WIK • Diskussionsbeitrag

Nr. 353

New regulatory approaches towards investments: a revision of international experiences

IRIN working paper for working package: Advancing incentive regulation with respect to smart grids

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Gefördert durch das
Bundesministerium für Wirtschaft und Technologie

Bad Honnef, April 2011

wik Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste

IRIN Innovative Regulierung für intelligente Netze

Impressum

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Handelsregister	Amtsgericht Siegburg, HRB 7225
Steuer-Nr.	222/5751/0722
Umsatzsteueridentifikations-Nr.	DE 123 383 795

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ISSN 1865-8997

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About „Innovative Regulation for Intelligent Networks“ (IRIN)

Ambitious climate policy in the triangle of the energy political goals sustainability, security of supply, and competitiveness increase the importance of decentralized energy generation and the development of network infrastructure to smart grids. Since 2009 German energy networks are subject to incentive regulation with the objective to incentivize efficient operation of gas and electricity networks. It is an open debate how to advance the regulatory framework such that it supports the necessary developments and the associated investments and innovations as well as coordination in future smart grids.

The research project IRIN - Innovative Regulation for Intelligent Networks - deals with the design of an adequate institutional framework that supports efficient and effective network development towards smart grids. The project is funded by the Federal Ministry of Economics (BMWi).

The project is a cooperation of the following institutes:

- Bremer Energie Institut at Jacobs University (project leader)
- Öko-Institut Freiburg
- WIK (Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste)
- Ruhr-Universität Bochum: Institut für Berg- und Energierecht

The research project aims to develop the institutional framework that guides efficient and effective network development towards smart grids. Central research questions are:

- How to design an incentive regulation that guarantees necessary investments while at the same time preventing inefficient investment?
- Which network pricing system sends effective signals for efficient coordination of network, generation and load installations?
- Which advancements should be made to incentive regulation to adequately account for network innovation and transformation?
- Are changes to the current legal framework required?

Each project partner is responsible for one of the following research foci:

- Work Package 1: Advancing incentive regulation with respect to smart grids (WIK)
- Work Package 2: Intelligent network pricing (Bremer Energie Institut)
- Work Package 3: Advancement of incentive regulation: network innovation and transformation (Öko-Institut Freiburg)
- Work Package 4: Adaptation of the legal framework (Ruhr-Universität Bochum)

The results from WIK’s work package are published as WIK discussion paper. More background information regarding the IRIN project is available at http://www.bremer-energie-institut.de/irin/de/background.

Zusammenfassung

Dieses Arbeitspapier präsentiert und evaluiert internationale Ländererfahrungen von Regulierungsregimen, die eine Vorreiterrolle im Hinblick auf eine intensivere regulatorische Auseinandersetzung mit dem Thema (dynamisch effiziente) Investitionen einnehmen. Hierzu werden Beispiele von Ländern betrachtet, die bereits auf eine längere Historie im Bereich der Anreizregulierung zurückblicken und ihren Regulierungsrahmen im Hinblick auf eine explizitere Incentivierung von Investitionen und Innovationen (im Kontext Smart Grids) kürzlich reformiert haben oder entsprechende Maßnahmen planen. Als einschlägige Beispiele werden das Vereinigte Königreich, Italien, Norwegen und die Niederlande herangezogen.

In diesen Ländern werden unterschiedlich intensive Maßnahmen zur regulatorischen Berücksichtigung von Investitionen und zur Stimulation dynamischer Effizienz ergriffen. Das Vereinigte Königreich kann hierbei als Pionierland betrachtet werden. Dort wurde der Regulierungsrahmen im Zuge der RPI-X@20-Initiative komplett revidiert und es wird eine Umstellung von einem auf Kosteneffizienz fokussierten Ansatz auf eine ganzheitliche, innovations- und outputorientierte Regulierungssystematik angestrebt. Im Fokus steht nunmehr eine in die Zukunft gerichtete, langfristige Preis-Leistungsbetrachtung, die allerdings noch in der Praxis erprobt werden muss. Weniger ganzheitlich, dafür eher pragmatisch ausgerichtet sind die Instrumente in Italien. Dort kann die Regulierungsbehörde bestimmte Investitionen mit einer zusätzlichen Rendite versehen. In den Niederlanden werden zusätzliche Anreizmaßnahmen für Investitionen und Innovationen aktuell intensiv diskutiert. In Norwegen hat man das Problem des Zeitverzuges bei der regulatorischen Anerkennung der Kapitalkosten korrigiert.

Insgesamt lässt sich aus den Ansätzen im Vereinigten Königreich, Italien und Norwegen sowie aus der aktuellen Debatte in den Niederlanden schlussfolgern, dass es sich hier um vielversprechende Ansätze im Hinblick auf eine zunehmende regulatorische Sensibilität in Bezug auf Investitionen im Kontext Smart Grids handelt. Damit die übergeordneten klimapolitischen Ziele in regulatorische Funktionalitäten überführt werden und der Systemumbau hin zu Smart Grids eingeleitet wird, ist es notwendig, dass auch andere Regulierungsregime diesbezüglich eine regulatorische Debatte anstoßen und den vorgestellten Beispielländern folgen. Eine gründliche Auseinandersetzung, inwiefern die regulatorischen Instrumente in den vorgestellten Beispielländern auch in Deutschland Anwendung finden können, sollte die Diskussion begleiten.

Summary

This paper presents and evaluates international case studies of countries pioneering increased regulatory measures towards (dynamic efficient) investment. Therefore it analyses international experiences from regulatory regimes that already have a long history of incentive regulation and recently revised or plan to revise their regulatory framework to further stimulate investments and innovation in a smart grids context. The pertinent examples in this context are the United Kingdom (UK), Italy, Norway and the Netherlands.

The case studies show that the analysed countries adopt more or less intense measures to increase the regulatory provision for investments and dynamic efficiency. The UK can be considered as pioneer in pursuing this path by changing the priorities from a regulatory focus on cost-efficiency to a holistic innovation and output-oriented approach with a forward looking, long-term value for money perspective, albeit still lacking regulatory practice. A less holistic but rather more straightforward solution has been implemented in Italy where the regulator may increase the rate of return for specific investments. In the Netherlands, revised approaches towards investments and innovation are still under discussion. The intensity of the debate however suggests the importance of this issue. Norway has corrected the time-lag problem with capital expenditure.

The approaches taken in the UK, Italy and Norway as well as the current discussions in the Netherlands are encouraging steps towards a more investment friendly regulatory approach in a smart grids context. In order to make sure that the overarching climate targets are transformed into regulatory functionalities in order to facilitate the paradigm shift towards smart grids it is crucial that other countries become alert, initiate the regulatory debate and follow their examples. A thorough assessment as to what extent the instruments implemented in the countries of reference would be appropriate in the German regulatory context should help in pursuing this path.

1 Introduction

Within Müller et al. (2010), we survey from a theoretical point of view to what extent cost-based and incentive-based regulatory regimes stimulate different categories of investments (replacement investment, expansion investments and asset innovation, i.e. smart grid investments). For the purpose of the former analysis, we furthermore differentiate by different efficiency measures, i.e. allocative efficiency, productive efficiency and dynamic efficiency and analyse to what extent each efficiency measure[1] is stimulated by the regulatory regime.[2]

Overall, we find that conventional cost-based regulation only stimulates allocative efficiency and strongly encourages over-capitalization (Averch-Johnson-Effect). Moreover, we argue that current forms of incentive regulation only lead to productive efficiency, predominantly incentivizing short-term efficiency in terms of operational expenditures (OPEX). Also, additional instruments such as quality regulation and/or additional allowances, e.g. investment budgets as applied in Germany, may incentivize replacement and expansions investments respectively. However, from a theoretical point of view, incentive regulation does not stimulate dynamic efficiency in the sense of explicit regulatory stimuli for asset innovation leading to a dynamically efficient CAPEX allocation. Thus, we conclude that complex trade-offs result from the guiding idea of an efficiency oriented network operation (productive efficiency) and the incentivisation of dynamic efficiency. A scrutiny of the state-of the art of related academic work shows that this problematic is merely characterized. Therefore we identify this issue as academic void that should be filled within the IRIN project.

In pursuing this path, the objective of this paper is to present international case studies of countries pioneering increased regulatory measures towards (dynamic efficient) investments in a smart grids context. Therefore this paper presents and analyses international experience from regulatory regimes that already have a long history of incentive regulation and recently revised or plan to revise their regulatory framework to further stimulate investments and innovation. The pertinent examples in this context are the United Kingdom (UK), Italy, Norway, and the Netherlands.

The paper is structured as follows: section two presents country specific facts and figures whilst section three deals with the case studies. Section four concludes.

1 Allocative efficiency describes a Pareto optimum where marginal revenue equals marginal cost. Productive efficiency exists when a fixed output is reached with minimum cost or - vice versa - a maximum output is reached with a fixed input. This implies that production is cost-efficient. However, both efficiency measures imply a static interpretation of efficiency not taking into account a long-term perspective. A dynamic development is determined by process innovation and investment in new technologies. This can be defined as dynamic efficiency. This efficiency measure does not only imply the creation of additional demand but also long-term cost reduction and the realisation of technological progress. Dynamic efficiency implies that welfare reaches a maximum over time. This allows for temporary static inefficiencies assuming that dynamic efficient investments and innovation are not always cost efficient from a short-term perspective.

2 Müller et al. (2010).

2 Country specific facts and figures

The objective of this section is to highlight regulatory and sector specific facts and figures of the countries of interest. The reporting period starts in 1995 and ends in 2010 albeit depending on data availability.

The statistics are based on different sources. Regarding the regulatory parameters, the paper relies on information contained in the national reports regulators annually submit to the Council of European Energy Regulators (CEER) and the European Regulators' Group for Electricity and Gas (ERGEG). Regarding the investment data, the analysis is based on data provided by courtesy of regulatory authorities. Some information has been received by expert interviews with regulatory authorities.

2.1 Regulatory and quality statistics

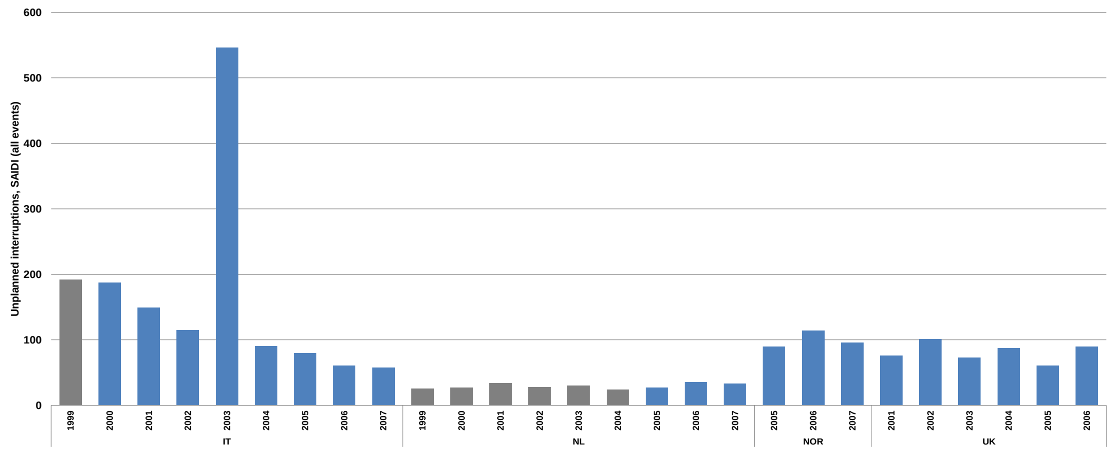
Table 1: Statistics on incentive regulation and quality regulation

	Incentive Regulation (since)	Quality Regulation - Bonus/Malus - (since)	Quality Regulation - Standards - (since)
Italy	2000	2000	2000
The Netherlands	2001	2005	2000
Norway	1997	2001	2007
UK	1990	1995	1995

Source: ERGEG national reports, 4th CEER Benchmarking report (2008) and regulator's data (Norway)

Table 1 provides an overview of the regulatory history of the countries of interest. The UK can be considered as one of the European pioneers in incentive and quality regulation looking back on two decades of regulatory experience. Norway certainly gives another state-of-the art approach in incentive and especially quality regulation. Likewise, the Netherlands and Italy can be considered as mature regulatory regimes, albeit each pursuing different approaches. Detailed insights are featured in section 3.

Figure 1: The development of the quality level (SAIDI[3]) in the reference countries



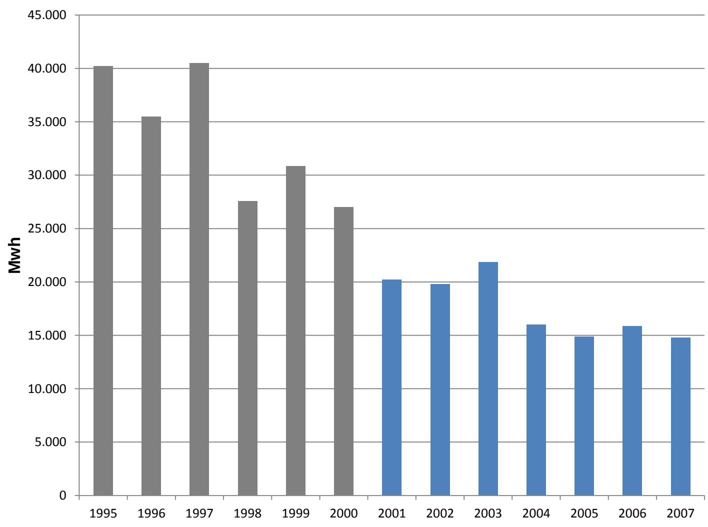
Source: 4th CEER Benchmarking report (2008)

Figure 1 exhibits the development of the quality level (SAIDI) in the countries of interest and highlights the presence (highlighted in blue) and non-presence (highlighted in grey) of quality regulation in the respective years[4].

In Italy, quality regulation was introduced in 2000 in order to increase the overall quality level and to bridge geographical differences between Northern and Southern Italy. Except from a significant peak in 2003 the overall quality level decreases visibly. In the Netherlands, quality regulation was introduced in 2005. Overall, the Dutch quality level remained low and stable over the years. The United Kingdom is one of the pioneers in quality regulation applying this regulatory instrument as from 1995. For the reported period, the quality level remains stable. As Norway introduced SAIDI as a quality measure only in 2005, the specific quality statistics are exhibited below.

3 System Average Interruption Duration
4 Highlighted in blue when country has introduced a bonus-malus based quality regulation.

Figure 2: The development of Energy Not Supplied (ENS) in Norway



Source: Regulator's data

The relevant quality performance indicator applied in Norway is the Energy Not Supplied (ENS), i.e. the amount of energy that would have been supplied to a customer if there had been no interruption. As Figure 2 shows, quality regulation was introduced in 2001 (indicated by blue bars). Overall, decreasing trends can be reported.

2.2 Rate of return statistics

Apart from the individual x-factor, the rate-of-return can be considered as the most sensitive regulatory parameter. Overall, all considered countries set their rate of return as weighted average cost of capital (WACC), i.e. a weighted average of equity and debt. However, a comparison of WACC employed in different countries should be done with care as different approaches may apply. The WACC can be indicated as pre (including taxes) or post (excluding taxes) value and in real (i.e. without inflation) or nominal (with inflation) terms. Table 2 provides the WACC applied in the countries of interest. For comparison purposes, the provided figures are shown in real, pre-tax terms as indicated by the regulatory authorities.

Table 2: WACC statistics (real, pre-tax values)

	Italy	The Netherlands	Norway	United Kingdom
1994				
1995				
1996				
1997			8.30	
1998			8.30	
1999			8.30	
2000	7.40	6.60	8.30	6.50
2001	7.40	6.60	8.30	6.50
2002	7.40	6.60	Rate of return determined annually by the average of daily observations of three years government bonds with a 2% risk *	6.50
2003	7.40	6.60		6.50
2004	6.85	6.60		6.50
2005	6.85	6.60		6.90
2006	6.85	6.60		6.90
2007	6.85	5.80	7.70	6.90
2008	7.00	5.50	7.70	6.90
2009	7.00	5.50	7.70	6.90
2010	7.00	5.50	7.70	6.90

Source: ERGEG national reports, desktop research, regulators' information * detailed data not available

The following briefly summarizes the regulatory approaches to set the rate of return in Italy, the Netherlands, UK and Norway. For a comprehensive theoretical discussion of the role of the rate of return under regulation, please refer to Pedell (2006).

In Italy, the value of the WACC for the DNOs was set at 7.4% (real pre-tax) in the first regulatory period (2000-2003). In the second period (2004-2007), the Italian regulator reduced the WACC from 7.4% to 6.85%. For the current third regulatory period (2008-2011), the basic real pre-tax WACC amounts to 7.0% for distribution services. Since the start of incentive regulation, Italy has been using a real pre-tax WACC.

In the Netherlands, initially different methods applied to calculate the WACC. In the first regulatory period (2000-2002) the WACC was calculated excluding corporate tax and amounted to 5% in real terms being equivalent to a WACC of 6,6% post corporate tax. For the following years, the corporate tax rate of 35% was applied to the WACC, using a real pre-tax WACC, which was set at 6.6% for the second regulatory period (2003-2006). In the third regulatory period (2007), the WACC amounted to 5,8%. In the current fourth regulatory period (2008-2010) the WACC is set at 5,5%. Broadly speaking, the approach used by the Dutch regulator is similar to the one in place for Italy as from the second regulatory period.

As regards the calculation of the cost of capital in the UK, before 2005 OFGEM used a pre-tax, real WACC in order to derive the remunerations for the regulated asset base.

During the third distribution price control review (2000-2005), OFGEM settled for a real pre-tax WACC of 6.5%. For the following years, Ofgem has decided to use a post-tax approach to the cost of capital as a means to capture the tax benefit associated with gearing up. OFGEM's rationale for this switch was i) to reduce the incentives to increase gearing and discourage excessive use of debt, ii) to reflect the change to the Inland Revenue's treatment of network capital expenditure, which is expected to increase effective tax rates for most companies; and iii) improve consistency with other aspects of the regulatory framework, in which changes in the level of costs are passed on to consumers at the subsequent price control review.[5] The post-tax WACC amounts to 4,8% in Ofgem's final proposal for the fourth price control period. Table 2 indicates the equivalent real, pre-tax value amounting to 6,9% for comparison purposes.

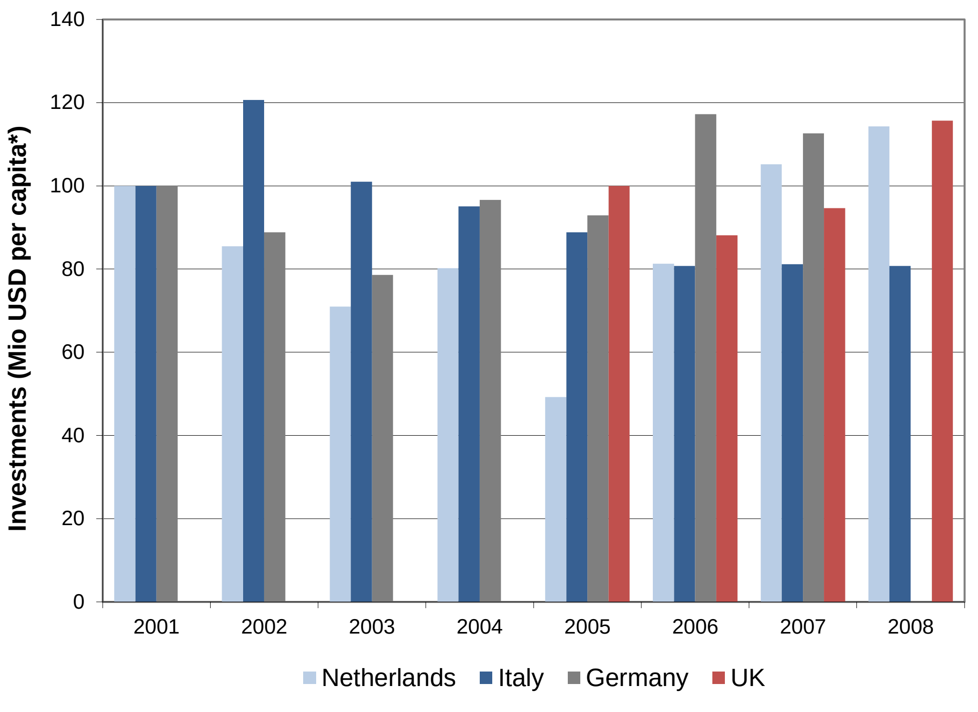
The WACC in Norway is calculated as nominal pre-tax. From 1997 to 2001 the average WACC amounted to 8,3%. From 2002 to 2006 the rate of return was determined annually by the average of daily observations of three years government bonds with a 2% risk premium added, allowing a range between 2% and 20%. As yearly values are not available, an average value of 11% is assumed[6]. For the regulatory period from 2007 to 2010 it is set at 7,7%.

5 Ofgem (2004).
6 For the 1997-2001 period, the rate of return was delimited between 2% and 15%, which would give an average value of 8.5%. This is pretty close to the actual value of 8.3%. Therefore an average assumption is made for the 2002 to 2006 values within the ceilings of 2% and 20%. This gives a rate of return of 11%.

2.3 Investment statistics

This sub-section describes the investment development in the reference countries. Information on DSO investments in Germany is included for comparison purposes.

Figure 3: DNO investments (in Mio USD per capita; normalised) for the Netherlands, Italy, the United Kingdom and Germany



*Corrected for purchasing power parities and inflation, normalised values (Netherlands, Italy, Germany starting in 2001; UK in 2005)

Source: Regulator's data (Netherlands, Italy, United Kingdom), BDEW (Germany)

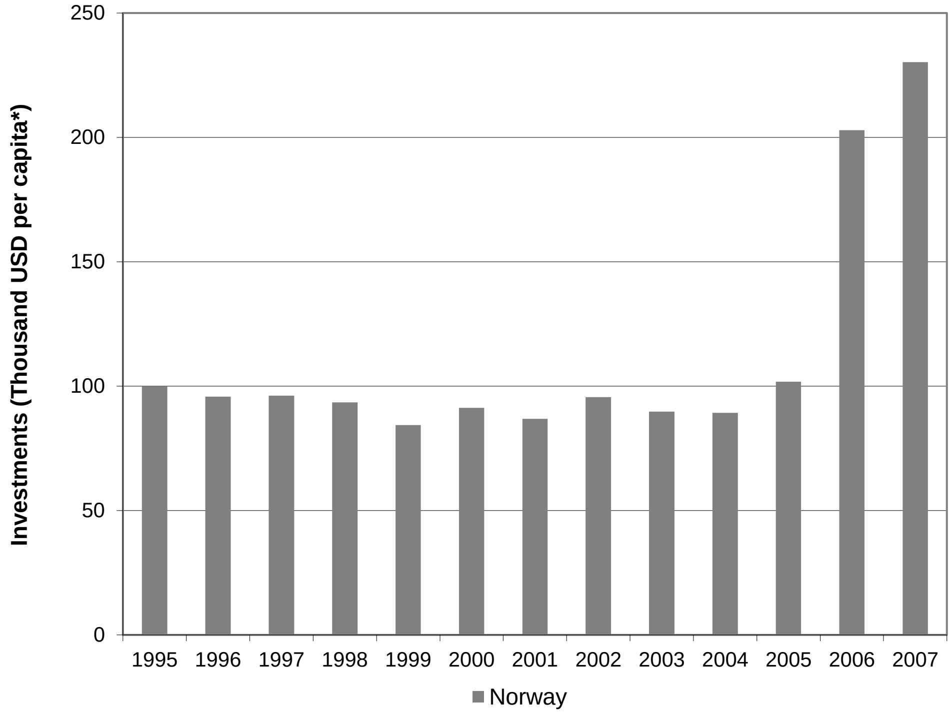
Figure 3 exhibits the DSO investments (expansion and replacement investments) in the Netherlands, Italy, the United Kingdom and Germany. Whilst the United Kingdom, Italy and the Netherlands already introduced incentive regulation in 1990, 2000 and 2001 respectively, Germany has no incentive regulation during the reporting period.[7]

As regards the investment trends, Italy exhibits a clear downwards trend as from 2002. Investments remain on a constant level as from 2006. The downward trend might be associated with a strong impact of efficiency targets but could also be due to cyclic investments. In the Netherlands, investments follow contrary trends. Whilst a downward trend can be reported from 2001 to 2005 an increase follows as from 2006. Here, the

7 Germany implemented incentive regulation only in 2009 and started with a form of cost-plus regulation in 2006. Prior to this, a negotiated third-party access was applied together with end-user tariffs approved by the Federal Ministry of Economics.

investment trends seem to suggest a cyclic nature of investment therefore. In the UK, investments are increasing as from 2006. Unfortunately no data prior 2005 is available as regulatory accounting rules changed at this date. In Germany, investments rather decrease in the first phase of the current decade. Then the development shows an increase as from 2006. This might be due to the cost review starting in 2006 prior to the implementation of incentive regulation.

Figure 4: DNO investments (in Thousand USD per capita; normalised) for Norway



*Corrected for purchasing power parities and inflation; normalised values starting in 1995

Source: Regulator’s data

As Figure 4 shows, the DNO investment level in Norway remains stable from 1995 to 2005. However from 2006, investments have more than doubled. From this development, one may conclude that the investment behaviour did not change with the introduction of incentive and quality regulation in 1997 and 2001 respectively. The increase in 2006 might be due to an ample reinvestment cycle.

Overall, investment trends are rather heterogeneous among the considered countries. Whilst the investments are rather cyclic in the United Kingdom, the Netherlands and Germany, a clear decreasing trend can be reported for Italy. In Norway, investments are stable for a long time and then increase significantly. The impact of incentive regulation, which is already implemented in all countries for the reporting period, can only be assumed. The most probable coherence is supposed for Italy. Norway, however, being the only country for which longer time series are available, does not at all give an indication that investment behaviour changed with the implementation of incentive regulation.

Comparing the investments trends to the quality level, opposite trends can be recorded for Italy where the quality level increases (except for the peak in 2003) and investments decrease. Intuitively one would rather assume simultaneous trends. In contrast, Norway exhibits slight simultaneous developments: The quality level visibly increases over time whilst investments also increase by the end of the observation period. However, any rationales should be treated with care, as all countries exhibit different network histories, voltage levels defined as “distribution” and geographical and environmental situations. Moreover, strong interdependencies might exist between the presence of incentive and/or quality regulation, the level of the WACC and investments.

Overall, no clear influences or causalities can be identified. Therefore the impact of the regulatory indicators and other relevant parameters on investments will be estimated in a separate paper relying on a more extensive data set. This will include information on countries without incentives regulation over time in order to enable a counterfactual argumentation. The estimations are however still dependent on data availability.

In the following the paper presents international approaches with increased regulatory measures towards investments. It features four case studies, namely the UK, Italy, Norway, and the Netherlands.

3 New regulatory approaches towards investments (international experiences)

Sustainability and decarbonisation targets play a central role in worldwide, European and national energy policy. The long-term target to become carbon neutral by 2050 and the medium-term targets of the European Union imposed by the 20-20-20 agenda (Lisbon Treaty) stipulate: i) a reduction of CO_2-emissions by 20%, ii) an increase of energy efficiency by 20%, and iii) 20% of energy needs met from renewable energy sources (RES) by 2020.

These binding long-term requirements will considerably affect the energy sector and change its structure substantially. As a matter of fact, the electricity distribution sector plays a key role in integrating intermittent, decentralized low carbon technologies, enabling new forms of demand-side-management and managing electric vehicles. This requires networks to respond to intermittent generation schedules, enable bi-directional energy flows and new forms of communication and network control. The key technology will be an ICT-based infrastructure, namely smart grids. Their development, however, will require an ample amount of investments and innovation in distribution networks. Being a natural monopolist, network operators invest in a regulatory environment. This may, however, not provide the right incentives anymore to enable the paradigm shift towards smart grids. Thus, the discussion of a realignment of the regulatory framework including reconfigured incentives that take into account the overarching sustainable policy objectives is one of the key debates at stake.[8]

In order to enrich the debate, the paper reviews international experiences to see what kind of approaches are taken to customize the regulatory framework to better stimulate investments and asset innovation. It refers to four pertinent examples, namely the United Kingdom, Norway, Italy, and the Netherlands. These countries currently revise or plan to revise their regulatory approach towards investments and innovation in different shapes.

For a better outline of the country studies, the paper firstly presents some key facts and figures regarding the sector structure of the respective country. Secondly the attention is drawn to the regulatory regime and current or planned amendments with a particular impact on smart grid implications, investments and innovation. For the country review, the following central questions are formulated:

- What are the international approaches to better stimulate investments and asset-innovation (dynamic efficiency)?
- Is regulation considered as the right place to stimulate investments and asset innovation?
- How do regulators see the role of the network operator?

These questions are condensed in the interim conclusions in sub-section 3.5.

8 Müller et al. (2010).

3.1 United Kingdom

Sector Structure

The UK electricity industry consists of three markets – England and Wales, Scotland and Northern Ireland. The first two are fully open to competition, while in Northern Ireland the market has been opened to non-household customers only. The following paragraphs provide an overview of the electricity supply sector in Great Britain (England and Wales and Scotland).[9]

The total installed capacity in the UK system amounted to 83.6 GW by the start of 2009/10. As regards the competition profile of the electricity generation market in 2008, eight companies had market shares exceeding five per cent and, of these, the largest three companies held 43% of transmission entry capacity. Furthermore, six out of the eight are part of vertically integrated corporate groups which are active in both generation and supply. According to capacity owned by different companies in the UK in 2008, EDF has the largest Herfindahl-Hirschman Index (HHI)[10] amounting to 339. EDF acquired British Energy in late 2008 and now owns and operates a number of nuclear plants in GB. Overall, Great Britain has the lowest generation sector concentration in the EU.[11]

In March 2001, the means of trading electricity changed with the introduction of the New Electricity Trading Arrangements (NETA) in England and Wales, which replaced the Electricity Pool of England and Wales. The former arrangements were based on bilateral trading between generators, suppliers, traders and customers in the Over The Counter (OTC) market. The NETA were introduced to deliver more competitive, market-based trading.

Since 2005, National Grid Plc has taken responsibility for the system operation of the two Scottish transmission networks in addition to the transmission networks in England and Wales. The ownership of the network however remains with the vertically integrated Scottish entities. While the British TSO is ownership unbundled, the distribution network operators (DNOs) in UK are all legally unbundled as of 2009. These DNOs were established as part of the privatisation process in 1990 and were the incumbent providers of distribution network services in each geographic area for several years. However, the Utilities Act 2000 changed the legislative and regulatory framework to enable each DNO to own and operate network assets in any area of Great Britain. These changes have also facilitated the entry of new DNOs that build, own and operate networks connected within existing distribution systems. As a result, there exist an additional four much

9 In the following, please refer to Ofgem (2009).
10 Per definition, a HHI under 1,000 index points indicates no market concentration, a HHI between 1,200 and 1,800 indicates that a market is ‘moderately concentrated’ and a HHI above 1,800 suggests a high concentration.
11 European Commission (2007a).

smaller independent distribution network operators (IDNOs). Thus, there are 18 licensed electricity distributors in total.

On the retail side, there are six main suppliers active in the household market with additional companies active in the large user sector.[12] The six large suppliers evolved from the fifteen former incumbent electricity and gas suppliers over the 1998-2003 period. These are: E.ON UK (formerly Powergen), RWE npower (owned by RWE AG), EDF Energy (owned by Electricité de France), Scottish and Southern Energy (SSE), Scottish Power (owned by Iberdrola) and British Gas (owned by Centrica). At the end of 2008, there were also five active domestic and eleven non-domestic electricity suppliers that are not former incumbents. The six large supplier groups in the domestic market are vertically integrated, i.e. they are part of a corporate group that is active in both the wholesale and retail markets. Between them, the six supplier groups account for 54% of generation capacity (excluding contractual arrangements between generators and suppliers). In addition to the six large supplier groups, other non-domestic suppliers are also vertically integrated (such as British Energy). About 70% of generation output is accounted for by vertically-integrated suppliers in the non-domestic markets.[13]

Regulatory Approach: the current regime

The UK can be characterized as a pioneer in the regulation of energy markets. The process of liberalisation and privatisation of the British utilities started in 1983. The famous RPI-X regulation was implemented in 1990 and shows a transparent history in the continuous enhancement of the regulatory approach. Therefore, the British approach serves as a pertinent example due to the long experience and pioneering features in their regulatory approach and provides useful lessons for the revision of regulatory regimes.

An independent regulator, the Office of Energy Regulation (Offer) was established in 1990. In 1999, Offer merged with the Office of Gas Regulation (Ofgas) to form the Office of Gas and Electricity Markets (Ofgem). The first regulatory period (price control review) started in 1990/1991 with the objective to promote efficiency and hence lower tariffs of distribution companies. Albeit lacking effectiveness at the beginning, the second and third price control reviews (1995-2000 and 2000-2005 respectively) significantly reduced distribution charges. Studies show empirical evidence that distribution companies succeeded in achieving significant efficiency improvements and delivering gains to customers.[14]

The incentive regulation model of distribution networks in Britain features a hybrid approach since 1990. Under the current arrangements, the operating expenditures (OPEX), capital expenditures (CAPEX), and quality of service (including network energy losses) are incentivised separately within the so called ‘building blocks‘ approach. In

12 Ofgem (2009).
13 Ibid.
14 Jamasb and Pollitt (2007).

this, these different cost components receive diverse regulatory treatment. This will be explained in the following.

As regards the first building block, the controllable OPEX are incentivised by benchmarking these against an efficient frontier made up of the best practice DNOs in the sector. Subsequently the allowed OPEX of individual DNOs are set such that network operators are required to close a specific proportion of their performance gap relative to the frontier during the price control period (x-factor). In addition, all DNOs are subject to a general technical efficiency improvement target that is common to all DNOs (general x-factor).

Secondly, CAPEX are fixed in the so called regulatory asset base (RAB) individually for each company. Companies earn an allowed rate of return on their assets based on a weighted average cost of capital (WACC). In order to provide for a reasonable level of CAPEX (old assets fall out of the RAB due to depreciation as new investments are added due to reinvestment cycles) Ofgem introduced the so-called ‘menu of sliding scales’ to individually assess the required level of CAPEX as from the fourth price control review (2005-2010). According to their investment strategy, network operators may choose between a regulatory menu of a rather cost-based driven regulation of their CAPEX or a rather incentive based approach.[15]

The derived allowed OPEX and CAPEX together form the basis of the utilities’ allowed revenues. DNOs are allowed to recover their capital (i.e. the WACC multiplied with the regulatory asset base and depreciation) and operating expenditures. The utilities’ actual revenue should reach the efficient level of allowed revenue by the end of the price control period. The x-factor constitutes the path to improve efficiency.

Quality of service is incentivised separately pertaining to different quality dimensions. Broadly speaking, these include i) interruptions (continuity of supply), ii) guaranteed standards of performance, and iii) quality of telephone service. The first dimension is linked to individual performance targets. Deviation from these targets results in company specific penalties and rewards, which affect the total allowed revenue. The last two dimensions involve compensation payments in case companies deviate from predefined standards.

Eventually, the regulatory framework provides incentives to reduce network losses based on a yardstick loss figure. The company receives a penalty or reward when it exceeds or decreases below the yardstick respectively.[16]

Due to the elaborated but also very complex incentive structure in the British regulatory regime, the network operator is likely to face trade-offs between the different incentives for the different cost-components. Ambiguous incentives may for example occur be-

15 Please refer to Müller et al. (2010) chapter 2.4.1 for a detailed description and evaluation of the menue-of-sliding-scales approach.

16 Jamasb and Pollitt (2007).

tween the network operator's preference not to invest in a low loss transformer in favour of limiting capital expenditures by investing in a conventional transformer. Moreover companies may be tempted to capitalize operational expenditures to promote efficiency gains in the OPEX benchmarking.[17]

Dipping more thoroughly into Ofgem's approach towards investments it becomes visible that the option for the fragmented regulatory approach allows for a flexible regulatory treatment of capital expenditures. This is first of all due to the fact that Ofgem opted for a pure OPEX benchmarking. This approach eliminates the economic pressure to also keep CAPEX low that regulatees face when a total cost-based (TOTEX) benchmarking approach applies. In other words, the TOTEX approach implies that efficiency targets will be derived from both operational and capital expenditures. This may hamper the network operator in undertaking the necessary investments in favour of reducing its cost of capital to realise higher efficiency gains. A pure OPEX benchmarking however stimulates short term-efficiency only with regard to operational expenditures and leaves regulatory flexibility to deal with investments. Thus, Ofgem implemented a more flexible regulatory approach with the separated investment appraisal and the introduction of the 'menu-of-sliding-scales'-regulation. Although different shortcomings should be noted with regard to the menu approach, one essential positive feature consists i) in the provision for the network operator's individual investment cycle (high vs low investment needs), ii) regulatory room for corporate optimisation between OPEX and CAPEX and iii) the possibility to receive a bonus when outperforming regulatory targets.

In addition to this, Ofgem's approach allowed an ample increase in the allowance for investments for network modernisation within the fourth regulatory period. This allowance boost has resulted in a positive x-factor for the sector as a whole and can be interpreted as a strong incentive to stimulate investments.[18]

Over and above a specific treatment of investment, Ofgem also implemented regulatory provision for innovation. Basically this includes the introduction of an innovation funding initiative (IFI) to recover research and development (R&D expenditures) via regulated tariffs. Moreover, the instrument of so-called registered power zones (RPZ) involves the option to create tariff space for demonstration projects aiming at the connection of distributed generation.[19]

Empirical evidence[20] and Ofgem's[21] overall appraisal suggest that RPI-X regulation significantly reduced distribution charges and improved the network operators' efficiency. However, critical reflection about the British regulatory approach with all its multifaceted features initiated a review of its 'fit for purpose' given the upcoming challenges for

17 Ibid.
18 Jamasb and Pollitt (2007).
19 For an in-depth overview of the British regulatory approach towards these two instruments and the current and upcoming regulatory treatment of R&D expenditures, please refer to Bauknecht (2010).
20 Jamasb and Pollitt (2007).
21 Ofgem (2010a).

networks triggered by ambitious decarbonisation and sustainability targets[22] and the required paradigm shift of all energy related activities. Therefore Ofgem decided to revise the regulatory framework accordingly.

Hence, the following sub-section deals with Ofgem's RPI-X@20 initiative, an in-depth review of energy network regulation aimed at finding an optimal framework enabling energy network companies to operate networks required for a sustainable low carbon energy sector. The most pertinent features of the RPI-X@20 initiative will be highlighted in the following sub-section. Special attention will be paid to the implications for investments.

Regulatory Approach: RPI-X@20 – the way forward

Followed by comprehensive debates and consultations on the merits and drawbacks of past and future regulatory design features, Ofgem published its final decision document for their revised regulatory approach in upcoming price controls for electricity and gas transmission and distribution companies.[23]

The new regulatory framework is known as the RIIO model, abbreviated for Revenue set to deliver strong Incentives, Innovation and Outputs. The underlying regulatory formula can be synthesised as the following equation: Revenues = Incentives + Innovation + Outputs.

Overall, the RIIO model is based on the RPI-X framework. Whilst some existing features were enhanced, others were retained or new dimensions were added. Two pertinent elements characterise the new framework: it is output driven and takes a long term perspective to deliver “long term value for money” in order to promote smarter networks for a low carbon future keeping in mind the 2030 and 2050 targets. Moreover this approach proactively provides for the long life-cycle of network assets, which may involve 30 to 40 years.[24] The long term vision also includes the option for network operators to decide themselves on an optimal allocation of OPEX and CAPEX and to minimise cost in the long run depending on the nature of the investment.

The following highlights the key features of the RIIO model[25]:

- Revenues and outputs

Revenues are set upfront during the price control review process based on a revised “building blocks approach”. These are the revenues a network operator is allowed to recover to efficiently deliver pre-defined outputs. These outputs will form the central regulatory reference value. The outputs to be delivered are defined during the review process. They are based on the following six categories:

22 The targets set by the British Government stipulate a 80% reduction in greenhouse gas emissions by 2050 and a decarbonised electricity generation by 2030.
23 Ofgem (2010a).
24 Ofgem (2010a).
25 In the following, please refer to Ofgem (2010b).

- Customer satisfaction
- Reliability and availability
- Safety
- Conditions for connection
- Environmental impact
- Social obligations

In each category, a set of so-called primary outputs is defined reflecting customer expectations with respect to the operational business of the network operator. An example should illustrate the approach: Taking the output category 'reliability and availability' 'customer interruptions' and 'customer minutes lost' could constitute primary outputs. For the category 'environmental impact' the 'role in consumer energy efficiency' or the 'carbon footprint of networks including losses' would be further examples for primary outputs. Output delivery is encouraged by incentives directly linked to primary outputs and the allowed revenue in the price control. This is, at each price control review the regulator determines a specific level of performance at which the network operator is expected to operate. In return, the network operators specify in their business plans what primary outputs they plan to deliver and what they expect to be the associated cost. The regulator sets the allowed revenues accordingly to fund the outputs efficiently assuming a long term value-for money perspective.

- Holistic and time-limited innovation stimulus

As a matter of fact, long-term thinking takes a central role in setting the output categories. Therefore, the new regulatory framework includes a flexible instrument to proactively provide for dynamic efficiency. This instrument was implemented to protect against the risk that pure delivery of primary outputs might be inefficient for certain activities and hence the required performance level in a certain category could not be reached within the eight years horizon of the regulatory period. With the instrument of 'secondary deliverables' the framework provides the opportunity for network operators to include expenses in their business plans aiming at innovative projects of which costs would occur immediately but benefits would only occur within a longer time horizon. These 'secondary deliverables' could form milestones in project delivery. With regard to the price control, this implies that network operators will merely be allowed to raise revenues from consumers given the milestone is reached. On the one hand, this approach has been chosen to provide certainty to network operators to engage in long-term investments and on the other that customers do not overpay and their money is only raised when there is certainty that network operators will deliver benefits in the long run. However, this instrument requires a deep level of involvement and scrutiny for both network operators and Ofgem. Therefore, it will only be applied to ample investments associated with a high level of uncertainty.

In addition to this holistic approach the RIIO model includes a time-limited ‘Innovation Stimulus Package’ based on the Low Carbon Network (LCN) fund that is already applied in the current regulatory period. Broadly speaking this instrument provides the opportunity that network companies or third parties may apply for a fund aimed at demonstration projects. Moreover it explicitly encourages third parties to apply if they can carry out a specific task more innovatively and efficiently than network operators.[26]

With these two instruments, the new regulatory framework comprises two ways to encourage innovative output delivery. First of all, as already suggested above, the price control review process will facilitate the inclusion of technical and commercial innovation related to capital expenditures with the option to define ‘secondary deliverables’ as milestones for innovation projects that span price control periods. Secondly, the explicit and time-limited innovation stimulus will especially provide for the transitional period adapting the energy sector to the decarbonisation and sustainability targets.

In order to provide consistency with the regulatory features described above further enhancements have been made.

- Extension of the regulatory period (price control review) to eight years

The extension of the regulatory period to eight years has been realized to provide network operators with more flexibility to efficiently optimise their delivery of outputs in a longer perspective and to reduce regulatory risks. This vision also involves drawing on longer-term business plans. If necessary, the regulatory scheme includes the option of a tightly-scoped mid-term review. This review will however not involve any new review of capital cost or existing output incentives. This approach goes hand in hand with a long-term regulatory commitment to the WACC and the network operators individual risk situation.[27]

- Business plan review as core instrument of the price control review process

In their business plans network operators demonstrate how they plan to deliver the determined outputs. Within this appraisal, the onus is on the network operator to justify that its plan to deliver output constitutes the best option to meet the RIIO targets. Depending on the quality of justification the regulator employs an assessment tool-kit to evaluate the business plans. This tool-kit is associated with an increased level of regulatory scrutiny. If the companies provide a reasonable, well-argued justification in its business plan the company will be fast-tracked through the price control review process. If however the regulator has certain doubts he may choose to apply additional regulatory instruments (comparison with performance in former regulatory periods,

26 For a detailed overview of the ‘innovation stimulus package’ planned within the RIIO model, please refer to Bauknecht (2010).
27 Ofgem (2010b).

TOTEX benchmarking techniques) evidencing the network operators efficiency situation.[28]

Keeping these new features in mind the paper now addresses the role of investments in the RIIO model more thoroughly.

The British Government’s sustainability targets to reduce carbon emissions by 80% by 2050 requires ample investments to adapt the network infrastructure both technologically and capacity-wise to a newly structured energy sector.

This long term perspective is the reason why Ofgem’s approach towards investments is strongly based on a long term value for money perspective and a holistic treatment of capital expenditures. This is reflected in a number of aspects involving flexibility from both the regulator and the network operator.

First of all, the network operator is supposed to set out its investment strategy to meet the long-term targets. This involves a well-justified strategy linking anticipated expenditures to the delivery of primary outputs and if necessary to secondary deliverables defined as milestones for a longer investment cycle. Moreover the network operator is required to consider alternative options to deliver outputs making an optimal compromise between OPEX and CAPEX deployment. This includes a thorough consideration of all implications an investment might have over and above the eight years regulatory period. As a matter of fact, with this approach the regulator requires a cultural change in the company’s operational business and rewards long-term, innovative thinking. The network operator’s response to this framework will be assessed by the regulatory toolkit controlling efficient expenditures. If considered necessary, the regulator may scrutinize specific expenditures by using benchmarking techniques to reveal efficient cost or if feeling concerned about a particular investment project require a detailed bottom-up justification of the project. The benchmarking approach will be based on a TOTEX benchmarking to avoid an OPEX CAPEX bias. However benchmarking results will no longer form the logical basis to determine the allowed revenues but will rather be considered as “one piece of evidence” as regards the network operator’s cost structure.

Secondly, different refinements were made in regulatory financing arrangements. The RIIO model transparently sets out the different principles of financeability in order to provide a clear ex-ante framework for investors, companies and other involved parties. Overall the RIIO model assumes a long-term view of financeability. Amongst others, this implies that the companies’ capitalisation policy is supported by a fixed percentage determining the OPEX/CAPEX split of the respective company. This is, the company may capitalize a certain amount during the price control period. The percentage is determined based on the submitted CAPEX presented in the business plan.

28 Ofgem (2010b).

As regards the depreciation rate, the RIIO model will henceforth refer to the average expected economic lifetime of the assets. Previously, the regulator reduced the lifetime of the assets to an assumed regulatory lifetime that was significantly lower than the physical one. This policy has been pursued in order to drive companies' perceived financeability due to higher cash flows. Hence the regulator is aware that the new approach may slow down the expected return on investment and will consider if appropriate a transition period with some flexibility as regards regulated revenues.

Within the future regulatory framework the rate of return is still based on a real weighted average cost of capital (WACC) approach. [29]

The sub-section above presented the main features of the current and future regulatory framework in the United Kingdom and the special role of investments in this context. It shows that the future regulatory framework puts investment in a long term context, designs regulatory functionalities for overarching sustainability and decarbonisation targets and adjusts related regulatory instruments accordingly to facilitate a long-term value for money consideration. Moreover, the Achilles heel of regulation, namely the crucial regulatory factors 'regulatory commitment' and 'regulatory uncertainty' respectively, is proactively taken into account[30]. However the enhancements of RIIO mentioned above simultaneously risk a rather "heavy handed" regulatory approach. The yet due practical regulatory implementation of RIIO has to prove if the new functionalities actually deliver a dynamic efficient outcome. Notwithstanding these caveats Ofgem can be considered as the pioneer in pursuing new regulatory design options.

3.2 Italy

Sector structure

The Italian Electricity sector is dominated by one major player, Enel, which is active in the generation, distribution and retail market. To begin with, the key generation figures.[31] In 2008, maximum net installed generation capacity amounted to 98,625 MW, and the net available capacity (for at least 50% of the time) was equal to 83,813 MW. Enel assumes a market share of 40.9% whilst only four other companies achieve a market share of over 5%. The market concentration is rather high with a HHI of 1,921 in terms of maximum net installed capacity and 2,242 regarding net available capacity. In 2004, a process of strong generation capacity expansion started and is still on-going. Net capacity increased by 6.2% in 2008, which is reported as by far the strongest increase in the last five years.[32] As in previous years, capacity growth came mostly from thermoelectric plants (more than 75%) followed by wind plants (17%) and, thirdly, photovoltaic plants (4.4%) whose overall power capacity is expected to overtake that of geothermal plants in the course of 2009. As regards the perspective for net installed

29 Ofgem (2010b).
30 Müller et al (2010).
31 In the following, please refer to AEEG (2009).
32 AEEG (2009).

capacity, AEEG (2009) underlines that significant differences exist between Southern and Northern Italy. Whilst the distribution of new thermoelectric capacity is almost equal with 47% in the south and 43% in the north, wind power and photovoltaic capacity will amount to 97% in the south and only to less than 1% in the north.

Electricity trading takes place on the regulated spot market managed by a market operator. The spot market is further divided into two submarkets, the day-ahead market, and the adjustment market. In the dispatching services market the Italian TSO Terna procures the resources required for providing transmission and dispatching services and for power system security.

Since 2005, power transmission and nationwide dispatch are operated by Terna. The model adopted for the Italian electricity system corresponds to ownership unbundling. As of 31 December 2008 29,99% of Terna's shares were owned by a public shareholder, whilst Enel and an asset management company held 5.1% each of the capital. The remaining 60% belong to public retail suppliers. Electricity distribution is undertaken by Enel Distribuzione in over 95% of Italy's municipalities. More than 100 medium sized and small companies undertake distribution in the remaining municipalities. In 2008, there was a total of 131 distribution companies, managing more than 1,200,000 km networks. Two thirds are low voltage lines and almost one third medium to high voltage lines.

The Italian electricity market has been 100% open for end-users since 2007. In the retail market, Terna also assumes a major role with a market share of 47.2%. Only two other retail companies attain a market share over 5%.

Regulatory Approach

Italy reflects upon one decade of quality and incentive regulation both starting in 2000. Tariff regulation is implemented through a price cap mechanism with efficiency goals for transmission, distribution and metering services set by the Italian regulator Autorità per l'energia elettrica e il gas (AEEG) over a four-year regulatory period. The electricity sector currently undergoes the third regulatory period (2008-11). The planned productivity gains for this period amount to 2,3% for transmission, 1,9% for distribution and 5,0% for metering.[33] Nota bene that the before mentioned x-factor only applies to operating cost as from the current regulatory period. In the previous ones, the x-factor was also applied to amortisation and depreciation (regulatory period 2004-2007) and additionally to the return on investment (regulatory period 2000-2003).[34]

The AEEG updates tariffs on an annual basis. This update provides for two cost categories. Firstly taking into account the reduction in real terms regarding operating costs and secondly a review of depreciation and return on invested capital, to adapt for new infrastructure investments to improve security of supply, competition, and quality of ser-

33 AEEG (2009).
34 AEEG (2008).

vice.[35] As regards the investment update, companies annually report their investments made in the year t-1, which will be allowed in the tariffs for the year t+1.[36]

Over and above this regulatory change to solely focus on OPEX efficiency as from this regulatory period, the Italian regulator also revised the approach towards investments. From now on, the regulator discriminates between different investment categories for transmission and distribution investment respectively, which are associated - provided they fall in a certain category - with an extra return on investment. On the TSO-Level this new incentive system allows an extra return for i) investments dedicated at the development of transmission capacity in order to reduce congestion between market zones and intrazones and ii) investments in Net Transfer Capacity (NTC) on electricity borders. The extra allowance amounts to 3 percentage points extra return on invested capital for 12 years over the 6.9% base rate of return. On the DNO-level, this new regulatory instrument grants an extra return of 2 percentage points over the 7% base return for crucial investments for the distribution system such as new HV/MV transformation stations, replacement of existing transformers with low loss transformers as well as MV active grid automation, protection and control systems.

In addition to these additional allowances for specific investments the AEEG also set off the introduction of efficiency indicators for investments in order to measure the extra benefit that individual investment bring to the system as from 2011. The objective of these indicators (relevant for both TSO and DNO investment) is to define an order of priority for infrastructure investments and objective criteria to grant an adequate rate of return for expansion investment.[37]

Originally, quality regulation has been implemented in Italy in order to improve the continuity of supply level compared to other European countries and to bridge national differences between North (higher quality level) and South (lower quality level). Overall, quality levels steadily decreased in Italy as confirmed by the statistics (see Figure 1). However exceptional events were responsible for increases in SAIDI values in 2003 and 2008.[38] For the regulatory period 2008-11, the Italian regulator introduced a new scheme of penalties and incentives providing for both the duration of power outages (similar to the previous years) and, to the number of both long and short outages, so that all outages lasting more than one second are now covered. Moreover, service quality regulation is applied.[39]

Smart meter roll-out is quite advanced in Italy having the largest smart meter base in the world.[40] This is mainly due to Enel's initiative that equipped 30 Million households with smart meters between 2001 and 2005. A nationwide rollout should be realised by

35 Ibid.
36 Ibid.
37 Ibid.
38 AEEG (2009).
39 CEER (2008) and AEEG (2009).
40 Meeus et al. (2010).

the end of 2011. Smart meters are used to give feedback to consumers and to introduce new business models and services based on the metering data. A recent Government decree enjoins distribution companies to install visual displays for its consumers.

All smart metering activities fall under the network operators' responsibility. Related tariffs are determined by the regulatory authority and include OPEX and CAPEX with a smart metering specific WACC amounting to 7,2%. The Italian regulator adjusts metering tariffs on an annual basis and adjustments refer to OPEX only. They also have a specific x-factor, which is 5% higher than the x-factors for distribution (1,9%) and transmission (2,3%). Moreover, smart metering activities have a link to quality regulation. The network operator receives a bonus of 15 € per customer when using smart meters to record unplanned interruptions longer than three minutes. Getting this reward however requires that the network operator fulfils certain smart metering roll-out provisions. More specifically, 85% instead of 65% low voltage withdrawal points have to be commissioned with smart meters by 30 June 2010.[41]

In parallel to its pioneering smart metering activities, the Italian regime includes instruments to promote innovation. A first instrument has existed since 1999 consisting of a general R&D component in the network tariff, which is paid by all consumers. The Italian regulator is responsible for determining this levy, which currently amounts to 0.03 c€/kWh. The objective of this levy is to fund R&D activities that have an impact on the electricity system. [42] Over and above, the regulatory authority incentivises demonstration projects within a competitive procedure. Selected projects will be awarded with an increased WACC of 2 percentage points for 12 years.[43]

Overall, the Italian approach can be considered as pragmatic. It provides clear incentives and a clear mandate regarding the smart grid/smart metering activities. However, the increased rate-of-return may involve demarcation problems specifying the appropriate investment category.

3.3 Norway

Sector structure

The Norwegian electricity market has one of the longest experiences with market liberalization and introduction of competition in Europe (in principal, full market opening started from 1st January 1991). The other Nordic markets followed soon and today, Norway is part of an open and integrated electricity market in the Nordic region with a common Nordic power exchange.

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41 Wissner (2009).
42 More information here: http://www.ricercadisistema.it/
43 Meeus et al. (2010).

As regards the organization and ownership, a total of 409 companies held a licence to operate in the Norwegian power sector as of 31st December 2009.[44] Of these, a total of 162 companies were involved in grid operations, while 64 companies are integrated companies engaged in generation, grid operation and supply to end-users. 42 companies were only involved in grid operations. In terms of ownership type, roughly 75% of the licensees were organised as limited companies, five per cent as cooperatives, while around 17% were organised as municipal, county or inter-municipal companies.

Both the Norwegian TSO Statnett SF – which owns about 90% of the national grid - as well as Norway's largest electricity producer Statkraft SF are fully state owned, with ownership interest held by two different ministerial portfolios.[45] As regards the structure of the power generation market, in 2007 there were six companies that had five per cent or more of installed available capacity in the Norwegian market.[46] The largest three companies owned roughly 40% of installed available capacity. When adjusting for direct and indirect financial ownership the figure increased to about 60%. Additionally, around 90% of the generation capacity was publicly owned in 2009, while private ownership accounted for the remaining 10%.

The most pertinent key indicators for the size and mix of electricity generation are as follows[47]: The Norwegian net generation was 142,4 TWh in 2008 and this figure declined to 132.8 TWh in 2009, driven by dry weather conditions. In 2009, hydropower accounted for 127.1 TWh (95.75), thermal power 4.7 TWh (3.55) and wind power 1 TWh (0.75). The annual hydroelectricity production for years with average inflow is estimated at 130.7 TWh and the installed capacity was 30,901 MW at the end of 2009. Somewhat more than 80% of the installed capacity is available in the winter season. The year 2009 saw 126 MW of capacity additions for hydro power and 2.3 MW of new wind power generation capacity while no capacity expansion took place for thermal generation.

The Norwegian wholesale market is integrated in the Nordic wholesale market through price coupling on a common power exchange, Nord Pool Spot. Nord Pool Spot organises the Nordic marketplace for trading electricity for physical delivery, and offers both day-ahead and intra-day markets to participants from 20 countries.

Although Norway does not fall under EU requirements, the Norwegian TSO Statnett was organized as a separate, ownership unbundled entity since the introduction of competition in the Norwegian electricity market. The Norwegian Ministry of Petroleum and Energy has full ownership of Statnett while the ownership interest of Statkraft SF (generation) lies with the Ministry of Trade and Industry. As the ownership interest is held by two different ministerial portfolios, organization of public ownership interest in

44 NVE (2009).
45 Herbert Smith (2010).
46 In the following, please refer to NVE (2009).
47 Ibid.

Statnett and Statkraft at the outset complies with EU ownership unbundling requirements.

At the distribution level, most of the grid is owned by county and municipal authorities. By June 2009, there were 162 DNOs in Norway. Of these, there are only seven large DNOs, i.e. with more than 100.000 customers. The rest of the country is covered by smaller DNOs.[48]

As regards the provisions for customer switching, the fees for changing supplier were totally removed in 1997 while a weekly change of supplier has been possible since 1998. Since 2005, provision was made for hourly metering of all customers with annual consumption above 100,000kWh/year. Meanwhile, only five suppliers for the retail market have a market share of 5% or more calculated by volume. Again three out of those five companies supply 32% of the total volume delivered to households. On average most end users are still customers of the incumbent supplier.[49]

Regulatory approach

The Norwegian regulatory regime consists of price-cap regulation with benchmarking since 1997 and quality regulation since 2001. Norway's regulatory approach is often considered as state-of-the-art when referring to international regulatory experience. Moreover, Norway is the only country in the European context with a long history in revenue-cap regulation. In general terms, this is the same approach according to which the German regulatory design has been conceived. Therefore a closer look at their regulatory framework shall be taken.

Since 1997, the total revenue for each distribution firm was capped using a RPI-X formula where the x-factor reflected both a common requirement for productivity improvement for the sector as a whole and an individual x-factor reflecting the network operator's efficiency improvement target. Currently, Norway is in the fourth regulatory period (from 2007 to 2011) and over the years investment incentives and quality regulation have been gradually enhanced from period to period. With the new regulatory period, the Norwegian regulator NVE introduced a number of changes in the revenue structure. From 1 January 2007 NVE network operators are regulated with one annual revenue cap based on a yardstick formula[50] and an annual return on historical capital. The cost base for the revenue cap for year t consists of the following components from the year t-2: OPEX, depreciation, the cost of physical losses and the cost of energy not supplied (CENS)[51]. According to this formula 40% of the companies' actual costs are recovered whilst the remaining 60% follow from a cost norm derived from benchmarking. The underlying method is a Data Envelopment Analysis (DEA) for regional transmission and

48 Ibid.
49 Ibid.
50 Please refer to Müller et al. (2010) for a detailed description of the yardstick approach.
51 For a detailed overview on the Norwegian approach towards quality regulation integrating the customer's willingness-to-pay via the CENS approach, please refer to Growitsch et al. (2010).

the DNOs performed separately. The norm cost for the TSO (Statnett) is based on an international benchmarking analysis (Ecom+ Model).

Overall, the norm cost is calibrated such that an average efficient network operator (DNO, regional transmission and TSO) has norms costs equal to its cost base. The allowance for investment includes reinvestments and new investments and is based on investments made in year t-2. Moreover a correction factor corrects for the investments not included due to the two years time lag. The WACC is based on the annual average of a five year government bond plus a risk premium.[52] To our knowledge, no explicit investment incentives are currently applied in Norway apart from introducing the corrector factor to tackle the time shift problem

3.4 The Netherlands

Sector Structure

The four largest producers of electricity in the Netherlands are Electrabel, E.ON Benelux, Essent and Nuon. Together they manage 65% of the installed production capacity and also have about 80% of the retail market.[53] According to the most recent EU benchmarking report, the share of the three biggest companies by capacity was 69.9% in 2008, an increase of 8.9 percentage points from 2007.[54]

Key figures for the wholesale markets in 2008 are as follows[55]: in 2008, total generation capacity amounted to 23.8 GW while net generation volume was 107.658 TWh. Likewise, import capacity was 3.65 GW and net import volume was 15,850TWh.

Approximately 25 electricity producers were active in the Netherlands in 2008. In terms of the size of generating companies, the Netherlands has seven large and 18 small electricity producers.[56] Three-quarters of the Dutch generating capacity belongs to four electricity producers. The degree of concentration in the Dutch wholesale market as measured using the HHI for 2008 was 1551 in terms of capacity and 1742 in terms of generation. The Netherlands is a net importer of electricity. Additionally, because Dutch generation capacity is largely gas fuelled in contrast to Germany and France where baseload electricity is generated by coal and nuclear power respectively, electricity prices in Netherlands are higher than the adjacent countries.

The Dutch wholesale market is composed of the trade in bilateral contracts, or the bilateral market; the OTC (over-the-counter) market; the day-ahead market (spot market, APX); and the balancing market, or the market for control and reserve power. As regards the retail sector, a total of 21 nationwide suppliers were active in Netherlands in

52 NVE (2008).
53 European Commission (2007b).
54 European Commission (2010).
55 Energiekamer (2009).
56 The large coal- and gas-fired plants and the combined heat-power plants which provide the bulk of production in the Netherlands are owned by a few large producers.

2008; four of them occupying a market share of greater than five percent in the whole retail market.[57]

Some recent developments have occurred in the Dutch electricity sector as a run up to the implementation of the Third Energy Package.[58] In June 2007, the Dutch Unbundling Act came into force which stipulated that companies carrying out network activities in the Netherlands are not allowed to be part of the same group as companies carrying out production, trade or supply. As a result of the Unbundling Act, public shareholders of electricity companies are not allowed to sell or transfer their share in network activities but may only sell or transfer the unbundled business (production, trade, supply) to non-government or non-government related third parties. Since the entry into force of the Unbundling Act, public shareholders of two out of the four major Dutch Energy companies (Nuon, Essent, Delta and Eneco) have sold their shares in the unbundled activities (production, trade, supply) to third parties: to RWE in the case of Essent and to Vattenfall in the case of Nuon. The Netherlands has one national grid company for the transmission of electricity (TSO) called TenneT TSO BV. Additionally, the Unbundling Act has redefined the national high voltage grid to also incorporate networks operated at 110kV and above. Previously, the high voltage grid was defined as networks operated at 220kV and above. As a consequence, starting from January 2008, TenneT is also responsible for 110kV and 150kV networks.[59]

Regulatory approach

The Netherlands had incentive regulation in the form of a price cap since 2001 and changed their system to yardstick competition from 2004. Currently, they are in the fifth regulatory period lasting from 2011 to 2013. The national TSO (TenneT) and the eight distribution companies are regulated separately.

The Dutch regulatory approach differentiates between financial regulation (tariff regulation via an x-factor) and technical regulation (quality regulation via a q-factor).

The tariff regulation scheme is based on yardstick regulation. This means that the tariffs of each network operator are based on a benchmark reflecting the average of all costs (per unit of output to correct for differences in size of DNOs) of all network operators. The Dutch regulator Energiekamer (within the Netherlands Competition authority NMa) sets network operator specific x-factors in order to make the company's cost reach the average efficient cost level by the end of the regulatory period. A network operator operating more efficiently than its peers will earn higher profits and vice versa.[60]

As regards special investment incentives, the Dutch energy law includes an optional allowance for considerable investments (in Dutch: 'aanmerkelijke investering') upon

57 Energiekamer (2009).
58 Herbert Smith (2010).
59 Energiekamer (2009).
60 Ibid.

request of the distribution network operators. It is included in the yardstick competition approach and the objective is to control one-off, large-sized investments (on higher voltage levels), which would, if not corrected, lead to a distortion of the cost structure between network operators. If the regulator positively decides upon the request, he will create an extra tariff space for this specific investment. Criteria for considerable investments e.g. relate to their relationship with other assets, the past investment patterns of the company, the influence on the cost level, and cost to finance the investment. However the instrument of considerable investment does not refer to expansion investments. As yet, this investment category is included in the conventional regulator tariff allowance via the yardstick approach.[61] Currently, the instrument of considerable investments is under revision.

As regards the Dutch approach towards quality, in 2000 the regulator implemented a bonus-malus based quality regulation within the yardstick scheme in order to avoid quality deterioration due to a potentially over excessive focus on cost efficiency. In this framework, the underlying q-factor makes the network operators' revenues dependent on its quality performance. This means that each network operator receives an individual q-factor depending on its individual performance in relation to the System Average Interruption Duration Index (SAIDI). Quality regulation only considers interruptions experienced by consumers on the low-voltage grid (< 50kV). If an individual company performs above or below average quality, higher or lower revenues are permitted.[62]

Over and above this output oriented quality approach, the regulator also requires network operators to submit so-called quality and capacity documents (QCDs) within a two year time period. With these documents, network companies report on their network related activities such as planned outage and interruption frequency, capacity planning, investment planning, and maintenance planning. The Dutch regulator goes quite deep into the companies' operations though no direct regulatory measure results from these investigations. The underlying audits however are designed to urge network operators to have a good overview of their planned asset investments and to perform asset management related activities thoroughly.

After almost one decade of incentive regulation, the Dutch regulator considered it necessary to deal more intensively with the role of investments to evaluate the current regulatory regime. Therefore the NMa commissioned three research agencies to investigate the economic and technical implications of the current regulatory approach. More precisely, PriceWaterhouseCoopers was responsible for the economic part and investigated the influence of the Dutch regulatory regime on the investment behaviour of the Dutch distribution network operators and the Dutch TSO TenneT.[63] Based on interviews and empirical data regarding the investment situation, the study concludes that i) regulation increased efficiency and network operators were able to make their neces-

61 Nederlandse Mededingsautoriteit (year unknown).
62 Energiekamer (2009).
63 PriceWaterhouseCoopers (2009).

sary investments ii) financial incentives for cost efficiency had no negative influence on network related investments (input) or quality (output) iii) quality incentives had no positive influence on network related investments (input) or quality (output) iv) main drivers for investment decisions are: quality and security of the networks, legal obligations regarding investments and cost of capital, and v) yardstick competition is considered as no barrier for future investments but gives incentives to make necessary investments as efficient as possible. However according to the interviews conducted with the network operators, a certain incertitude is associated with the future regulatory system, which might be associated with obstacles to investments. As examples, the study highlights distributed generation, the x-factor (in terms of the underlying data basis, the related time lag of cost recovery, as well as comparability between network operators) and the security and reliability of the networks.[64]

Following up on the commissioned studies, the Dutch regulator issued an 'Ontwerp-methodebesluit' and formulated its vision regarding the regulatory framework. Overall the Energiekamer/NMa conclude that the general principles of the current regulatory approach in the Netherlands should be retained and considers yardstick competition as an effective regulatory approach. Also the NMa advocates the advantages of a short regulatory period (three years) providing the possibility to quickly respond to the latest changes in the regulatee's cost situation.[65]

However the regulator also emphasizes the importance to have the flexibility to respond to new developments in the energy industry and their influence on investment patterns. In this context, the NMa and the Dutch Ministry of Economics will investigate to what extent the use of the instrument of considerable investments can be expanded in order to respond to the specific circumstances of network operators in terms of new developments such as distributed generation or electric vehicles.[66]

In 2009, the regulator also launched a consultation regarding the appraisal of innovation within the regulatory system[67]. The regulator considers innovation as one of the key elements to guarantee long-term economic efficiency. Moreover the regulatory method should stimulate and not hamper innovation and enable network operators to earn their expenditures for innovation.[68]

In the consultation network operators underline the pivotal rule of innovation facing the new developments in the energy markets and state that they have launched all innovation projects they consider necessary. However, they agree that the current framework for innovation was not stimulating. As reasons they refer to the fact that innovation projects do not directly remunerate the network operator who takes the initiative and that cash flows could be only earned back with a time lag. In this context, network operators

64 Ibid.
65 Nederlandse Mededingsautoriteit (2010a).
66 Nederlandse Mededingsautoriteit (2010b).
67 Nederlandse Mededingsautoriteit (2009).
68 Nederlandse Mededingsautoriteit (2010a).

argue for direct innovation incentives in the form of higher allowances directly related to innovation. They also consider it helpful to correct for the time-lag with cost recovery. Other parties (consumer organisations) state that no explicit innovation incentives were necessary as the current regulatory framework would comprehensively control for efficiency being due to innovative operations. Moreover representatives argue that necessary innovation might also be facilitated by other parties than network operators and that direct incentives for these parties would disadvantage other market participants.[69]

The NMa concludes from the consultation that the current regulatory framework includes sufficient incentives to stimulate network operators to innovate and does not foresee regulatory changes to create extra tariff space for innovation. Moreover extra tariff space would not guarantee that network operators would use this extra grant for innovation. Moreover the regulator currently investigates to what extent the instrument of 'considerable investments' might be customized to the upcoming challenge of decentralised generation and changes in legislation. The NMa will also investigate the role of innovation in this context and to what extent amendments to this instrument might correct for the critical time lag.[70]

In parallel to the regulator's activities, the Dutch Ministry of Economics installed a taskforce for smart grids (in Dutch: 'Taskforce Intelligente Netten'). The objective of this task-force is to discuss potential amendments of the regulatory framework due to the upcoming challenge of smart grids.

Whilst the regulator does not see any crucial shortcomings in the regulatory incentive structure to stimulate investments, the taskforce smart grids emphasizes different restraints as regards the development of smart grids.[71] In this context, the taskforce especially highlights the issue that the current regulatory tariff structure does not provide for intelligent network expenses and therefore does not include adequate incentives for innovation. Moreover, the taskforce states the importance of encouraging R&D activities and practical demonstration projects. The network operator is considered as a central actor in the field of smart grids, though strongly regulated. Therefore innovation should play an adequate role in the regulatory framework.

In more detail, the related discussion document sets out the taskforce's vision of how to stimulate innovation in a regulated environment. First of all, network operators should get more *room to invest* in smart grids supporting infrastructure on a local and regional level. They should decide themselves upon their role as an enabler or platform operator[72]. Secondly network operators should receive the *mandate to invest* in the supporting infrastructure. A politically determined national infrastructure plan should serve as a basis for investment.

69 Ibid.
70 Ibid.
71 Ministerie van Economische Zaken (2010).
72 A more detailed public presentation of the Dutch approach is expected soon.

Related cost should be socialised. For these two central arguments, the task force differentiates by three different types of innovation as highlighted in the table below:

Table 3: Differentiation between different innovation categories

N°	Type	Example	Potential regulatory approach
1	Innovations that are related to the central task of a network operator such as renewal and upgrade of the operating material	Investment in ICT to avoid disturbances or for the purpose of congestion management	This type of innovation belongs to the regular running costs and shall be recovered by the regulated tariffs
2	Innovations for which the network operator incurs cost whilst the benefit occurs elsewhere. This refers to a shared responsibility between network operators, the public and other stakeholders	• Support of projects (micro-CHP and other distributed generation, sustainable neighbourhoods) • The connection of generation units (windparks, biogascollection, international gas transport connections, Supergrid), which are triggered due to sustainable and decarbonsiation targets.	The Ministry carries out a politically driven cost-benefit analysis for the required type of investments. Followed by a chamber debate over the vision and the cost-benefit-analysis the political consequences are clear and hence a corporate mandate can be given to the network operators. The network operators prepare their QCDs in accordance with this mandate. These documents form the national infrastructure plan. Based on the cost-benefit-analysis the minister decides upon the submitted infrastructure plan. If economically desired developments are insufficiently supported the minister may issue a directive for it. In this the underlying cost will be incorporated in the network operators' tariffs. Afterwards, the NMA controls whether the investments have been made efficiently.
3	Innovation that might give a fundamental change to today's role allocation and institutional design in the market. These changes cannot be integrated in the current system but need to be established in parallel to the existing system. In this the system does not only experience technological changes but also changes of the roles of the different market parties, their interactions and market rules.	• Large-sized bi-directional energy distribution systems • New forms of balancing, metering and billing • Energy flows from the network operator to a market maker • New forms of participation of users and prosumers • New roles, responsibilities, duties and rights	Provide room for experiments. Network operators must be able to participate in demonstration projects, which are free of and repressive legal, fiscal or administrative rules. However the taskforce emphasizes in this context that the construction of a network that is able to facilitate heat pumps, electrical cars, microchip or photovoltaic has to happen in the normal operational management.

Source: Ministerie van Economische Zaken (2010), own depiction

Overall this country example shows that the Dutch regulator as well as the Dutch Ministry of Economics developed an increased awareness of investment treatment after one decade of incentive regulation. However the studies, consultations and discussions also indicate that the opinion about the regulatory role of investments and innovation is quite heterogeneous and still requires substantial discussions before specific regulatory investment incentives will be implemented.

3.5 Interim conclusions

This section has provided a comprehensive insight into the international approaches that the countries of reference take to customize their regulatory framework regarding increased regulatory measures towards investments and dynamic efficiency within a smart grids context.

The following central questions have been formulated at the outset.

- What are the international approaches to better stimulate investments and asset-innovation (dynamic efficiency)?
- Is regulation considered as the right place to stimulate investments and asset innovation?
- How do regulators see the role of the network operator?

Taking these into account, the following conclusions from the case studies can be drawn:

The most intense adaption of the regulatory regime takes place in the United Kingdom. Here, the regulatory framework undergoes a deep revision, proactively adapting the regulatory parameters to an output oriented, forward looking, long-term value for money perspective in order to stimulate dynamic efficient investments and hence innovation. All this happens in order to facilitate an adaption of the networks to the overarching decarbonisation and sustainability targets. Hence the RIIO model in the UK suggests that, theoretically, a regulatory stimulation of dynamic efficient investments and a transformation of climate targets into regulatory functionalities is possible. The practical implementation however is yet to be proven. One essential learning nevertheless is already the new regulatory awareness to undertake a long-term perspective with respect to regulatory incentives instead of focussing solely on short-term efficiency targets. More precisely, the output based approach in the UK including criteria such as environmental impact or social obligations indicate a new regulatory vision of the network operator's role. This is, over and above cost efficiency (OPEX and CAPEX) new regulatory criteria are at stake. These criteria mirror the policy targets in terms of sustainability and decarbonisation. The future will show to what extent the RIIO model proves to be the right approach to encourage a paradigm shift from short term efficiency incentives to a holistic, long-term value for money strategy.

Moreover, Ofgem's role in the UK electricity markets goes beyond a pure network focus but its influence also pertains to the entire industry to encourage environmental improvement. This leaves room to inspire third parties to efficiently take over parts of the network operators' duties and hence constitutes a competitive element to stimulate innovation. Thus, one can conclude that in the UK the regulatory framework is considered as the right place to stimulate investments and asset innovation but also has the flexibility to yield this task to third parties. This implies that the network operator is not assigned the central role in facilitating smart grids but other market participants are also encouraged to take the initiative, which creates a competitive environment.

Another essential feature of the UK case is the low number of regulated entities. The fact that there are less than 20 distribution network operators keeps a lot of room for regulatory flexibility and makes it possible in the first place to allow for very individual regulatory instruments such as the ‘secondary deliverables’. The in-depth scrutiny of business plans, however, turns the regulatory approach out to be heavy-handed. Especially a larger number of regulated entities might not be fit for purpose for such concepts.

The other analysed countries do not undergo a substantial regulatory paradigm shift but also increase their regulatory measures towards investments. Italy took a pragmatic approach and increased the rate of return for special investments, e.g. related to smart grids activities. However, this might involve demarcation problems. To illustrate this, let us suppose an investment is to be made in intelligent substations. For such an investment the regulatory demarcation between conventional replacement investments and e.g. investments in intelligent network control, which do not fall in the first category, might blur. Identifying clear regulatory boundaries is a crucial task, therefore. Moreover, the AEEG plans to implement regulatory incentives for efficient expansion investments as from 2011, and demonstration projects are encouraged in a competitive way. In contrast to the UK, however, the network operator is assigned the central role in the development of smart grids and smart metering. In the Netherlands, the discussion as to what extent the regulatory framework will be adapted regarding investments and asset innovation is still under extensive discussion. Here one can also state an increasing regulatory awareness towards the adaption of the networks to enable smart grids solutions. This also implies an on-going discussion as to which role the network operator plays in this context. Eventually, Norway does not seem to take explicit measures to incentivise smart grids investment/innovation but provides for an extra allowance in the regulatory framework to correct for the two year time lag in the regulatory consideration of investments. In this, investment related shortcomings are corrected in the regulatory design. The time-lag is also considered as an issue in the Netherlands.

4 Conclusions

The objective of this paper was to present international experiences of countries pioneering increased regulatory measures towards (dynamic efficient) investments.

To begin with, country specific facts and figures were presented in order to empirically underline the most relevant regulatory parameters and the investment situation. As a matter of fact, however, no causalities can be identified. Therefore potential relationships will be elicited in an empirical paper once the required data is available.

Subsequently, the paper discussed four case studies where regulators revise their regulatory framework towards a more sensitive approach to stimulate investments and dynamic efficiency. The case studies show that the analysed countries take more or less intense measures to increase the regulatory provision for investments and dynamic efficiency. The UK can be considered as pioneer in pursuing this path by changing the priorities from a regulatory focus on cost-efficiency to a holistic innovation and output-oriented approach with a forward looking, long-term value for money perspective transforming climate targets into regulatory functionalities. A less holistic but rather straightforward solution has been implemented in Italy where the regulator may increase the rate of return for specific investments. In the Netherlands, revised approaches towards investments and innovation are still under discussion. The intensity of the debate however suggests the importance of this issue. Norway corrected the time-lag problem.

To conclude, the following should be taken into account when considering a “smart” regulatory framework.

Dynamic efficient investments are not a target in themselves. They are the essential catalyst to facilitate smart grids in order to tackle the overarching sustainability and decarbonisation targets. Therefore policymakers when deciding upon these targets should provide a clear mandate and clear incentives to stimulate investments in the necessary infrastructure. This goes together with the need to consider new market design options, role definitions and a critical reflection on the regulatory framework within a long-term, forward-looking perspective. This may imply rather multi-faceted output oriented approaches. “Living” dynamic efficiency, avoiding micro-management and ensuring consistency will however be crucial challenges in this context. Depending on the “maturity” of the regulatory framework and the number of regulated entities, pragmatic solutions should therefore get priority in the regulatory debate albeit being aware of potential demarcation problems. Moreover, essential shortcomings in the regulatory design such as the time-lag problem should be corrected.

Policy makers and regulators should also be aware that the paradigm shift towards smart grids will enable new players and new organizational design options. This implies that benefits of smart grids investments will accrue to different participants to the value chain in different dimensions. This requires new regulatory flexibility to integrate third parties and to internalise cost and benefits appropriately. The “fit for purpose” of the overarching market framework should be critically reflected in this context.

The approaches taken in the UK, Italy and Norway as well as the current discussions in the Netherlands are encouraging steps in this direction. In order to tackle the overarching climate targets and facilitate the paradigm shift towards smart grids it is crucial that other countries become alert, initiate the regulatory debate and follow their examples. A thorough assessment as to what extent the instruments implemented in the countries of reference would be appropriate in the German regulatory context should help in pursuing this path.

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