthermore, our analysis of the legal and implementation practices and the identification of good practices and options for improvement, include several limitations:

- The information obtained from the stakeholder interviews can never be exhaustive and complete. This results directly from the fact that interviewees were asked semi-open questions, with each interviewee having his/her own focus. While we note that we base our analysis on more information than just interviews, this is an important caveat where there are potentially significant differences in the available information;
- One has to keep in mind that a NRF which looks good "on paper" does not necessarily guarantee favourable investment outcomes. For this reason, we also asked interviewees about perceptions on outcomes. Moreover, it is difficult to identify "universal" good practices due to the differences in context in each of the Member States. Good practices that work well in one MS may function in a different way in another MS;
- There are considerable differences between NRAs in the awareness of investment needs of TSOs. The NRAs that operate in a regulatory framework that focuses on outputs are for example, less involved in the details of investments plans than NRAs in a framework with more emphasis on inputs. It is difficult to assess whether TSOs are performing optimally from a societal perspective, especially in

the case of innovation, which is difficult to quantify.[8] This means that NRAs may not get signals if TSOs are not as innovative as they could be. For this reason, there are benefits of having a regulatory process, which provides TSOs and other stakeholders the opportunity to signal to the NRA when regulatory barriers discourage them from innovating;

- The design of a regulatory framework has to respect several objectives that are partly contradictory to each other. Clearly, one of these objectives is to incentivise investments into projects that are considered necessary or at least beneficial to cover demand for transmission, providing for the level of security of supply that is commonly considered as desirable. Fostering investments in innovative solutions can be an objective as well, but this is far less clear because innovation does not provide value as such. Rather, innovation is desirable only if it leads to efficiency improvements, at least in the long term, or to other advantages e.g. in terms of better acceptance by the public, or preparing the ground for solutions that are expected to be needed in the future for implementing the energy transition. However, besides these objectives, which are at the core of this study, there are other objectives of regulatory frameworks, which are at least equally important. In particular, NRFs are expected to support overall cost efficiency of system operation and to support a fair distribution of costs and benefits among system users and system operators. These objectives can be in conflict to the ones mentioned above. For example, providing a higher level of security of supply will typically be associated with higher cost. And providing strong incentives to TSOs can mean to allocate a large part of benefits gained by efficiency improvements to the TSOs rather than to system users. Given these unavoidable conflicts of objectives and, consequently, the necessity to find appropriate trade-offs, it appears questionable, in principle, to judge specific instruments as being better or worse in general.

As a consequence of these considerations, it appears questionable if regulatory instruments can be judged as "better" or "worse" suited to support TSOs' investment activities without a detailed analysis of the context in which they are applied. The relevant context in a given member state is characterised by a number of aspects like:

- The demand for new transmission capacity caused by changing external requirements;
- The potentials of better utilising existing capacity e.g. by smart grid solutions;
- The priorities of regulatory objectives (e.g. the trade-off between incentives for new investments and incentives to improve cost efficiency);
- The processes of development, assessment and approval of TSO investment projects and the role of network development plans (e.g. the question if TSOs are obliged to implement approved projects);
- The interdependencies between different regulatory instruments; and
- The overall culture of revenue regulation (e.g. individual negotiations vs. mechanical incentive-based regulation).

[8] Key principle of output-based regulation is to define specific objectives and make the TSO's revenues dependent on the achievement of these objectives. Thus, NRAs focusing on outputs typically assess the effects of projects, e.g. their (social) cost benefits effects, other indicators, such as security of supply indicators, or how the portfolio of projects fits into the TYNDP. NRAs focusing on inputs usually are using input-based regulatory schemes, such as cost-plus and rate-of-return methodologies when computing the TSOs revenues. Therefore, they pay attention to the details of the specific projects the TSO is pursuing, e.g. by auditing specific costs for key equipment in a system of reference unit costs or by an external assessment of planning aspects and estimated cost, and approve the projects individually.

We take these (and also other factors) into account when assessing our options to improve the regulatory framework and we formulate our conclusions in a modest way, pointing to "options to consider" where appropriate.

The analysis shows that NRFs can be improved. However, it is important to note that an "optimum" level of investment cannot be objectively or easily defined, particularly in light of uncertainties about market and technological developments. Our analysis shows that the NRFs form a delicate mix of efficiency requirements and investment incentives where small details can have a large impact. Potential changes in regulatory frameworks need to be assessed against the backdrop of striking a balance between various objectives (efficiency, reliability and security of supply). Innovation is a potential means to reach these objectives in a cost effective way, but not an end in itself. For this reason, we recommend a gradual, incremental approach, continuously evaluating the regulatory framework and assessing how it can be further improved.

2 Legal review of the national regulatory frameworks

2.1 Approach

The objective of Section 2 is to provide a summary of the existing regulatory rules in the 26 MS for electricity and gas in relation to ensuring security of supply and contributing to the efficient uptake of innovative technologies.

In Annex IV, we then classify these existing rules into various categories, using illustrative examples, in order to identify broad similarities and differences in the current regulatory rules throughout the 26MS.

2.1.1 Regulatory framework terminology in Section 2

In this report, where we refer to the **regulatory framework,** we use that term in a broad sense. The regulatory framework for a specific jurisdiction will comprise a wide variety of duties and rights and will be set out in a number of different places or elements as indicated in Table 2.1. It is all of these elements, taken together and examined as a whole, which make up the regulatory framework for a particular jurisdiction.

Where we refer to the **high-level regulatory framework**, we are referring to European legislation and Member State-specific primary and secondary legislation. We have highlighted those elements in green in Table 2.1. It is this high-level regulatory framework which sets the overall scope of legal powers and duties. The other elements of the regulatory framework (highlighted in blue in Table 2.1) are largely constrained by any limitations in the scope of the high-level regulatory framework.

Table 2.1 Sources of National Regulatory Frameworks

Sector specific European legislation	First, Second and Third Packages, TEN-E Regulation and (for gas) the Security of Gas Supply Regulation.[9] Certain aspects of EU law will have direct effect in each jurisdiction and take precedence over local laws. Other EU law will require to be transposed into local law by specific action of the relevant legislature.
Statute or primary legislation	Legislation made by the relevant legislature in each jurisdiction either to give effect to European law, or to enact Member State specific legislation.
Secondary/delegated or subordinate legislation	Legislation made by the executive branch of government under delegated authority from the relevant legislature.
Case law	Law created by judicial action through decisions of courts or tribunals. Case law is referred to where there are specific cases of relevance to the topics of the study.
Regulatory instruments or methodologies	Tools used to implement energy policy that typically sit below the level of the legal instruments listed above and may be developed and/or enforced by the executive branch or, more often, by the independent regulator established under primary legislation to regulate the sector. These may include: • licences, permits or other forms of authorisation – typically, in the context of this study, a licence to transmit power or transport gas, or a permission to build a new transmission wire or pipe;

[9] The European legislation is discussed in depth in this section. Please see footnotes 1, 2 and 3 for the legislative references of the Third Package, TEN-E Regulation and Security of Gas Supply Regulation respectively.

	• tariff methodologies which apply to transmission businesses given their status as providers of a monopoly service; • standardised industry codes which industry participants are required to adhere to; • contractual arrangements between industry participants that are subject to regulatory oversight.

Source: Shepherd and Wedderburn LLP.

2.2 Results of the legal analysis

2.2.1 General regulatory overview

The analysis of legal frameworks confirms that electricity and gas regulatory frameworks throughout the 26MS are often complex and dynamic with many key pieces of legislation being regularly amended over the years. The law in each jurisdiction has also been developed and applied within the political and economic context of that location. For example, some NRAs have broader responsibilities than others. TSOs are also subject to some variations in their duties and the technical challenges each TSO faces can vary e.g. strongly integrated systems vs isolated systems, or those with significant island communities.[10] This makes like for like comparisons across jurisdictions difficult.

Despite these variations, however, there is still strong evidence of a high level of commonality in the roles and responsibilities of the various parties in the electricity and gas sectors and there are other key structures and themes that emerge.

That commonality is without doubt driven by the various EU energy packages, particularly the Third Package, TEN-E Regulation and (for gas) the Security of Gas Supply Regulation.

Unless expressly stated, any example used in this Section 2.2 applies equally to electricity and gas.

2.2.2 Role of the various parties in the regulatory framework

Government or State role

The governmental or State role is to set the Member State's overall energy strategy at policy level and to promote the required legislation which provides the overall scope and structure for the regulatory framework through the relevant legislature. Despite the requirements of the Third Package and subsequent EU legislation seeking to establish and maintain the independence of NRAs, whether or not the State retains additional powers in connection with ongoing supervision and monitoring of market players including the TSO, or in connection with approval of major capital investments, varies across the 26MS. We have analysed the State's role further in Annex IV.

[10] Greece, for example, has some incentives relating to connection of isolated island networks to the mainland.

TSO role

Whilst there are variations in how this is achieved, the core legal responsibilities (many, if not all, of which are derived from Directives 2009/72/EC and 2009/73/EC) of a TSO tend to include:

(i.) operating, maintaining and developing the transmission network in an efficient, safe, reliable, economic and environmentally sustainable manner;
(ii.) providing third party access on a non-discriminatory basis;
(iii.) contributing to security of supply through e.g. long term network planning in order to meet reasonable demands and development of the network particularly through the ten year network development plan process;
(iv.) cooperation with neighbouring/regional TSOs on cross-border and integrated market issues and facilitating cross-border interconnections with other countries including by way of co-operation through the ENTSO-E and ENTSO-G, managing cross-border flows and related payments/compensation etc.;
(v.) information exchange with other TSOs particularly in relation to security and (for electricity only) congestion management; and
(vi.) providing dispatching (for electricity only) and balancing services where within their role.

In relation to long-term planning this is partly delivered through the TSO being required to prepare and submit a national Network Development Plan (NDP) that details its investments over the coming ten year period.

The projects in the NDPs feed into the Union-wide TYNDP which is prepared by ENTSO-E and ENTSOG. The Union-wide TYNDP, although non-binding, sets the priorities of regional groups and is instrumental in the regional CBA, the selection of PCIs and can lead to CEF funding for projects.

Although the requirement for the NDP is generally enforced throughout the 26MS, there are two countries that stand out as exceptions when considering how the NDP is applied in practice. Portugal has had legal provisions since 2012, which set the procedure for the creation and approval of the NDP in electricity and gas, however no NDP has ever been approved (or rejected) by the Portuguese Government. The law does not establish a consequence for the NDP not being approved or rejected, which diminishes its impact. Also, in Finland, the electricity TSO is required to adopt a NDP but it is only used for the purposes of contributing to the development of the Union-wide TYNDP. The Finnish electricity NDP has no other effects on the TSO, users of the network or the NRA. For gas, there is no requirement on the Finnish gas TSO, once unbundled, to adopt an NDP. In the remainder of the 26MS countries, having a NDP is a legal requirement that is used to plan, finance and implement investments in the national network.

Generally, the NDP will be submitted to the NRA who consults with users and who considers whether the plan is consistent with the Union-wide TYNDP developed by the ENTSOs. The NRA generally has enforcement powers to ensure that the investments set out in the NDP are realised.[11] The responsibilities detailed in the NDP are also usually financed through tariffs from network users, which are set through a tariff methodology or are approved by the NRAs.

The majority of countries have a sole TSO operating each transmission network. This eliminates the need to manage relationships and responsibilities between TSOs. There are notable exceptions to this generality. Examples include Germany, which has four

[11] Again the language echoes/transposes that used in Directive 2009/72/EC, Directive 2009/73/EC, Regulation (EC) No 714/2009 and Regulation (EC) No 715/2009. The NRA's specific powers to ensure investments are made will vary depending on the unbundling model used by the TSO.

electricity TSOs, and Austria, which has three. For gas, Austria and France both have two TSOs and Germany has sixteen (which differ significantly in size).

As a result of the unbundling regime contained in the Third Package, TSOs are independent of energy supply and generation companies. This also currently means that TSOs are not permitted to own assets which are not strictly transmission assets, such as storage assets.

It is most common for the TSO to be the owner of the transmission assets. Some countries use an alternative approach where a separate entity owns the transmission assets. This can be seen in electricity in Belgium, Ireland, Romania and the United Kingdom. Using the example of Belgium, the transmission asset owner is a separate company that is part of the TSO's group of companies, whereas in Romania the owner of the transmission assets is the Romanian State. For gas in Ireland, ownership of transmission assets and operation of the transmission system are addressed as two separate licences (although in practice these are both held by Gas Networks Ireland), and, as for electricity, the Romanian State owns the gas transmission assets in Romania. There is therefore no homogenous view of the entity that will be the transmission asset owner when the owner is not the TSO.

National Regulatory Authority (NRA) role

The duties of the NRAs include licensing of TSOs as well as fixing or approving transmission or distribution tariffs or their methodologies and supervising the TSOs' performance (including in relation to cross border issues).

NRA independence from the State is mandated by the EU legislation referred to above. In countries where the State owns TSOs or generation/supply companies, there may be higher pressure on the NRA to take decisions in favour of these State-owned entities. In some cases, NRAs are not fully independent in their decision making on tariffs or investments because of State intervention. The Commission is following up these cases with infringement proceedings. An example of such proceedings is in the ongoing case of the Commission referring Germany to the Court of Justice of the European Union to ensure correct implementation of the Third Package because of concerns regarding the NRA not having full discretion to set network tariffs and terms of access because many of these elements have been set out in detailed regulations adopted by the federal government.[12]

In addition, there are a number of countries where the State has more active controls in terms of having final approval of the NDP and of individual projects. In electricity, for example, the Ministry of Infrastructure in Slovenia and the Ministry of Energy in Spain each have final approval of the NDP. In Portugal, the NDP is approved by the Minister following discussion in Parliament. Further examples of exceptions and a classification based on the level of delegation from the State to the NRA are discussed in Annex IV.

2.2.3 Barriers to investment

Most countries have at least some level of constraint, which means that the process of making investments in the transmission network is not as efficient as it could be. This

[12] C-718/18 - Commission v Germany.

was highlighted in the legal analysis in some countries more than others, however, there is still a level of commonality among the 26MS on the types of issues that arise.

Some countries in the 26MS have experienced damaging effects from the economic downturn over the last ten or so years, leading to a decrease in investment into their transmission network. In Portugal, there is a drive to reduce transmission tariffs, which is limiting investments being carried out due to the lack of remuneration. In Slovakia, due to social and political reasons, the NRA's primary responsibility is to keep prices low over anything else. Both of these policies take precedence over any proposals to invest in the transmission network, with the practical effect of inhibiting investment in the network.

The constraint that was highlighted in the legal analysis more than any other is spatial planning. There are several factors that contribute towards spatial planning being a barrier to investment, but the most common related to:

- Time consuming decision-making processes which are susceptible to being challenged by stakeholder bodies and / or the general public;
- Multiple consents being required from different authorities. For example this could be consents in relation to the environment, water courses, forestry, etc.;
- Blurred boundaries between federal and local planners, which create uncertainty in the process. This is the case in Austria where the general planning system is within local planner's competence, but the planning process for investments under the NDP is under federal competence and there is nothing in the regulatory framework to link these two processes;
- Difficulty in competing with other major linear projects such as roads and rail which may attract more favourable treatment – this is highlighted in Austria; and
- Local planning issues, such as the permitting requirements in relation to cultural heritage and antiquities in Greece. The absence of a one stop shop in non-PCI projects for permitting was noted as delaying one in three NDP projects.

Other potential barriers to investment highlighted in the legal analysis include the following:

- In order to implement any gas investments in Hungary, the TSO's licence must be amended. This facilitates investment by allowing the NRA to impose time limits for completing investments directly on the TSO through their licence. This does, however, raise a potential indirect barrier to investment because the licence amendment must be completed before any works are carried out, which may cause delay;
- The Swedish legal analysis also highlighted a barrier to investment in the way that the gas TSO was affected by the rules for calculating the cost of capital and depreciation. This led the gas TSO to appeal against its revenue cap on the basis that the method of calculation made it more difficult for the TSO to develop the transmission network to become 'climate neutral' i.e. by replacing natural gas with biogas (which is the target for 2045). The appeal court agreed with the gas TSO and extended the depreciation period to encourage investment to be made;
- Another constraint identified in several jurisdictions was the risk of statutory duties conflicting with each other and therefore requiring a balance to be struck. For example, Bulgarian electricity regulation requires the development of the network to meet investment objectives to be balanced with the need to supply energy at lowest cost to consumers. The legal analysis for Latvia expressed similar concerns;
- The unbundling regime was highlighted as being a potential barrier to investment because TSOs are restricted in the types of assets that they are permitted to hold. An example that was given related to the inability of TSOs to invest in storage assets. As the unbundling regime is part of European law, this is

applicable in all 26MS. This perceived barrier to TSO investment is discussed in more depth in Section 3 of this report, including discussion on whether unbundling truly is a barrier to TSO investment or whether it actually stimulates investment;
- The absence of any statutory requirement or other regulatory duty on the TSO to invest in innovative projects or on the NRA to incentivise innovative projects could be regarded as a constraint – this was mentioned, for example, in relation to Estonia (for the TSO) and Germany (for the NRA);
- Change or postponement in the timing of network investments for new generation investment creates uncertainty and affects the scope and timelines of investments as the TSO seeks to avoid stranded costs. This was mentioned in relation to electricity in Poland and the UK and may be more widespread;
- Regulatory uncertainty – it was noted that, as TSO income is so sensitive to regulatory decisions e.g. under the price control mechanisms, any change in regulation or regulatory implementation practices could act as an important constraint on the TSO. An examples includes the Netherlands where there is an *ex-post* efficiency adjustment by the NRA on investments made by the TSO.

2.2.4 Regulatory approach to security of supply investments

There is a high level of consistency across the 26MS regulatory frameworks in relation to security of supply. This is driven by key elements of the Third Package such as the provisions referring directly to security of supply, together with congestion management requirements and duties to promote TSO and (separately) NRA cooperation on a cross-border and regional basis and also market integration requirements.

Security of supply duties are usually explicitly set out in the regulatory framework. Whilst it is a commonly understood concept there can be:

- Different understandings of the scope of security of supply, i.e. a wider scope including electricity / gas storage and emergency measures or a narrow scope which focuses on investments and long-term planning;[13]
- (Predominantly for electricity) different approaches to where the core responsibility sits in the regulatory framework and how it is expressed – for most this is in the TSO's statutory or licence responsibilities under supervision of and monitoring by the NRA but for some, such as the Czechia, the duty is less clearly expressed in the high-level regulatory framework but instead flows through the more detailed technical rules regarding management and development of the network; and
- Differences in interpretation. Security of supply can also be interpreted to mean diversity of supply i.e. new facilities or reverse flow facilities have to be developed.

We have also commented further, in Annex IV, on those countries where the State appears to retain a strong, hands on, relationship with security of supply, in place of or in addition to, the NRA role.[14]

As already noted, security of supply is delivered in part through the implementation of the NDP by the TSOs. This is in addition to the EU-wide implementation of PCIs, which are taken from projects proposed in Member States' NDPs, to deliver investments for security of supply across the EU. Implementation of the NDP is generally monitored by

[13] The scope of the legal analysis was to focus on investments that further the aim of security of supply, for example interconnectors. The legal analysis does not generally address other measures, which may assist or encourage security of supply such as electricity storage and emergency measures in any detail.
[14] Please note that the further comment in Annex IV looks at who is responsible in a wider sense for security of supply in a given country (for example approval of NDP), rather than merely who has been designated as being responsible in terms of the Security of Gas Supply Regulation.

the NRAs. The majority of TSOs update the NDP annually, but several countries require an update only every 2 years (or sometimes longer in electricity). For example, in Belgium the electricity TSO is only required to update their NDP every 4 years.

The State may also have some involvement in relation to investments made for the purposes of security of supply. This tends to appear at the level of controls over the physical aspects of investments. In some countries, the State requires the TSO to have a State issued permit in order to construct the infrastructure. This is the case in a number of 26MS countries, including Austria where a permit requires to be issued by the Ministry for Sustainability and Tourism for the construction and operation of new gas pipelines, and Bulgaria where the TSO must obtain a construction permit for gas pipelines from the Minister of Regional Development and Public Works. An example of State retained control which appears to sit more at the level of regulatory economic assessment occurs where the State may review proposed investments at the point when the investment is being made in order to decide whether the investment is necessary – this is the case in the Netherlands.

2.2.5 Regulatory approach to innovative investments

Based on the legal analysis of regulatory framework for investments in innovation, and in contrast to the analysis for security of supply, the evidence shows there is generally no clear and consistent content in the regulatory frameworks across the EU for innovation or similar related concepts (such as research and development, technological change and smart grids).[15]

We observe four broad categories of countries which exhibit one of the following characteristics in their regulatory approach to investments in innovation:

- Countries with explicit references in the high-level regulatory framework to innovation or related concepts. For example, this includes references to research and development, technological change and smart grids;
- Countries with explicit references to innovation or related concepts at the lower regulatory level by way of the various types of regulatory instrument. For example, tariff methodologies may explicitly encourage innovative investment or the NDP in a jurisdiction may explicitly encourage innovation or new technological solutions;
- Countries with no explicit references to innovation or related concepts, but which have references to the economic and efficient development of the network (which may be interpreted to include innovation); and
- Countries with no evidence of support for innovative investments in the regulatory framework.

Looking at these four categories in turn we set out some further comments on the findings from the legal analysis.

Countries with explicit references to innovation or related concepts in the high-level regulatory framework

Whilst the word innovation is not (beyond Lithuania) explicitly used in the high-level regulatory framework, one example in electricity of strong support in the high-level regulatory framework for technological change is in Romania where the legislation contains clear language in favour of the implementation of the related concepts of long

[15] By way of example, the specific words "innovate" or "innovation" are not used in the high-level regulatory frameworks across the EU at present, with one exception to that rule. This is in Lithuania where the TSO is required by statute (i.e. in the high-level regulatory framework) to (amongst other things) develop innovative pricing formulas.

term smart transmission networks and also supporting measures to encourage investment in R&D activities. We set out further examples in Annex IV.

Whilst we recognise that references to these concepts may not, of themselves, encourage investments in infrastructure or operational practices that are innovative, we have reported on them here given that they do appear in the high-level regulatory framework and in order to give as full a picture as possible of the patchwork of references that may have some bearing on the delivery of innovative investments. The practical implementation of the NRFs (and, therefore, the extent to which any of these references are effective at a practical level) is discussed in depth in Section 3.

Countries with explicit references to innovation or related concepts in the lower-level regulatory framework

Looking beyond the high-level regulatory frameworks there are a number of countries which have mechanisms within their regulatory framework, but at a lower level in terms of the overall legal hierarchy, that encourage innovation or related concepts. This is usually done through the tariff methodology and can include a favourable financial return or a specific allowance for innovation. These include the UK's Network Innovation Allowance, Network Innovation Competition and Innovation Link.

At present, this package of UK measures appears to be the most developed NRA approach to incentivising both TSO and third party innovation activity as it incentivises innovation to a level not seen in most other Member States. The regime was introduced in recognition that innovation and R&D activity were sacrificed under the RPI-X model where the efficiency factor tended to favour cutting investment in innovative activity. The package includes a number of measures aimed at incentivising the TSO to innovate and also at encouraging smaller scale innovative projects both by the TSO and third parties (for example, the operators of distribution networks).

The measures include possible NRA involvement in requiring the TSO to provide facilitated access to the network. The NRA is now considering how to further refine these measures for the RIIO-2 regulatory price control period (2021 – 2026). The NRA has confirmed that they will retain a package of measures to stimulate innovation during the RIIO-2 period, but this will be limited to projects that may not otherwise be delivered via the regular price control (for example high-risk innovation projects or innovative projects where the benefits accrue to other parties). This has been decided to achieve the NRA's aim to drive the TSO to build innovation into its business as usual activities. Further work is currently being done by the NRA to refine the type of innovation stimulus that will be used in this period; the projects that can benefit from this; and any differences to be applied between electricity and gas.[16]

Another example of references to innovation or related concepts in the lower-level regulatory framework includes the TSO's NDP which may contain explicit support for innovation and new technologies. In Hungary, for example, the electricity NDP refers to network development principles, which include a duty on the electricity TSO to examine the possibility of introducing new technological solutions.

It is interesting to note, therefore, that the absence of a broad duty in favour of innovation or innovative investment in the high-level regulatory frameworks throughout the 26MS has not prevented the NRAs in a number of jurisdictions from using a variety of regulatory tools to expressly encourage innovation or related concepts.

[16] Ofgem, July 2018, *RIIO-2 Framework Decision*: https://www.ofgem.gov.uk/system/files/docs/2018/07/riio-2_july_decision_document_final_300718.pdf.

Countries with no explicit references to innovation or related concepts, but which do have an economic and efficient requirement

Most countries have a legal requirement to act in an economic/efficient manner in relation to TSO network development and investment. This has received conflicting interpretations in the legal analysis. Some have interpreted this economic and efficient requirement as encouraging innovation because an innovative technology will usually be more efficient than the current technology. However, others have said that innovation is rarely cost efficient, so this discourages innovation. The only conclusion that we would draw from the requirement for efficiency is that it does not preclude innovation from occurring where it can be demonstrated to be cost effective.

Countries with no evidence of support for innovative investments in the regulatory framework

In some countries, the legal analysis does not contain any reference to innovation and does not imply any support for innovation from the efficiency requirement. The conclusion from a legal perspective would therefore be that these legal frameworks do not provide any evidence of encouraging innovative investments. Of course, this does not mean that there is no innovation taking place in those countries. The legal analysis must be understood alongside the outcomes of Section 3 of this report which reports on the practical implementation of the legal rules. We comment further on the various categories of references to innovation in Annex IV.

Overall, what we can say about innovation is that the language used, and the level of importance given to innovation and related concepts in the regulatory framework, is highly variable across the 26MS. Given that is the case, it is difficult to classify different approaches in a meaningful way and accordingly, we have classified the 26MS into two broad categories – those regulatory frameworks that do make reference to innovation or related concepts, and those that do not make any reference to innovation or related concepts (described further in Annex IV). In addition, we provide further examples of the innovation provisions in various countries for electricity and gas respectively also in Annex IV.

2.2.6 Financing Mechanisms

The legal analysis summarises the financing mechanisms for TSO's investments in their jurisdiction. Although not conclusive, the legal analysis is a useful starting point in order to be able to classify and categorise countries, as is seen in further depth in Annex IV.

When assessing the investments made in a Member State, an understanding of the financing mechanisms is critical. The mechanisms, usually contained in a tariff methodology, set out how investments will be initially financed and how the TSO can recover the sums for the investments that are made. They are also crucial when evaluating the need for an investment (from a security of supply perspective) and whether it can be progressed economically. Some financing mechanisms also contain separate incentives for investments in innovative technology, which will influence the TSO's behaviour in relation to innovation.

The majority of the tariff methodologies fall into one of the following four categories:

- **Cost based regulation (Rate of return / cost plus regulation)**

The CEER Report on Investment Conditions in European Countries[17] published in December 2017, contains a good summary of the differences between cost based regulation and incentive based regulation. The CEER Report states:

"*In the past, cost based regulation approaches (rate of return regulation or cost plus regulation) were widely used for tariff regulation purposes. The rate of return model guarantees the regulated company a certain pre-defined rate of return on its regulatory asset base. Another approach is cost plus regulation in which a pre-defined profit margin is added to the costs of the [TSO]. Obviously, the [TSO] has no incentive to minimise its costs under a cost based regulation framework, because it can increase its profits by simply expanding the asset or cost base. Under cost plus regulation a company may have an incentive to signal incorrect costs to the regulator or to even opt for wasting resources in order to increase the cost base ("gold-plating")*."[18]

Examples of rate of return or cost plus regulation in electricity include countries such as Austria, Croatia and Estonia, and in gas include Austria, Czechia and Poland;

- **Incentive based regulation**
  The CEER Report further notes that:

  "*As a response to the major drawbacks of the cost based regulation, incentive based approaches to tariff regulation were first developed in Great Britain (GB) and are currently applied in many countries.*

  Incentive based regulation can be characterised by the use of financial rewards and penalties to induce the regulated company to achieve the desired goals (generally in the form of an efficient cost base) whereby the company is allowed some discretion in how to achieve them. Rewards and penalties replace a 'command and control' form of regulation and provide incentives to the company to achieve the goals by allowing it to share the 'extra profit' if it over-fulfils the targets set by the regulator, in general aiming cost control – so that grid users later could benefit from them in a quantitative way through lower tariffs in the future."[19]

  Some countries now favour incentive-based regulation to achieve certain required outcomes – and to allow the TSO to achieve greater profitability if they improve their efficiency. Some countries, such as Germany, have recognised that this may assist with innovation because returns are no longer directly coupled with the cost of the assets;

- **Hybrid approach**
  The legal analysis also provide strong evidence of a large number of jurisdictions where a blend of cost based and incentive based methodologies are in place, painting a relatively complex picture of the variety of approaches taken. For example, some countries such as Italy and Portugal (in electricity) and Croatia and Italy (in gas) have a hybrid approach where CAPEX is calculated using a cost plus mechanism and OPEX is calculated using an incentive based method;

[17] Council of European Energy Regulators ("CEER"), 11 December 2017. *CEER Report on Investment Conditions in European Countries* Ref: C17-IRB-30-03: https://www.ceer.eu/documents/104400/-/-/fbd6a80e-5825-d1f3-fe35-bb3682b40c98.
[18] *Ibid*, Section 2.
[19] *Ibid*, Section 2.

- **State budgetary control over State owned bodies**
  Where the State controls the TSO's budget, it is usually set ex ante or there may be provision for an ex post review of the budget. This relates to a smaller group of countries including Denmark.

One outlier in the type of financing mechanism used is the mechanism in the Slovakian gas sector. The price cap in Slovakia is calculated solely by benchmarking against transmission tariffs in other EU Member States for the previous 4 years. Neither the TSO's costs nor a reasonable rate of return is taken into account. The legal analysis is that this may give rise to a risk that the TSO cannot generate enough profit from the tariffs that have been set and therefore investment may be curtailed. Within our interviews, stakeholders did not mention this aspect of the financing mechanism as being an obstacle for investments but rather say that, in general, investments are sufficiently refunded.

We have provided a break-down of the various approaches to tariffs and revenue controls on a per Member State basis in Annex IV.

2.2.7 Regulatory periods

One clear distinction that can be drawn between countries is the length of their regulatory periods. These periods are broad in range, from 1 to 8 years in both electricity and gas, with countries spread throughout this range. Due to the diversity in regulatory periods throughout the 26MS, a variety of views were expressed across the 26MS regarding whether or not a longer or shorter regulatory period represents best practice in the context of the topics of this study. Some comments suggested that longer periods may favour innovation because the TSO benefits from the efficiency savings for longer before these costs are socialised. For example, the move in the UK from a 5 to an 8 year regulatory period was seen as positive for supporting innovation. However, other jurisdictions have disagreed with this proposition, saying that a longer period means that the regulatory framework is more inflexible and therefore has the effect of stifling, and not adequately rewarding, innovation.

The regulatory period is, however, only one feature of the regulatory framework and as a standalone issue, this would not be sufficient to positively encourage or support innovation and security of supply. It is only where a longer period is combined with additional features supporting innovation and security of supply that the best conditions exist. For a full break-down of regulatory periods, see Annex IV. The practical implementation of the NRFs is discussed in depth in Section 3.

2.2.8 How different types of investments are financed

Financing for the majority of network investments is to a large extent delivered through the tariffs paid for by the users of the grid. It is clear, therefore, that the extent to which a particular tariff methodology either does or does not encourage network investments that are required for security of supply and/or that are innovative, will have a material impact on the likely outcomes in a Member State.

In addition, the legal analysis has highlighted that there are separate financing methods that apply to certain types of investment. For example, Projects of Common Interest (PCI) can at times be co-funded such that a share of the funding comes from the Connecting Europe Facility. The PCI concept is used, *inter alia*, to ensure security of supply for larger projects that have benefits in more than one Member State. This helps achieve the energy policy objectives of the EU.

Other EU funds and financing methods are also referred to in the legal analysis in terms of enabling network investments to happen, for example loans from the European

Investment Bank in Croatia and Czechia or Horizon 2020 grants in some jurisdictions. Another example is the EBRD monitored International Decommissioning Fund Kozloduy in Bulgaria, which manages grants from the EU under the Phare Program to reduce the negative impact from early decommissioning of a nuclear power plant. This fund has awarded grants to construct high pressure gas pipelines in Silistra, Kozloduy and Oryahovo. In general, the availability of non-refundable EU grants means that the assets funded in that way do not form part of the regulated asset base for the TSO, although there are a variety of approaches.

In the electricity sector specifically, congestion rents are collected by the TSO. All revenues generated from congestion rents must generally be used either to guarantee the availability of the allocated capacity (e.g. redispatching and counter trading) or to maintain or increase interconnection capacity through network investments. Only if it cannot be used efficiently for these purposes, may the NRA take congestion rents into account when approving or fixing network tariffs i.e. to reduce tariffs.[20] Congestion rents can therefore be used to finance investment in interconnection capacity such as investments in new infrastructure, upgrading of existing infrastructure and investments to resolve bottlenecks in the network which increase interconnection capacity. Examples of this practice are found in Estonia and Latvia. The practices is also common for investments in sub-sea interconnectors in the North Sea.

However, congestion rents can also be a disincentive for investments (see Commission impact assessment Clean Energy Package or recent study on tariffs setting and congestion rents from 2017). If congestion rents can be used to lower national tariffs, the incentives to reduce the income from congestion rents through building new connection may be limited. In individual cases investments into new interconnection were not taken between two countries although the costs for such interconnection would have been lower than the congestion rent income of a single year (which can amount to a three digit million figure). The Commission proposed to modify the existing rules on congestion rents to limit this disincentive (ultimate outcome: ACER methodology, see Art17 E-Regulation).

In some countries, there are also different regulatory and financing frameworks for electricity interconnectors and/or for offshore wind farm connections. This is the case for offshore wind in Belgium, Germany, Netherlands and the United Kingdom. These have been put in place where the general regulatory framework does not adequately cater for the specific type of investment to that extent that bespoke rules are required.

In some countries, certain investments are characterised as nationally important infrastructure. This is a national concept, so is separate to the EU-level concept of PCI. The criteria for inclusion in this category vary throughout the 26MS, as does the party who makes the decision on whether a project is nationally important. In terms of financing a project, a nationally important project may benefit from funding sources which are beyond the standard price control / network tariffs. Once a project is designated as nationally important, then it will generally benefit from exemptions from regulation, for example a consolidated and streamlined planning process, and potentially additional financial incentives, for example in Slovakia for gas where a special incentive has been approved for the "Polish-Slovak Interconnection of Gas Transmission Networks" project.

The legal analysis therefore shows that there are a variety of means to fund different types of investments, over and above the network tariff. Generally, these funds are granted for projects that will ensure security of supply. Although there is nothing precluding innovative projects for benefitting from these alternative funding sources,

[20] Article 16(6) of Regulation (EC) No 714/2009.

there is little evidence from the legal analysis that any of these mechanisms explicitly support innovation (except in relation to smart grid PCIs).

Annex IV provides further details of how different types of investments are financed on a per Member State basis.

2.3 Conclusion

The legal analysis found that there is a high level of commonality in the key structures and roles of the relevant parties in the gas and electricity markets in the EU. For a large part, this is driven by legislation at an EU level, such as the Third Package, the TEN-E Regulation and the Security of Gas Supply Regulation:

- There is also a high level of consistency across the 26MS regulatory frameworks in relation to security of supply. Security of supply duties are usually explicitly set out in the regulatory framework. This can be traced back to elements of the Third Package such as the provisions referring directly to security of supply, together with congestion management requirements and duties to promote TSO and (separately) NRA cooperation on a cross-border and regional basis as well as market integration requirements;
- With respect to innovation (and related concepts such as research and development, technological change and smart grids), there is no clear and consistent message in the regulatory frameworks. Countries can be split into four categories:
  - In the first category of countries there are explicit references in the high-level regulatory framework (for example, in legislation) to innovation or related concepts;
  - In the second category of countries, there are explicit references to innovation or related concepts at a lower level of the regulatory framework, by way of the various types of regulatory instrument. For example, tariff methodologies may explicitly encourage innovative investment or the NDP in a jurisdiction may explicitly encourage investment in innovation or new technological solutions;
  - The third category of countries has references to the economic and efficient development of the network, which could be interpreted as providing a basis for innovative approaches, although not an explicit basis; and
  - The fourth category of countries is where there is no evidence of support for innovative investments in the regulatory framework.

Further detail of the legal findings, including examples and classifications, are found in Annex IV.

3 Review of national implementation practices

3.1 Approach

The approach for the review of national implementation practice includes (a) an analysis of concrete implementation practices, through interviews with NRAs/TSOs; and (b) the development of European good practices; and (c) the identification of options for improvement at a Member State level.

Mirroring the approach taken in Section 2, we discuss results related to gas and electricity in one section as, very often, the regulations for gas and electricity resemble each other in the same countries. We highlight gas or electricity specific differences in case they arise.

3.1.1 An analysis of implementation practices

This analysis was conducted through interviews with NRAs/TSOs. The interviews were conducted in two stages. In the first stage, the general framework was discussed; while in the second stage, follow-up questions were presented as well as a deep-dive into potentially illustrative projects was conducted. The interview questionnaires were based on our understanding of innovation and security of supply, see Section 1.

During the interviews we discussed how the NRAs and TSOs view the general functioning of the regulatory framework and how they incentivise innovative and security of supply investments. Moreover for both innovation and security of supply we analysed the satisfaction of the stakeholders with the NRF, specific potential regulatory barriers, and the need for changes to the NRF to accommodate new developments. We also discussed the different meanings of "innovation" across countries and stakeholders as well as the role of PCI projects. Our main observations are presented in Section 3.2. Following the interviews, we identified the problems and barriers of the regulatory framework. The most common regulatory barriers are outlined in Section 3.2.4, while the Member State specific ones can be found in the Member State annexes (Annex I).

3.1.2 The development of European good practices

Based on the problems and barriers identified, we analysed whether there are any illustrative Member State examples tackling these issues in order to establish potential European good practices. In doing so, we drew on the identified key mechanisms in Section 2, the legal analysis in Section 2 and on the analysis of implementation practices in Section 3.2. The European good practices act as a "toolkit" with possible solutions at a national level. Our findings are presented in Section 4.3.

3.1.3 The identification of options for improvement at Member State level

The identified European good practices were the basis for developing the options for improvement at the Member State level. These options are linked to identified barriers or problems. In Section 3.4, we provide an overview of the options for improvement per Member State. We first outline general observations and then describe the most recommended options for improvement.

The more detailed descriptions of potential options for improvement per MS are outlined in the Member State specific annexes (Annex I). The annexes per Member State include a legal analysis of the national regulatory framework in the Member State, an overview of the regulatory practise in the Member State including barriers to innovation and security of supply, and finally an overview of potential options for improvement proposed. In addition to outlining the options for improvement we describe how these options could improve the regulatory practice and describe how national law could be

amended for implementing such options. Finally, the annexes also provide an impact assessment of the proposed changes.

3.2 National implementation practices

We firstly discuss the high-level outcomes based on the interviews conducted with NRAs and TSOs related to the general functioning of the regulatory framework and the incentives it provides for investment in general. After that, we go into details regarding innovation and security of supply, in particular. The high-level outcomes are further illustrated by specific Member State examples.

3.2.1 Observations related to the general functioning of the regulatory framework

The NRAs and TSOs are generally satisfied with the regulatory framework when it comes to security of supply; while for innovation there is room for improvement

Most of gas and electricity TSOs as well as NRAs are satisfied that their regulatory frameworks adequately incentivise investments. In general, there is more criticism on the framework for investments in innovation than in security of supply, reflecting the fact that security of supply is a well-established and extensively debated topic on the Member State and EU level. Exceptions being Latvia and Czechia. In the case of Latvia, the regulator understands and prioritises the developments in electricity and is open to new investments due to strong market signals. In case of gas there is a focus on avoiding increasing tariffs which is reflected in a perceived lengthy approval procedure of projects with investments in innovative technologies. In Czechia, the electricity TSO is enjoying a high WACC premium during this regulatory period and does not experience troubles in having projects approved. On the gas side, in contrast, some security of supply projects and even PCI projects are being held up due to their expected effect on the tariffs. Similarly, some respondents from Croatia reported that the high increase in gas pipeline length due to gasification of the Member State in recent years has resulted in Croatian tariffs for network use being among the highest in Europe. Therefore, the aim to limit further tariff increases is sometimes said to be restrictive, especially regarding security of supply projects.

Interviewees find it challenging to give a precise overall rating of the regulation

Stakeholders struggle to provide a precise overall rating of the regulation, based on the extent it supports investments in innovation and security of supply – this mirrors the complexity of frameworks and instruments at hand. This is also understandable, as the multidimensional nature of the NRFs makes it difficult to assess what the outcome would have been if the regulatory framework had been different and to set an objective standard as to what represents an appropriate incentive (which could differ from member state to member state).

Incentives aiming at promoting both investments and efficiency are in place in all countries

The regulatory practice shows that TSOs recognize that a balance needs to be found between efficiency, reliability, security of supply and innovation. This is mirrored in the delicate mix of efficiency requirements and investment incentives, which many countries employ in practice.

The most common mechanisms to ensure efficiency are (backward-looking) price or revenue caps, e.g. in the Netherlands, Hungary, UK and Germany; efficiency targets

(for OPEX), e.g. in Ireland and Luxembourg (both related to electricity); and efficiency assessments, such as benchmarking in the Netherlands and in Ireland.

The most common elements that support investments comprise of rate-of –return/cost-plus regulation elements, which can be found, for instance, in Portugal, Austria, Italy and Bulgaria. But usually the chosen basic regulation principles are added by specific incentives to support but also limit investments. In the following, application examples are listed to illustrate the broad spectrum of existing principles.

Provisions related to cost-plus regulation and other provisions regarded to be supportive of (innovative) investments include:

- Provisions for the mismatch between realised and expected CAPEX and OPEX, such as in Ireland (electricity) and in Portugal (electricity and gas);
- The requirement to provide a SCBA (Social Cost Benefit Analysis) for national investment projects, such as in Denmark;
- Ex-ante approval of CAPEX/rules for anticipatory investment effective, e.g. in Austria and France;
- A WACC premium for projects deemed risky by the TSO, e.g. in Belgium and in Greece;
- Exemptions from regulation, e.g. in Germany for projects in electricity and gas meeting special requirements[21], and the possible exemption (in discussion) from benchmarking of the new tower (pylon) design in the Netherlands.

More incentive-based schemes are used in other countries, such as:

- In Portugal, benefits and losses are shared between the TSO and the customer, this means that the TSO benefits from cost reductions;
- There is also revenue sharing in the UK, where budget overruns or shortages are shared between the operator and consumers;
- In France, the NRA will audit the budget of projects presented by the TSO exceeding € 20m and will set a target budget. If this budget is under- or overrun bonuses or penalties respectively will be attributed;
- Lastly, the rules for the length of the regulatory period are also mentioned as providing (dis)incentives depending on its length. For example, the regulatory period of 3 years in Portugal is perceived as being too short, not providing the TSO with enough time to invest and to recover the benefits of their investments, whereas the regulatory period of 8 years in the UK as well as the 1 year in Austria (for electricity) are perceived as supportive to investments.[22]

3.2.2 Observations related to innovative investments

Respondents recognise the list of typological innovative investments

Most of the respondents agreed with the list of innovative typological investments and concurred that they are implementing some of the innovative technologies listed.

Some stakeholders proposed additional categories of innovative investments in addition to the list of typological investments for electricity, but those investments are in most

[21] This refers to the so-called "IMA" (investment measures). Costs incurred for the expansion or restructuring of gas and electricity transmission systems and meeting further criteria specified in §23 ARegV are accepted as being 100% efficient during the construction and then until the end of the regulatory period that follows the start up. After that, costs will be integrated into the regulatory asset base and might be cut according to potential inefficiency.

[22] More information on the length of the regulatory periods are provided in Section 2.2.7 and Annex IV.

cases not (or indirectly) related to investments in transmission infrastructure, examples are:

- Data management system solution (data hub and cyber security);
- New potential investments which straddle the TSO and DSO business area (smart metering and investments in demand side management);
- The provision of new sources of flexibility for ancillary services (this category is closely related to 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' on the list of typological innovative investments); and
- Investments into micro-grids (large scale, including islanding operation and resilience schemes).

There are innovative investments – although limited in scope

Respondents generally find difficult to answer what the share of innovative projects is. For example, the share depends on whether it is determined by the *number* of projects or by the project *volume* as well as it depends on the classification of projects to the category "*innovation*". In all these areas respondents have difficulties providing an estimate, which is understandable as such an estimate is subjective and respondents often do not have a complete overview.

Yet, innovative projects were generally thought to make up only a relatively small share of total expenditures. The electricity investments in Slovenia, however, are exceptional: a large share of infrastructure investments is related to innovative technologies. The regulatory framework does not provide many (significant) incentives, but the TSO is intrinsically motivated to be innovative. In the UK, in contrast, innovation is recognized as a real opportunity and is part of the regulatory framework. The gas TSO invests about £300/400 million a year of which £100 million is on innovation, including projects such as making it possible to do internal inspections using robotics, open source information system (IS) platforms, lightning detection and radar, coating techniques, drone network for visual inspection, etc. Generally, interviewees agree on the fact that investment in cost-saving innovative technologies is usually directly incentivised by regulatory frameworks as regulatory frameworks generally promote efficiency.

The impression from the interviews is that over the past few years electricity TSOs were, on average, applying more innovative typological investments than gas TSOs. This, of course, does not mean that gas TSOs did not have far-reaching innovative ambitions for the future as individual examples from the interviews show. Reasons for relatively smaller appetite for innovation in the gas sector encompass low gas demand during the recent years of economic crisis and sufficient transmission capacity in many countries, reducing the incentive to invest into new infrastructure. This was the case for Spain and Portugal, for instance, whereas the French and German interviewees see a decreasing gas demand as motivation to think about innovative (IT-) solutions avoiding investment in assets lowering the risk for stranded investments in the future.

Gas TSOs use innovative solutions to varying degrees – one can speak of a West-East slope: whereas there are only a few innovative small and non-costly projects in Bulgaria and Croatia, such as pilot projects for pipeline rehabilitation or improved maintenance, for instance, innovative 'front runners', such as France, Germany and Italy, are investing in transport efficiency and carbon footprint improvement measures (e. g. waste heat collection, pipeline evacuation with mobile compressors prior to maintenance), in the improvement of network operation and surveillance with help of digital solutions (e.g. caloric value calculation, prevention of contractual constraints), and in the integration of Power to Gas and biogas/hydrogen infeed (e.g. reverse flow from downstream to upstream). The UK is also seen as a front-runner regarding innovative gas infrastructure projects. The UK carries out projects related to the maintaining and extending of asset

life, to making internal inspection by using robotics possible, to creating open source information system (IS) platforms, to using lightning detection and radar. For their gas pipelines, they have innovation projects related to new coating techniques, pigging, in line insulation for off shore use, and the use of drones. Investments in the bio and renewable gas sector (the installation of compressed natural gas filling stations is a potential future project the gas TSO envisions), along with investment towards CO2 reduction, have made Denmark one of the frontrunners in innovation, among the Scandinavian countries. Being an exception from the rule, Poland has invested in innovative investments related to Gas-To-Power solutions, such as waste cold recovery from regasification processes, waste heat recovery from, among others, gas compressors, and energy recovery at gas reduction stations. As mentioned above, innovation not only encompasses the employment of technology, but it also might relate to bringing new products on the market. Latvia, for instance, is an example of how the introduction of new products meeting new gas players' needs in light of the gas market liberalization process can be innovative. The Lithuanian gas TSO, AB Amber Grid, has embarked on innovative projects spanning from new technological solutions, such as intelligent metering systems and remote control of transmission system related process, to a new market platform aiming at interconnecting Lithuania to the Baltic gas market.

The understanding of the term "innovation" differs across countries and stakeholders

Although most respondents agreed with the list of innovative typological investments (see Section 1.3) that does not mean that the definition of 'innovation' as used in this study overlaps with how innovation is defined or experienced within TSOs and is the way it is mentioned in national regulatory frameworks (NRFs) in the Member State (if at all). Interviews have provided evidence that the term "Innovation" not only is absent in most of the member states' NRFs, but has a Member State-specific connotation in its interpretation, especially in electricity. We elaborate on these differences now.

Electricity

"Innovation" is occasionally associated with R&D, as it is the case of Finland where up to 1% of R&D costs may be deducted in the calculation of the realised adjusted profit. In the case of the Spanish TSO, there is about 0.5% of the yearly spending available for R&D, and in France, there is a budget for the TSOs' R&D activities. The Luxembourgian TSO can factor in 1% of their R&D costs into the tariffs. The Slovenian TSO has a "budget under coordination" of 130 million Euros for innovation. Within this budget, the main focus is on R&D, demonstration projects and projects which range from core-business practice to international cross-border cooperation and cross-border market projects. In Hungary 1.1% of the TSO's CAPEX are dedicated to innovative investments. In Germany, the cost of R&D activities must be financed from the regulated yearly revenue in general, but in case of publicly managed or funded schemes, 50% of the costs of these schemes can be covered if the TSO cannot receive them otherwise.

For other TSOs, however, innovation could cover R&D but more likely also other investment types, reflecting a broader view towards innovation. Energinet in Denmark, one of the "frontrunners" of innovation among TSOs, maintains that innovative investments should comprise of cutting-edge products and might involve new ways of re-applying "old-fashioned" technology. A concrete example of it is the employment of "synchronous condensers" the Danish TSO employs to ensure stability in energy delivery. The Danish TSO, indeed, agrees with the overall understanding and definition of innovation we specifically applied for the study, with an exception being made for the reference to R&D projects, which, in their opinion, should be considered outside the scope of innovative investments. Another example of creating innovation solutions through "classic" technology is offered by Finland. Fingrid, the Finish Electricity TSO, is investing in "classic" electro technology to increase transmission capacity without

building new physical transmission lines through the inclusion of control-type of devises (FACTS - Flexible Alternating Current Transmission System) in the grid.

The UK uses a broader definition of innovation. The listed typological innovations are mostly 'hardware' related innovations, but in the UK, also commercial and operational innovations are encouraged. More specifically, they see innovation in terms of using a new piece of equipment, a new way of using an existing piece of equipment, a new operational practice or a new commercial arrangement.

Some electricity TSOs indicated that innovation often occurs in cases where there is a need to increase capacity, but there are restrictions to carrying out the investment in the "traditional way". For example, TSOs replace conductors of overhead lines with new types of conducts that have higher transmission capacity. However, other TSOs indicate that solely replacing overhead lines with new ones with improved characteristics is not necessarily an innovative investment.

Other TSOs define innovation on the basis of whether the technology has been implemented elsewhere in the EU. The Member State-specific perception/understanding of investing in innovation is strengthened by the fact that what is regarded as an innovation in a Member State, may be perceived as conventional or at least well-known in others. Among the typological investments for electricity from which examples of investments are drawn during interviews, HVDC lines, part of the category "New transmission lines based on innovative technology or change of technology of existing lines", are deemed as "novel" in the Polish transmission system by the Polish NRA, but "classic" for the Danish E-TSO. In Germany, the operation of HVDC-lines as interconnectors is considered business as usual. Whereas for the planned HVDC-lines, that will be operated in parallel to the AC system, new operational rules had to be found. Moreover, planning and construction of onshore HVDC-cables with lengths of several 100kms was seen as new challenge, whereas other innovative typological investments from the list are frequently applied, when regarded as necessary and efficient. Another example relates to sub-sea electricity cables, which are considered business as usual in Greece, but innovative in Belgium. Sub-sea cables are also considered innovative in Greece if they cover large distances and are technically difficult; such as the PCI projects 'EuroAsia Interconnector' and the 'Peloponnese and Crete Interconnector'. In the UK, the entire list of innovative typological investments is carried out, but not all of the listed investments are considered innovative. New transmission towers and underground cables, for instance, are not considered innovative.

Gas

On the gas side, the "real" innovative technologies are seen as storage utilisation, Power to gas, biogas/hydrogen applications, small scale LNG, CCS, and waste heat usage projects. However, gas TSOs lack a mandate to participate in these innovative activities. Whereas many of the typological investment categories we provided, e.g. drone inspections, are perceived as "business as usual".

Again, different perceptions of innovation are present. For example, the sub-sea pipelines are considered innovative in Poland while countries with offshore production do not consider subsea pipelines innovative.

Innovation on the gas side may also take place in the market to meet challenges and changes in gas market regime. In light of the recent liberalization of the gas market and low seasonal price spread, the Latvian Gas TSO considers the recent introduction of new storage products to satisfy new gas players' needs as an innovative investment.

Specific regulatory barriers for innovation

We identified the following barriers for innovation:

A. Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised;
B. Bias towards capital expenditure (CAPEX) based solutions instead of operational expenditures (OPEX-solutions);
C. No specific provision related to innovation (e.g. allowances, duties, etc.);
D. TSOs are deterred from risky investments due to perceived high project risk and strict penalties for not meeting deadlines;
E. Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs; and
F. Lack of clarity of mandate for TSOs in certain innovative fields.

A. Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised;

In many countries, especially in those having a strong emphasis on minimising cost in order to avoid or limit tariff increase, projects with higher specific cost but wider societal benefits are not always incentivised. Although there are mandatory CBAs for larger national projects in some countries, the evaluation criteria sometimes focus primarily on direct costs and benefits. Other, in particular non-monetary benefits such as environmental benefits or shorter implementation times are therefore not taken into account, which may limit the choice of technology. The Italian TSO argues, for example, that the CBA currently in use practically excludes the use of underground cables, since the higher costs cannot be offset by the benefits currently taken into account. Thus, almost exclusively overhead lines are planned, the planning of which is often challenged in court and thus the implementation time increases sharply and making the realisation generally uncertain. In the view of the Italian TSO, a CBA taking into account the wider benefits of an underground cable would in certain circumstances prefer a cable solution.

The problem, that there is no structured process and clearly defined criteria to assess the broader societal benefits compared to alternatives remains in countries that do not apply CBAs as well as in those that do.[23]

For countries with cost-plus/rate of return regulation elements, this barrier is less relevant, as, often, there is room for the TSO to make a case for a specific project and have it remunerated.

B. Bias towards CAPEX based solutions instead of OPEX based solutions

Most respondents recognized this barrier: in most countries, CAPEX and OPEX investments are treated differently and very often, there is a bias in favour of CAPEX investments. This is the case many countries, such as Sweden, Belgium, Austria, Germany, Italy and Luxembourg, where investing in capital intensive assets guarantees the entitlement to a higher revenue cap or regulatory asset base. In addition, the regulatory granted interest tends to be perceived as higher than the actual financing costs, so CAPEX solutions are more stimulated than (high) OPEX solutions. At the same time, this barrier is seen as only a potential one in some cases, such as in Portugal or Germany, as the practical relevance of the potential bias is felt to be very small due to the majority of today's projects being infrastructure investments with a high CAPEX nature.

[23] For TYNDP projects, in contrast, a SCBA is mandatory.

C. No specific provision related to innovation (e.g. allowances, duties, etc.)

Based on our interviews with stakeholders, we find that within regulatory frameworks that aim for cost reductions and efficiency it is not a given that innovation is prioritized.

Generally, countries can be grouped into 4 levels of provision as presented below and previously. Most countries fall within bullet 2, 3 & 4.

1. Jurisdictions with [explicit] references in the high level regulatory frameworks to concepts that may be linked or are related to investments in innovation;
2. Jurisdictions with [implicit] references to innovation and related concepts at the lower regulatory level by way of the various types of regulatory instrument;
3. Jurisdictions with no references to the economic and efficient development of the network;
4. Some jurisdictions with no evidence of support for innovative investments in the regulatory framework.

Even in countries where there are incentives to stimulate and increase investments in innovation and the uptake of new technologies, these incentives are not used by TSOs or work differently than expected, for instance because they do not target the main barriers to investment. An example is Belgium (electricity), where there is a R&D incentive, which allows the TSO to recover the costs of trying to find a subsidy to finance the R&D investment. This provision is not seen to work very well. Another example is Luxembourg with their strong modernisation agenda targeting the introduction of smart grid this modernisation agenda has however not proved very successful so far.

D. TSOs are deterred from risky investments due to perceived high project risk and strict penalties for not meeting deadlines

Penalties for not meeting deadlines and delivering projects on time are present in some NRFs and are generally perceived as a necessary requirement to induce efficiency. Yet, each NRF comprises of provisions aiming at both increasing efficiency and providing investment incentives. Innovative projects are not risky per definition, but some innovative technologies have a perceived high project risk as there is uncertainty for meeting deadlines and thus could face penalties.

Some countries, such as Greece (electricity) and Luxembourg, reported that they are deterred from risky investments in innovative projects which may expose the national TSO to an unbearable financial burden. In Greece, high cost projects are categorized as projects of major importance (PMIs) by the regulator RAE. This means that the TSO is only able to recover the costs after the project has been completed successfully. In that sense, the TSO must bear the project risk on its own. After the project has been completed, however, the TSO receives a benefit in the form of a higher rent premium. Yet, the costs of a project remain a barrier if the expenses during construction are not reimbursed by the Regulatory Authority for Energy (RAE). In Luxembourg, the TSO is penalized for overrun project costs, delays and a deviance from the CAPEX-OPEX ratio determined in a 'photo year'.

Similarly, in Slovenia, interviewees stated that this barrier is relevant as the TSO is inclined to act conservatively when considering investments. In Lithuania, some stakeholders underlined how, in general, innovative projects not only entail high CAPEX but also higher OPEX than what was estimated thus increasing the

TSO's burden of the risk in investing in innovative projects in the face of uncertain costs.

E. Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs

As already explained for the barrier "B" the TSOs receive a regulatory granted return on their invested capital forming the regulatory asset base (RAB). So, any solution that will reduce the need for physical investments and therefore do not lead to a further increase or even decrease of the RAB is therefore unlikely to be of interest for the TSOs in the absence of any other incentives such as revenue-sharing schemes. In many cases, smart grid technologies have the potential to replace or postpone the need for physical investments e.g. by improved prediction methods minimising forecast errors, algorithms for controlling the calorific value and mixing ratio of biogas, hydrogen etc., virtual storages at virtual gas trading points. So, this barrier, especially in connection with a bias towards CAPEX based solutions (barrier B) creates a disincentive for TSOs to invest in such technologies.

Despite this, smart grid projects are already being implemented in some countries, without positive incentives being in place – sometimes even in the presence of disincentives. Even though in Finland smart grid investments impact the level of regulated revenue, the Finnish TSO decided to invest. Despite only having modest incentives in the NRF, Slovenia is one of the front runners regarding smart grid development, it has a smart grid PCI project together with Croatia called "SINCRO.GRID".

F. Lack of clarity of mandate in certain innovative fields (perceived as a barrier for gas and, to a lesser degree, for electricity TSOs)

The 3rd Energy Package limits the activities which can be performed by TSOs. However, some stakeholders have significantly different views on the scope of the TSOs' mission regarding specific kinds of innovative technologies, i.e. electricity storage, small scale LNG, Power to Gas, biogas/hydrogen related projects, and coupling of electricity and gas markets. These TSOs fear that if they are not involved in these fields and take action to implement the innovative technologies they regard as being necessary to foster the energy transition these technologies will not develop and the energy transition might be decelerated. However, it is important to note that our research was conducted before the Clean Energy Package was agreed upon in December 2018 that further clarifies the role of TSOs in relation to storage ownership.

A general observation is that a distinction can be made between new uses for existing infrastructure and projects related to storage and the integration of energy systems (including Power-to-X projects). The new use of existing infrastructure is only relevant for the gas network. The gas TSOs would like to push these technologies to maintain a role in transporting (non-fossil) gases in the energy transition as market demand picks up. Nonetheless, TSOs wish to clarify and receive guidance on how their role in these types of projects, along with the scope of their involvement in the investment and operation of these technologies, might still abide by the unbundling regime.

The Danish, German and French gas TSOs, for instance, observed how the current NRFs have been adequate for current conventional transmission system investments, but fall short on supporting "foreseeable" upcoming technology, as for instance Power-to-gas solutions. In some countries, there are no incentives

to upgrade the transmission system to accept inlet of green hydrogen production and injection into the gas transmission system.

We do not see any reason why there should be barriers for TSOs to use their infrastructure for transport of biomethane and hydrogen, as have been prevalent in some countries (e.g. hydrogen in the case of the Netherlands or in Germany, where a levy system had been introduced to cover cost occurring as a result of biogas producers connecting to the grid).

Another challenge relates to innovative investments lying on waste cold recovery from the regasification process, waste heat recovery from, among others, gas compressors as well as energy recovery at gas reduction stations. The Polish, German and French NRFs, for instance, are currently unable to embrace energy efficient solutions which are combining electricity and gas.

A further challenge is related to which storage assets the TSO can own. While grid operators may have an interest to expand their business into new fields of activities, the rules on unbundling are meant to protect customers and market players against a situation in which the grid owners use their grid monopoly in order to maximise their profits in the new business (e.g. favouring access to the grid for their own services). The current approach of most NRAs regarding this is that only in case markets are not able to support deployment of these technologies, the regulated tasks of TSOs could potentially be extended accordingly as far as this is considered necessary by legislators and regulators.

3.2.3 Observations related to security of supply investments

Overall, the satisfaction with the NRF regarding security of supply investments is high

Most interviewees (TSOs and NRAs) see security of supply in the sense of guaranteeing reliability of the transmission system as the core TSO business and thus consider most TSO projects as security of supply projects. The share of security of supply projects in a broad sense is hence high. Neither gas nor electricity TSOs experience noticeable barriers in implementing security of supply related projects in general and national NRFs are, in general deemed adequate to support security of supply investments.

Nonetheless some security of supply investments have been delayed or held up, example are:

- In Czechia, the stakeholders noted that the wording in the PCI regulation is not always clear and can be interpreted in different ways. This has resulted in disagreements between the TSO and NRA and led to projects being cancelled or delayed;
- The situation in Croatia is similar to the situation in Czechia. The Croatian NRA is very eager to limit the gas tariffs, as they are the highest amongst the EU Member States. Therefore, it is difficult for the TSO to get projects approved by the NRA if they are likely not being used to a high extent and have a significant influence on the tariff;
- Both the Estonian and the Finnish TSOs commented on the CBCA process (assumed for the Baltic-connector) finding the process of negotiating and finally agreeing on cost split challenging.

Despite the general satisfaction with the regulatory framework regarding security of supply, the following barriers were identified during the course of the project.

A. Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised

Open season procedures are often required for project acceptance by the regulator. Market tests and open seasons often – but not always – only captures the market demand for new transmission capacity. Reliance on solely the market test will make it difficult to justify investments aimed primarily increasing security of supply rather than fostering market integration. This barrier has been named by some TSOs and by NRAs, such as in Slovenia or Bulgaria, where the NRA is cautious about supporting projects without sufficient commitment by market participants as demonstrated by an open season. There, the NRA decides on a case-by-case basis. There is an inherent conflict between the open season procedure and the concern for security of supply; a project solely to increase security of supply may have no commercial interest in the market, whereas a commercially interesting project may only have small impact on security of supply. Hence, a 'too strong' focus on commercially viable project can potentially lead to a diminished focus on security of supply. Yet, the practical relevance of this barrier seems small across Europe: there is little risk of stranded investments and the level of security of supply is high. In general, the projects deemed necessary for security of supply are accepted by the NRA and implemented one example is the Baltic Pipe which is first and foremost a project for Polish security of supply.

Many PCIs contain innovative elements, but at the same time contribute to security of supply and market integration

Stakeholders consider PCIs to contribute mostly to security of supply and market integration in the regional gas and electricity corridors. However the thematic areas for PCIs in smart grids and gas dioxide infrastructure focus on more innovative solutions. Some examples of innovative PCIs are:

- The smart grid PCI, called SINCRO.GRID between Slovenia and Croatia;
- The German internal HVDC cables to increase internal North-South transmission capacity;
- The so called "Kriegers Flak Combined Grid Solution" that connects Denmark and Germany via the offshore wind parks Kriegers Flak and Baltic 1 & 2;
- The EuroAsia interconnector that will connect Greece and Europe with Israel, Cyprus and Crete through subsea HVDC cables;
- The new gas pipeline between the UK and Ireland has an innovative element – it makes physical reverse flow possible, an innovative typological investment according to our definition;
- In Estonia, the Baltic synchronization project to adopt the Member State's electricity transmission system to the European continental transmission system is a clear example of a PCI which fosters solutions regarded as innovative in the Member State; and
- In Finland, there are currently two PCI projects, which are related to innovative technologies, both in the gas and power sector: the Baltic Connector gas pipeline system interlinking Estonia and Finland, and the third 400 KV AC interconnection cable project adding 30% capacity between the cross-border connection between the northern part of Finland and Sweden.

3.2.4 Overview of regulatory barriers

We identified six main barriers and problems based on the empirical observations and outcomes outlined in the sections above. The identified barriers for each Member State are often the same for both gas and electricity. Table 4.1 provides an overview of the general barriers that can hinder investments in security of supply and innovative solutions as well as which barriers appear in which Member States.

Most of these barriers can impact both innovation and security of supply investments. However, "No specific provision related to innovation (e.g. allowances, duties, etc.)" and "Lack of mandate in certain innovative fields" are specific for innovation. The barrier that is most applicable for security of supply is "Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised".

Table 3.1 Overview of regulatory barriers

	Most common regulatory barriers	Applicable countries
A	Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised	BG, HR, HU, IE, LU, NL, PT, SI, ES, EE, LV, LT
B	Bias towards CAPEX based solutions instead of OPEX base solution	AT, CZ, DK, FI, DE, HU, IE, IT, LU, NL, PT, SI, SE
C	No specific provision related to innovation (e.g. allowances, duties, etc.)	AT, BG, HR, CZ, DK, DE, HU, IE, LV, LT, LU, NL, PL, PT, SK, SI, ES
D	TSOs are deterred from risky investments due to perceived high project risk and strict penalties for not meeting deadlines	BE, HU, IT, LU
E	Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs	AT, LU, SI
F	Lack of clarity of mandate for TSOs in certain innovative fields (perceived as a barrier for gas and, to a lesser degree, for electricity TSOs)	AT, BE, HR, FR, DE, HU, IE, SK, SI, ES

3.3 Examples of European 'good practices'

Based on the problems and barriers identified in section 3.2.4, we present illustrative potential European good practices that tackle these issues. In Section 3.3.1 we provide an overview of the good practices which tackle the main regulatory barriers. In Section 3.3.2 we describe these good practices in further detail.

3.3.1 Overview of good practices related to identified barriers and problems

In this Section, we provide an overview of good practices that can be used to overcome the key barriers identified in Section 3.2.4.

Table 3.2 Good practices related to identified barriers and problems

Most common regulatory barriers	Good practices
A. Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised	• Include social CBA as requirement in national plans for projects not in TYNDP; • Organise stakeholder consultation; • Organise specific stakeholder consultation on innovative projects; • If a Social CBA is conducted for large projects or for the national plans then need to include stakeholder consultation; and • Obligation to (explicitly) consider innovative options in national TYNDP.
B. Bias towards CAPEX based solutions instead of OPEX-based solutions, potentially inhibiting OPEX based innovation (e.g. smart grid solutions).	• Provide specific incentives for OPEX based or innovative solutions (e.g. monetary rewards, specific budget for IT-technology); • Obligation to consider OPEX-related innovative options in network development plan, i.e. options which substitute for CAPEX investments; and • Develop a framework that determines when OPEX based solutions have to be used; • A move to a 'TOTEX (total expenditures)-approach is a partial solution- there can still be a bias towards CAPEX.

Most common regulatory barriers	Good practices
C. No specific provision related to innovation (e.g. allowances, duties, etc.)	• Explicit reference to innovation in the regulatory framework; governmental policies; or NDP. • Include duty in regulatory framework; • Possibility of exemptions from regulation for specific innovative investments, i.e. offshore grids; • Obligation to (explicitly) consider innovative options in network development plan; and
D. TSOs are deterred from risky investments due to perceived high project risk	Ensure that measures aimed at ensuring efficiency do not result in barriers for investments in (innovative) projects by: • Differentiating the WACC for different projects as the WACC should be in line with the risk of the project; and • Providing ex-ante approval of CAPEX/costs (e.g. for specific categories of projects that are relatively risky).
	• Make deadlines more flexible or remove the penalties for not meeting the deadline for certain risky or innovative projects; and • Bonus system for meeting deadlines.
E. Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs	• Specific incentives for smart grid investments; • Set up a different financing regime for smart grid investments; and • Several solutions exist to challenge this barrier, but they are very individual and specifically tailored to the Member State specific NRFs.
F. The lack of clarity of mandate for TSOs in certain innovative fields(perceived as a barrier for gas and, to a lesser degree for electricity TSOs)	• Allow for pilot-tests or small scale facilities with a fixed, known duration as test-bed for later market based services; • TSOs, in their contracts, should incentivise third parties to make investments in innovative fields that the TSO cannot undertake itself.

3.3.2 Description and examples of European good practices

This section describes the good practices that could be implemented to overcome the six main regulatory barriers.

A. Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised

Essentially, we have identified two solutions to counteract this barrier: introducing a SCBA or stakeholder consultation. Although many countries report that a reference is made to additional, non-quantifiable (social, environmental etc.) benefits for some projects to convince the regulator to approve these projects, this is not done in a structured fashion. So, we could only find few good practices to illustrate how countries have approached this barrier:

- In Luxembourg, there is a debate about introducing the requirement to conduct social cost benefit analyses at least for larger projects;
- In Italy, the NRA is consulting on the introduction of additional and more detailed requirements for the CBA to better reflect wider societal benefits within the methodology;
- In Slovenia, a CBA was carried out related to the introduction of a smart grid;
- In Denmark, there is a structured process for both electricity and gas to assess investments. The requirement for projects to be socio-economically attractive is written in the law of Energinet and must follow the specific guidelines for calculating the socio-economic value of a project published and updated by the Ministry of Finance. Hence, upon the submission of a socio-

economic analysis, aiming at justifying capital-intensive projects (e.g. the Viking link, the Kriegers Flak link, etc.), the Energy Agency can decide whether or not to approve the proposed investments.

Possible solutions encompass the introduction of regular public consultation and the requirement to conduct SCBA for (larger) projects that do not already fall under the TYNDP SCBA. A challenge during the implementation of the solution will be to find adequate but simple metrics to value the wider benefits in order to decide whether the wider benefits outweigh the higher specific cost.

B. Bias towards CAPEX based solutions instead of OPEX based solution

This has been the most named barrier among the interviewees, even though it was said by many of the interviewees that the practical relevance is still considered low. To overcome this barrier, we have identified two possible options. But it must be admitted that both are difficult to be implemented well balanced without introducing new distortions.

A bias towards CAPEX based solutions could be reduced by turning to a more TOTEX (total expenditures) related regulation. But depending on the implementation of such regulation, which is quite complex as there are many requirements that must be met coincidently, a bias might still be persistent within a TOTEX oriented framework.

Another possibility would be to provide specific incentives for OPEX-intensive solutions. One possibility for such incentives is, for example, exemptions from efficiency requirements for innovation or R&D- related OPEX expenses. In France, for instance, the electricity TSO can gain additional budgets for smart grid projects subject to a cost-benefit analysis. In addition, both electricity and gas TSOs have a certain budget to cover R&D costs. In our understanding, these budgets do not have fixed efficiency requirements, but the expenditure is reviewed by the NRA.

Another option is to identify advantageous or necessary OPEX-based solutions and provide specific incentives for the application of these solutions. An example of an explicit regulatory support for specific technologies is the following, even though it addresses CAPEX rather than OPEX but it illustrates the basic idea. In 2012, the Italian NRA promoted first electro-chemical storages and dynamic line rating applications in the transmission systems as being innovative and showing a need for initial support. The key (and project-specific) feature to support related projects was a (conditional) WACC premium. Generally, it must be considered that incentives for specific solutions directly lead to disincentives for other solutions. So, such incentives have the risk to turn out to be a technology-specific incentive that do not necessarily lead to economically efficient decisions and may even encourage an increase of total costs. Also, innovative and socially beneficial OPEX solutions to be favoured by the regulation need to be defined. Such projects would need to be redefined for each regulatory period, possibly in cooperation with the TSOs and maybe including a stakeholder consultation in order to ensure technology neutrality. Therefore, depending on the specific implementation the effort for the NRA and the TSOs can be high. Additionally, adequate incentives for efficiency must be set to avoid inefficiencies.

Therefore, we must conclude that despite that this barrier is named frequently, pinpointed solutions are not easy to find. Solutions with low level of intervention (e.g. exemption from efficiency requirements, incentives for specific technologies) could be implemented using legal powers already available to the NRA or others under the existing NRF in most countries. But, the risk of introducing new distortions must be carefully weighed against the effort of

necessary changes to the law that are often needed to implement larger changes to the NRF such as turning to (a yardstick based) TOTEX regulation.

C. No specific provision related to innovation (e.g. allowances, duties, etc.)

Despite the lack of explicit incentives, several countries have taken steps to try and introduce it in legislation. In our interviews this was discussed and the following examples and practices were identified:

- Cost-plus elements, e.g. in Greece, Belgium, Czechia, Denmark, and Luxembourg, preclude that the regulator distinguishes between conventional technological solutions and innovative investments. The TSO can invest in innovative projects or projects with innovative elements, if they are approved;[24]
- Direct support to innovation within the regulatory framework, e.g. innovation allowances in the UK. The TSO in the UK can apply for revenue adjustment for innovation projects, there is a Network Innovation Allowance and a Network Innovation Competition fostering smaller trials and projects, and the NRA has established the Innovation Link, allowing solutions from outside the regulatory model to be proposed for trial. It is not surprising that the NRF is given a high overall rating by the stakeholders and that many innovative projects are being implemented in the UK;
- The possibility to propose new innovative categories of investments remunerated based on audited costs in a system of reference unit costs, e.g. in Spain, or external cost assessment, such as in France;
- The Slovenian electricity TSO has created a department for strategic innovation. The TSO is active regarding smart grids, being the leader of the first smart grid PCI. The TSO has a "budget under coordination" of 130 million Euro for innovation, within which the main focus is on R&D, demonstration projects and pilot projects which range from core-business practices to international cross-border cooperation and cross-border market projects. They are conducting a micro grid project for the city of Ljubljana and are involved in a large consortium led by the French RTE working on OSMOSE, a project on storage at a cross-border level and including multi-use of storage. In contrast to the UK, there are few (innovation) incentives in the regulation (e.g. for smart grids);
- Estonia is an example of a frontrunner in innovation in which NRA and TSO closely collaborate to implement innovative projects yielding a social benefit for the community. Any project, whether it is considered innovative or not, has to be justified by a socio-economic assessment by the TSO. Despite the fact that the NRF does not directly incentivise innovative investments, the NRA is willing to listen to the TSO's suggestions regarding investing in innovative projects. The willingness to invest in innovation is demonstrated by the fact that the government bolstered the "Data Exchange Platform" and "Smart-metering" projects for which, costs have been fully recognised and included in the RAB;
- Finland is an example of a Member State in which the NRF allows for incentives for "innovation" fostering R&D projects able to create new knowledge, technology, products or methods of operation in network operations, or to the planning work of such projects. Pursuant to the regulatory methodology, the NRA aims at encouraging research and development by allowing for the deduction of up to 1% of R&D costs when calculating realised adjusted profits."

[24] It has to be kept in mind that there are no pure cost-plus systems, as laid out in Section 2. Within a regulatory framework, cost-plus and incentive-based regulatory elements are often intertwined.

Another aspect is the collaboration between TSOs and NRAs. Among the countries where TSOs and NRAs express that there is an emphasis on innovation (e.g. Denmark, Finland, Estonia), it has been observed that there is a higher degree of flexibility in applying the regulatory framework in practice, when compared to countries which are more inclined to invest in "conventional" infrastructures. To bolster "non-conventional" type of investments, in fact, different countries have underlined a close collaboration between NRA and TSO in adapting measures or provisions of the frameworks to the case at hand.

The above examples show that there are several practices with regard to innovation at very different levels of the regulatory framework that can be drawn upon in looking at the future framework:

- A common national definition of innovation can be the first step to lay the ground for innovative solutions to materialize. It appears that TSOs and NRAs that have a good corporation succeed in developing projects;
- An explicit reference to innovation in the regulatory framework and/or the inclusion of duties for innovation;
- An obligation to (explicitly) consider innovative options in the network development plan.

We can conclude that including provisions relating to innovation and including incentives for the take-up of (specific) innovative technologies seems to increase the likelihood that innovative projects are indeed conducted, the examples above show that the success of such provisions depends on the entire make-up of the regulatory framework. Moreover, it also depends on the mind-set of the stakeholders involved.

D. TSOs are deterred from risky investments due to perceived high project risk and strict penalties for not meeting deadlines

In some countries, provisions are in place, which decrease the risk of innovative projects. Examples are:

- In the current regulatory period in the Czechia, the electricity TSO receives a WACC premium, which supports the investment in risky or innovative projects;
- In Belgium, the electricity TSO can receive a WACC premium for risky projects; however, it has not been widely applied and only been recently used for offshore projects;
- Ex-ante approval of CAPEX costs and minimizing the time lag for remuneration can reduce the perceived risk, as is the case in Germany and in Austria (for electricity);
- In Germany, investment projects that are stipulated in the national network development plan are eligible for so-called investment measures ("IMA"). When the German NRA BNetzA approves an investment measure, the related costs are considered so-called permanently non-influenceable costs, which are not subject to individual efficiency targets and thus can be fully reflected in the revenue cap. In addition, the costs are reflected in the revenue cap already during an on-going regulatory period. After the commissioning of an investment measure, the costs are integrated in the regulatory asset base and regarded as influenceable (potentially inefficient) costs at the end of the regulatory period after the commissioning.

These examples show that efficiency provisions do not have to be sacrificed in order to create a regulatory climate supportive to innovative or risky investments. Nevertheless, requirements relating to a fixed CAPEX-OPEX ratio

seem ill-equipped both to support innovative and risky investments and to induce efficiency, especially those where the positive effect on future OPEX is uncertain.

The good practices identified a number of potential changes and measures which could be included in the tool box incentivising both efficiency improvements and lowering the risk of innovative investments:

- Differentiate the WACC for different projects as the WACC should be in line with the risk of the project;
- Provide ex-ante approval of CAPEX/costs (e.g. for specific categories of projects that are relatively risky);
- Make deadlines more flexible or remove the penalties for not meeting the deadline for certain risky or innovative projects.

E. Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs (electricity)

In Member States where stakeholders chose to improve the incentive structure, different paths were followed:

- The NRA in Luxembourg defined particular projects yielding monetary benefits to incentivize the TSO to conduct smart grid projects;
- In Slovenia, specific incentives for smart grid investments have been set out: If the system operator realizes the investments in smart grids that meet the requirements set out in the methodology, a single incentive is acknowledged amounting to 3% of the current value of the asset in the year in which the asset was put into service. Yet, these incentives were considered to be too low and will be increased in the next regulatory period. Nevertheless, a PCI smart grid project, SINCRO.GRID, is already being carried out in Slovenia and Croatia;
- A positive example of overcoming this barrier is Estonia, where the electricity TSO focussed about 20% to 30% of last year's investment on investing in digitalisation related to market integration with neighbouring countries. Yet, the success was not due to a favourable NRF, but rather due to the intense collaboration with the NRA and the government to justify costs and evaluate socio-economic aspects. These projects were part of the political agenda;
- In Denmark, the ongoing "smart-metering" roll-out project represents an example of collaboration between a TSO and NRA to justify costs, which are not strictly confined at TSO level.

Another idea would be to set up a different financing regime for smart grid investments. Yet, this approach has not yet been taken by any Member State.

Finally, it can be stated that several solutions exist to challenge this barrier, but they are very individual and specifically tailored to the Member State specific NRFs. A universal solution fitting to all countries facing the barrier can therefore not be specified.

F. The lack of clarity of a mandate for TSOs in certain innovative fields (perceived as a barrier for gas and, to a lesser degree for electricity TSOs)

Across Europe, there are few good practices yet related to removing this perceived regulatory barrier. In some instances, TSOs have been investing in these innovative projects despite the regulatory risk but mainly these are pilot projects and at least for some cases NRAs made it clear that they would not accept costs of such projects on a regular basis.

As mentioned in Section 3.2.2, we do not see any reason why there should be barriers for TSOs to use their infrastructure for transport of biomethane and hydrogen, as have been prevalent in some countries (e.g. hydrogen in the case of the Netherlands). In Luxembourg, for example, there are incentives to facilitate the upgraded biogas to be transported in the transmission system. In Germany a levy system has been introduced to cover all costs incurred by network operators (TSOs and DSOs) in connection with biogas-related third-party access arrangements. Also, the Danish TSO expects to be able to tackle some challenges even in case the regulations do not change, for instance, the inclusion of new type of gasses (bio and green gas) into the transmission system.

In regards to the lack of clarity of TSOs owning electricity storage assets, the market test approach in the Clean Energy Package for electricity storage projects should be considered to ensure that TSOs are not involved in activities that can also be done by other market participants. This proposed approach aims to ensure that where there is an open and transparent market consultation and tender procedure which could not identify a third party to own, manage or operate an energy storage facility, then the TSO may (temporarily) own, manage or operate the storage assets.

3.4 Options for improvement - Member State level

After identifying the European good practices, we recommended potential options for improvement per Member State. The detailed recommendations and their impact at a member state level are elaborated on in each of the Member State Annexes. In total there were 40 tailored options for improvement identified.

Following general observations of the options for improvement in Section 3.4.1, the most recommended options for improvement are further elaborated in section 3.4.2.

3.4.1 General observations

The number of options for improvement does not necessarily reflect the severity of the regulatory barriers or the functioning of the regulatory framework.

The table below provides an overview of the number of options per Member State and a split between electricity and gas. However, the number of options for improvement per Member State does not reflect the severity of the barriers or the functioning of the regulatory framework as often we presented multiple options for improvements for one barrier or one option for improvement in response to multiple barriers. It should also be noted that we have not been able to analyse the NRF of countries from which we have received no or only limited responses to our requests in the same depth as those from countries with detailed responses. As a result, fewer suggestions for improvement could naturally be developed in countries with less input from NRAs and TSOs. Therefore, the functioning of the regulatory framework cannot be judged by the number of options for improvement.

Table 3.3 Overview of number of options for improvement

	Countries with 6-5 options for improvement	Countries with 4-3 options for improvement	Countries with 1-2 options for improvement
Electricity	Luxembourg, Denmark, Germany, Netherlands, Slovenia	Poland, Hungary, Austria, Belgium, Portugal, Ireland	Finland, Greece, Lithuania, Spain, Latvia, Italy, Czechia

	Countries with 6-5 options for improvement	Countries with 4-3 options for improvement	Countries with 1-2 options for improvement
Gas	Luxembourg, Denmark, Germany, Netherlands, Slovenia	Poland, Hungary, Austria, Belgium, Italy, Portugal, Croatia, Ireland, Latvia, Spain, Bulgaria	Estonia, Finland, France, Lithuania, Slovakia, Sweden, Ireland, Czechia

For some barriers, we presented multiple options for improvement.

In several Member States we have identified a bias towards CAPEX based solutions instead of OPEX-based solutions, potentially inhibiting OPEX based innovation (e.g. smart grid solutions). More than one potential solution has been identified for this barrier.

For example in Germany, we have suggested three potential solutions that could be applied in both electricity and gas. Among them are the solutions named "favouring of OPEX-based solutions" and "obligation to consider alternatives":

- Favouring of OPEX-based solutions could be achieved by setting specific incentives for OPEX based or innovative solutions such as monetary rewards for the application of OPEX-intensive technology that has been identified as advantageous or necessary, specific budget for a partial automation of system operation processes etc.;
- A more general approach to foster OPEX-based solutions in the long-term, i.e. beyond a single regulatory period, would be the introduction of an obligation to consider OPEX-related innovative options in the network development plan. The TSOs would then have to provide OPEX-based options as alternatives to CAPEX-based projects outlined in the network development plan. This approach necessitates that a framework is developed determining when OPEX-based solutions should be favoured over CAPEX-based solutions. This approach should be coupled with monetary incentives (see previous paragraph) for the TSOs to invest in OPEX solutions to counteract a CAPEX bias. This coupling also illustrates that a barrier can be approached with several potential solutions to achieve the best possible effect.

Some options for improvement (e.g. stakeholder consultation/ SCBA) can be recommended to overcome multiple barriers at once.

In many countries, consultations are already present in the regulatory framework, e.g. to discuss the NRA's suggestions for improvements of the regulatory framework with parties concerned. But to increase the likelihood that the most socially beneficial projects are selected, both the national plan as well as large individual projects could also be consulted with TSOs, consumers, industry etc. Stakeholder consultations can also be used to verify in which instances OPEX solutions might be favoured as well as to help shape the long-term perspective on innovation.

- In Bulgaria we recommended stakeholder consultations to improve the support for security of supply investments with no or little commercial benefits as well as to foster the application of innovative solutions;
- In Luxembourg, we recommended stakeholder consultations to improve support for OPEX solutions and to encourage a long-term perspective on innovation;
- Similarly, in Denmark we suggested incentives for OPEX based solutions, as CAPEX heavy solutions are indirectly favoured (through low financing costs and no interest feeds into the regulatory asset base).

There are also options for improvement that were only recommended once and are very specific to the context of the Member State.

In Italy interviewees reported that processes to receive necessary permissions for infrastructure construction are time consuming. The TSO must look far into the future to estimate what transmission tasks will develop (based on expected market developments such as new RES, load changes, storage, flexibility, sector coupling etc.) and which investments will be needed at a certain point of time. In this uncertain environment, the TSO needs to take into account that there may be several years between the time when the need for an investment is identified and the time when it is put into operation. Generally, uncertainty of the development of the transmission task will increase the longer the TSO must look into the future. So, an investment could turn out to be inefficient later if the market develops differently than expected, which could lead to reluctance of implementing projects that anticipate developments many years in the future. Therefore, in case investments turn out to be necessary and have not been started early enough to be put into operation on time, potentially security of supply could deteriorate. A potential solution for this investment barrier is to accept *ex ante* that *ex post* an investment project could be unnecessary. Alternatively, to reduce the risk of imperfect investments, the time needed for permission processes could be reduced. Therefore, mitigation of authorisation obstacles could be approached by simplifying and accelerating necessary permissions for infrastructure construction both at EU and the Member State level, as recommended for example for Italy.

In the Netherlands, revenues for electricity are set based on historic costs, any increases in operational expenditures would need to be pre-financed by the TSO before they are incorporated in the revenue cap at the start of the next regulatory period. So, the TSO might be reluctant to apply technologies leading to an OPEX increase, even though the total expenditure might be less compared to other more CAPEX-intensive solutions. An option for improvement to reduce the risk of any CAPEX-bias is to model the (efficient) expected operational expenditures in a forward-looking way, and to take the results into account when setting the revenue cap. This would reduce the reliance on historic costs when setting rates although it can have a negative impact on cost efficiency incentives. In Ireland, we recommend to mitigate possible negative consequences of the benchmarking by adjusting the cost base or asset categories for benchmarking for certain innovative technologies, which are more expensive but have benefits such as enhancing public acceptance or increasing the implementation speed. This adjustment could be done by the NRA, although it would probably cause additional workload.

For some countries no options for improvement were identified for various reasons.

A simple reason why we could not identify any options for improvement in some countries is that we have received no or just limited feedback to our questionnaires and requests. Therefore, a description and analysis of the regulatory practice to derive improvement options was not possible. For some countries we received feedback, but as the interviewees did not report any barriers or problems and were satisfied with the regulatory frameworks, there seems to be no need for improvement, e.g. Greece (gas) and the UK (gas and electricity).

More profound reasons for not recommending any improvement options in some countries, e.g. in the case of France, is that the interviews showed that the NRF is perceived as being well-designed and functional for both security of supply and innovative projects and the interviewees are largely content with the existing framework. For example, in France there is flexibility within the NRF to allow for an approval of pilot projects and innovative solutions, incentives are provided to meet projected costs and maintain the level of security of supply. Moreover, the French NRF already contains a large number of individual regulatory instruments (such as public consultations, CBA, and bonus/penalty mechanisms) that, in case a need manifests, can

be adopted using legal powers already available to the NRA or the Ministry under the existing NRF. In the UK no options for improvement were identified as the NRF is considered accommodating to both security of supply and innovative investments. 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. Finally, in Sweden no improvements were identified – but this was rather due to a low participation rate among the TSOs/NRA (no TSOs wished to take part and the regulator only took part in the first round of interviews).

We do not provide specific options for improvement at a Member State level to address concerns related to lack of clarity in innovative fields.

In the interviews, many TSOs expressed that a lack of clarity of TSOs' mandate in innovative fields (Barrier F) can be a barrier for investments in innovative projects by TSOs. This includes not only owning storage assets for electricity TSOs, but also the role of gas TSOs in transport of biomethane and hydrogen. As outlined in Section 3.2.2, we do not find a regulatory barrier TSOs being involved in the transport of biomethane, hydrogen, etc.; however as there seems to be a lack of clarity on the TSO's role the NRA should clarify this role.

An intended effect of unbundling requirements is that the scope of activities of TSOs is limited. This means that TSOs cannot own certain types of assets (e.g. storage assets). During the research, we found that unbundling requirements were indeed perceived as limiting TSOs' role in owning certain types of assets (e.g. storage assets) and potentially slowing down the uptake of innovative technologies. As unbundling requirements apply to all Member States, we do not provide specific recommendations on a Member State level; however, we recommend that the role TSOs could potentially have should be further clarified and that MSs should apply the market test foreseen in the Clean Energy Package to see whether there is a need for electricity TSOs to own storage assets, see Section 4 for further details.

3.4.2 Most recommended options for improvement

This section provides an overview of the six most recommended options for improvement. The description of the options for improvement in this section is a generalised description. In each of the Member State annexes the option for improvement was tailored to the Member State and sector context. Furthermore, the Member State annexes include an analysis how the options for improvement could be potentially implemented in the Member State—whether a legal change is required or if the NRA already has the power to implement the change, etc.

Table 3.4 Overview of most recommended options for improvement

Options for improvement	Applicable countries
Requirement to consider innovative solutions	Austria, Belgium, Bulgaria, Croatia, Czechia, Germany, Greece, Hungary, Ireland, Latvia, Luxembourg, Portugal, Slovakia, Slovenia, Spain.
Perform Social Cost Benefit Analysis (SCBA) for larger projects	Latvia, Poland, Bulgaria, Croatia, Hungary, Ireland, Lithuania, Luxembourg, Poland, Slovenia, Spain.
Mitigation of CAPEX bias by encouraging a balanced consideration of OPEX-based solutions	Austria, Belgium, Czechia, Denmark, Finland, Germany, Hungary, Luxembourg, Slovenia, Sweden.
Consult on National Development Plan / investment plans and on a project level with stakeholders	Bulgaria, Croatia, Germany, Luxembourg, Portugal, Slovenia, Spain.

Options for improvement	Applicable countries
Requirement to consider OPEX-based options	Austria, Belgium, Denmark, Germany, Hungary, Luxembourg, Netherlands, Poland, Slovenia.

In the Member State annexes, we often cited "EU level options" as further options for improvement. These options for improvement refer to the impact of the unbundling regime. However, as unbundling requirements apply to all Member States, we do not provide recommendations on how issues with the application of those requirements in the Member States can be addressed. In Section 4, we analyse whether these options for improvement should be dealt with at an EU level.

Requirement to consider innovative solutions

This option for improvement is recommended to make it explicit that TSOs have a duty to consider innovative options, while innovative options chosen should be funded through tariffs. This should reduce uncertainty of TSOs regarding the approval of innovative projects, also encouraging the development of a long-term perspective on the role of TSOs wish to play with respect to the uptake of new technologies. It is likely that such a long-term strategic perspective is more easily developed if the regulatory framework contains an explicit reference to innovation, also because its development will require resources. The long-term strategic perspective could be shaped by governmental policies, duties or could be included in the TYNDP. However, this does not mean that innovation should become an end in itself. Only new technologies that have been identified as advantageous by NRAs, necessary or economically beneficial, but are not applied, perhaps due to regulatory barriers, should be encouraged. When implementing this option for improvement, the best practices identified in Section 3.3.2 should be consulted. Furthermore this option for improvement will be further analysed in the next section to see if there is a case for change at an EU level.

Perform Social Cost Benefit Analysis (SCBA) for larger projects

This option for improvement aims to ensure that wider societal benefits are taken into account in order to justify a project being built. These wider societal benefits include benefits such as public acceptance benefits, decarbonisation benefits, and regional benefits. For each Member State that this option for improvement was applicable, the option was tailored to fit the context. For instance, SCBA could be considered on multiple levels: on the level of the national plan and on project level for larger projects. On a project level, it could be a requirement to undertake such an assessment before approval of the final investment decision or before approval of cost recovery in the tariffs. Furthermore, the extent to which a SCBA already exists in a Member States varies, thus sometimes the option recommends introducing a SCBA for others it is recommending to extend the existing SCBA.

For some Member States, such as for gas in Bulgaria, Croatia, and Spain, this included a recommendation to introduce the requirement to conduct a SCBA in order to support security of supply investments with no or little commercial benefit. However, SCBA is not exclusively recommended to foster security of supply projects, but also for innovative projects to capture socio-economic gains that are currently not taken into account, such as in Poland and in Luxembourg for gas. For other Member States, such as Denmark, this recommendation suggested to include regional socio-economic benefits and not only national benefits. Nonetheless this option for improvement is targeted towards national projects that are not in the TYNDP and thus not subject to the TYNDP SCBA processes.

We note that implementing SCBA or extending current CBA is not always straightforward because sometimes the TSO's or NRA's mandate prohibits them from including benefits such as environmental benefits in investment decisions, as is the case in Ireland. We also acknowledge that a SCBA should not be conducted for every project, but that a threshold based on the project size could be introduced.

Requirement to consider OPEX-based options

A general approach to foster OPEX-based solutions in the long-term would be the introduction of an obligation to consider and report on considered OPEX-related innovative options in the network development plan or investment plan. The TSO would then have to report on potential OPEX-based options as alternatives to (CAPEX) projects outlined in their plans. This approach necessitates that a framework is developed determining when OPEX-based solutions should be favoured over CAPEX-based solutions. In certain cases, this approach could be complemented with incentives for the TSO to invest in OPEX solutions to counteract any CAPEX bias.

Additionally, it may be cost-effective to explicitly allow the TSO to also consider other options, such as procuring flexibility, if not already permitted. The conditions under which this would be deemed a desirable solution should be made explicit in legislation to provide legal certainty to network users and TSOs.

Consult on the National Development Plan / investment plans and on a project level with stakeholders

Interviewees have often indicated that planning processes are too opaque and that the interests of various parties are not sufficiently taken into account when deciding on planning alternatives. Including a stakeholder consultation would require the TSO to explain the alternatives considered when developing the relevant plans / projects. This recommendation could be combined with a requirement to consider innovative technologies or approaches if thought desirable. The duty to consult could increase the likelihood that the output will ultimately be beneficial to the network users. It could also be used to help shape the long-term perspective on innovation and to overcome reluctance to invest in security of supply projects with low commercial benefits. Yet, it should ensure that the organisation of stakeholder consultations is done in an efficient way, minimising the additional burden for both the party organising the consultation (the TSO or NRA) and the parties contributing to it. Moreover, potential delays as a result of stakeholder consultations should be minimised by carefully planning them well in advance. Hence, one needs to think carefully when, how often and for which purposes one wants to consult stakeholders, while realising that it may increase public acceptance (resulting in quicker realisation times) and could lead to a more complete assessment of available options.

Mitigation of CAPEX bias by encouraging a balanced consideration of OPEX-based solutions

This option is recommended when stakeholders shared their concern about a bias in favour of CAPEX solutions. This bias might develop a significant distortion for the choice of solutions that becomes economically relevant or it may impact the level of investments in innovative OPEX heavy solutions, and can potentially lead to over-investment in CAPEX-intensive projects and result in high tariffs. Encouraging investment in OPEX-based solutions may involve introducing incentives or a specific budget for OPEX-based solutions or other regulatory changes aimed to ensure a balanced consideration of both OPEX and CAPEX when considering potential projects. Note that OPEX is often based on historical cost and adjusted by an inflation/efficiency factor, thus the regulatory framework may require an adjustment to include forward looking estimates of OPEX in the allowed cost base. Care needs to be taken that specific incentives for OPEX-based solutions do not create an 'OPEX-bias' and may result in inefficient investment decisions.

3.5 Conclusion

The regulatory framework seems to be generally sufficient when it comes to security of supply. Security of supply is seen as the core TSO business and thus most TSOs' projects are perceived as security of supply projects. Neither gas nor electricity TSOs experience

noticeable barriers in implementing security of supply related projects in general and national NRFs are, in general, deemed adequate to support security of supply investments.

NRAs and TSOs see more room for improvement when it comes to innovation. In many cases, innovation is not explicitly incentivised or recognised in the regulatory framework. This is an issue where the gains from innovative approaches are uncertain or hard to quantify. Moreover, where innovative approaches reduce the asset base or do not directly benefit the TSO, TSOs have less to gain or potentially lose from pursuing innovative approaches. Our analysis also shows that TSOs only pursue projects that they expect will be accepted by the regulator, while novel approaches that are not certain to be accepted often do not pass the stage of an idea. This demonstrates the importance of carefully assessing the incentives provided by the NRF.

The main regulatory barriers that were encountered (mostly for both gas and electricity) in the NRF's include:

- Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised;
- Bias towards capital expenditure (CAPEX) based solutions instead of operational expenditures (OPEX-solutions);
- No specific provision related to innovation (e.g. allowances, duties, etc.);
- TSOs are deterred from risky investments due to perceived high project risk and strict penalties for not meeting deadlines;
- Smart grid technologies reducing need for physical investments lower TSOs' financial return, creating a disincentive to invest for TSOs; and
- Lack of clarity of mandate for TSOs in certain innovative fields.

Most of these barriers can affect both innovation and security of supply investments. However, "No specific provision related to innovation (e.g. allowances, duties, etc.)" and "Lack of certainty about a mandate in certain innovative fields" are specific for innovation. The barrier that is most applicable for security of supply is "Socially beneficial but (for the TSO) not viable projects are not sufficiently incentivised".

It is important to note that the understanding of the term "innovation" differs across countries and stakeholders. Interviews have provided evidence that the term "Innovation" (or similar) is not only absent in most of the Member States' NRFs, but also has a Member State-specific connotation in its interpretation, especially in electricity. Moreover, even where there is a lack of explicit incentives, examples have shown there can be innovative investments although limited in scope.

The options for improvement for each member state are as much as possible adapted to the national context and regulatory framework. In total, 43 tailored options for improvement were identified. The most frequently recommended options for improvement include:

- Requirement to consider innovative solutions;
- Perform Social Cost Benefit Analysis (SCBA) for larger projects;
- Mitigation of CAPEX bias by encouraging a balanced consideration of OPEX-based solutions;
- Consult on NDP/investment plans and on a project level with stakeholders; and
- Requirement to consider OPEX-based options.

The number of options for improvement per Member State does not reflect the severity of the barriers or the functioning of the regulatory framework as sometimes multiple options for improvements for one barrier have been proposed while in other cases, only one option for improvement has been formulated in response to multiple barriers. There are also a few options for improvement that were recommended once and are very

specific to the context of the Member State. For some countries, no option for improvement was identified, for various reasons, including lack of engagement from stakeholders and that the NRF is well-designed and functional for both security of supply and innovative projects and the interviewees are largely content with the existing framework.

4 Options for improvement- EU level

The overall scope of this Section is to identify and evaluate potential options for the improvement of the European regulatory framework in order to ensure security of supply and to contribute to the efficient uptake of innovative technologies.

To achieve this objective, we took a three-step approach:

- **Step 1 –** Investigate whether revision of the relevant EU legal framework is necessary or advisable in order to trigger changes to the national frameworks and/or national practice;
- **Step 2 –** Analyse the EU regulatory framework to identify possible improvements to these regulatory rules; and
- **Step 3 –** Prioritise possible improvements with regard to their expected impact and ease of implementation.

4.1 Assessment of long list of potential EU level options

The options for improvement identified in relation to individual Member States in Section 3 of this report are the starting point for assessing potential EU level options for improvement.

4.1.1 Investigate whether revision of the relevant EU legal framework is necessary or advisable

The potential options for improvement identified in more than two Member States in Section 3 are highlighted as possible options for improvement to be implemented at an EU level. This is because an option for improvement that exists in only one Member State will be addressed more proportionately at a Member State level, however if an option for improvement occurs in at least two Member States, it may be that an EU level change is required, or preferred, to obtain the improvement in all Member States. In Section 3.4, we identified six main options for improvement at a national level. These have already been described in that section, but are summarised below for convenience:

Option 1. **Requirement to consider innovative solutions.** This option for improvement is recommended to make it explicit that TSOs have a duty to consider innovative options, while innovative options chosen might be funded through tariffs, subject to the NRA's decision;

Option 2. **Perform Social Cost-Benefit Analyses for larger projects.** This option for improvement aims to ensure that wider societal benefits (public acceptance or decarbonisation benefits such as less curtailment of renewables) are taken into account in order to justify a project being built. As projects that are in the Union-wide TYNDP are already subject to a SCBA, this option refers only to national projects not in the Union-wide TYNDP;

Option 3. **Clarify the role of TSOs in innovative fields.** This option focuses on ensuring that the market test (Article 36/54) from the Clean Energy Package (with respect to electricity) is applied and thereby gain clarity as to whether the market will provide innovative solutions or the TSOs shall have to step in;

Option 4. **Mitigation of CAPEX bias by encouraging a balanced consideration of OPEX-based solutions.** This may involve introducing incentives or a specific budget for OPEX-based solutions;

Option 5. **Consult on national Network Development Plan/investment plans and on a project level with stakeholders.** This would require the TSO to explain the alternatives considered when developing the relevant plans/projects; and

Option 6. **Requirement to consider OPEX-based options.** A general approach to foster OPEX-based solutions in the long-term would be the introduction of an obligation to consider and report on considered OPEX-related innovative options in the network development plan or investment plan.

In order to assess for which options, if any, EU level intervention is preferable to intervention at a national level, we assessed the options against the current EU regulatory framework through two rationalisation exercises.

The rationalisation exercises included consideration of both subsidiarity and proportionality.

In this context, subsidiarity means that an EU level intervention is only appropriate where an intervention at a Member State level will not adequately bring the desired change. Our consideration of the subsidiarity principle has reduced the number of potential EU interventions proposed by eliminating those where action can more appropriately be taken at a Member State level i.e. where a harmonised approach across the EU is not required.

Proportionality limits the EU to doing only that what is necessary to achieve the stated objective. In proposing the options for improvement at an EU level, we have considered whether the changes are proportionate to the aim that is being sought.

First rationalisation

We first looked at whether the current EU regulatory framework (including the CEP) prevents or hinders implementation of any of these options for improvement. If any of the above options would be prevented or hindered as a consequence of the EU regulatory framework, then an amendment/adjustment allowing the option for improvement to be realised should be made at an EU level.

From the list of six options for improvement identified above, none of the options are prevented or hindered by the current EU regulatory framework. In other words, there are no current rules at an EU level that would prevent these options for improvement from being implemented.

Second rationalisation

The second rationalisation was carried out using the options which were not taken forward following the first rationalisation (i.e. options 1, 2, and 4 – 6). These options were evaluated to discover whether any enabling change was required at an EU level in order to implement the improvement. In this process, an enabling change means that the change would not necessarily happen unless the EU intervened. In other words, this is an EU change that is needed: (i) to ensure that an option for improvement is implemented; or (ii) to facilitate the implementation of the option.

Through this process, options 4-6 were found to be able to be implemented without an enabling change at EU level:

- Option 3 is not included as an option at EU level as the clarification of the TSOs mandate should happen at MS level. As indicated in Section 3 we identified that the role of the TSO needs to be clarified in innovative fields and we suggest that the NRA should clarify the role of gas TSOs in relation to transportation of new gases. As to TSOs owning electricity storage and/ or provisions for certain ancillary services, we recommend that MS should apply the market test outlined in Article 54 of the recast Electricity Directive. The market test shall be conducted following an open and transparent tendering procedure where no other parties have

expressed their interest to own, control, manage, or operate such facilities offering storage and/or non-frequency ancillary services to the TSO. If such facilities or services are deemed necessary for the TSO to fulfil their obligations to ensure an efficient, reliable and secure operation of the transmission system then TSOs may own such storage facilities or assets. At an EU level we recommend that the market test should be monitored and evaluated to see in which countries and for which technologies a market failure could be detected within the market test. In addition, the results of regular re-testing should be evaluated to identify those segments in which the market failure no longer exists;

- In the case of options 4 and 5, using the law as it currently stands and having guidance or other lower level regulatory changes at a national level in order to promote the relevant option. For example, the legislative structure requiring a NDP is contained at the EU level. However, changes regarding the detail of what should be considered for inclusion in a NDP will differ between Member States and so any change should be implemented on a national level; or
- In the case of option 6, amending the law at a Member State level. Whether OPEX-based solutions are to be considered as alternatives to CAPEX based projects when preparing a NDP is a matter for each Member State to decide as this is likely to vary between Member States. A requirement to do this would therefore be included in a Member State's national law. On this basis, advocating for a change to the EU regulatory framework would not satisfy the subsidiarity principle.

Following the rationale above, no adjustments at an EU level are proposed for options 3 – 6.

Options 1 and 2, however, may require changes to be made at an EU level (beyond those foreseen in the CEP) and are thus further analysed below.

4.2 Analysis of potential EU policy options

4.2.1 Option 1 –Requirement to consider innovative solutions

The encouragement of the uptake of new technologies is a topic that has been prevalent throughout this study. The TSO and NRA interviews made it clear across a number of Member States that if innovative solutions are encouraged in order to facilitate the uptake of new technologies, then this would be best achieved by some form of intervention in the national and/or EU regulatory framework to incentivise innovative solutions. Criticisms received from respondents are that there is no long-term perspective on innovative investments and that any current incentives to innovate are insufficient. In the respondents' view, there is currently too much focus on keeping costs low which is indirectly stifling some types of innovation which, due to their novel character, are usually initially more costly to develop and refine. Some examples of requirements to consider innovative solutions at a Member State level are discussed in the text box below.

Examples of references to innovation and innovative solutions in different levels of national regulatory frameworks

There are currently a number of references to innovation and innovative solutions in different levels of national regulatory frameworks, as set out in more detail in Section 3.3.5.

Finland is an example of Member State in which the NRF provides incentives for "innovation" in order to foster R&D projects able to create new knowledge, technology, products or methods of operation in network operations, or to the planning work of such projects. Pursuant to the regulatory methodology, the Energy Agency aims at encouraging research and development by allowing for the deduction of up to 1% of R&D costs when calculating realised adjusted profits. In Germany, we have found three examples of solutions that show how the consideration of innovative solutions could be promoted:

1. In the German extra high voltage grid, underground cables were only used in very special situations and to a very limited extent. The TSOs did not consider underground cables to be state of the art, especially in the AC system. However, sufficient experience with this new technology must be gathered before underground cables can be used on a larger scale in the transmission system. Therefore, in December 2015, the "Act amending the provisions of the law on the construction of power lines" (PDF: 87.2 KB) came into force. Among others, the law basically regulates the following points: For new extra-high voltage direct current transmission lines (HVDC lines), the priority of underground cabling was introduced in the federal planning procedures. In the case of AC lines, the number of pilot projects for underground cables and the criteria for underground cabling were extended. This is an example of how the use of new technologies can be enforced having higher specific investment costs but broader environmental, public acceptance, etc. benefits that are expected to outweigh the higher costs;

2. When approving the German Scenario Frame report being the basis for the German NDP, the German NRA obliged the TSOs to also consider innovative solutions:

    a. (Section 7) “Transmission system operators are obliged to set out in the draft of the network development plan 2019-2030 the potential for reducing the need for grid expansion through optimal use of the existing grid and further flexibility options and to use this potential for minimising the need for grid expansion”;

    b. (Section 8) “The transmission system operators are obliged to present new and innovative technical approaches for the use of network resources and network operations management in the draft network development plan 2019-2030 and to assess their suitability for increasing transport capacity. This includes an economic feasibility study. If such approaches are technically and economically appropriate, they shall be included in the draft network development plan 2019-2030 for the target year. If pilot applications are initially required to make use of such approaches, they shall be included in the draft network development plan 2019-2030.”

    Already during the approval of the NDP 2017-2030, phase shifting transformers (PST), for example, proved to be particularly effective and cost-efficient as so-called ad hoc measures for load flow control and thus for the medium-term elimination of bottlenecks. Even though, this obligation is placed at the lowest level of legislation in Germany, it is a good example of a way how the consideration of innovative solutions could be promoted.

3. Under the initiative of the German Energy Agency (dena) and supported by the German Federal Ministry of Economics and Energy (BMWi), a technology overview of power transmission technologies at the extra-high voltage level was developed with the broad participation of a wide range of stakeholders. This technology overview aims to create a generally understandable, compact and neutral overview of the transmission technologies currently available in the extra-high voltage grid and outline the legal framework and the planning and permitting procedures that will be used to determine the technology to be used in the respective measure for conversion or extension of the networks. In addition to this, a detailed overview of the transmission technologies with

> detailed data and facts is compiled in order to enable an appropriate comparison from a technical point of view. The overview takes into account technology options that are currently available as well as technologies that are currently still in development or testing but are regularly included in the discussion. Such technology overview can be used as a basis for discussions about the reasons why specific solutions have been chosen and others haven't. But in Germany there is currently no obligation to use the overview as a reference in discussions about the consideration of innovative solutions and to constantly adapt the overview to the current state of developments. Such obligation could be added to the national and/or EU regulatory framework if the preparation of such technical overview is seen as a useful instrument to foster the consideration of innovative solutions.

This option for improvement is raised in 10 Member States for electricity and 13 Member States for gas. The fact that this option for improvement was identified in a number of Member States means that it could satisfy the Step 1 criteria to be listed as a potential option for improvement at an EU level.

The rationalisation process highlighted that although the current EU regulatory framework does not prevent or hinder innovation, there is nothing within the current legislative structure to promote innovation. An enabling change could therefore be made at the EU level to set a broad long-term strategy for the promotion of innovation and encouraging/incentivising the development of innovative solutions and technologies.

After the EU level change has been made, national level changes will be required to provide the detail at a Member State level for how the long-term strategy will be implemented by government policies, duties and/or the NDP. Innovation would therefore be promoted through a combination of EU and Member State interventions. This could include incentives to innovate and Member States developing policies on innovation throughout their national regulatory framework. Notably, some initial progress on this concept has been made in the Governance Regulation.[25] This Regulation requires integrated reporting on research, innovation and competitiveness, as set out in Article 25. This is a rare explicit reference to innovation in the EU's regulatory framework for energy. It should be highlighted, however, that this is concerned with reporting on innovative practices happening in a Member State rather than establishing a requirement that innovative technologies should be considered.

In order to set a long-term strategy for innovation, all Member States should be encouraged or incentivised to consider innovative solutions to identifiable problems. Otherwise, Member States and NRA's might continue to focus on delivering electricity and gas for the lowest cost possible in the short term which will usually lead to the use of low-cost proven solutions rather than investing in an innovative solution that is expected to generate relatively higher benefits in the medium to long term. When setting a long-term strategy, it must be borne in mind that innovation is a means to an end, rather than being an end in itself. For this reason, we do not recommend an R&D spending target to be reached by TSOs, for example.

Due to this option for improvement requiring a broad strategy in relation to innovation that is applicable in all Member States, we consider the subsidiarity test to be met such that some of the required changes would be carried out at EU level due to the need to

[25] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0001.01.ENG&toc=OJ:L:2018:328:TOC.

encourage Member States to consider innovative solutions and to promote the uptake of new technologies.

Potential options for EU intervention

A requirement to consider innovative solutions could be enabled by a change to EU legislation which achieves the following three objectives:

(i.) Sets a long-term strategy for innovation and incentivises the development of innovative solutions and new technologies;
(ii.) States that the TSOs must consider innovative solutions; and
(iii.) Sets the parameters of what innovation encompasses.

If a binding requirement is desired in order to implement this option for improvement and achieve the three objectives set out above, this would require an amendment to EU primary legislation.

The primary shortcoming of the proposal to amend binding EU legislation in this case is whether the change could be seen as proportionate to the objective that the improvement is seeking to achieve. We have also considered lower impact changes to discover whether this option for improvement can be implemented using a more proportionate means.

A lower impact manner in which this option for improvement may be introduced is for the European Commission to consider a policy guideline or recommendation which could achieves the three objectives noted above.

The primary shortcoming of this proposal is that a policy guideline and recommendations are non-binding, so this may not be seen to be a strong "requirement", which this option for improvement suggests. Notwithstanding this criticism, a policy or recommendation would encourage Member States to set their own policies and requirements regarding innovation, but would also allow the European Commission to provide clarity on how it defines innovation and how it intends TSO activities to be taken forward with regard to the development of innovative solutions and new technologies.

Analysis

Having a detailed strategy or policy guideline in relation to innovation at EU-level would be overbearing and prescriptive, requiring Member States to make potentially fundamental changes to their mechanisms for evaluating projects and technical solutions. Instead, we suggest that the introduction of provisions regarding innovation should be by way of a non-binding policy guideline or recommendation (in the first instance) in order to ease the introduction of the concept of innovation at an EU level. We have also seen, from Sections 2 and 3, that a lack of reference to innovation in the regulatory framework does not necessarily inhibit innovation, therefore our view is that a European Commission policy or recommendation could be successful in encouraging innovation within the current legislative framework without requiring a binding, prescriptive requirement. A policy guideline or recommendation can also be made more quickly and easily compared to amending EU-level legislation.

This policy guideline or recommendation could include a broad overarching statement which sets a long-term strategy for innovation and encourages the development of innovative solutions and new technologies. It could provide a long-term perspective for innovation whilst encouraging Member States to enact their own policies and support mechanisms to promote innovation, where appropriate.

The main obstacle to this solution is that, as a policy or recommendation is non-binding, Member States may not follow the policy or recommendation and may fail to develop

their own policies to support and promote innovation. The European Commission could closely monitor Member States' progress in meeting innovation targets for a set period of time after the policy or recommendation is issued. This may include the requirement on Member States to submit relevant information to allow such monitoring. If no changes are made, or if Member States have not adequately catered for innovative solutions in the European Commission's view, then the European Commission may wish to consider changes to EU-level legislation to require Member States to adopt an innovation strategy and to require their TSOs to consider innovative solutions and new technologies.

4.2.2 Option 2 – Perform a social cost-benefit analysis for larger projects

Another key area highlighted in the interviews for this study as an area for improvement is the consideration of societal benefits when conducting a cost-benefit analysis for national projects. These wider societal benefits include benefits such as public acceptance benefits, decarbonisation benefits, and regional benefits of national projects. Introducing a SCBA would represent a step towards a better understanding of the social benefits of a particular project before deciding whether to commence the project. At the national level, this option for improvement was tailored to the Member State's context by recommending to introduce a SCBA or extending an existing SCBA process when assessing national projects or project portfolios. Furthermore, for some Member State (such as Bulgaria, Croatia and Spain) this option was introduced to support security of supply investments with little commercial benefit. For others it was recommended to capture the social benefits of innovative projects such as in Poland and Luxembourg. Furthermore, a SCBA should not be conducted for every project, but rather a threshold based on the project size should be introduced.

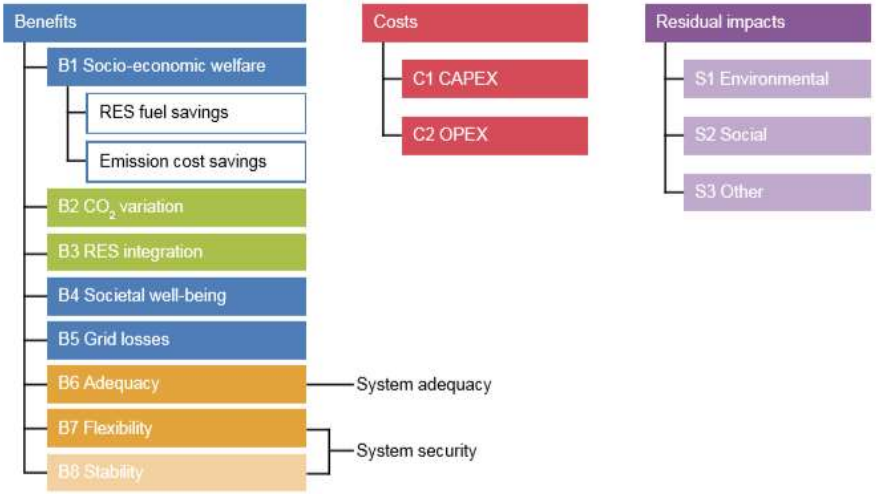
The SCBA could be done on multiple levels: on the level of the NDP or on project level for larger projects. On project level, the SCBA could be a requirement before approval of the final investment decision or before approval of the cost recovery. For all Member States this recommendation is targeted towards *national* projects that are not included in the Union-wide TYNDP and thus not subject to the TYNDP SCBA processes (outlined in the textbox below).

Social CBA for Union-wide TYNDP

The Union-wide ten-year network development plans (TYNDP) are prepared by ENTSO-E and ENTSOG respectively, in close cooperation with stakeholders. The draft TYNDPs will be examined by ACER and finally adopted by the European Commission. The underlying legal base indicates that the TYNDPs aim at identifying those infrastructure projects that are key to EU's achievement of its climate and energy objectives.

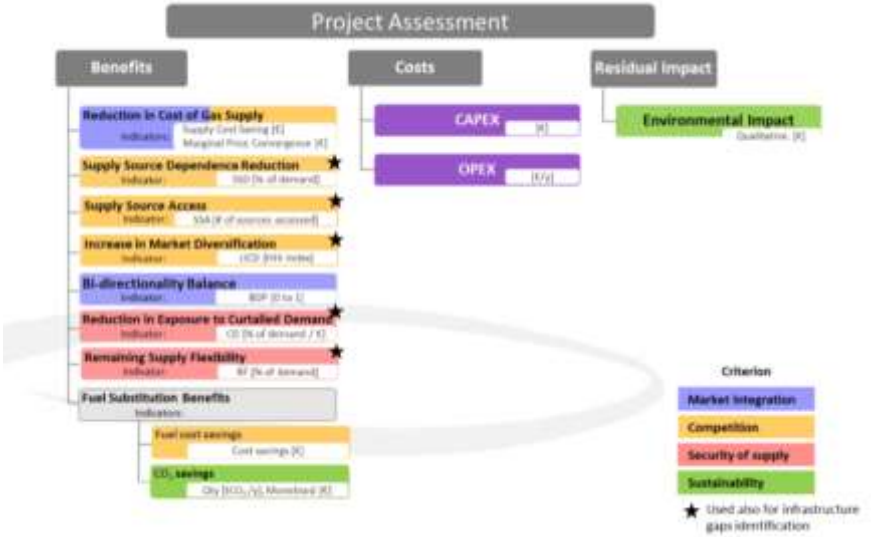
The TYNDPs are updated every two years. Each project, which is nominated by the TSOs to be included into the TYNDPs, is assessed using the pan-European CBA methodologies. The CBA methodologies are developed by ENTSO-E and ENTSOG respectively in consultation with stakeholders and adopted by the European Commission. The methodologies assess projects against socio-economic and environmental criteria. Further, projects of common interest (PCI) are selected from the TYNDP overall list of transmission and storage projects, with the exception of smart grids PCIs which are not part of the TYNDP. Currently, the used criteria in the CBA methodologies differ in Gas and Electricity (see following tables) but it is under consideration to closer connect the TYNDPs and CBA methodologies in both sectors.

Assessment of TYNDP projects in Electricity



Source: TYNDP 2018 Executive Report, published by ENTSO-E.

Assessment of TYNDP projects in Gas



Source: 2nd ENTSOG Methodology for Cost-Benefit Analysis of Gas Infrastructure Projects by ENTSOG, dated 22 October 2018.

Performing a social cost-benefit analysis also reflects the recommendations from ACER in their recent Market Monitoring Report on Gas Wholesale Markets[26] in which they recommend that gas infrastructure developments must be coherent with other EU policy objectives and also that all individual investment decisions should be subject to a cost-benefit analysis assessing the impacts on, *inter alia*, costs to consumers.

This option for improvement arises in 6 of the electricity responses and 10 of the gas responses. The fact that this option for improvement was identified in a number of Member States means that it could satisfy the Step 1 criteria to be listed as a potential option for improvement at an EU level. The rationalisation process highlighted that the EU regulatory framework does not facilitate this activity.

[26] Agency for the Cooperation of Energy Regulators, *ACER Market Monitoring Report 2017 – Gas Wholesale Markets Volume,* published 3 October 2018: https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202017%20-%20Gas%20Wholesale%20Markets%20Volume.pdf.

Potential options for EU intervention

There are two potential options for EU intervention to implement this option for improvement.

The first option is that the EU legislation could be amended in order to explicitly state that each Member State's TSO(s) must conduct a social cost-benefit analysis for each non-PCI project above a certain threshold that is included in the TSO's NDP. Further analysis is needed to determine the threshold as there are various ways that such a threshold could be set. One example is the threshold in France which defines large projects as projects that exceed 30 million Euro in the electricity and 20 million Euro in the gas sector. This would involve a change to the Electricity Directive and the Gas Directive that form part of the Third Package (i.e. Directive 2009/72/EC and Directive 2009/73/EC respectively). Specifically, the respective Article 22 of both Directives provide that the TSO must prepare a network development plan to guarantee system adequacy and security of supply, and it is these Articles that would be amended to include this requirement. The primary shortcoming of the proposal to amend EU legislation in this case is whether this change could be seen as proportionate to the objective that the improvement is seeking to achieve.

An alternative way to implement this option for improvement is for the European Commission to issue guidance to facilitate the effective application of the Directives. This guidance would not be legally binding – instead its aim would be to clarify that the proper implementation of Article 22 of the Directives requires projects over a certain threshold to be subject to a SCBA.

Issuing guidance would require no change to be made to the relevant EU legislation as this forms part of the lower-level regulatory framework. It would be more proportionate to make changes by way of guidance rather than in the legislation as both methods would achieve the same aim.

Analysis

The EU regulatory framework does not require to be amended in order to implement this option for improvement.

The most appropriate method to implement this option is for the European Commission to issue guidance on the implementation of Article 22 of the Third Package Electricity and Gas Directives. The guidance would state that a social cost-benefit analysis should be carried out by TSOs/project promoters where the project is not a PCI and where the overall project costs exceed a threshold determined by the European Commission. The rationale for the production of this guidance is that it assists in achieving the outcomes of Article 22(1) which requires the national network development plan to contain "efficient measures…to guarantee the adequacy of the system and security of supply." A social cost-benefit analysis will further the aims of ensuring system adequacy and security of supply.

The guidance may contain a common understanding of what should be reviewed as part of a social cost-benefit analysis. We propose that this would include, but would not be limited to, the consideration of the regional benefits of a project (i.e. the benefits occurring outside of the Member State hosting the investment). The Governance Regulation[27] contains provisions which also point towards regional benefits being a key consideration for investments in the EU energy sector. Article 3(2)(a) requires integrated national energy and climate plans to be prepared in cooperation with other Member States in the same region. This plan includes planned policies, measures and investments needed to meet, *inter alia*, the objective of interconnectivity of the internal

[27] See footnote [24] above.

energy market. It is also acknowledged in the Governance Regulation that regional cooperation improves effectiveness and efficiency of network investments and is also cost-optimal.

It is also proposed that the social cost-benefit analysis may include a consideration of decarbonisation. This may involve an appreciation of greenhouse gas emissions of the proposed project as well as ways in which the project could be realised in a more environmentally friendly manner.

The guidance may also contain a reverse obligation on a TSO to explain to the NRA why it is not necessary to carry out a social cost-benefit analysis for their project if it meets the criteria (i.e. if the project is non-PCI and above the relevant threshold).

The outcome of the social cost-benefit analysis may then be used in order to prioritise which projects are progressed. For example, the guidance may say that projects with the most benefits identified in the social cost-benefit analysis should be prioritised over projects with fewer benefits.

It is beyond the scope of this study, and too early in this process, to form a view on whether the social cost-benefit analysis should result in cost allocation between Member States on the basis of the identified benefits. Further provisions in the regulatory framework regarding cost allocation may be justified in the future following the implementation of this requirement to conduct a social cost-benefit analysis for national non-PCI projects above a certain threshold. It would be unwise to pre-judge this before implementing the measure that provides the initial transparency to highlight the benefits generated by these projects.

The most apparent obstacle to the solution of issuing European Commission guidance is that the guidance is not followed by TSOs. For this reason, the European Commission should monitor the application of this guidance, and specifically whether cost-benefit analyses are being undertaken. This could be done by the guidance requiring TSOs to share the results of the social cost-benefit analyses with the relevant NRA when submitting the NDP, as well as imposing the reverse obligation on TSOs mentioned above. This allows NRAs and the European Commission to monitor whether the social cost-benefit analysis has been completed for the relevant project(s).

If the guidance is not being followed, then the European Commission may wish to consider changes to the Third Package Electricity or the CEP and Gas Directives in order to make conducting a social cost-benefit analysis for the non-PCI project that exceeds the relevant threshold a legislative requirement. For example, in electricity, this could be inserted as an additional amendment proposed as part of the Clean Energy Package, which already seeks to amend the relevant Electricity Directive. Amending these Directives should operate as a last resort, only invoked in the event of non-compliance with the European Commission guidance.

It may also be considered expedient for the European Commission to encourage the exchange of good practice among TSOs and NRAs that already apply or are considering to introduce social cost-benefit analyses for larger projects that do not subject to the pan-European CBA methodologies. This exchange of information may be achieved through ACER, ENTSO-E and ENTSOG or via forums or seminars set up specifically to discuss good practice.

4.2.3 Prioritisation of options for improvement

The two options for improvement have been identified and evaluated as being appropriate to implement through changes made to the EU regulatory framework. These options are ranked in order of priority based on the following factors:

- Number of incidences of the option being identified in Member State's responses;
- How easily the recommended change can be made; and
- The expected impact of the change on innovation and/or security of supply.

In order to compare the results across the prioritisation criteria, each of the criteria was given a score from 1 to 5. For number of incidences, this translated to one point for every 4 instances that the option was proposed. For the ease of making the change, the scores ranged from 1 (change to the regulatory framework by amending an EU Treaty) to 5 (no change required). For the expected impact of the change on innovation and/or security of supply, the scores ranged from 1 (no impact) to 5 (large impact).[28]

Based on the above methodology, we have ranked the options according to priority:

- **Option 1 (Requirement to consider innovative solutions)** – this option has the highest number of incidences and has the potential for a large impact. It is more difficult to change than option 2, however due to the impact and desire for the change, this has been ranked as the highest priority; and
- **Option 2 (Perform a social cost-benefit analysis for larger projects)** – this option has the second highest number of incidences. The expected impact is the same as option 1, but the ease of change is the lowest, thus it is ranked as the third highest priority.

The prioritisation is a qualitative exercise and serves only as a tool to prioritise which option to tackle first if it is not possible to implement both options. Both options can be implemented relatively easily as none of them require amendments to be made to EU legislation by the European Commission. Therefore, there are no apparent reasons why all of the options for improvement cannot be implemented in a timely and efficient manner.

4.3 Conclusion

Options for improvement at EU level

This report shows that the current EU regulatory framework is largely, but not entirely, fit for purpose. Through the proposed Clean Energy Package and Governance Regulation, the EU has already taken steps to address some of the existing shortcomings. The options for improvement identified in this report attempt to 'fine tune' the EU regulatory framework rather than suggest a radical overhaul. The conclusions drawn regarding the options for improvement at an EU level are as follows:

Option 1 - Requirement to consider innovative solutions

An EU-level policy guideline or recommendation setting a long-term strategy for innovation and encouraging the uptake of innovative technologies could be beneficial. This will set a basis for Member States to then develop their own policies and incentives in this area. If the policy guidance or recommendation does not achieve the desired effect, changes to EU legislation could be considered in order to require Member States

[28] Please note that this is a qualitative exercise based on expert judgement as there is no quantitative objective data available that would provide a basis for this assessment.

to have an innovation strategy and to require their TSOs to consider innovative solutions and new technologies.

Option 2 - Perform Social Cost-Benefit Analysis for larger projects

The European Commission may consider further improving the implementation of (for example) Article 22 of the Electricity and Gas Directives by requiring a social cost-benefit analysis to be undertaken for all non-PCI projects over a certain threshold (set ex-ante). It would target national projects that are not part of the current Union-wide TYNDP and thus not subject to a SCBA process at EU-level. Considerations could include: (i) a common understanding of what should be contained in a SCBA (e.g. regional benefits, public acceptance benefits, decarbonisation benefits); and (ii) putting an obligation on the TSO to explain why it does not carry out a SCBA if a project meets the non-PCI and threshold criteria. The outcome of the SCBA could be used to prioritise projects based on the benefits that they are expected to generate.

ANNEX I: Member State Annexes

ANNEX II: Development of the key regulatory features promoting investments in innovation and security of supply

Introduction and approach

This annex provides an overview of the development of the key regulatory features promoting investments in innovation and security of supply.

The annex develops a framework of regulatory key features conducive to support the European objectives regarding the deployment of innovation and security of supply at national level. To arrive at this set of important elements of a regulatory model, two sub-activities are identified:

- Identifying key features regulatory model;
- Identifying barriers to security of supply and innovation;

Regulatory key features – Objective and approach

Objective

The objective is to develop a framework consisting of a set of principles and criteria that any National Regulatory Framework (NRF) for electricity and gas infrastructure could incorporate to attain the energy policy objectives of the European Union. The principles and criteria focus on investments related to innovation and security of supply within gas and electricity transmission. This section, accordingly, does not present one single theoretically optimal regulatory model, recommended to be implemented in the 28 EU Member States in the future, but a list of key features to look for in legislative frameworks and implementation practices.

The focus is on tractable, implementable, and operational key features that are relevant within the EU context of the regulation of electricity and gas infrastructure. These key features of a regulatory framework are expected to contribute to the balanced investment levels required to achieve the corresponding policy goals. By balanced investment levels we refer to levels of investment which are not insufficient but also not excessive from a social point of view. Insufficient investment levels could be the result of a lack of incentives to invest, leading to lower than optimal innovation and insufficient security of supply. Excessive investment levels would, conversely, result in a system with overinvestment and consequently high tariffs.

As explained above, we do not aim at developing an exhaustive regulatory model in the strictest sense of the term. Yet, for the sake of convenience, we choose to use the term 'regulatory model' to describe the key features and criteria which we identify. For the reader, it is important to keep this definition in mind.

Approach

To structure the analysis, we divided the framework of principles and criteria of the 'regulatory model', into two layers: (i) the meta level and (ii) the mechanical level.

The *meta level* is the higher level of regulation. This level is usually formulated in a more general and sometimes political fashion or as a system of incentive regulation. Examples of meta level regulation include, for instance:

- "The regulation must be transparent", meaning that the regulatory system operates transparently, so that stakeholders are aware of what is going on and know the terms of the deal (Ashley C. Brown, 2006);
- "Funds for innovation are exempt from efficiency demands", a principle aiming at encouraging investments in innovation.

The *mechanical level* is the technical or economic specific part of the regulation. Examples of mechanical level can encompass, for instance:

- "Reimbursement of capital expenses during construction" in order to reduce the risk of insufficient coverage of capital costs during construction (ENTSO-E, 2014);
- "Adjusted depreciation periods for innovative projects" where the lifetime of the assets turned out to be shorter than initially anticipated (ACER, 2014); and
- "Exemption from efficiency gains" to achieve performance and cost efficiency improvements (DG ENER, 2014).

The key regulatory features resulting from our analysis is, in essence, a list of 'meta level' and 'mechanical level' principles supportive of EU energy objectives. The resulting list provides concrete guidelines Section 3 and 4 of the report.

Identifying key features regulatory model

This sub-section surveys the literature for regulatory principles or elements designed to address and overcome barriers to invest in energy infrastructure projects. It is beyond the scope of this study to include the entire set of best practices of meta and mechanical level for a regulatory framework of infrastructure regulation. This means that the literature surveyed is narrowed down to the most relevant specific literature for our purposes: literature relating to the energy sector and investment in innovation and security of supply. From a meta and mechanical perspective, this means that we focus on regulatory design elements which directly support investments in security of supply and innovation. A review of the literature has been made and the findings in this sub section built on the literature listed in the table below:

Table A.2.1 Relevant literature

Literature	Main recommendation
ACER. (2014). On Incentives for Projects of Common Interest and on a Common Methodology for Risk Evaluation. Ljubljana: Agency for the Cooperation of Energy Regulators.	In this recommendation, ACER proposes a general framework for incentives for promoters of PCIs who are incurring higher risks than for comparable projects.
Ashley C. Brown, J. S. (2006). Handbook for Evaluating Infrastructure Regulatory Systems. Washington, D.C.: World Bank.	The handbook presents detailed, practical guidance on how to conduct quick, mid-level, and in-depth regulatory evaluations of existing national- and state- or province-level regulatory systems through structured case studies. The focus is on economic regulation of commercialized enterprises, whether publicly or privately owned.
CEER. (2016). Report on Investment Conditions in European Countries. Brussels: Council of European Energy Regulators (CEER).	This report provides a general overview of the regulatory regimes, the required efficiency developments and analyses the overall investment scenario in European Countries.
DG ENER. (2014). Study on regulatory incentives for investments in electricity and gas infrastructure projects. Luxemburg: Publications Office of the European Union.	This study investigates how specific features of projects of common interest (PCIs) impact the risks faced by project promoters, and may therefore justify special regulatory treatments.
ENTSO-E. (2014). Fostering Electricity transmission investments to achieve Europe´s energy goals: Towards a future-looking regulation. Brussels: European Network of Transmission System Operators for Electricity.	In this policy brief, ENTSO-E proposes a toolkit of possible regulatory instruments from which policy makers can choose when creating the framework for TSOs willing to provide the required transmission infrastructure.
JM. Glachant, M. S. (2014). Harmonizing regulation of electricity TSO to ensure their	This study analyses potential consequences of national choices with regard to pan-European network investment.

Literature	Main recommendation
finance ability. Florence: European University Institute, Florence School of Regulation	
Leigh Hancher, S. L. (2004). Principles of good market governance. Tijdschrift voor Economie en Management, 49(2), 339-374.	This article discusses which legal principles of good economic governance should form the basis of market legislation and supervision.
Littechild, S. (2012). Regulation and Customer Engagement. Economics of Energy & Environmental Policy.	The paper describes the framework of economic regulation of utilities in the UK and North America. The framework allows regulated stakeholders to negotiate with users on the commercial terms for the provision of network services, e.g. revenues, expenditure allowances and service standards. Regulators in these setting play the role of a backstop and an arbitrator, and guide the process of concluding tariff negotiations.
MIT. (2016). Utility of the Future, An MIT Energy Initiative response to an industry in transition. Cambridge: MIT Energy Initiative.	The study presents a framework for proactive regulatory, policy, and market reforms designed to enable the efficient evolution of power systems over the next decade and beyond.
Ofgem. (2016). Cap and floor regime: unlocking investment in the electricity interconnectors.	The study presents a regime for and results of cap and floor regimes for electricity interconnectors in Europe.

The first sub-section in this section relates to meta-level regulatory principles, the second sub-section to mechanical-level regulatory principles.

Meta level principles for the regulatory model

A set of meta level principles for laws, regulations, processes and regulatory arrangements is found in *Principles of good market governance* (Leigh Hancher, 2004). These meta principles are: (1) transparency, (2) independent supervision of the market, (3) clear legislative mandate, (4) proportionality, (5) predictability, (6) accountability, (7) consistency, (8) respect for general competition policy, (9) respect for European law and co-operation and (10) flexible powers.

Proper meta level regulation should comprise this set of ten meta principles, providing overall legitimacy to the regulatory system (Ashley C. Brown, 2006). Brown et al. argues that "[w]ithout legitimacy, a regulatory system, even if technically competent, will not survive. Legitimacy requires that consumers and investors believe that the regulatory system is producing value for them" (Ashley C. Brown, 2006). Thus, the importance of meta level design principles cannot be underestimated. Nevertheless, even with the proper meta level regulatory principles and the accompanying mechanisms, there is a theoretical risk that the regulatory framework does not produce the intended or better outcomes than the regulatory framework previously in place (if any). Sometimes, regulation is not better than no regulation. Brown et al. argues that "[e]conomic regulation is justified only if it produces better sector outcomes — for example, in terms of prices, productivity, investment, access, financial viability, service quality, and social objectives – than some other system of control" (Ashley C. Brown, 2006). For this reason, as principle of good practise, the framework of principles and criteria of the regulatory model should be subject to periodic evaluation and adjustments to accommodate to changes in European energy goals and energy markets.

In the energy sector, one can distinguish between two distinctive approaches to regulatory systems: incentive based and cost plus regulation. The box below briefly describes the two approaches in comparison to each other.

Incentive based vs. cost plus regulation

Economic regulation of natural monopolies in the EU is designed to counterbalance the market failures to charge higher prices, deliver lower service, and to be less efficient than markets

characterised by competition. To accomplish this, incentive based economic regulation based on benchmarking has gained traction in recent years. It is now dominant in many countries/regions and sectors, such as most of European countries in electricity infrastructure regulation (CEER, 2016), and is even sometimes prescribed by the law; i.e. German and Dutch law strongly rely on benchmarking as a tool to promote efficiency.

Cost plus regulation provides strong incentives for developing new infrastructure. A certain level of profit is ensured by the fact that the rate of return is guaranteed to be covered. Yet, it typically is 'backward-looking', "focused on reviewing the prudency of incurred investments after the fact", **(MIT, 2016)**. A regulatory framework accounting for conditions from many years in the past poses a risk in a changing environment as it could discourage the TSO to take advantage of new technologies and capabilities **(MIT, 2016)**.

In line with the trend and our literature review, we prefer incentive based regulation as the core of a regulatory framework to best introduce competitive elements in natural monopoly industries. However, when compared to cost plus regulation, it is not clear that incentive based regulation offers better outcomes in terms of security of supply and innovation.

Mechanical level principles

We distinguish between two kinds of principles or mechanisms designed to incentivise investments promoters (DG ENER, 2014):

1. Mechanisms aiming at **mitigating** risks; and
2. Mechanisms increasing **remuneration** (or conversely penalties) for project promoters.

It is often impossible to evaluate the benefits and drawbacks of a mechanism as such, i.e. "stand-alone". Typically, its evaluation depends on the other features of a regulatory regime. To make it even more complex, a mechanism can be beneficial with respect to one criterion and disadvantageous with respect to another. For example, a high return on CAPEX can incentivise construction of new assets but it can dis-incentivise the adoption of innovative, OPEX intensive solutions.

Below in Table A.2.2 a matrix of the mechanism categories and security of supply and innovation is presented. Each mechanism is detailed further in the following section "Mechanical level– mechanisms and principles for supporting security of supply".

Table A.2.2 Mechanical level mechanisms

	Mechanical level	
Mechanisms	Security of supply	Innovation.
Mitigation	a. Cost plus regulation; b. Extended regulatory periods; c. Stability arrangements; d. Exemptions from regulation; e. Early recognition of costs; f. Minimizing time lag for remuneration; g. Tendering of services.	Not applicable.

	Mechanical level	
Remuneration	h. Altering debt to equity ratio in the WACC; i. Sliding scale sets or profit sharing; j. Exemption from benchmarking/efficiency demands; k. Adjusted depreciation periods; l. Rules for anticipatory investments; m. Premiums (WACC surcharge); n. Assessment of efficiency of investments (e.g. through benchmarking; bottom-up assessment).	o. Innovative projects funded from regulated rates (explicitly or implicitly); p. Adjust the revenue cap if the innovative investment has higher costs than a traditional solution; *q.* Reduce the depreciation period of the asset if the lifetime of the asset is shown to be shorter than expected; r. Exemption from benchmarking/efficiency demands; s. Explicit mandate to invest in innovation; **t.** Penalise the TSO economically for not meeting deadlines on commissioned innovative projects; **u.** Stakeholder engagement and commitment.

Mechanical level– mechanisms and principles for supporting security of supply

Firstly, we specifically look at the regulatory framework and financial incentives supporting security of supply. As explained above, the mechanisms are divided into mechanisms mitigating risks and mechanisms implying remuneration and/or penalty incentives (DG ENER 2014). In this section, we review and in-depth describe the workings of the mechanisms presented in Table A.2.2 , the choice of each mechanism is justified subsequently.[29]

Mechanisms mitigating risks

The investment risks the TSOs face are potential barriers which can be addressed through mitigating mechanisms. Here we present key mechanisms for mitigating risks in a regulatory framework.

a. **Cost plus regulation** provides strong incentives for developing new infrastructure.[30] Under this framework, the rate of return is guaranteed to be covered, which ensures a certain level of profit. However, cost plus regulation potentially poses other problems. It typically is 'backward-looking', "focused on reviewing the prudency of incurred investments after the fact", (MIT, 2016). Although it represents a very reliable way to provide security of supply, it can pose impediments to innovation in an active and changing market (MIT, 2016). A regulatory framework accounting for conditions from many years in the past poses a risk in a changing environment as it could discourage the TSO to take advantage of new technologies and capabilities (MIT, 2016). We conclude that, although cost plus regulation can guarantee the provision of security of supply in a stable way, it does not fully account for the current market situation, which might affect the incentives and level of innovation;
b. **Extended regulatory periods** provide certainty in predicting future regulation, a main concern for TSOs (ENTSO-E, 2014). Longer regulatory periods can also provide incentives for TSOs to achieve reductions in cost, unless the TSO is operating under a classical cost plus regulation. In a stable market environment with low risk of external shocks to market, price controls for longer terms are

[29] Unless otherwise stated the content of this section is derived directly from *Study on regulatory incentives for investments in electricity and gas infrastructure projects*, DG ENER, 2014, pp. 55-67.
[30] Cost plus is found in member states Malta, Latvia, Greece, Denmark, and Croatia.

less risky. Conversely, in an active and changing market with higher risks of shocks beyond the control of the TSO, price controls can have negative consequences;

c. **Stability arrangements** can be introduced, when there are greater changes in the regulatory framework. These transition rules can include provisions such as:
   - key factors are not adjusted during a transition;
   - regulators alert TSOs of upcoming changes;
   - introduce changes step-by-step and not all at once; provide flexibility for TSO to comply with new regulation.

d. **Exemptions from regulation** by removing specific obligations and requirements can provide incentives for investing, if these exemptions affect the attractiveness of the investment. In the Third Energy Package, exemptions for requirements on third party access are available, making these expenditures more attractive in certain cases. The "price" the project promoter pays is that costs cannot be socialized to all users of the infrastructure, but only on those using this infrastructure. Rules of exemption should be transparent and the regulator should have limited power to provide exemptions *ad hoc* to minimize the incentive for lobbying and thus limit the potential impact from regulatory capture;

e. **Early recognition of costs** means including asset values into CAPEX and/or including costs of operation into OPEX already at a time before the asset is brought into use. If CAPEX of a new piece of infrastructure can be recognized early (i.e. before operation), the cost of the project can be spread over a longer period – even before the project starts to generate revenue. This could provide incentives for investing in large projects and should be used for such cases only. Allowing for early recognition of costs for investments of all volumes could reduce incentives to do proper due diligence when evaluating investments;

f. **Minimizing time lag for remuneration**. Time lag from when an investment is commissioned to the time when the TSO receives compensation should be minimized. In this time the TSO is limited in its capability to finance its activities. A regulatory regime should ideally provide remuneration at the time of commission (ENTSO-E, 2014). Given depreciation rules, it can take up to 55 years before a TSO is fully compensated;

g. **Tendering of services** is a mitigating way to let the market decide on the balance of both penalty (risk) and remuneration, where "bidders can price the level of risk pertinent to the project" (ACER, 2014). Successful tendering, however, is best attained in a competitive environment with more than one bidder, making it suitable for, e.g., offshore transmission projects.

Remuneration or penalty incentives

In addition to mitigating the TSO's risks, a regulatory framework can incentivise TSO investments supporting security of supply by allowing remuneration or penalty.

h. **Altering debt to equity ratio in the WACC.** In most regulatory frameworks, the TSO is allowed a rate of return on its investments. The most common method for setting the rate of return is the WACC method. The WACC is a function of the ratio of debt to equity (or gearing) ratio, altering this ratio will affect the value of the WACC. Thus, for certain investments, the regulator could alter the WACC in a more favourable direction to incentivize these investments;

i. **Sliding scale sets or profit sharing** incentives for "regulated companies to achieve specific regulatory targets by splitting the benefits or costs of over- and under-achieving those targets between the company and the customers (following pre-set rules)" (DG ENER, 2014) and (ENTSO-E, 2014);

j. **Exemption from benchmarking/efficiency demands** (DG ENER, 2014) is a special case of exemptions from regulation;

k. **Adjusted depreciation periods** – If "depreciation can account for a significant proportion of a regulated company´s total costs, such companies will be more motivated to make investments in infrastructure when they enjoy greater certainty that their depreciation costs will be recovered (and conversely, will be

less motivated to make investments when there is less certainty that their depreciation costs would be recovered)" (DG ENER, 2014) and (ENTSO-E, 2014);

l. **Rules for anticipatory investments** relating to "anticipatory investments in infrastructure which will be needed to prevent inadequate and untimely infrastructure developments" (DG ENER, 2014);
m. **Premiums (WACC surcharge)** (DG ENER, 2014);
   Reward for investments with positive impact on security of supply, e.g. uplift in the allowed return on invested capital;
n. **Assessment of efficiency of investments (e.g. through benchmarking; bottom-up assessment).**

Mechanical level– mechanisms and principles for supporting innovation

Like our analysis of mechanical level principles supporting security of supply, we move from broad meta level principles for a regulatory framework to mechanical-level mechanisms supporting innovation.

There is need for investment in innovative technologies through applied research and development together with demonstration projects (MIT, 2016). Although the TSOs are uniquely qualified to play a major role here, they do not necessarily have all the financial incentives to invest in innovative solutions and development or demonstration projects. Thus, we look for financial mechanisms incentivising innovative investments.

The most common way to incentivise innovative investments is through input-based financial incentives (MIT, 2016). Here, demonstration projects are capitalized and included in the regulated asset base. Another way to incentivise demonstration projects is via output-based financial incentives, which provides the TSO with incentives to innovate in the near term (MIT, 2016).

Below we list some of the key mechanisms for supporting innovation in a regulatory framework:

a. **Innovative projects can be funded from regulated rates (explicitly or implicitly);**
b. **Adjustment of the revenue cap if the innovative investment has higher costs than a traditional solution;**
c. **Reduce the depreciation period of the asset if the lifetime of the asset is shown to be shorter than expected;**
   The inherent uncertainty of innovative solutions also applies to lifetime expectancy of the asset. In case of innovative investments, the regulator may allow for reduced depreciation if the lifetime after the investment is commissioned is shorter than the depreciation period. This will align the asset lifetime better with the annual allowed recoupment in tariffs;
d. **Exemption from benchmarking/efficiency demands**
   As engaging in innovative projects is costly, cost benchmarking and efficiency demands are disincentives to innovation. Benchmarking risky, innovative solutions can leave an image of a less cost-efficient TSO, and efficiency gains from demands can be hard to envision. Therefore, the regulator can exempt all or parts of the cost for innovation from benchmarking and/or efficiency demands;
e. **Explicit mandate to invest in innovation**
   The regulator can also mandate the TSO to invest in selected innovative solutions;
f. **Penalise the TSO economically for not meeting deadlines on commissioned innovative projects;**
g. **Stakeholder engagement and commitment.** Regulation by Contract (also called negotiated settlements) are examples of rate decisions that are widely supported, and could be applied to TSO activities in innovation. Most often, if an agreement cannot be reached, the fall-back option is the traditional regulation. In the traditional system, the regulator oversees the TSO on behalf of the

customers and other stakeholders. In Regulation by Contract, the TSO and the stakeholders (organised in industry or customer associations), engage in a bilateral agreement which is then approved by the regulator. The principle behind is simple: the stakeholders know their situation better than the regulator. Hence, they can in a more direct way approach the TSO, and the TSO can in a better way organize investments to accommodate the need for investment and the need for cost efficiency for the stakeholders.

The traditional approach can sometimes have a difficult time leaving room for:

- Company differences;
- Long term efficiency targets;
- Exceeded efficiency targets;
- Competition on other aspects than just price/efficiency (i.e. environmental concerns, service or quality).

Hence, Regulation by Contract gives:

- opportunity to include customers and stakeholders in the regulation process;
- opportunity to compete on other parameters as price/efficiency;
- opportunity to remove the frustration the regulated company can have with the regulator.

Identifying barriers to security of supply and innovation

To determine which of the principles of good market governance must be adapted to define a regulatory framework that fosters innovation and security of supply, there is a need to identify and understand the potential barriers for innovation and security of supply investments.

The focus throughout this sub-section is to identify barriers to investments in innovation and/or security of supply. As the list of potential factors that could have an impact on investment levels is relatively long, we have chosen to focus on those factors that are relevant within an EU context and are particularly relevant for security of supply and innovation.

Security of supply for gas is well defined in the security of gas supply regulation, most recently in the updated Regulation 994/2010. However, an overarching requirement is to come to a commonly accepted understanding about the desired level of security of supply. On the mechanical level, one can try to achieve this by, for example, a transparent process for the evaluation and discussion of network development plans, including not only TSOs and NRAs but also grid users and other parties. Across Europe, there are different national preferences for security of supply.

Unlike security of supply, innovation is not well defined in the regulation. The very nature of innovation is that the benefits are sometimes less certain, and the benefits can arise a long time after the innovation was initiated. Moreover, innovations leading to cost reductions may be incentivised by some regulatory regimes, but innovations leading to benefits elsewhere (e.g. market facilitation or quality increase) are not.

Investment in networked industries such as the electricity and gas infrastructures are characterized by capital-intensive investments with long lifetimes (typically 30 to 40 years, sometimes longer). Because the investments typically also represent sunk costs, it is necessary to have sufficiently high allowed returns (in line with financial market conditions) and regulatory stability to justify investing in assets from which it is unclear whether they will still be adequate in 30 to 40 years from now. Furthermore, the transition towards a more sustainable energy system is causing the need for a more flexible electricity and natural gas grid. This flexibility, however, not only concerns

physical capabilities, but also flexibility in terms of incentives for network users, and how the physical capabilities are managed, and which services are offered (e.g. time-of-use pricing). To realize both the physical and non-physical demands that the energy system of the future will ask from the electricity and natural gas grids, there is a need for incorporating incentives for non-physical investments as well.

In the following subsections, a selection of barriers is explained that my lead to sub-optimal (or inadequate) investment levels from a societal point of view. Each barrier is evaluated along a three-star scoring system, where one star represents low importance and three stars high importance. The scoring is subjective and based on the researchers' perceived level of importance and magnitude/impact.

Barriers influenced by regulation

In this subsection, we present the barriers identified which are directly influenced by regulation.

Inadequate financial incentives	**Importance: ★★★**
The development of infrastructure projects and engaging in innovation will often be associated with higher costs and more risk. If the regulator fails to provide the financial incentives to take such risk, the TSO will be inclined not to invest. Typically, the regulated revenue allows for a return on the investment made in the infrastructure. The regulated revenue allows for a return on assets not written down corresponding to the specified cost of capital allowance, also called the Weighted Average Cost of Capital (WACC). Whereas returns on capital markets change, the WACC is only periodically readjusted by the regulator. This could imply the WACC being too low in some periods that would prevent investments to be carried out. Similarly, the WACC could be too high in other periods. To improve the financial incentives, a list of tools can be applied. This list includes: Penalties for not providing sufficient security of supply or innovation; WACC-uplifts for engaging in specific activities (i.e. innovation and/or security of supply); Cap and floor regimes for specific investments, where a minimum revenue (the floor) is guaranteed, but any revenue exceeding a threshold will be returned from the project (the cap)[31]; Determination of regulated revenue base for tariff setting. For instance, the regulated revenue base can be justified from i) realized historical investments, ii) optimal replacement costs, or iii) market based benchmarking.	
Tariff methodology	**Importance: ★★**
As a tariff methodology is a method to spread the regulated revenue base (i.e. CAPEX of the TSO), any tariff methodology will favour some entry- or exit points relative to others. Security of supply initiatives can be concentrated on selected entry- or exit points, and the relationship with the tariff methodology can give rise to unfortunate distortionary effects on the project selection by the TSO. Any tariff methodology will implicitly favour some specific points. However, in the European gas market there are examples of countries that set high border exit tariffs. This keeps 'the gas in the Member State', but greatly reduces both security of supply and market efficiency on a European level. Especially for the gas market, different tariff methodologies will lead to different incentives to invest in infrastructure. For instance, a postage stamp tariff will provide different incentives compared to Capacity Weighted Distance Model, as proposed by the network code on rules regarding harmonised transmission tariff structures for gas, the TAR NC).	
Inappropriate division of risk in early phases of a project financing period	**Importance: ★★**
To ensure the market's support to new infrastructure, an Open Season Procedure is often carried out. In an Open Season, the market is asked to make binding commitments to buy future capacity made available by the new infrastructure. The Open Season procedure is usually carried out before the Final Investment Decision. Thus, it is carried out at a time of significant uncertainty within the project. The uncertainty to the project includes the cost, the utilisation,	

[31] https://www.ofgem.gov.uk/system/files/docs/2016/05/cap_and_floor_brochure.pdf.

and the construction period. During Open Season, the market's binding commitment is given subject to a set of assumptions. In particular, as the final tariff is not yet known (as the final cost of investment is not yet realized) the market is typically given a tariff range. Further, the Open Season specifies when the project is ready for operation. This is necessary for the market participants to secure their long-term contracts. Hence, the narrower the project can be defined by the TSO (i.e. the more narrow a tariff range and the more specific the time of operation can be defined) the less risk does the market face – and thus, the more is the market inclined to support the project. An inherent problem of the Open Season procedure is, that the 'future' users of the infrastructure in question may not exist. It is likely, that a piece of infrastructure, that increases competition and security of supply will only attract new shippers once it has been built. Thus, the a priori Open Season does not catch all potential users. (Existing potential customers will make binding commitments in the Open Season, and will thus not 'disappear' from the market). Furthermore, cost of promoting and developing the project are not necessarily covered, if the project is never completed. Hence, inappropriate division of risk can increase the financial loss. In turn, risk neutral or risk averse TSOs would not engage in promoting such projects, as the increased risk they are facing is not compensated by the regulator.	
Inappropriate benchmarking, efficiency and risk	**Importance: ★★**
To evaluate the cost structure of TSOs, benchmarking is often used either directly or implicitly. The rationale behind benchmarking seems to be that a TSO's cost base can be evaluated and justified by a comparison of other comparable institutions/TSOs. While cost structures will be different from Member State to Member State (based on geography, price levels, etc.) that may be overcome by performing a proper benchmarking. While benchmarking is difficult to handle, governance is often easier for the NRA. As development of a project or engaging in innovative projects are costly, and the costs and benefits are spread across time, benchmarking can leave an image of a less cost-efficient TSO The focus on efficiency implies the danger of not giving room for innovation, and the inherent risk taking that it includes.	
Lack of transparency, stability, predictability leaves status quo cherished	**Importance: ★★**
TSOs have incentives to keep tariffs constant and predictable, such that they can be a reliable partner in the market and provide a solid foundation for the market to make long term planning and commitments. However, the need for transparency, stability, and predictability could lead to the status quo being cherished. Hence, innovation and implementation of new ideas is an abandonment of old methods, and could theoretically conflict with the overall aim of predictability. For instance, the goal of maintaining predictability on the short term may prevent the long term goal of increasing efficiency by applying innovative solutions.	
Lengthy or convoluted approval process of projects	**Importance: ★**
The procedures for discussion/approval of projects proposed by TSOs can be complex and time-consuming. The more cumbersome the process, the fewer projects can the TSOs be expected to propose.	
Bias towards CAPEX intensive projects	**Importance: ★★★**
Depending on the instruments for financial regulation applied (including their parameters like the WACC), the incentives can be biased towards incentivising CAPEX intensive projects, as the CAPEX enters directly into the regulated revenue. This may be considered beneficial for the realisation of new assets needed for security of supply, but it can dis-incentivise the application of innovative approaches that are rather OPEX than CAPEX intensive. For example, it relates to such types of innovation that would allow to decrease overall cost by improving the utilisation of existing assets.	
Incentive based regulator regimes	**Importance: ★**
Incentive based regimes – where the TSO's revenue is agreed upon for several consecutive years - will not favour any long-term or risky investments. Under such a regime, the revenue to be obtained by the TSO is fixed, whereas the costs are not regulated. This leaves the TSO with the incentives to provide the lowest feasible service and investment to reduce cost and consequently improve profit margin. Further, risky projects and/or projects that mature over a long-time horizon are not incentivized.	
Local optimization rather than regional/(global optimization	**Importance: ★★**
More generally, it can be considered a barrier if a NRF does not include incentives for a "global" optimisation of solutions applied, but rather incentivises separate parts of total costs with	

separate mechanisms. A well-balanced global incentive would encourage TSOs to seek for optimal solutions e.g. in terms of CAPEX/OPEX ratio, implementation time, complexity, risk profile and so on. However, well-balanced global incentives are difficult to design, and therefore NRFs typically consist of a set of partial incentive instruments rather than a global one.

Barriers and the mechanisms within innovation and security of supply

Table A.2.3 summarises the key features of regulation for supporting security of supply and innovation. For each mechanism it is marked whether it pertains to security of supply (all) or innovation (a majority). The far-right column lists the identified barriers which each mechanism addresses.

Table A.2.3 Mechanisms supporting security of supply and innovation

	Mechanism	Security of supply	Innovation	Barriers addressed
a	Cost plus regulation	x	x	1.Inadequate financial incentives 2.Inappropriate tariff methodology 8. Incentive based regulatory regimes
b	Extended regulatory periods	x		1.Inadequate financial incentives 4.Benchmarking and efficiency demands
c	Stability arrangements	x	x	1.Inadequate financial incentives 5. Status quo is cherished
d	Exemptions from regulation	x	x	3. Inappropriate division of risk Regulatory risks 4.Benchmarking and efficiency demands 5. Status quo is cherished 7. Bias towards CAPEX intensive projects
e	Early recognition of costs	x	x	1.Inadequate financial incentives 3. Inappropriate division of risk
f	Minimizing time lag for remuneration	x	x	1.Inadequate financial incentives 7. Bias towards CAPEX intensive projects
g	Tendering of services	x		1. Inadequate financial incentives 2. Inappropriate tariff methodology 3. Inappropriate division of risk 4.Benchmarking and efficiency demands 5. Status quo is cherished
h	Altering debt to equity ratio in the WACC	x	x	1.Inadequate financial incentives 2. Inappropriate tariff methodology 3. Inappropriate division of risk 7. Bias towards CAPEX intensive projects

	Mechanism	Security of supply	Innovation	Barriers addressed
i	Sliding scale sets/profit sharing	x	x	1.In adequate financial incentives 3.In appropriate division of risk
j	Exemption from benchmarking/efficiency demands	x	x	1.In adequate financial incentives 3.In appropriate division of risk 4.Benchmarking and efficiency demands
k	Adjusted depreciation periods	x	x	1.Inadequate financial incentives 4.Benchmarking and efficiency demands
l	Rules for anticipatory investments	x		1. Inadequate financial incentives 4.Benchmarking and efficiency demands
m	Premiums (WACC surcharge)	x	x	1.Inadequate financial incentives
n	Assessment of efficiency of investments (e.g. through benchmarking; bottom-up assessment)	x		5. Status quo is cherished
o	Innovative projects funded from regulated rates (explicitly or implicitly)	x	x	1.Inadequate financial incentives 3. Inappropriate division of risk
p	Adjust the revenue cap if the innovative investment has higher costs than a traditional solution	x	x	1. Inadequate financial incentives 2. Inappropriate tariff methodology 3. Inappropriate division of risk 4.Benchmarking and efficiency demands
q	Reduce the depreciation period of the asset if the lifetime of the asset is shown to be shorter than expected	x	x	1. Inadequate financial incentives 3. Inappropriate division of risk 4.Benchmarking and efficiency demands 7. Bias towards CAPEX intensive projects
r	Exemption from benchmarking/efficiency demands	x	x	1. Inadequate financial incentives 4.Benchmarking and efficiency demands 7. Bias towards CAPEX intensive projects
s	Explicit mandate to invest in innovation	x	x	4. Benchmarking and efficiency demands 5. Status quo is cherished
t	Penalise the TSO economically for not meeting deadline on commissioned innovative project	x	x	1. Inadequate financial incentives 5. Status quo is cherished
u	Stakeholder engagement and commitment	x	x	1.Inadequate financial incentives Regulatory instability Asymmetry of information 2. Inappropriate tariff

	Mechanism	Security of supply	Innovation	Barriers addressed
				methodology 3.Inappropriate division of risk Regulatory risks 4.Benchmarking and efficiency demands 6. Lengthy or convoluted approval process of projects 5. Status quo is cherished Fear of criticism 7. Bias towards CAPEX intensive projects

ANNEX III: List of law firms providing the legal content

Member State	Law Firm
Austria	Schima Mayer Starlinger Rechtsanwälte GmbH
Belgium	Liedekerke Wolters Waelbroeck Kirkpatrick
Bulgaria	Djingov, Gouginski, Kyutchukov & Velichkov
Croatia	Žurić i Partneri
Czech Republic	LEGALITÉ advokátní kancelář s.r.o.
Denmark	Gorrissen Federspiel
Estonia	Ellex (Raidla Ellex)
Finland	Hannes Snellman Attorneys
France	Jeantet
Germany	Hengeler Mueller
Greece	Sarantitis Law Firm
Hungary	Szecskay Attorneys at Law
Ireland	Arthur Cox
Italy	Nunziante Magrone
Latvia	Ellex (Klavins Ellex)
Lithuania	Ellex (Valiunas Ellex)
Luxembourg	Wildgen S.A.
Netherlands	Van Doorne
Poland	Sołtysiński Kawecki & Szlęzak
Portugal	Morais Leitão, Galvão Teles, Soares da Silva & Associados
Romania	Nestor Nestor Diculescu Kingston Petersen
Slovakia	LEGALITÉ advokátní kancelář s.r.o
Slovenia	Karanović & Nikolić
Spain	Garrigues
Sweden	Advokatfirman Hammarskiöld & Co
United Kingdom	Shepherd and Wedderburn LLP

ANNEX IV: Classification of existing regulatory rules and illustrative examples

Classification process

Following on from the results of the legal analysis in Section 2.2, we have identified various classifications of existing national regulatory frameworks. Having identified those classifications, the next step was to test whether each classification does or does not impact on security of supply and/or innovation across the electricity and gas sectors i.e. to test the relevance of those classifications to this study.

A crucial point is to recognise that the process of identifying groups of countries based purely on the legal analysis is a process which has its limitations. In particular, the fact that the law in a particular Member State requires something to happen does not necessarily mean that it is implemented in practice. Taking an example from the water sector, the legislation in Romania is very forward looking, but our experience of the position on the ground is that the framework has not yet been applied fully in practice.

What this means is that countries we highlight in this Annex as being supportive of innovation on the basis of the legal analysis, may, in practice, not show positive evidence of innovative investments. Similarly, countries highlighted as being particularly lacking in evidence of innovation on the basis of the legal analysis, may in practice be highly ambitious, innovative and forward looking at a practical level.

We have provided a short summary for each classification as it applies in each of the electricity and gas sectors.

Financing Mechanisms – Cost-plus versus incentive regulation

Context

We have explained, in Section 2.2.6 on financing mechanisms, the key differences between the types of regulation which we have categorised as cost plus / rate of return and incentive based regulation. The classification of pricing methodologies between cost-plus/rate of return approaches on the one hand and incentive based regulation on the other is complex. This was recognised in the CEER Report.[32] In particular, the report notes that "*national investment conditions can only be compared with each other to a certain extent. As tariff regulation schemes are highly complex, a direct comparison of certain parameters, such as capital costs, is difficult and should only be done in the context of the whole regulatory system.*"[33]

The CEER Report identified that, often, there may be a combined approach taken that blends elements of cost plus/rate of return regulation with more incentive based regulation. To the extent that the legal analysis summarises the approach in a particular jurisdiction, the results of the legal analysis support this (as you would expect).

We have replicated the base data in the CEER Report tables for electricity transmission and gas transmission below, and have made our own additional comments where appropriate (in red text), based on the legal analysis carried out for our study.

[32] See footnote [11].
[33] *Ibid*, at page 7.

Relevance to innovation and security of supply

What is clear from both the legal analysis and the CEER Report is that the picture across the EU is one of a broad spectrum of approaches rather than a situation where each Member State sits clearly within either a cost plus/rate of return classification or an incentive based classification. Understanding how the network tariff regulatory approach in each Member State may or may not encourage investments that are innovative or support security of supply is, therefore, not a simple or binary task. It is also a question of blending both legal analysis and economic understanding.

To the extent that the legal analysis has shown whether the approach in their jurisdiction does or does not contribute to innovation or security of supply, we have included those results in the tables below.

Table A.4.0.1 Classification of tariff methodologies - cost plus/rate of return versus incentive based regulation (for electricity)[34]

Member State	What regulatory system is in place?	Snapshot from legal analysis
Austria	Rate-of-Return (Cost based)[35]	Legislation requires adequate consideration of security of supply, taking into account quality criteria, market integration and energy efficiency. Legislation also confirms costs arising from efficient implementation of new technologies shall be included.
Belgium	Revenue Cap + cost control incentives + quality related incentives (Hybrid)	Quality related incentives include premiums on the cost of capital where it relates to innovation and/or security of supply. These include an amount awarded for the measured increase of the available interconnection capacity.
Bulgaria	Rate-of-Return (combined with cap on prices)	The general principles that apply to the NRA are oriented towards creating incentives for effective development of secure and reliable networks in accordance with the interests of customers.
Croatia	Cost Plus (Cost based)	Seen as incentivising investment and eliminating the risk of not covering the costs of infrastructure projects if they are deemed eligible and economically efficient by the NRA. Different to the regime in place for gas.
Czech Republic	Revenue Cap	Costs of projects within NDP are met largely through tariffs but legal analysis does not identify any specific mechanism that would particularly incentivise innovation.
Denmark	Annual break even process (Other)	Seen as favouring investment subject to NRA approval based on socio-economic value.

[34] *Ibid.* at 2.1.1, with amendments in red text.
[35] References in parenthesis in red refer to the categories identified in Section 3.

Member State	What regulatory system is in place?	Snapshot from legal analysis
Estonia	Rate-of-Return (Cost based)	Comment that major cross border investment is typically funded under e.g. CEF and not treated as part of the RAB.
Finland	Revenue Cap	No price control in advance – *ex post* assessment by NRA based on "reasonable return".
France	Revenue Cap, incentive based	Treatment of CAPEX encourages innovative projects that are efficient. TSO capital cost differentials between forecast and actual trajectories are now 100% covered by the tariff through the reconciliation, which is likely to limit the incentive for TSOs to control their investment costs. However overruns beyond approved investment expenditure will not be compensated and incentives in place for minimisation of implementation times and for underruns of projected costs.
Germany	Revenue Cap (Incentive based)	Exempts "investment measures" projects from efficiency targets. Many are innovative. Incentive to invest in innovation resulting in lower cost within the regulatory period but less incentives for long-term cost reductions as efficiency gains must be passed on to consumers in the next regulatory period.
Greece	Revenue Cap	Premium rate of return for projects of major importance. May encourage investment in projects with innovative elements.
Hungary	Combined model of Incentive-based Regulation and Cost-plus (Hybrid)	Strong emphasis on least cost principle – unclear if focus is on investment cost only or if also life-cycle costs are considered.
Ireland	Revenue Cap based on Rate-of-Return with Incentive-based Regulation (Hybrid)	Price control caters for TSO exploring innovative technologies provided expenditure is efficient.
Italy	Combined model of Price Cap (OPEX) and Rate-of-Return (CAPEX) (Cost based)	Specific premiums are available for investments, which relate to innovation. Transition to TOTEX regulation regime envisaged.
Latvia	Cost-plus/Rate-of-Return (Cost based)	New transmission projects are funded via the tariff or CEF. No explicit link identified between tariff methodologies and investing in particular types or projects or innovative investments.
Lithuania	50/50 Price/Revenue Cap – Hybrid Cap (Hybrid)	Increased returns available for investments contributing to achievement of national/EU policy objectives including security of supply.

Member State	What regulatory system is in place?	Snapshot from legal analysis
Luxembourg	Revenue Cap	Allows for added remuneration for projects with high added value for consumers.
Netherlands	Revenue Cap	Strong emphasis on total cost reduction. NRA does not assess specific investments but benchmarks total costs.
~~Norway~~	~~Revenue Cap – incentive based~~	Not included in this study.
Poland	Cost of service (with elements of Revenue Cap)	TSO no fault liability if fails to meet supply standards (Voltage deviations and interruptions). Leads to discounted tariffs.[36]
Portugal	Combined model of Price Cap (OPEX), standard costs in new investments and Rate-of-Return (CAPEX)	Finance mechanism is not seen as either incentivising innovation or limiting innovation.
Romania	Price Cap	OPEX includes provision for research and study costs.
Slovakia	Cost-plus / Rate-of-Return	Ministry of Economics seen as having wide influence to encourage investments in particular types of projects and in innovation.
Slovenia	Revenue Cap	Some incentives exist that appear to favour innovation e.g. investments in smart meters, smart grid projects and in pilot projects.
Spain	Rate-of-Return (Cost based)	Reference unit values of investment and of O+M are used. Special investments catered for separately e.g. sub-marine lines, DC lines and AC/DC converters.
Sweden	Revenue Cap	Unnecessary assets not to be included in price control but exclusion of such assets is subject to reasonableness test. May provide opportunity to include costs of innovative/pilot investments i.e. if it would be unreasonable to exclude them.
United Kingdom	Revenue Cap based on Rate-of-Return with Incentive-based Regulation (Hybrid)	Flexibility within regime for TSO to bring forward strategic wider works within a price control period for projects not allocated funding via the price control. Should support security of supply objectives.

[36] It may be of interest to our study to identify whether penalising as opposed to incentivising the TSO has the effect of encouraging greater investment in security of supply.

Table A.4.0.2 Classification of tariff methodologies - cost plus/rate of return versus incentive based regulation (for gas)[37]

Member State	What regulatory system is in place?	Snapshot from legal analysis
Austria	Combined model of Revenue Cap (OPEX) and Rate-of-Return (CAPEX) (Cost based)[38]	This model guarantees earnings above costs for the TSO in an ongoing manner only if the TSO makes investments. In the current reg. period as incentive for future investments a mark-up on the equity capital interest of 0.8 percentage points was introduced. Approved costs must be reasonable, transparent and are benchmarked for efficiency.
Belgium	Revenue Cap + cost control incentives	TSO has to demonstrate the efficiency of its investment projects to the CREG by a cost-benefit analysis. TSO can be encouraged to invest in new infrastructure by NRA including more favourable provisions on cost and profit margin in the tariff methodology.
Bulgaria	Rate-of-Return (combined with cap on revenue)	Efficiency and quality indicators, basis criteria and various other benchmarks are included in revenue setting. If an investment can be justified in terms of developing and maintaining an efficient, coordinated and economical transmission system then likely to be approved.
Croatia	Combined Model of Incentive based (OPEX) and Cost-Plus (CAPEX) (Hybrid)	Regular audit of allowed revenues and reconciliation eliminates risk of under-recovery of the costs of an approved asset – risk on system users not TSO.
Czech Republic	Revenue Cap	TSO encouraged to invest because depreciation is revalued each year. Any amount not invested will result in a reduction of that amount from the revalued depreciation in the following year.
Denmark	Annual break even process (Other)	Ensuring security of supply is one of the main objectives of the regulatory system.
Estonia	Rate-of-Return (Cost based)	The method applied in practice may have the effect of limiting investments in innovation or innovative projects as only investment deemed necessary by NRA are included in the RAB of the TSO.

[37] *Ibid.* at 2.1.3, with amendments in red text.
[38] References in parenthesis in red refer to the categories identified in Section 3.2.4 of this report.

Member State	What regulatory system is in place?	Snapshot from legal analysis
Finland	Revenue Cap	No price control in advance – *ex post* assessment by NRA based on "reasonable return".
France	Revenue Cap, incentive based	TSO capital cost differentials between forecast and actual trajectories are now 100% covered by the tariff through the reconciliation, which is likely to limit the incentive for TSOs to control their investment costs. However overruns beyond approved investment expenditure will not be compensated and incentives in place for minimisation of implementation times and for underruns of projected costs.
Germany	Revenue Cap (Incentive based)	Exempts "investment measures" projects from efficiency targets. Many are innovative. Incentive to invest in innovation resulting in lower cost within the regulatory period but less incentives for long-term cost reductions as efficiency gains must be passed on to consumers in the next regulatory period.
Greece	Rate-of-Return (Cost based)	Major projects (over EUR 130 mio) are included in the regulated asset base from the year when they come online rather than at the next tariff setting.
Hungary	Incentive-based Regulation (mixture of price cap, revenue cap and quality regulation) (Hybrid)	Strong emphasis on least cost principle – unclear if focus is on investment cost only or if also life-cycle costs are considered.
Ireland	Revenue Cap based on Rate-of-Return with Incentive-based Regulation (Hybrid)	Price control caters for TSO exploring innovative technologies provided expenditure is efficient.
Italy	Combined model of Price Cap (OPEX) and Rate-of-Return (CAPEX) (Cost based)	The tariff system seeks to create a balance between the costs of maintaining and developing the network and remuneration of the service.
Latvia	Revenue Cap	The tariff methodology does not contain any special provisions that would directly encourage the development of any specific projects.
Lithuania	Price Cap (Cost based)	Price cap encourages TSO to reduce its costs and improve efficiency.
Luxembourg	Revenue Cap	Allows for added remuneration for projects with high added value for consumers.
Netherlands	Revenue Cap	Strong emphasis on total cost reduction. NRA does not assess specific investments but benchmarks total costs.

Member State	What regulatory system is in place?	Snapshot from legal analysis
Poland	Cost of service (with elements of Revenue Cap)	Strong emphasis on total cost reduction. NRA does not assess specific investments but benchmarks total costs.
Portugal	Combined model of Price Cap (OPEX), and Rate-of-Return (CAPEX)	Tariff must aim to guarantee transparent and efficiency-driven pricing as well as protecting consumers whilst guaranteeing an incentive for TSO to increase the network's efficiency and promote market integration.
Romania	Revenue Cap	OPEX includes provision for research and study costs.
Slovakia	Price Cap (Cost based)	Cap is based entirely on benchmarking against other EU Member States, not linked to TSO assets or costs.
Slovenia	Revenue Cap	New investments are only approved if they increase the infrastructure standard or reduce the critical risks in the security of supply risk assessment.
Spain	Combined model. Revenue Cap for investments before 2001. Standard costs in new investments and rate of return after 2001. Since 2014, in addition to standard costs there is a new concept that considers Continuity of Supply.	Based on concept of "efficient and well-managed company".
Sweden	Revenue Cap	Unnecessary assets not to be included in price control but exclusion of such assets is subject to reasonableness test.
United Kingdom	Revenue Cap based on Rate-of-Return with Incentive-based Regulation (Hybrid)	Specific innovation allowances encourage innovation.

Regulatory Periods

Context

One element where clear distinctions can be drawn from the legal analysis is the relative lengths of the regulatory periods adopted in each jurisdiction. We have illustrated the range of regulatory periods in Tables A.4.4 and A.4.5 below.

As noted in Section 2.2.6, due to the diversity of regulatory periods throughout the 26MS, there is no conclusive view on which regulatory period represents a best practice in the context of the topics of this study. The legal analysis from Germany indicated that the five year regulatory period created an incentive for the TSO to use efficiency gains to innovate within the regulatory period, but provided less of an incentive to invest in long-term investments because of the requirement to pass on efficiency gains to consumers at the end of each regulatory period. Implicit in this analysis is that longer regulatory periods could help incentivise innovation. A contrary view was put forward in the Spanish legal analysis, which stated that having a six year regulatory period without being able to modify the compensation scheme was too long as it does not allow the NRA the flexibility to adapt the model to reflect financial or technological changes that have arisen in the short term.

The conclusion drawn from the legal review is that only where a longer regulatory period is combined with additional features supporting innovation and/or security of supply will the regulatory period be seen as assisting security of supply or incentivising innovation.

Table A.4.0.3 Length of regulatory periods for electricity

Regulatory period	Countries
1 year	Austria, Bulgaria, Croatia
2 years	n/a
3 years	Czechia, Poland, Portugal and Slovenia
4 years	Belgium, Finland, France, Greece, Hungary, Luxembourg and Sweden
5 years	Germany, Ireland, Lithuania, Slovakia and Romania
6 years	Italy, Spain
7 years	n/a
8 years	UK (moving to 5 years from 2021)
No defined period	Denmark (annual break-even), Estonia, Latvia, Netherlands (3-5 years)

Table A.4.0.4 Length of regulatory periods for gas

Regulatory period	Countries
1 year	Poland and Slovakia
2 years	Italy
3 years	Czechia, Portugal and Slovenia.
4 years	Austria, Belgium, Finland, France, Greece, Hungary, Luxembourg and Sweden.
5 years	Germany, Ireland, Lithuania and Romania.
6 years	Spain
7 years	n/a
8 years	UK (moving to 5 years from 2021)
No defined period	Bulgaria (2 to 5 years), Croatia (multi-annual period), Denmark, Estonia, Latvia and Netherlands (3 to 5 years).

How different types of investments are financed

Context

One of topics we investigated was to assess whether different types of investments are funded in different ways. The analysis confirms that the majority of investments are funded through network tariff charges. It is clear that the extent to which a particular tariff methodology either does or does not encourage network investments that are required for security of supply and/or that are innovative, will have a material impact on the investments made in that Member State.

In addition to this, however, some countries pointed to certain types of project or investments that are funded (either entirely or in part) by other means.

The outputs from the legal analysis on this topic are shown for electricity and gas in the tables below.

Relevance to innovation and security of supply

Tables A.4.6 and A.4. below highlight specific types of funding approaches available in relation to projects (that are wholly or partly located in that Member State) over and above network tariff charges, namely other EU funds, congestion management income and approved State Aid programmes.

By the nature of what the regime seeks to promote, PCIs are generally larger projects which are required to have a cross-border element, whether that is by the infrastructure directly crossing the border of another Member State or EEA Member State, or whether it is located in one Member State but has a significant cross-border impact on at least one other Member State. For both electricity and gas transmission projects, a significant contribution to security of supply is a criterion which may be used to justify a project being awarded PCI status. From content and examples included in the legal analysis, it has been identified that PCI investments are usually made, *inter alia*, in order to provide a further layer of security in the electricity or gas network of the two or more countries involved.

This is often done with the support of the Connection Europe Facility which provides a grant and/or access to new classes of investors for PCI projects which help ensure security of supply but which are not otherwise commercially viable (e.g. because of market conditions). The PCI regime clearly, therefore, supports investments that help ensure security of supply.

It is however noted in the recent ACER Market Monitoring Report for Gas Wholesale Markets[39] that the EU gas sector has high levels of security of supply and therefore gas infrastructure developments (including PCIs) need to be coherent with other EU policy objectives, which includes climate change goals and which could also be extended to innovative projects (for example power to gas). This suggests a change in emphasis for PCIs in gas.

The PCI regime also support projects with innovative elements. Projects may be eligible for a grant of financial assistance through the Connecting Europe Facility if they satisfy various criteria, one of which is a cost-benefit analysis that provides evidence of "significant positive externalities", an example of which is innovation.[40] Innovation is not, however, a requirement for a project to be designated as a PCI. Examples of innovative PCI projects can be found in the thematic area of smart grids such as ALPGRID in Austria and Italy, ACON in Czechia and Slovakia, The Smart Border Initiative in Germany and France, and SINCRO.GRID in Slovenia and Croatia. Each of these projects seeks to implement technology based solutions to aid integration of the energy markets. This increases security of supply in an innovative manner.

For electricity, security of supply is similarly supported through Regulation (EC) No 714/2009, which requires that congestion rents are generally used to cover the costs of operational measures to guarantee the actual availability of the capacity (e.g. redispatching and counter trading), or used to maintain or increase interconnection capacity through network investments. If it cannot be used efficiently for these purposes, NRAs may approve some or all of the congestion rents to be taken into account when approving the tariff methodology and/or fixing the tariffs. Congestion rents are therefore used to ensure security of supply in a variety of different ways, including through new and replacement investments in interconnection capacity. There is no parallel provision for gas.

Some countries treat funding for interconnectors and nationally important infrastructure partly or entirely outside of the standard network tariffs due to the network resilience benefits that these projects bring to a Member State, including ensuring security of supply. This is entirely separate to the concept of PCI. Once a project is designated as nationally important, then it will generally benefit from exemptions from regulation, or for example consolidated and streamlined planning processes, and potentially additional financial incentives. For example in Hungary, a gas "project of crucial interest to the

[39] Agency for the Cooperation of Energy Regulators, *ACER Market Monitoring Report 2017 – Gas Wholesale Markets Volume,* published 3 October 2018: https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202017%20-%20Gas%20Wholesale%20Markets%20Volume.pdf.
[40] Article 14(2) of Regulation (EU) No 347/2013.

national economy" can be exempt from some administrative rules if it meets certain binding criteria.

Whilst these additional funding mechanisms do not preclude innovation, there is little evidence from the legal analysis that any of these mechanisms explicitly support innovation. It will be for the party proposing the investment to decide whether to use an innovative process or innovative equipment and to be able to justify the costs of doing so.

It can be seen from the commentary above that significant cross border investments may receive funding from a variety of sources. For example, the NordBalt link between Lithuania and Sweden received funding in Lithuania through a mix of EU (Energy Programme for Recovery) funding and national public service obligation funding whereas LitPol (link between Lithuania and Poland) was partly CEF funded.

Table A.4.0.5 Other funding mechanisms – electricity

Member State	Price control/ tariffs	Other EU funds / loan arrangements / congestion rent	Nationally Important Infrastructure
Austria	✓		
Belgium	✓		✓*
Bulgaria	✓	✓	
Croatia	✓	✓	
Czechia	✓	✓	
Denmark	✓		
Estonia	✓	✓	
Finland	✓**		
France	✓		
Germany	✓		✓*
Greece	✓		✓
Hungary	✓		
Ireland	✓		
Italy	✓	✓	
Latvia	✓		
Lithuania	✓	✓	✓
Luxembourg	✓		✓
Netherlands	✓	✓	✓*
Poland	✓	✓	
Portugal	✓		
Romania	✓		
Slovakia	✓	✓	
Slovenia	✓		
Spain	✓		✓
Sweden	✓	✓	
United Kingdom	✓		✓*

*This category includes various rules that exist for offshore wind support mechanisms – these can be briefly summarised as follows:

Countries	Rules related to transmission infrastructure that connects offshore wind farms to the network
Belgium	TSO to finance, build and exploit the Modular Offshore Grid i.e. a connection of several offshore wind farms to a high-voltage substation located on an offshore platform, which is, in turn, connected to the onshore grid, as opposed to an individual radial connection for each wind farm. Covered by existing tariff methodology and also specific incentive provisions currently under development. The TSO also pays one third of the costs of the

Countries	Rules related to transmission infrastructure that connects offshore wind farms to the network
	individual connection of older wind farms to the onshore grid.
Germany	Offshore wind farm connection costs are socialised by horizontal balancing between TSOs. The TSO responsible for the relevant control area bears the costs pro rata to the energy off-taken by end consumers in their control area. These costs are not subject to price control efficiency targets and are instead fully reflected in revenue cap and tariffs. Costs are included under a separate levy ultimately paid by consumers in addition to regulator network tariffs.
The Netherlands	The offshore grid can be financed via subsidy. The legislation allows the TSO to receive a subsidy that covers all or part of the costs for the construction, management and maintenance of the offshore grid. A choice was made for a system of regulation based on the determination of the total permitted revenues of the offshore grid operator, without also setting tariffs i.e. not cost plus for offshore.
UK	Early development work for offshore wind connections (short of actual infrastructure construction) may be carried out by the TSO in advance of need and there is a risk that such development work ends up 'stranded' in the event that it is not eventually required (e.g., if the wind farm project does not complete). The NRA accepts that such 'anticipatory' investment (to the extent it is efficiently incurred) should be funded by customers through the RIIO funding mechanism. Actual costs of design, construction and commissioning of the transmission assets (incurred by the generator under the generator build model) will only be paid for to the extent the NRA confirms they have been efficiently incurred. Costs of O&M and financing the transmission assets are also subject to competitive pressure via the offshore transmission owner competitive framework.

**Only to the extent the NRA does an *ex post* review of tariffs. No price control carried out in advance.

Table A.4.0.6 Other funding mechanisms – gas

Member State	Price control/ tariffs	Other EU funds / loan arrangements	Nationally Important Infrastructure
Austria	✓		
Belgium	✓		✓
Bulgaria	✓	✓	
Croatia	✓	✓	
Czechia	✓	✓	
Denmark	✓		
Estonia	✓	✓	
Finland	✓		
France	✓		
Germany	✓		✓
Greece	✓		✓
Hungary	✓		✓
Ireland	✓		
Italy	✓	✓	
Latvia	✓	✓	
Lithuania	✓	✓	
Luxembourg	✓		
Netherlands	✓		✓
Poland	✓	✓	✓
Portugal	✓		
Romania	✓	✓	✓
Slovakia	✓	✓	✓
Slovenia	✓		
Spain	✓		
Sweden	✓		
United Kingdom	✓		

Regulatory approach to innovative investments

Context

One of the clearest results to be drawn from the legal analysis is the strong contrast between how the regulatory frameworks positively address security of supply (in light of the requirements of the Third Package) and how the regulatory frameworks address innovation. There is no clear and consistent message in the regulatory frameworks across the EU in relation to innovation, in strong contrast to the position in security of supply.

As noted under the innovation headings in Section 2.2.5, the legal analysis presented very little evidence of the word "innovation" in the high-level regulatory frameworks, but we do see a number of references to concepts such as technological change and research and development at this level, i.e. concepts related to innovation.

Looking then at the lower tiers in the regulatory frameworks, we do see explicit references to innovation and also to these related concepts. For example, tariff methodologies may explicitly encourage innovative investments.

We have noted, therefore, that the absence of a broad duty in favour of innovation or innovative investment in the high-level regulatory frameworks has not prevented the NRAs in a number of jurisdictions from using a variety of regulatory tools to expressly encourage innovation or related concepts.

Overall, we can say that the language used, and the level of importance given, to innovation and related concepts in the regulatory framework is highly variable. Given that is the case, it is difficult to classify different approaches in a meaningful way and, accordingly, we have classified the 26MS into two broad categories – those regulatory frameworks that do make reference to innovation or related concepts and those that do not make reference to innovation or related concepts.

We have described each category further below, allocated each Member State to a category in Tables 0.7 and 0.8 and provided examples of the innovation provisions in various countries for electricity and gas respectively.

Category 1–Reference to innovation in the regulatory framework

These are countries where we have found evidence of explicit reference to innovation, innovative technologies, innovative investments or related concepts at some level in the regulatory framework.

As already noted, the more explicit references to innovation tend to appear via regulatory instruments such as tariff methodologies, rather than appearing in the high-level regulatory framework.

Irrespective of where they are set out, what can be said of all countries in this class is that there is support for innovation in some form within the regulatory framework.

Category 2 – No reference to innovation in the regulatory framework

This category covers those countries where we have found no evidence of reference to innovation, innovative technologies, innovative investments or related concepts at any level in the regulatory framework.

This includes countries where the concept of developing networks in an effective and efficient manner was interpreted in the legal analysis as implying a requirement to innovate to the extent that it is cost effective to do so. This is a question of legal opinion / interpretation – the factual position is that there is an absence of any explicit reference to innovation or related concepts. This category also contains countries where little or no evidence was provided in the legal analysis regarding support for innovation.

Despite the lack of reference to innovation or related concepts, countries in this category may, at a practical level still demonstrate support for innovation – we have therefore shown in this category a number of countries where the absence of explicit regulatory framework references does not appear to have prevented some innovative activity – some examples are given below.

Section 3 of this report sets out the results of the interview process and analyses whether the practical implementation of the types of incentives in Category 1 truly drives innovative investment.

Table A.4.0.7 Reference to innovation or related concepts – electricity

Reference to innovation or related concepts in regulatory framework	No reference to innovation or related concepts in regulatory framework
Austria	Czechia
Bulgaria	Estonia
Belgium	Greece
Croatia	Latvia
Denmark	Netherlands
Finland	Portugal
France	Slovakia
Germany	Spain
Hungary	
Ireland	
Italy	
Lithuania	
Luxembourg	
Poland	
Romania	
Slovenia	
Sweden	
UK	

Table A.4.0.8 Reference to innovation or related concepts – gas

Reference to innovation in regulatory framework	No reference to innovation or related concepts in regulatory framework
Belgium	Austria
Bulgaria	Croatia
Denmark	Czechia
Finland	Estonia
France	Greece
Germany	Hungary
Ireland	Italy
Lithuania	Latvia
Luxembourg	Netherlands
Romania	Poland
Sweden	Portugal
UK	Slovakia
	Slovenia
	Spain

Innovation or related concepts in electricity

Category 1 - Reference to innovation or related concepts in the regulatory framework

Examples of references in the high-level regulatory framework

- **Belgium** – the legislation requires that the tariff methodology must incentivise the TSO to ensure security of supply – this is applied to existing and new infrastructure of national or European interest and offshore infrastructure. Whilst it refers to the objective of security of supply and not to innovation *per se*, it allows the tariff methodology to contain more favourable provisions in order to incentivise innovative investments;
- **Bulgaria** – the general statutory functions of the NRA include performing assessments regarding introducing smart metering systems;
- **Denmark** – there is an explicit statutory duty on TSO to ensure R&D activities required for environmentally friendly and energy efficient network are carried out. One example of this in practice is Kriegers Flak - combining offshore wind with power exchange between two countries which is a world first;

- **France** – there is a statutory objective imposed on the TSOs to develop research in the field of energy. The TSO is required (through public service contract) to offer new technological solutions and develop a methodology for optimisation and development of intelligent networks;
- **Lithuania** – there is a statutory requirement on the TSO to develop innovative pricing formulas and to consider development of smart energy grids and smart energy accounting systems;
- **Romania** – the national energy strategy includes moving to a smart transmission network and encouraging investments in R&D and this is embedded in the primary legislation;
- **Sweden** – the Swedish Energy Agency (government body, not NRA) has the authority to promote R&D in the sector. This translates into a TSO duty to promote R&D and produce an R&D plan.

Examples of references in the tariff methodologies/incentives

- **Austria** – legislation states that costs arising from the efficient implementation of new technologies may be included in the network charges;
- **Belgium** – in light of the statutory requirement mentioned above, within the tariff methodology, the NRA incentivises the TSO to implement R&D necessary for its activities by allowing recovery of costs incurred with a cap of (i) 50% of total of subsidies received in that year; and (ii) a maximum of € 1m per year;
- **Finland** – the tariff methodology allows the TSO to deduct up to 1% of specific R&D costs when calculating realised adjusted profits, reducing the likelihood of the TSO being required to lower tariffs set for the next year;
- **Germany** – the NRA can approve limited scope of R&D costs within the revenue cap. Relates to R&D costs under publicly managed and funded schemes, only 50% of costs not publicly funded and cannot otherwise be financed by the TSO;
- **Ireland** – the NRA has provided for an innovation allowance to support and trial specific new and emerging technologies. Further revenues can also be provided on case-by-case basis where TSO makes submissions to the NRA including a business case;
- **Italy –** support of innovative projects through approved State Aid particularly in the area of smart grids;
- **Luxembourg** – there is a strong modernisation agenda targeting introduction of smart grid and new technologies. Tariff methodology includes pass through of R&D costs related to TSOs activities and may be included in tariff up to 1% of maximum allowed income;
- **Slovenia** – Some incentives exist that appear to favour innovation, e.g. investments in smart meters and smart grid projects and in pilot stage;
- **UK:**
  - The TSO can apply for revenue adjustment for innovation projects if they can demonstrate cost efficient, low carbon or environmental benefits;
  - Network Innovation Allowance and Network Innovation Competition foster smaller innovative trials and projects;
  - The NRA has established Innovation Link which allows solutions outside of regulatory model to be proposed for trial.

Examples of references in NDP

- **Croatia –** investments in NDP include application of new technologies particularly if innovation leads to efficiency saving;
- **Hungary –** NDP refers to network development principles, which include duty to examine possibility of introducing new technological solutions. Also tariffs motivate TSO to develop smart grid methods;
- **Poland –** Via NDP, TSO includes budget for innovative investments.

Category 2 – No reference to innovation or linked concepts in the regulatory framework for NRAs and/or TSOs

Countries with no reference include: **Estonia, Greece, Portugal** and **Slovakia**.

Some evidence of innovative activities found in the legal analysis despite the lack of any reference in the regulatory framework:

- **Czechia** –Innovative projects are being financed using Operational Programme Enterprise and Innovations for Competitiveness. Significant for the TSO is priority axis 3, where subsidies can be drawn under the chapter Smart Grids II – Transmission Grids;
- **Latvia** – strong emphasis to innovate through the development of the electricity transmission system in an economic and efficient manner and NDP requirements. However there are no explicit funding mechanisms in favour of innovative investments beyond CEF for PCIs;
- **Netherlands** – duty to develop the transmission system in an economic and efficient manner requires the TSO to innovate. There was also a specific Netherlands Enterprise Agency smart grid experimental playing field (ended in 2016) and the TSO block chain initiative;
- **Spain** - Evidence provided of 76 technology innovation projects aimed at increasing the efficiency of system and facilitating the integration of renewables.

Innovation or related concepts in gas

Category 1 - Reference to innovation or related concepts in the regulatory framework for NRAs and/or TSOs

Examples of references in the high-level regulatory framework

- **Belgium –** legislation requires the tariff methodology to incentivise the TSO to implement R&D necessary for its activities;
- **Bulgaria** – the general statutory functions of NRA include performing assessments for introduction of smart metering systems;
- **Denmark** – Minister for Energy, Utilities and Climate may decide that the TSO in cooperation with distribution companies must initiate research and development with a view to efficient energy use, environmental improvements and safety in natural gas use;
- **France** – statutory objective of NRA to develop research in the field of energy. TSO required (through public service contract) to offer new technological solutions and develop methodology for optimisation and development of intelligent networks;
- **Lithuania** – statutory requirement on TSO to provide energy management services, develop innovative pricing formulas, introduce intelligent systems and smart meters and promote efficiency;
- **Sweden** – Swedish Energy Agency (government body, not NRA) has the funding authority to promote R&D in the gas transmission sector.

Examples of references in the tariff methodologies / incentives

- **Finland –** The tariff methodology allows TSO to deduct up to 1% of specific R&D costs when calculating realised adjusted profits, reducing the likelihood of the TSO being required to lower the tariffs set for the next year;
- **Germany –** the NRA can approve a limited scope of R&D costs within the revenue cap. This provision relates to R&D carried out under publicly managed and funded schemes, and the approved costs cover only 50% of costs which are not publicly funded and which cannot otherwise be financed by the TSO;
- **Ireland –** the NRA has an innovation allowance to support and trial specific new and emerging technologies;
- **Luxembourg –** There is a strong modernisation agenda targeting the introduction of smart grid and other new technologies. The tariff methodology

includes pass through of R&D costs related to TSOs activities and may be included in the tariff up to 1% of maximum allowed income;
- **Romania** – NRA may approve the TSO receiving an increment of 1.4% from the regulated return rate for development/innovation costs incurred with a view to increase the efficiency in O&M of the transmission system;
- **UK:**
  - The TSO can apply for a revenue adjustment for innovation projects if they can demonstrate cost efficient, low carbon or environmental benefits;
  - Network Innovation Allowance and Network Innovation Competition foster smaller innovative trials and projects;
  - NRA has established Innovation Link, which allows solutions outside of regulatory model to be proposed for trial.

Category 2 – No reference to innovation or linked concepts in the regulatory framework for NRAs and/or TSOs

- **Portugal** and **Slovakia** – Desire to keep costs to consumers low in current economic conditions;
- Generally, no evidence (in the legal analysis) of support for innovation has been found in **Estonia**, **Greece**, **Italy** and **Spain**.

Some evidence of innovative activities found in the legal analysis despite the lack of an explicit reference:

- **Czechia** – the NRA may indirectly promote innovation by their ability to levy fines if the TSO does not secure a reliable, safe and effective transmission network;
- **Slovenia** – the legal analysis noted that the TSO has developed an internal innovation management system, which encourages employees to contribute new ideas to improve system operation and company procedures, without support of legislation or regulation.

A further point to note from the legal analysis in relation to innovation is that several countries refer to innovation in the sense of regulatory innovation, rather than innovative investments. We have not taken account of these regulatory innovations, *per se*, in developing the categories above. For completeness, examples include:

- the approach taken by the NRA in Germany to connection of offshore wind including the move to merge the NDP and the separate maritime federal offshore plan into a single offshore area development plan;
- the use of competition in relation to new high voltage connections in Greece which are ultimately taken over and operated by the TSO; and
- the combination of the spatial planning and network development plan processes in Italy to help avoid later planning delays for NDP assets.

Regulatory approach to security of supply investments – differing levels of delegated powers

Context

As noted under the security of supply headings in Section 2.2.4, a key feature of the regulatory frameworks supporting security of supply is that there is a strong commonality of approach across the 26MS driven by EU-level legislation.

That being said, there are differences between how each Member State has transposed those concepts (where appropriate) into national law and other variations which are driven by a variety of factors such as the:

- level within the legal framework where duties are set out;
- specific drafting of duties applied to NRAs and TSOs; and
- breadth of duties allocated to NRAs and TSOs.

One aspect that does stand out with reasonable clarity is the extent to which some countries have a different approach to the level of powers and responsibilities that remain with the State and those that are delegated to the NRA. Whilst there is some correlation between those countries that retain more powers at State level and those with State owned TSOs, this is only a partial link.

We have set out in the tables below those countries where there appears to be a stronger State role in the supervision of security of supply. For example, this may be due to State approval being required before an investment can be implemented. We have contrasted them with other countries that follow what may be seen to be a more typical model where the core responsibility for security of supply is delegated to the TSO under the supervision of the NRA and with limited direct State supervision or control. For interest, we have also included in these tables, confirmation of those countries where the TSO is under State ownership.

Table A.4.0.9 Delegated powers regarding security of supply – electricity

Member State	State with strong role in SoS	NRA clearly delegated responsibility for SoS	NRA and State have shared responsibility for SoS	TSO in State ownership*
Austria		✓		51% State owned
Belgium	✓			No
Bulgaria		✓		Yes**
Croatia		✓		No
Czechia	✓			Yes
Denmark	✓			Yes
Estonia		✓		Yes
Finland		✓		53.1% State owned
France			✓	No
Germany		✓		No
Greece		✓		No
Hungary		✓		No
Ireland		✓		Yes
Italy	✓			No
Latvia		✓		Yes
Lithuania			✓	Yes
Luxembourg	✓			No
Netherlands	✓			Yes
Poland			✓	Yes
Portugal	✓			No
Romania			✓	58.69% State owned
Slovakia	✓			Yes
Slovenia	✓			Yes
Spain	✓			No
Sweden			✓	Yes
UK		✓		No

*We list only countries where the State for the jurisdiction in question owns the TSO (as opposed to where the TSO is owned by another country). We also include here TSOs that are more than 50% State owned. There are a number of different corporate structures included within the State ownership category from State owned listed entities, e.g. France, through to State departments/public bodies, e.g. Sweden.
** Private company, but parent company is ultimately State owned.

Table A.4.0.10 Delegated powers regarding Security of Supply – gas

Country	State with strong role in SoS	NRA clearly delegated responsibility for SoS	NRA and State have shared responsibility for SoS	TSO in State ownership*
Austria		✓		No
Belgium	✓			No
Bulgaria			✓	Yes**
Croatia		✓		Yes
Czechia	✓			No
Denmark	✓			Yes
Estonia		✓		Yes
Finland		✓		No
France			✓	No
Germany		✓		No
Greece		✓		Yes**
Hungary		✓		No
Ireland		✓		No
Italy	✓			No
Latvia		✓		No
Lithuania			✓	No
Luxembourg	✓			No
Netherlands	✓			No
Poland			✓	Yes
Portugal	✓			No
Romania			✓	Yes
Slovakia	✓			51% State owned
Slovenia		✓		No
Spain	✓			No
Sweden			✓	No
UK		✓		No

*We list only countries where the State for the jurisdiction in question owns the TSO (as opposed to where the TSO is owned by a third country). We include here TSOs that are more than 50% State owned. There are a number of different corporate structures included within the State ownership category from private companies whose parent company is 100% State owned e.g. Bulgaria, through to the majority shareholder being State departments/public bodies e.g. Romania.
** Private company, but parent company is State owned.

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