European Commission

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

Country Report - Sweden

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March– 2019

EUROPEAN COMMISSION

Directorate-General for Energy
Directorate B — Internal Energy Market
Unit B.1 — Networks & Regional Initiatives

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Directorate-General for Energy

March 2019

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Luxembourg: Publications Office of the European Union, 2019

ISBN: 978-92-76-03988-4
Doi: 10.2833/8823

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2. The Swedish Energy Markets Inspectorate (the "Inspectorate"), the main regulatory body which derives its duties and objectives from the Electricity Act, the Electricity Regulation and the Inspectorate Regulation; and
3. The Swedish Energy Agency, the administrative authority responsible for matters regarding supply and usage of energy.[1] This includes e.g. ensuring security of supply and promoting research and innovation within the energy sector.[2]

A "Revenue-cap" based mechanism allows Svenska Kraftnät to carry out necessary investment projects to comply with the statutory and regulatory duties as TSO. Despite it having no direct involvement in project-specific financing, the Inspectorate sets the revenue-cap in the financing mechanism.

Svenska Kraftnät shall promote research and development of new techniques of relevance e.g. for the national grid. Svenska Kraftnät establishes a research and development plan for every three year period.

Contrary to the Swedish Energy Agency, the Inspectorate does not directly encourage innovation or research and development on supply, conversion, distribution and use of energy as well as development of new technologies through financing or other means.

Regarding Security of Supply, the TSO's system task is to take measures in respect of security of supply. In general terms, the TSO:

- has to ensure that balance between generation and consumption of electricity in the whole or parts of Sweden can be maintained in the short term;
- is responsible for the maintenance of the national grid and expanding it by construction of new power lines; and
- is formally appointed to be the authority responsible for contingency planning.[3]

The Swedish regulatory practice in the electricity sector

The NRF works well in general to support innovation and security of supply, notwithstanding its revenue-cap financing mechanism, which might lead to choosing capital intensive projects to the detriment of OPEX-based alternatives.

Options for improvement

One option for improvement could be including TOTEX in the revenue cap, or providing specific incentives for OPEX heavy investments.

Assessment of the NRF and the regulatory practice of the Swedish gas sector

The Swedish gas NRF

The key participants in the Sweden gas transmission sector are:

1. Swedegas, the sole Transmission System Operator (TSO) in Sweden which owns, operates and develops the stations and lines of the Swedish national gas grid;
2. The Swedish Energy Markets Inspectorate (the "Inspectorate"), the main regulatory body which derives its duties and objectives from the Natural Gas Act, the Natural Gas Regulation, the Regulation on the Calculation of Revenue Caps for the Natural Gas market and the Inspectorate Regulation; and

[1] Section 1 of the Swedish Energy Agency Regulation.
[2] Section 1 and Section 2, Subsections 1 and 7 of the Swedish Energy Agency Regulation.
[3] Section 1 of Regulation (1997:294) on Electricity Contingency.

3. The Swedish Energy Agency, the administrative authority responsible for matters regarding supply and usage of energy.[4] This includes e.g. ensuring security of supply and promoting research and innovation within the energy sector.[5]

A "Revenue-cap" based mechanism allows Swedegas AB to carry out necessary investment projects to comply with the statutory and regulatory duties as TSO. Despite it having no direct involvement in project-specific financing, the Inspectorate sets the revenue-cap in the financing mechanism.

There are no explicit rules on the role of the TSO in investment projects, other than the TSO's general obligations. Yet, Swedegas is involved in certain innovative projects aimed at encouraging the transformation of the natural gas transmission system to a fossil free transmission system.

Contrary to the Swedish Energy Agency, the Inspectorate does not directly encourage innovation or research and development on supply, conversion, distribution and use of energy as well as development of new technologies through financing or other means.

As to security of supply, the Energy Agency's implementation rules provide that the emergency plan shall contain the measures the TSO plans to take in case the respective crisis levels referred to in art. 10(3) of Directive 994/2010/EC are reached[6]. With regards to the preventive action plans, TSOs are obliged to carry out risk and vulnerability assessments every second year[7].

The Swedish regulatory practice in the gas sector

The NRF works well in general to support innovation and security of supply, notwithstanding its revenue-cap financing mechanism, which might lead to choosing capital intensive projects to the detriment of OPEX-based alternatives.

Options for improvement

One option for improvement could be including TOTEX in the revenue cap or providing specific incentives for OPEX heavy investments.

4 Section 1 of the Swedish Energy Agency Regulation.
5 Section 1 and Section 2, Subsections 1 and 7 of the Swedish Energy Agency Regulation.
6 Section 5 and 6 of STEMFS 2016:1.
7 Section 13 of STEMFS 2016:1.

1. INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

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

2. ELECTRICITY

2.1. Legal analysis of the NRF in Sweden

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

The Legal Framework for electricity in Sweden, as relevant for transmission network development, is mainly comprised by the Electricity Act (1997:857) (the "Electricity Act"), the Electricity Regulation (2013:208) (the "Electricity Regulation"), the Act (2011:710) on Certification of National Electricity Grid Operators, Regulation (2016:742) with Instructions for the Swedish Energy Markets Inspectorate (the "Inspectorate Regulation"), Regulation (2014:520) with Instructions for the Swedish Energy Agency (the "Swedish Energy Agency Regulation") and Regulation (2007:1119) with Instructions for Affärsverket svenska kraftnät (the "Svenska Kraftnät Regulation").

The regulatory responsibility within the energy and electricity sector is divided between three government agencies:

1 The Swedish Energy Markets Inspectorate (the "Inspectorate") is the main regulatory body and derives its duties and objectives from the Electricity Act, the Electricity Regulation and the Inspectorate Regulation. According to Chapter 1, Section 7, of the Electricity Act, the Government shall appoint an authority to deal with the matters that, according to the act or to regulations that have been made under the act, are imposed on the network authority. In the Electricity Regulation, the Inspectorate is formally appointed to be the "network authority" referred to in the Electricity Act.[8] The Inspectorate supervises that the laws and regulations on the electricity market are adhered to and is also responsible for providing permits for constructing and using electricity cables as well as for determining the revenue cap.[9] In general, the Inspectorate is responsible for an efficient and well-functioning electricity market, including effective competition;[10]
2 The Swedish Energy Agency is the administrative authority responsible for matters regarding supply and usage of energy.[11] This includes e.g. ensuring security of supply and promoting research and innovation within the energy sector;[12]
3 Svenska Kraftnät is formally appointed to be the authority with system responsibility and is hence the TSO in Sweden. The Government shall pursuant to the Electricity Act appoint an authority to have system responsibility for power installations being coordinated in an operationally secure manner to ensure that balance between generation and consumption of electricity in the whole or parts of Sweden can be maintained in the short term.[13]

Svenska Kraftnät

Svenska Kraftnät is the sole Transmission System Operator (TSO) in Sweden and carries a certificate for its activities issued by the Inspectorate. The certification is issued based on formal requirements[14], such as being independent from companies that produce electricity, but the certification is not accompanied by any specific standard conditions for operating or developing the transmission network.

A "Revenue-cap" financing scheme

To comply with the statutory and regulatory duties, Svenska Kraftnät has to carry out necessary investment projects. The TSO is responsible for deciding which investment projects are deemed necessary based on the duties allocated to the TSO. The Government has to approve some of the investment projects within the scope of the submitted investment and financing plan. Further, investment projects are indirectly approved through the revenue cap financing mechanism. Since the revenue cap is set ex-ante, and investments over the four-year revenue cap period are considered when setting the revenue cap, Svenska Kraftnät has to submit a forecast of necessary investment projects to the Inspectorate.

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8 Section 3 of the Electricity Regulation.
9 Chapter 12, Section 1, Chapter 2, Section 1a and Chapter 5, Section 3 of the Electricity Act.
10 Sections 5 and 6 of the Inspectorate Regulation.
11 Section 1 of the Swedish Energy Agency Regulation.
12 Section 1 and Section 2, Subsections 1 and 7 of the Swedish Energy Agency Regulation.
13 Chapter 8, Section 1 of the Electricity Act.
14 Chapter 3, Section 1a and Sections 1f-1j of the Electricity Act.

The Inspectorate has no direct involvement in the financing of specific investment projects. However, part of Svenska Kraftnät's financing of investment projects is derived from their revenue. Svenska Kraftnät's revenue is governed by the revenue cap set by the Inspectorate. Through the revenue cap the Inspectorate therefore, indirectly, is involved in the financing of investment projects.

The Electricity Act uses the term revenue cap, which denotes the maximum combined revenues, which a network concessionaire may draw from network operation during a supervisory period.[15] The network concessionaire shall submit a proposal for a revenue cap to the Inspectorate who issues a decision on the amount of the revenue cap.[16] The revenue cap shall cover reasonable costs for conducting network operations during the supervisory period and provide a reasonable return on the capital required in order to conduct the operations (asset base).[17] This means that both operational expenditure and capital expenditure is taken into account when the revenue cap is calculated. However, there is a clear division between the costs that are classified as operational expenditure and costs that are classified as capital expenditure and they are taken into account for separately and with slightly different methods.

In deciding the revenue cap, the Inspectorate shall consider the quality of the network concessionaire's way of conducting the network operations and to what degree the network operations are conducted in a way that promotes efficient utilisation of the electricity network.[18] Reasonable costs for conducting network operations shall be considered to be the costs for an appropriate and efficient operation of network operations with similar and objective conditions.[19] The operational expenditure is divided into two categories, costs that the TSO can affect and costs the TSO does not have any influence over (e.g. costs for network losses, certain fees etc.). The revenue cap is based on (i) the operational costs that the TSO can affect from the period of the four calendar years that ends two years before the new supervisory period begins and (ii) the projected operational costs that the TSO cannot affect. The operational costs that the TSO can affect are thus based on historical costs and projected costs are not considered. As regards the operational costs that the TSO can affect, these are also subject to an efficiency requirement.[20] This means that the Inspectorate is not required to include the full costs in the revenue cap decision if the Inspectorate considers that the operations could be run more efficiently.

The asset base shall be calculated based on the assets which the network concessionaire use in order to conduct network operations, and consideration shall also be given to investments, based on the forecast submitted by the TSO, and depreciations during the supervisory period.[21] There are no regulated efficiency requirements as regards capital expenditure. Further, if the combined revenue from network operations during the supervisory period exceeds or falls short of the revenue cap, the amount shall lower or raise the cap for the following supervisory period.[22] If the combined revenues during the supervisory period exceed the revenue cap by more than five percent an excess billing supplement, which shall be calculated based on the part of the combined revenues that exceeds the revenue cap, shall reduce the revenue cap for the following supervisory period.[23]

The revenue cap can be adjusted during or after the supervisory period. The network concessionaire can apply for reconsideration of the revenue cap and the Inspectorate may change the revenue cap if there are circumstances deemed to entail a considerable increase of the revenue cap[24], or if there are other special circumstances.[25] The Inspectorate may also

15 Chapter 1, Section 5a of the Electricity Act. A supervisory period is according to Chapter 5, Section 4, four years.
16 Chapter 5, Sections 2 and 3 of the Electricity Act.
17 Chapter 5, Section 6 of the Electricity Act.
18 Chapter 5, Sections 7 and 7a of the Electricity Act.
19 Chapter 5, Section 8 of the Electricity Act.
20 Chapter 5, Section 8 of the Electricity Act.
21 Chapter 5, Section 9 of the Electricity Act.
22 Chapter 5, Section 20 of the Electricity Act.
23 Chapter 5, Section 21 of the Electricity Act.
24 An example would be if the concessionaire is planning to make investments that are not covered by the planned investments reported to the Inspectorate before the revenue cap was decided.
25 Chapter 5, Section 10 of the Electricity Act.

independently revise the revenue cap if the network concessionaire has submitted inaccurate or insufficient information or if there are other special reasons for a revision.[26]

There are certain aspects of the revenue cap that may drive or influence investment decisions in general and more specifically drive investment decisions of innovative character or investments in new technology. For example, when calculating the revenue cap, assets that are not necessary for the network operations shall not be included in the asset base, provided it is not unreasonable to the network operator to exclude them.[27] This is a mechanism designed to incentivise sound investment decisions and drive investments in new network infrastructure, which would raise the revenue cap, rather than investments or reinvestments in stranded or unnecessary assets.[28] It is however not clear in which situations it shall be deemed unreasonable to the network operator to exclude the assets. The preparatory works state that the unreasonableness shall be evaluated on a case by case basis and that the reason why the asset is not necessary anymore and the financial consequences for the network operator must be considered. One example is if the statutory duties of the TSO change and make a certain asset unnecessary. The unreasonableness rule is designed as an exception from the main rule that unnecessary assets should not be included. Further, it is also stated that in applying this rule, the special function of the TSO, as opposed to other network operators, must be considered.[29]

It should also be noted that there is an ongoing discussion on the length of the depreciation periods of assets within the scope of a discussion on investment incentives. An important aspect when calculating capital costs is that the depreciation period corresponds to the economical lifespan of the asset. A revamp of the rules on depreciation periods is therefore proposed to ensure that the depreciation periods are not too long, which would mean that the network operator is forced to reinvest before it has received full compensation for the old asset, or too short, which would mean that the network operator is incentivised to replace fully functioning assets prematurely.[30]

Of importance for incentivising investments aimed at security of supply is the consideration of efficient utilisation of the electricity network in the establishment of the revenue cap. By evaluating efficiency when setting the revenue cap, the Inspectorate aims at incentivising the grid operators to reduce the total network loss during the supervisory period, which in turn has a positive effect on security of supply for customers. After evaluating efficiency, the Inspectorate grants an increase of the revenue cap if the accumulated network loss has decreased compared to the grid operator's own history of network losses. Vice versa, if the accumulated network loss has increased, the revenue cap will be decreased. This is designed to incentivise investments contributing towards e.g. climate goals and security of supply.

Limited non-regulated activities

Svenska Kraftnät is also co-owner of Energiforsk AB, which is a company dedicated to conducting and coordinating research and development within the energy sector. For example, one of the main areas of focus is security of supply. STRI AB is another company co-owned by Svenska Kraftnät, specialising in research and development in high voltage testing, high voltage technology, and power system applications designed to improve performance, efficiency, reliability, profitability, and minimising impact on the environment.

2.1.2. Specific legal rights and duties

Role of the TSO

The general role, including applicable legal rights and duties, allocated to the TSO, as relevant for the development of the transmission network.

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[26] Chapter 5, Section 11 of the Electricity Act.
[27] Chapter 5, Section 9 of the Electricity Act.
[28] Prop. 2008/09:141 p. 75. ("Prop." is a short form for Proposition, which denotes the preparatory works of legislation.)
[29] Prop. 2008/09:141 p. 75.
[30] Report Ei R2017:07.

Transmission tasks

The further duties of Svenska Kraftnät are set out in the Svenska Kraftnät Regulation. As relevant to transmission network development, these duties include: managing, operating and developing a cost effective, reliable and environmentally sound transmission network[31], expanding the national grid based on socioeconomic profitability evaluations[32], promoting effective competition by, inter alia, eliminating "bottle-neck" effects through expansion and/or re-routing of grid lines[33], and promoting research and development of new techniques of relevance for e.g. the national grid lines.[34]

These duties include developing the transmission network, as the TSO is responsible for the network to be well-functioning. Further, Svenska Kraftnät is also under a statutory duty to establish objectives for operational security under foreseeable conditions in the national grid and in the interstate lines connected to the national grid. These objectives shall be transparent, non-discriminatory and of objective character.[35] The role of the TSO is also assigned through appropriation directions issued by the Government. These directions are set once a year and specify the objectives specifically to be focused on for the upcoming budget year.

Pursuant to Regulation (EC) 714/2009, Svenska Kraftnät prepares Network Development Plans, System Development Plans and other development plans for the transmission network that feed into the ENTSO-E community-wide Ten Year Network Development Plan.

2.1.3. Mechanism for financing of investment projects

The TSO's investments in transmission network development are financed mainly through four sources; self-financing (through the network tariffs, set within the limits of the revenue cap), loans via the Swedish National Debt Office[36], investment grants and congestion revenues. An example of an investment grant is the fee that Svenska Kraftnät charges for connecting network customers to the grid. The connection fee will fund the measures that, for capacity or operational security reasons, must be taken to connect a particular facility.[37] Congestion revenues result from price differences between bidding zones, either between countries or Swedish bidding zones.[38]

Detailed information of the mechanism for financing of investment projects have been outlined in section 2.1.1.

2.1.4. Regulatory rules with respect to innovation

Specific duties of the TSO aimed at encouraging innovation

Svenska Kraftnät shall promote research and development of new techniques of relevance for e.g. the national grid. Svenska Kraftnät establishes a research and development plan for every three year period. The research and development plan is divided into four strategic areas:

1. New techniques: This strategic area focuses on research and development for the purpose of developing new techniques and knowledge contributing to operational security, cost efficiency, and an environmentally sustainable national grid line;
2. Future electricity systems: The scope of this area includes research and development for the purpose of managing future challenges and issues regarding system operations due to increased, non-plannable, electricity production and decreased conventional electricity production within the Nordic transmission system;
3. Maintenance and planning: This area mainly comprises research and development regarding surveillance and control of the transmission system for the purpose of improving the estimation models for operational security; and
4. Security of competence: The purpose of research and development in this area is to ensure future long-term security of competence.

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31 Section 1 of the Svenska Kraftnät Regulation.
32 Section 3, Subsection 1 of the Svenska Kraftnät Regulation.
33 Section 3, Subsection 3 of the Svenska Kraftnät Regulation.
34 Section 3, Subsection 4 of the Svenska Kraftnät Regulation.
35 Chapter 8, Section 1a of the Electricity Act.
36 These loans are available to Svenska Kraftnät due to it being organised as a governmental authority.
37 This example is taken from the Svenska Kraftnät Annual Report 2013 p. 28.
38 Svenska Kraftnät – System Development Plan 2018-2027 p. 65.

Specific duties of the NRA aimed at encouraging innovation

The Legal Framework imposes limited duties on the Inspectorate to encourage innovation. The Inspectorate does not directly encourage innovation or research and development through financing or other means. The general responsibility to ensure an efficient and well-functioning electricity market, described in section 2.1.1, can however likely be said to implicitly impose a duty to promote innovation. The financing mechanisms, mainly the revenue cap, described above in section 2.1.1 may also indirectly fund innovation projects.

The Swedish Energy Agency does, more broadly, support innovation, research and development on supply, conversion, distribution and use of energy as well as development of new technologies. The Swedish Energy Agency can grant funding for research and development, and innovation projects. This is administered as a type of state aid and is regulated by Regulation (2008:761) on State Aid for Research, Development and Innovation within the Energy Sector.

2.1.5. Regulatory rules with respect to security of supply

Specific duties of the TSO aiming at safeguarding security of supply

The TSO is under a statutory duty to ensure that balance between generation and consumption of electricity in the whole or parts of Sweden can be maintained in the short term. This balance is important to avoid major disruptions on the grid, and thereby is important for safeguarding security of supply. Another aspect of security of supply is maintenance of the national grid and expanding it by construction of new power lines. These duties are inherent in the statutory duties described in section 2.1.2. Incentivising measures aimed at security of supply are also indirectly promoted through the revenue caps set by the Inspectorate.

Additionally, according to the Electricity Contingency Act (1997:288) the Government appoints an authority responsible for Sweden's electricity contingency planning.[39] Svenska Kraftnät is formally appointed to be the authority responsible for contingency planning.[40] This includes, among other things, the responsibility to ensure that the entire Swedish electricity supply is prepared for extraordinary events such as war, terrorism, and earthquakes.

Svenska Kraftnät is also responsible for procuring a capacity reserve to be available when electricity consumption is forecasted to exceed production.[41] The reserve is for example used during extreme winter conditions. To procure the capacity reserve, Svenska Kraftnät can enter into contracts with power generators that have backup power plants. Contracts can also be entered into with large scale electricity users and suppliers to reduce electricity consumption and create a capacity reserve.

Specific duties of the NRA aimed at aiming at safeguarding security of supply

The general powers and/or duties available to the NRA are described in section 2.1 above. These are mainly exercised through the mechanisms described section 2.1.1.

The Electricity Act also sets up a documentation and information procedure regarding security of supply. This means that a network operator on an annual basis has to present a risk and vulnerability analysis report to the Inspectorate regarding security of supply, and an action plan on how the operator can improve. However, this reporting requirement does not apply to the TSO. The TSO does report on security of supply issues but not directly to the Inspectorate, although such reports are communicated to the Inspectorate.

2.2. Regulatory practice

2.2.1. Overview over regulatory practice in Sweden

Main regulatory barriers

NRF is, in general terms, adequate to support current innovation and security of supply in the Sweden.

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39 Section 1a of the Electricity Contingency Act.
40 Section 1 of Regulation (1997:294) on Electricity Contingency.
41 Section 1 of the Capacity Reserve Act (2003:436).

2.2.2. Regulatory practice related to innovation

Innovative projects

Focus was drawn to the fact that the revenue-cap financing mechanism might lead to choosing capital intensive projects to the detriment of OPEX-based alternatives.
No ongoing projects have been regarded as innovative from the interviewees' perspective.

Adequacy of the NRF relating to its support for innovative investments

The interviewees did not evaluate how adequate the current NRF is as to innovation.

Possible improvement of the NRF

No suggestion for improvement was identified during the interview.

2.2.3. Regulatory practice related to security of supply

Security of supply projects

The South-West link represents a pivotal project for the security of supply of Sweden as it allows to transmit energy produced from the Southern part of Sweden, steadily supplied by nuclear and partially by wind plants, to the Northern region purely supplied by renewable energy from hydro and wind plants. The Northern part is accordingly less subject to the risk of system inadequacy in years of scarce rain and low wind. Hence, the projects shows how the regulatory regime works in practice when it comes to projects enhancing security of supply.

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

Generally, the NRF is considered adequate in supporting security of supply investments.

The respondent highlighted the following general barriers:

- Construction law in the field of building permits for network investments;
- Environmental protection law regarding environmental decisions for network investments.

Possible improvement of the NRF

No need for improvement came up in the interview.

2.2.4. Illustrative specific projects

The project below illustrate how the regulatory practice works, when it comes to projects driven by security of supply reasons.

The South-West Link

In southern Sweden, the consumption of electricity sometimes exceeds supply. There are also a number of electricity connections to other countries. With a capacity to transport 2 x 600 megawatts, roughly equivalent to what two nuclear reactors produce, the SouthWest Link is expected to limit the differences in electricity prices caused by a deficit of electricity.

- Investment: 7 300 millions (SEK) ;
- Technique Hallsberg – Barkeryd: AC overhead line (400 kV) ;
- Technique Barkeryd – Hurva: DC connection, HVDC VSC (2 x 600 MW) ;
- Length AC overhead line: 180 km ;
- Length DC overhead line: 60 km ;
- Length DC cable: 190 km ;
- Substations included in the project: Östansjö, Barkeryd and Hurva.

2.3. Options for improvement

2.3.1. Options to improve regulatory practice

(i) CAPEX biased solutions

Revenue cap financing mechanisms may present the inherent drawback of favouring CAPEX intensive projects over OPEX focused ones.

The proposed remedy is to include TOTEX in the revenue cap decision, or to provide specific incentives for OPEX heavy investments.

2.3.2. National law mechanism(s) for implementing options

To implement the suggested changes, the NRA should change practice of setting the regulated revenue. However, as we understand the proposed remedy, i.e. that the revenue cap decision should be based on a TOTEX method instead of an OPEX-CAPEX split method, the underlying Electricity Act would most likely have to be amended to allow such a new approach.

To amend the Electricity Act, the normal Swedish legislative process needs to be adhered to. This process generally entails the following: In most cases, it is the Government that initiates legislative proposals presented to Parliament. Before the Government can draw up a legislative proposal, the matter in question must be analysed and evaluated. The Government often assigns to a so called committee of inquiry to perform such an analysis and evaluation but it is however possible to instead assign this task to officials at the relevant ministry or to a special expert. The committee then presents its proposals and conclusions in a report, which is published in the Swedish Government Official Reports series (Sw. *Statens Offentliga Utredningar*). Such report is then circulated for consideration to the relevant referral bodies, which may include central government agencies, local government authorities, special interest groups, or other bodies who may be affected by the proposals in the report. The intention of such referral process is to receive feedback on the proposals, which may or may not be taken into account at a later stage of the process. Following review and comments from the committee, the responsible ministry drafts the bill that will be submitted to the Parliament. In principle, the Government has to submit major or important draft bills to the Council of Legislation (Sw. *Lagrådet*). The Council is however consultative and not a decision-making body. The bill is subsequently submitted by the Government to the Parliament where the bill is dealt with by one of the parliamentary committees. At this stage, any member of parliament can table a counter-proposal to a bill introduced by the Government. If such a counter-proposal is formally adopted by Parliament, the Government must implement the provisions of the counter-proposal. When the deliberations of the committee are completed, the committee submits a report to the chamber of Parliament for debate and approval. If approved, the bill becomes law. Normally, laws are enacted by a single majority decision. When the proposed law is adopted, the Government formally issues the law.

To a large extent, it is the NRA that decides how OPEX should be calculated and taken into consideration when the revenue cap is set. Certain measures to provide incentives for OPEX based investments could thus be implemented by the NRA itself without having to go through the legislative process.

2.3.3. Impact assessment

By implementing the above-mentioned solution, the analysis of a project and the recurring revenue cap procedure will be slightly more detailed. This will lead to a slight increase in the time spent and hence increase in cost. However, the gains may however translate into a higher certainty that the right projects are promoted and matured, and that OPEX-CAPEX split will not be driving investment decisions per se.

3. GAS

3.1. Legal analysis of the NRF in Sweden

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

The Natural Gas Act (SFS 2005:403)

The Natural Gas Act (SFS 2005:403) is the key legislation regulating the energy market for natural gas in Sweden. In the meaning of the Natural Gas Act, the term "natural gas" also includes biogas, gas from biomass and other gases so long as it is technically possible to use these gases in a natural gas system.[42] Directive 2009/73/EC of the Third Energy Package has been implemented mainly through the Natural Gas Act. Complementary rules can be found in the Natural Gas Regulation (SFS 2006:1043) (the "Natural Gas Regulation"). Furthermore, there is the Regulation on the Calculation of Revenue Caps (2014:35) (the "Revenue Caps Regulation").

As per EU Regulation No 994/2010, Sweden is according to article 6(10) exempt from the N-1 criteria. Similary, Sweden is exempt from the solidarity principle, according to EU Regulation 2017/1938 article 5(9).

The Swedish Energy Markets Inspectorate

The Swedish Energy Markets Inspectorate (the "Inspectorate")[43] is the main regulatory body overseeing the energy markets of Sweden. Certain tasks for the NRA are given through the Regulation (SFS 2016:742) with Instruction for the Energy Markets Inspectorate (the "Inspectorate Regulation"). The Inspectorate is responsible for surveillance of the energy sector and for ensuring effective competition in energy markets. The Inspectorate oversees the revenue regulation and is authorized to issue implementation regulations on the calculation of revenue caps, which it has done through the Energy Markets Inspectorate's Regulations (EIFS 2014:6). The purpose of the Legal Framework regulating the revenue cap is to ensure that customers pay reasonable prices for energy, to secure the long-term security of supply of gas and that necessary investments are made to maintain the capacity of the transmission system and, when required, extending the system.[44]

The Swedish Energy Agency

The Swedish Energy Agency (the "Energy Agency")[45] is the authority that, in accordance with Directive 2004/67/EC, has been appointed by the Swedish Government to safeguard the security of gas supply.[46] Its tasks are regulated in the Act (2012:273) on Secure Natural Gas Supply (the "Act on Secure Gas Supply") and the complementary Regulation (2012:275) on the Secure Supply of Natural Gas. The Energy Agency has also issued implementation rules through STEMFS 2016:1. General duties and tasks for the Energy Agency have been given through the Regulation with Instruction for the Energy Agency (SFS 2014:520) (the "Instruction for the Energy Agency").

Swedegas AB

Since 2012, Swedegas is the certified transmission system operator in Sweden and private owner of the gas transmission network in Sweden. The national transmission system for natural gas in Sweden consists of about 600 km of transmission pipelines, including extensions, and only extends from Malmö to Stenungsund north of Gothenburg on the west coast of Sweden with a few minor extensions inland. In addition, there are a few small local gas networks. However, none of these are connected to a transmission system.[47]

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42 Chapter 1 Section 2 of the Natural Gas Act.
43 Energimarknadsinspektionen (www.ei.se/en).
44 Government bill (proposition) 2012/13:85, p. 29.
45 Energimyndigheten (http://www.energimyndigheten.se/en).
46 Regulation (2014:520) with Instruction for the Swedish Energy Agency.
47 Report from the Inspectorate, Ei 2017:6, p. 50.

3.1.2. Specific legal rights and duties

Swedegas is the owner and operator of the national transmission network for gas in Sweden. In this role, it covers a number of statutory tasks to fulfil including the obligations to construct, repair and extend the network.

Transmission tasks

The Natural Gas Act holds that the owners of natural gas pipes that engage in the transmission of gas are responsible for operating, maintaining and, when required, extending its pipeline system and, when appropriate, its connection with other pipeline systems. This applies to Swedegas as the TSO and owner of the transmission network. The owner of a natural gas pipeline is also under an obligation to connect it to other natural gas pipelines under reasonable terms. Neither the Legal Framework nor the preparatory works give detailed guidance on when operation, maintenance or extension is considered required or desirable.

There are no explicit rules on the role of the TSO in investment projects, other than the TSO's general obligations above described. The obligations to operate, maintain and, when required, extend the pipeline system, do, however, require the TSO to carry out the investments necessary to fulfil its obligations. The scope and level of investments that the TSO can make are determined and limited by the revenue cap described in section 3.1.3.

3.1.3. Mechanism for financing of investment projects

Tariffs

The TSO's investment projects are financed through a "Revenue Cap" mechanism, which determines the maximum revenue the TSO is allowed to make through transmission tariffs.

The "Revenue Caps Regulation"

Investments in the transmission system are facilitated through the revenue cap system, which determines the TSO's allowed revenues. The Natural Gas Act uses the term revenue cap to denote the maximum combined revenues an undertaking may draw from the transmission of gas during a supervisory period.[48] The supervisory period is four years and the revenue cap is set ex-ante.[49] The TSO presents its proposal for a revenue cap to the Inspectorate who evaluates and decides on the revenue cap. [50] The revenue caps are calculated separately for transmission systems and storage facilities.[51] The Inspectorate has no direct role in the financing of specific investment projects through funding or otherwise, but has an indirect influence through its role in the revenue cap system.

The revenue cap shall cover reasonable costs for the operation of the network. It shall also provide a reasonable return on the capital expenditure required to operate the network (the "asset base").[52] This means that both operational expenditure and capital expenditure is taken into account when the revenue cap is calculated. However, there is clear division between the costs that are classified as operational expenditure and costs that are classified as capital expenditure and they are taken into account separately and with slightly different methods.

Reasonable costs for conducting network operations shall be considered to be the costs for an appropriate and efficient operation of network operations with similar objective conditions.[53] The operational expenditure is divided into two categories, costs that the TSO can affect and costs the TSO does not have any influence over (e.g. costs for network losses, certain fees and taxes). The revenue cap is based on (i) the operational costs that the TSO can affect from the period of the four calendar years that ends two years before the new supervisory period begins and (ii) the projected operational costs that the TSO cannot affect.[54] The operational costs that the TSO can affect are thus based on historical costs and projected costs are not considered. As regards the operational costs that the TSO can affect, these are also subject to an efficiency

48 Chapter 1 Section 8a of the Natural Gas Act.
49 Chapter 6 Section 6 of the Natural Gas Act.
50 Chapter 6 Sections 7 and 8 of the Natural Gas Act.
51 Chapter 6 Section 6 of the Natural Gas Act.
52 Chapter 6 Section 10 of the Natural Gas Act.
53 Chapter 5 Section 11 of the Natural Gas Act.
54 Chapter 3 Sections 10-15 of EIFS 2014:5 (The Energy Markets Inspectorate's Implementation Regulations).

requirement.[55] This means that the Inspectorate is not required to include the full costs in the revenue cap decision if the Inspectorate considers that the operations could be run more efficiently.

The calculation of the asset base is based on the assets the TSO needs to operate the network. Consideration shall be given to planned investments and depreciations made during the supervisory period. Investments in new as well as existing assets are included. Assets that are not needed to operate the network shall not be included in the calculation.[56] There are no regulated efficiency requirements as regards capital expenditure. Although the revenue cap regulation seeks to ensure that the network operator receives a reasonable return on any investments in innovation, there is no explicit allowance targeted particularly at investments in these areas.

The revenue cap can be adjusted during the surveillance period under certain circumstances[57] or after the surveillance period. [58] Costs for new investments in the asset base during the surveillance period that were not included as projected costs shall typically be adjusted for after the surveillance period. However, if the cost of the investment would raise the revenue cap considerably it can be adjusted for during the supervisory period. The Inspectorate may also independently revise the revenue cap *inter alia* if the network concessionaire has submitted inaccurate or insufficient information that has affected the revenue cap to a significant extent.[59]

3.1.4. Regulatory rules with respect to innovation

Specific duties of the TSO aimed at encouraging innovation

No specific duties of the TSO imposed by the Legal Framework aimed at encouraging innovation were found applicable. However, Swedegas is involved in certain projects aimed at encouraging the transformation of the natural gas transmission system to a fossil free transmission system. In light of this approach, the Swedish natural gas system can and is to some extent already used for transmission of biogas.[60]

The following are initiatives aimed at enhancing a fossil free transmission system:

- Swedegas is involved in the project National Biogas Strategy[61] together with other undertakings in the gas sector. Swedegas' express aim is that all gas in the transmission system shall be renewable by 2050;[62]
- Swedegas also takes part in the Fossil Free Sweden Initiative. This is a project involving public and private actors that seeks to make Sweden one of the first fossil free countries in the world;[63]
- Swedegas is further, together with TSOs in other European countries, involved in the project Green Gas Initiative. The purpose of the project is to encourage the TSOs to have fossil free transmission systems by 2050.[64]

Specific duties of the NRA aimed at encouraging innovation

There are no express powers or duties of the NRA specifically aimed at encouraging innovation in the natural gas sector. The Instruction for the Inspectorate does not make any explicit mention of innovation either.

In the Instruction for the Energy Agency, there are general statements that the authority shall encourage innovation in the energy sector as a whole to support the accomplishment of

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55 Chapter 5 Section 11 of the Natural Gas Act.
56 Chapter 6 Section 12 of the Natural Gas Act.
57 Chapter 6 Section 13 of the Natural Gas Act.
58 Chapter 6 Section 15 of the Natural Gas Act.
59 Chapter 6 Section 14 of the Natural Gas Act.
60 Report from Inspectorate, Ei 2017:06, p. 51.
61 Projekt nationell biogas-strategi: http://www.energigas.se/om-oss/nationella-samarbeten/projekt-nationell-biogasstrategi/.
62 Proposal for a National Biogas Strategy: www.enerigas.se/library/1691/nationell-biogas-strategi-rapport.pdf.
63 Fossilfritt Sverige http://fossilfritt-sverige.se/in-english/.
64 http://www.greengasinitiative.eu/.

environmental goals set by the Swedish Parliament.[65] The Instruction further provides that the Energy Agency shall promote research and innovation in a strategically designed effort in close collaboration with, and as a complement to, other environmental policy instruments.[66]

The Energy Agency can, however, fund research and development and innovation projects in the energy sector in general. This is administered as a type of state aid and is regulated by Regulation (2008:761) on State Aid for Research, Development and Innovation within the Energy Sector. A research project involving the TSO on the concept of "power-to-gas" has been funded. [67] This project is concerned with research concerning ways to produce biogas and is indirectly linked to innovation in the transmission system through the explicit aim to make the Swedish natural gas transmission system fossil free.

3.1.5. Regulatory rules with respect to security of supply

Specific duties of the TSO aiming at safeguarding security of supply

Under the Act on Secure Gas Supply, the Government or an authority appointed by the Government can issue instructions requiring companies in the natural gas market to adopt preventive action plans and emergency plans.[68] This task has been assigned to the Energy Agency through Regulation (2012:275) mentioned under question 1 above. The Energy Agency's implementation rules provide that the emergency plan shall contain the measures the TSO plans to take in case the respective crisis levels referred to in art. 10(3) of Directive 994/2010/EC are reached.[69] With regards to the preventive action plans, TSOs are obliged to carry out risk and vulnerability assessments every second year.[70]

Swedegas, as the Swedish TSO, also has the overall system balance responsibility, it is responsible for maintenance of the short-term balance between infeed and outtake of natural gas in the national natural gas system.[71]

Specific duties of the NRA aiming at safeguarding security of supply

As described in section 3.1.1, the Energy Agency has been given the task to safeguard security of natural gas supply. The authority issues implementation rules on the preventive action and emergency plans that the TSO is obliged to prepare and maintain. The Energy Agency has also published a national preventive action and emergency plan in accordance with the requirements imposed on member states by Directive 994/2010/EC.

The revenue cap regulation, described in 3.1.3, also aims, inter alia, at safeguarding security of supply of gas by allowing the TSO to efficiently operate its business. The Inspectorate's role in safeguarding security of supply lies in its supervision of the TSO and its approval of the revenue cap.

3.2. Regulatory practice

This part of the analysis is structured around two rounds of interviews, conducted with the two TSOs and the regulator. In Sweden, despite numerous attempts, the TSO for gas did not reply. The TSO for electricity replied, but refused to take part in the interview. The regulator took part, but only in the first round of interviews. In conclusion, the regulatory practice is based on a single interview with the regulator only.

3.2.1. Overview over regulatory practice in Sweden

65 Sections 2(1) of the Instruction for the Energy Agency.
66 Sections 2(7) of the Instruction for the Energy Agency.
67 http://www.energimyndigheten.se/forskning-och-innovation/projektdatabas/sokresultat/?projectid=19882.
68 Section 4 of the Act on Secure Gas Supply.
69 Section 5 and 6 of STEMFS 2016:1.
70 Section 13 of STEMFS 2016:1.
71 Section 21 of the Natural Gas Regulation.

Main regulatory barriers

The NRF is, in general terms, adequate to support current innovation and security of supply in the Sweden.

3.2.2. Regulatory practice related to innovation

Innovative projects

The focus was drawn to the fact that the revenue-cap financing mechanism might lead to choosing capital intensive projects to the detriment of OPEX-based alternatives.

No ongoing projects have been regarded as innovative from the interviewees' perspectives.

Adequacy of the NRF relating to its support for innovative investments

The interviewees did not evaluate how adequate the current NRA is as to innovation during the interview.

Possible improvement of the NRF

No suggestion for improvement was identified during the interview.

3.2.3. Regulatory practice related to security of supply

Security of supply projects

As the only import route is from the Danish natural gas transmission grid, Sweden is exempt from compliance with the infrastructure standard, cf. Article 6(10).
Further, Sweden is exempt from the obligation to provide solidarity to Denmark.

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

The interviewees did not evaluate how adequate the current NRA is as to innovation during the interview.

Possible improvement of the NRF

No suggestions for improvement were identified during the interview.

3.2.4. Illustrative specific projects

No security of supply projects have been undertaken by the TSO in the gas sector recently. A remotely related project of a LNG terminal in a port not connected to the gas grid is the only example recently.

3.3. Options for improvement

3.3.1. Options to improve regulatory practice

(i) CAPEX biased solutions

Revenue cap financing mechanisms may present the inherent drawback of favouring CAPEX intensive projects to OPEX based ones.

The proposed remedy is to include TOTEX in the revenue cap decision, or to provide specific incentives for OPEX heavy investments.

3.3.2. National law mechanism(s) for implementing options

To implement the suggested changes, the NRA should change practice of setting the regulated revenue. However, as we understand the proposed remedy, i.e. that the revenue cap decision should be based on a TOTEX method instead of an OPEX-CAPEX split method, the underlying Natural Gas Act would most likely have to be amended to allow such a new approach.

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proposal, the matter in question must be analysed and evaluated. The Government often assigns to a so called committee of inquiry to perform such an analysis and evaluation but it is however possible to instead assign this task to officials at the relevant ministry or to a special expert. The committee then presents its proposals and conclusions in a report, which is published in the Swedish Government Official Reports series (Sw. *Statens Offentliga Utredningar*). Such report is then circulated for consideration to the relevant referral bodies, which may include central government agencies, local government authorities, special interest groups, or other bodies who may be affected by the proposals in the report. The intention of such referral process is to receive feedback on the proposals, which may or may not be taken into account at a later stage of the process. Following review and comments from the committee, the responsible ministry drafts the bill that will be submitted to the Parliament. In principle, the Government has to submit major or important draft bills to the Council of Legislation (Sw. *Lagrådet*). The Council is however consultative and not a decision-making body. The bill is subsequently submitted by the Government to the Parliament where the bill is dealt with by one of the parliamentary committees. At this stage, any member of parliament can table a counter-proposal to a bill introduced by the Government. If such a counter-proposal is formally adopted by Parliament, the Government must implement the provisions of the counter-proposal. When the deliberations of the committee are completed, the committee submits a report to the chamber of Parliament for debate and approval. If approved, the bill becomes law. Normally, laws are enacted by a single majority decision. When the proposed law is adopted, the Government formally issues the law.

To a large extent, it is the NRA that decides how OPEX should be calculated and taken into consideration when the revenue cap is set. Certain measures to provide incentives for OPEX based investments could thus be implemented by the NRA itself without having to go through the legislative process.

3.3.3. Impact assessment

By implementing the above-mentioned solution, the analysis of a project and the recurring revenue cap procedure will be slightly more detailed. This will lead to a slight increase in the time spent and hence increase in cost. However, the gains may translate into a higher likelihood that the right projects are promoted and matured, and that OPEX-CAPEX split will not be driving investment decisions per se.

ANNEX I: TYPOLOGICAL INVESTMENTS – ELECTRICITY

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

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

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

ANNEX II: TYPOLOGICAL INVESTMENTS – GAS

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

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

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

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

ANNEX III: POTENTIAL REGULATORY BARRIERS FOR PROJECTS

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

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

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MJ-01-19-486-EN-N

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doi: 10.2833/8823