The introduction of quality regulation of electricity distribution in The Netherlands

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CHAPTER 7.
THE INTRODUCTION OF QUALITY REGULATION FOR ELECTRICITY DISTRIBUTION IN THE NETHERLANDS

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1. INTRODUCTION

In the 1980s and 1990s, the Dutch energy market witnessed large-scale restructuring and a significant amount of mergers and acquisitions. In 1989, production and distribution were unbundled. A year later, the number of distribution operators had been reduced from 158 to 50. The Dutch Ministry of Economic Affairs applied an integrated system of cost plus regulation, from production to distribution and supply, in which the costs of all companies were pooled. Investment decisions were dictated by technical and political rather than economic considerations.[1]

Following the arrival of a new government in 1994[2] and pushed by the European energy directives,[3] the Dutch energy market was set on the path to liberalization and regulation. Since 1998, a series of successive legal changes has transformed the system under which energy companies operate in the Netherlands. The most important ones for this paper are the following. The Dutch energy regulator DTe[4] was set up in 1998 as the national regulatory authority for electricity and gas.[5] Tariff regulation for Dutch electricity distribution networks was introduced in 2000 and for gas one year later.

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1 See De Jong, J.J. et al., *Dertig Jaar Nederlands Energiebeleid*, Clingendael International Energy Programma, Den Haag 2005, p. 354, and Köper, N., *Tegenpolen. De liberalisering van de Nederlandse energiemarkt*, Het Spectrum, Utrecht 2003, pp. 26-33.

2 The so-called purple coalition of Social-Democrats (PvdA), Conservative Liberals (VVD) and Liberal Democrats (D66).

3 Directive 96/92/EC for electricity and directive 98/30/EC for gas

4 Originally *Dienst uitvoering en toezicht Elektriciteit*, later *Dienst uitvoering en toezicht Energie*, currently *Directie Toezicht Energie*; www.dte.nl

5 DTe is not responsible for oil or district heating.

Since July 1, 2004, the Dutch energy market has been fully liberalized, three years before the final date set by the European directives. Dutch law requires legal unbundling between a network operator and other entities in a holding and specifies a system of regulated third-party access to the networks.[6] An integrated system of price-quality regulation for electricity distribution was enacted in 2004. DTe applies the legal provisions in the Dutch Electricity and Gas Acts and supervises compliance with these acts.

In 2004, total turnover of energy companies in the Netherlands was 27.6 billion euros.[7] About 7.5 and 6.8 million customers are connected to the electricity and gas networks, respectively, meaning virtually all buildings in the Netherlands are connected.[8] For gas, this means the Netherlands has the highest connection density in the EU. Over these networks, 106.5 billion kWh of electricity and 47.9 billion m^3 of gas are transported annually. Fifteen per cent of the electricity is imported, whereas 41% of the gas produced in the Netherlands is exported. With the Groningen field, the Netherlands possesses one of the largest producing natural gas fields in the world. Since most power plants in the Netherlands are gas-fired, there are strong links between the functioning of the gas and electricity markets.

Four players produce the vast majority of electricity in the Netherlands: Essent, Electrabel, Nuon and E.on, two of which are foreign-owned. Transmission is secured by the national electricity TSO TenneT, after which electricity is distributed over networks of 150 kV and below by 10 regional network operators. The three major electricity distribution network operators Essent, Continuon and Eneco cover more than 90% of the market. Around 35 licensed supply companies deliver electricity to end consumers over these networks.

In this paper, we present the form of quality regulation for electricity distribution which was introduced in the Netherlands, why this form was chosen and how it was implemented. The presentation is generally given from the perspective of the regulator. This paper is organized as follows. In section 2, the role of the Dutch energy regulator DTe is explained. In section 3 we discuss the possible methods of price regulation and make the case for the application of yardstick competition for distribution networks in the Netherlands. In section 4 the legal aspects of quality regulation are presented.

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6 For gas transportation, the first laws prescribed a hybrid system of negotiated third party access under guidelines of the regulator. When it became clear that it was difficult to negotiate with a monopolist, the legal system was changed to proper regulated third party access.

7 EnergieNed, *Energie in Nederland/Energy in the Netherlands*, Arnhem 2005. All figures in this paragraph are from this source and are for 2004.

8 The number of gas connections is lower than for electricity because in certain areas district heating is used instead of gas.

In section 5 we present the form of quality regulation that was implemented in the Netherlands, focusing on the integrated price-quality yardstick competition model. Our concluding remarks are given in section 6.

2. ROLE DTe

DTe is an independent regulator which is part of the Dutch competition authority NMa. The mission of DTe is to make energy markets function as effectively as possible. As such, its objective is to promote competition where possible. Where competition is not possible, DTe aims to achieve the same outcome as a competitive market would have generated, through a system of incentive regulation. DTe sees itself as a benevolent regulator, i.e., it aims to maximize total surplus (the sum of consumers', firms' and taxpayers' surplus) and to allocate welfare gains to consumers.

The legal instruments to carry out DTe's tasks are specified in the Dutch Electricity Act 1998 and the Dutch Gas Act, both of which are based on European directives.[9] On legislative issues, DTe is an advisor to the Dutch Minister of Economic Affairs and, through the European Regulators' Group for Electricity and Gas (ERGEG), to the European Commission. The European Commission and the Dutch Minister of Economic Affairs are responsible for the energy policy framework within which DTe works.

In order to carry out its mission, DTe is active along the whole value chain, with a particular focus on the monopoly network segments. In the production markets, DTe monitors market developments, promotes market transparency, and strives to integrate the Dutch electricity and gas markets into regional North-West European markets. In the transmission and distribution networks, DTe secures third party access and regulates transportation tariffs, system operator functions and quality of service. Finally, in the retail markets, DTe monitors market developments and supervises tariffs for household consumers, grants licences, and ensures a level playing field among other things by promoting market transparency.

In regulating energy networks, DTe has four target groups: consumers, network operators, network users, and investors. Through network regulation, DTe strives to achieve a number of goals, which vary for each of these groups. For consumers (or end users in general), the goal is to ensure they get value for money: an optimal quality of service for reasonable tariffs (allocative efficiency). In order for consumers to get value for money, the regulatory system has to give network operators incentives to

[9] For electricity 2003/54/EC, for gas 2003/55/EC.

optimize the cost-quality ratio of their services within the legal and technical constraints (productive efficiency). In particular, the regulatory system should not give perverse incentives that could lead to a deterioration of safety records in the case of gas networks. For network users, the tariffs are less important, since these are eventually passed on to consumers. The most important issue for them is to make sure there is a level playing field, in particular between integrated and non-integrated companies, for instance in getting non-discriminatory access to the grid. Finally, in order to secure the long-term viability of the energy sector in the Netherlands, a favourable investment climate is needed. In particular, the regulatory system should ensure a reasonable and predictable return on investment. It is DTe's job to balance the sometimes-conflicting interests of these four target groups. In doing so, it uses output regulation where possible, leaving operational decisions to network operators. It should be noted that distributional fairness, which is sometimes included in a regulator's responsibilities, is not a task of DTe but of the Dutch government.

Since July 2005, the Board of the NMa has been an independent administrative body,[10] ensuring its independence from political influence. In order to minimize not only the political, but also the regulatory risk, DTe uses both informal and formal means to ensure accountability. Informal accountability takes place by means of consultation with stakeholders before a decision is taken, and afterwards by explaining and justifying the decision. Consultation sessions typically focus on the interpretation and implementation of the energy laws. For example, DTe has consulted extensively in the past before introducing a system of yardstick competition. In such a consultation, network operators, network users and end consumers are invited to contribute. DTe takes their comments into account in its final decision.

The main formal accountability of DTe is to the Dutch courts. If a stakeholder does not agree with a decision of DTe, he can take recourse to the specialized court (CBB). Over the past few years, this has proven a very popular tool for both energy companies and end users' organizations. On average, DTe has won about half of these cases.

3. TARIFF REGULATION

3.1. INTRODUCTION

A significant part of the quality regulation that DTe applies is integrated with its tariff regulation. Therefore, it is important to first understand the tariff regulation of

[10] In Dutch: *zelfstandig bestuursorgaan.*

electricity distribution networks in the Netherlands, and why this form of regulation was chosen.

The main dimension along which regulatory tariff methods are classified is the power of the incentives they give to regulated firms. On one extreme is the low-powered regulation called rate of return regulation; on the other high-powered regulation in the form of a price (or revenue) cap. Models between these extremes are called incentive regulation or hybrid models.[11]

3.2. RATE OF RETURN VS. PRICE CAP REGULATION

In rate of return regulation the regulator sets yearly tariffs based on the actual cost of the regulated firms, including a regulated return on capital. Rate of return regulation, also known as cost-plus or cost of service regulation, is historically the most important form of utility regulation and is still widely used in the USA. The main disadvantage of such a scheme is that it provides no incentives for network operators to cut cost. On the contrary: since the rate of return earned is typically higher than the market cost of capital, network operators have an incentive to over-invest in their networks.[12]

To avoid such perverse incentives, many European and Latin American utility regulators use price (or revenue) cap regulation. Although this form of regulation is generally known as price cap regulation, many regulators (including DTe) use a revenue cap rather than a price cap. A revenue cap has the advantage of leaving more freedom to network operators to set individual tariffs, so that historical cross-subsidies can be phased out. In price (revenue) cap regulation, the regulator sets multi-year forward-looking tariffs (or revenues) for the network operator. Since the network operator knows his tariffs (revenue) beforehand, he has strong incentives to cut cost. Price cap regulation was first applied by the UK telecom regulator in the 1980s. The forward-looking tariffs (or revenues) are usually set by adjusting tariffs for the consumer price index (CPI) minus an efficiency factor x, which the regulator has to determine.

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[11] See Laffont, J.J., Tirole, J., *A Theory of Incentives in Procurement and Regulation*, MIT Press, Cambridge, Massachusetts (1993), pp. 1-49.

[12] The so-called Averch-Johnson effect, see Averch, H., Johnson, L.L., "Behaviour of the firm under regulatory constraints", *American Economic Review* 52 (1962), pp. 1052-1069.

Note that these two extremes[13] give different incentives because of the different links between the regulated firm's cost and its tariffs, and because of a difference in timing. Under rate of return regulation, a firm's tariffs are determined by its own, actual cost, with a relatively short delay in timing. Under price cap regulation, a firm's tariffs are de-linked from its own cost and known a number of years beforehand – hence the strong incentive.

An important drawback of both rate of return and price cap regulation is that they allocate both firm-specific and sector risks to one party. A firm-specific risk is, for instance, the risk that a new IT program which a particular firm has applied does not work out well, or the risk that a new firm director does not function well. A good example of a sector risk is new legislation for the regulated sector. Under rate of return regulation, since it is based on actual cost, cost increases caused by either firm-specific or sector risk are both paid for by consumers (the consumers are residual claimants). Under price cap regulation, the firms are residual claimants. Since the x-factor is set beforehand and not re-calculated afterwards, cost increases during the regulatory period caused by either firm-specific or sector risk are both paid for by network operators.

3.3. YARDSTICK COMPETITION

Yardstick competition is a form of incentive regulation that provides a more balanced way of dealing with risks than either rate of return or price cap regulation. Under a system of yardstick competition, the x-factor is set beforehand, based on the estimated productivity growth in the regulated sector. At the end of the regulatory period the realized productivity growth is calculated. In case the estimated and the realized productivity growth are not equal, the resulting difference in regulated revenues per network operator is carried forward to the next regulatory period. Such a system of yardstick competition provides a high-powered incentive scheme because the x-factor of a firm is de-linked from its own cost and known beforehand. However, because of the recalculation of the productivity growth and the correction of any resulting differences in revenues, taking into account the (official) interest, network operators should be neutral towards the initial estimate of the x-factor by the regulator.[14] Thus, network operators do not have to fight the regulators' estimate, but fight each other in a form of simulated competition.

[13] The forms of rate of return and price cap regulation presented here are idealized extremes, for the sake of clarity. In practice, many versions of regulation exist which combine elements of both approaches.

[14] Assuming the regulator's estimate is good enough an approximation to avoid financial distress for the network operators.

An important prerequisite to make such a system of yardstick competition work is that there should be a level playing field between the network operators involved. If not all network operators have reached the efficient level at the beginning of the regulatory period in which yardstick competition is applied, only the most efficient network operators (the peer group) are taken into account when calculating the productivity growth. Otherwise, catch-up effects would be classified as productivity gains, which could be at the expense of already efficient firms.

An important benefit of yardstick competition is that firm-specific risks are allocated to the firms and sector risks to the consumers. In order to explain how this works, we first show how yardstick competition gives incentives to the regulated companies by means of the following, simplified example.

Suppose that the set of regulated companies consists of three electricity distribution network operators A, B and C. Suppose further that A, B and C are of equal size (output) and are comparable, i.e., there are no regional differences that would allow one of the operators to charge more for the same transportation service than the other. Suppose finally that A and B are members of the peer group, i.e. they are efficient at the beginning of the regulatory period, while C is not. Let the following table represent their total cost at the beginning and at the end of the regulatory period, together with the allowed revenues for the regulatory period:

Company	**A**	**B**	**C**
Total cost beginning	100	100	110
Allowed revenues	100	100	100
Total cost end	100	95	105

Note that, since the revenues of the efficient companies A and B remain unchanged over the regulatory period, the estimated productivity growth is zero. Since A and B are members of the peer group while C is not, only their data are taken into account in calculating the productivity growth. Assuming for simplicity that their outputs do not change over the regulatory period, the productivity growth is calculated as follows:

Company	**A**	**B**	**C**
Productivity growth	0%	5%	(not relevant)
Average productivity growth	2.5%	2.5%	–
Calculated productivity growth	2.5%	2.5%	2.5%

The difference between the estimated and the calculated productivity growth has to be applied to the next regulatory period (for the sake of simplicity, we do not take into account interest in this example). Since the estimated productivity growth was zero, this amounts to applying the calculated productivity growth to the tariffs or revenues of the following regulatory period. This has the following effect on the companies' allowed revenues and additional profits (above or below the regulated WACC) at the beginning of the next regulatory period:

Company	**A**	**B**	**C**
Allowed revenues	97.5	97.5	97.5
Total cost	100	95	105
Additional profit	-2.5	2.5	-7.5

In this way, companies such as B that beat the yardstick (average productivity growth) as well as those, such as A, that do not, are given incentives by the regulatory model to become more productive. Furthermore, productivity gains are eventually passed on to consumers.

For the risk allocation, such a system of yardstick competition has the following effect. Firm-specific risks in principle do not influence the productivity growth of the sector, and therefore do not influence its re-calculation.[15] Thus, cost increases caused by firm-specific risks are allocated to the specific network operator. Cost increases caused by sector-specific risks, on the other hand, show up as part of the realized productivity growth and are thus allocated to consumers. In this way, network operators are given incentives to minimize the risks they can manage, but are not penalized for risk they have little influence on.

Because of the superior risk allocation and because it gives the right incentives for efficiency, DTe has moved from revenue cap regulation by benchmarking to a system where the revenue cap is determined by yardstick competition.[16] The yardstick competition model is based on total cost, since the trade-off between operational and capital expenditure is best made by network operators. Hence, the productivity growth

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15 An exception would be if the major firms in the peer group all happened to have suffered cost increases in the same regulatory period caused by firm-specific risks.

16 In the first regulatory period, DTe applied an input-oriented DEA-based benchmark with constant returns to scale to set the x-factors for the revenue cap. However, the system was defeated in court. For a full account of these events (in Dutch), see De Jong, J.J. et al., *Dertig Jaar Nederlands Energiebeleid*, Clingendael International Energy Programme, Den Haag 2005, pp. 337-385. See also (in German) Hesseling, D.E., 'Fünf Jahre unterwegs: Engpässe und Erfolge der Energieregulierung in den Niederlanden', *Energiewirtschaftliche Tagesfragen* 56/5 (2006), pp. 60-64.

is measured by the change in total cost over standardized output for all firms in the peer group during the regulatory period.[17]

In order to guarantee comparability of the data, DTe has issued regulatory accounting rules, which prescribe the way in which network operators have to report, including e.g. depreciation periods. Regional differences between network operators, such as differences in the composition of the soil, different population densities or different numbers of water crossings, are investigated during the current regulatory period. If any of these are found to be objective and significant, they are taken into account in the next regulatory period.

4. LEGAL ASPECTS OF QUALITY REGULATION

Since July 2004, quality issues have been dealt with in more detail by the relevant Dutch legislation. Before these legal changes, the Electricity and Gas acts merely stipulated that system operators had the task of safeguarding a secure and reliable distribution system in the most efficient way.[18] Also, network operators were obliged to compile plans to indicate that they would have sufficient capacity in the near future. Finally, system operators had to register the interruptions in their network.

In July 2004, a new legislative package was passed in the Dutch Parliament. Its aim was to implement the new European energy directives,[19] as well as to strengthen the grip on network operators. In particular, the law introduced a quality component into the system of yardstick competition for distribution networks, extended the capacity planning to include planning of quality, and set stricter rules for the registration of interruptions.[20] Now, the legal yardstick competition formula is the following:

$$AR' = (1 + cpi \pm \times + q)\ AR\ ,$$

where AR stand for allowed revenues, cpi is the consumer price index, x the efficiency factor, q the quality factor and ' indicates the next regulatory period.

17 Total cost is defined as OPEX plus depreciation plus WACC times Regulatory Asset Base; standardized output as billed volumes times weighted average sector tariffs. For more details (in Dutch), see DTe (15/9/2003), *Besluit tot vaststelling van de methode van de korting ter bevordering van de doelmatige bedrijfsvoering ingevolgde artikel 41, vierde lid, van de Elektriciteitswet 1998,* www.dte.nl, in particular Appendix A.

18 Article 16 Electricity Act and Article 10 Gas Act.

19 For electricity directive 2003/54/EC, for gas 2003/55/EC.

20 Articles 41, 41a, 41b, 21 and 19a Electricity Act and 81, 81a , 81b, 8, and 35a Gas Act, respectively.

Following these legal changes, network operators have to control the quality of their networks in three ways: by means of indicators of the past situation, by means of quality control systems on how to maintain the current quality, and by means of quality plans on how to achieve the desired level of quality in the future. The quality indicators have to be reported annually to the Dutch competition authority, which can investigate the registration process. The quality plans have to start from a comprehensive assessment of the current transport situation, including bottlenecks, and have to specify which means, including financial ones, the network operators will use to address those.

The law specifies that secondary legislation will be developed on both the quality control and quality registration process, including the possibility of certification. Following these legal changes, a Ministerial Decree was adopted on the registration of quality indicators and the system of quality control for distribution network operators. Finally, DTe made changes to its technical codes (network code and system code) to accommodate the new legal environment.

5. QUALITY REGULATION IN PRACTICE

5.1. INTRODUCTION

The main dimensions of quality for distribution network operators are safety, continuity of supply, technical quality of the commodity, customer service and environmental impact. For gas distribution, safety is by far the most important aspect of quality. Therefore, although the general legal framework and economic considerations are similar for electricity and gas distribution, quality regulation for gas distribution differs significantly from that for electricity. In what follows, we restrict ourselves to quality regulation for electricity distribution, focussing on the quality dimension continuity of supply.[21]

Because of the cost-plus regulation of distribution networks in the past, Dutch network operators have invested significantly in their assets. Figure 1 shows that this investment climate has resulted in a relatively high quality of Dutch electricity networks, since the Netherlands had, after Latvia, the lowest average interruption duration per customer in the year 2004.

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21 For more information on quality regulation for gas distribution (in Dutch), see DTe (2003), *Informatie- en consultatiedocument Kwaliteitsregulering Gasdistributie Nederland* and DTe (2003), *Standpuntendocument Kwaliteitsregulering Gasdistributie Nederland*.

Figure 1. Average interruption duration in the year 2004 (in minutes per customer)[22]

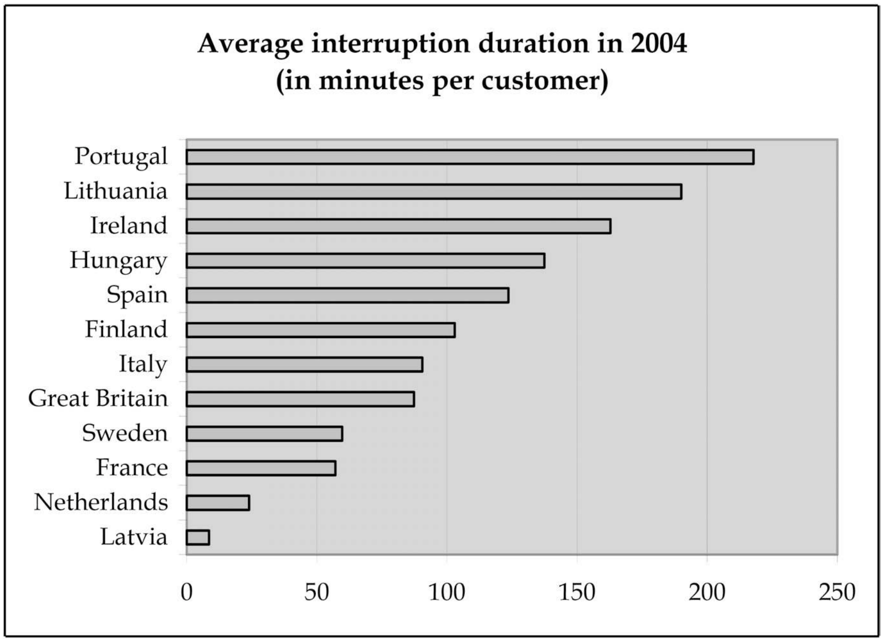
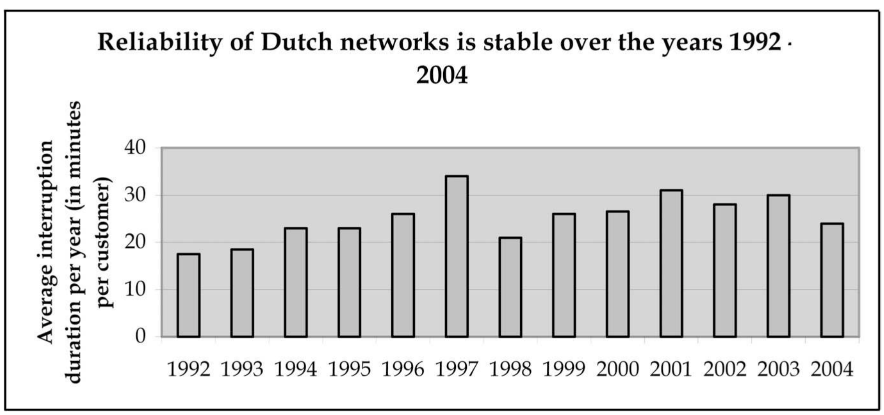


Figure 2. Reliability of Dutch networks over the years 1992-2004[23]



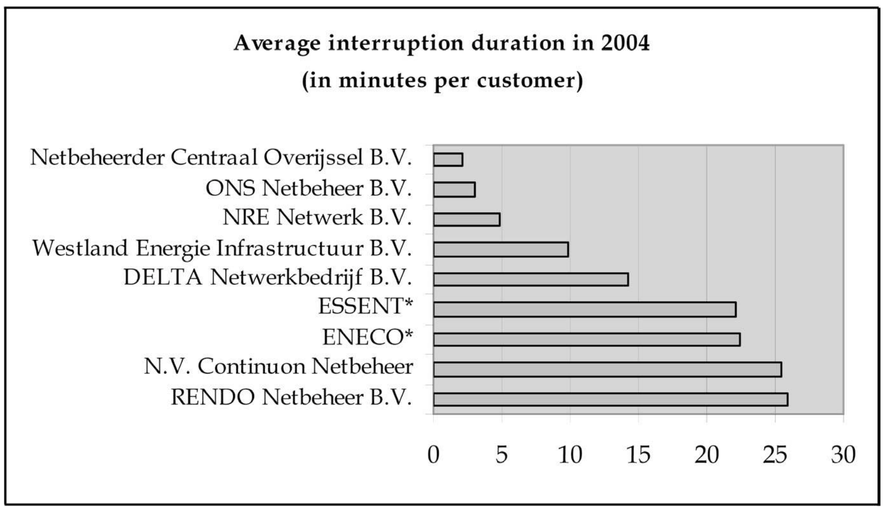
[22] Source: CEER, *3rd Benchmarking Report on Quality of Electricity Supply*, December 2005. Extract from Table 3.2: Unplanned interruptions of low voltage networks, Minutes lost per customer per year (1999–2004).

[23] Source: KEMA, *Betrouwbaarheid van elektriciteitsnetten in Nederland. Rapportage over netten van 0,4 kV tot en met 150 kV*, various years, and annual report NMa/DTe 2004.

The high reliability of the networks of the Netherlands in 2004 is not an exception. The Dutch networks have been providing stable continuity of supply to its customers for many years. This is shown in figure 2. The average interruption duration over the period 1992–2004 was about 25 minutes per customer (per year).

These figures can vary significantly between the different network operators, as is shown in figure 3 below for the year 2004. However, it should be noted that small firms (such as the four with the best scores and the one with the worst score in 2004) show larger volatility in average interruption durations between different years, because a single interruption affects a relatively higher number of its customers.

Figure 3. Average interruption duration in 2004[24]



With the introduction of incentive regulation, the (favourable) investment climate changed. DTe started the implementation of yardstick competition by introducing cost incentives. Focusing solely on cost cutting, however, gives network operators perverse incentives, since costs could be lowered by cutting the investment, maintenance or personnel needed to achieve a proper level of network quality. As Shestalova has shown, a yardstick competition scheme that does not penalize network failures is suboptimal and leads to underinvestment.[25] Therefore, quality regulation is needed

[24] Source: Annual report 2004 NMa/DTe, p. 100. For firms consisting of several network operators (indicated by the asterisk *), the average interruption duration is weighted by the number of customers for each operator in the same holding.

[25] V. Shestalova (2002), *Essays in Productivity and Efficiency*, CentER dissertation series, Tilburg, pp. 75-98.

in order to complement price regulation. In this way, network operators are given incentives to provide not only an efficient, but also a reliable transport service.

The regulation of quality sets the preconditions for an optimal quality of service, but leaves the end responsibility with the network operators. In this respect, it should be pointed out that lower quality in terms of interruptions is often primarily caused by digging activities by third parties. However, also in this respect network operators can be seen as being responsible for preventing digging accidents from happening and/or for punishing those that were responsible for the digging works.

Shestalova has shown that the socially optimal outcome can be achieved by introducing penalties for undersupply equal to the value of the associated losses as perceived by the consumers, assuming both network operators and consumers are risk-neutral.[26] In what follows, we present the way in which DTe has introduced such a scheme for electricity distribution, based on output regulation. However, such a scheme is unlikely to cover all aspects of quality or to function perfectly from the beginning. Furthermore, there is an important time lag: some effects of (lack of) action on quality take years to materialize at the output level. Therefore other, complementary measures on quality regulation are needed, which we first present below.

5.2. LEVELS OF QUALITY REGULATION

In general, quality can be regulated at input, process or output level.

Input regulation
Input is regulated through technical codes which prescribe quality requirements for the networks. A well-known example is the N-1 requirement, which prescribes that the Dutch electricity TSO TenneT has to be able to maintain a functioning network even if one of its nodes is missing (by damage or for maintenance). Other requirements include a frequency requirement, which allows a small deviation from 50 Hz. In addition, DTe has the power to set additional requirements.

Process regulation
Distribution network operators have the legal obligation to compile capacity and quality plans. These plans give an indication whether the operators will be able to reach and maintain a certain level of quality in the future. DTe evaluates these plans. Furthermore, there are legal prescriptions on the way in which network operators

[26] Ibidem.

register the interruptions in their network. Finally, the Minister has the power to intervene in specific cases if necessary.

Output regulation
Output is regulated by looking at the quality delivered by network operators to end users. The main indicators are the number and duration of interruptions. The basic idea is that end users should be compensated for these interruptions. The main instruments to regulate quality by its output are liability, standardised compensation, and tariff regulation through a q-factor. In what follows, these are explained in more detail.

5.3. OUTPUT-BASED QUALITY REGULATION

Liability
Where liability is used as a means for regulating the quality of the network, a network operator can be taken to court for not performing up to standard. In order to avoid such a case, the network operator has to negotiate with users who have experienced interruptions because of network failures. The advantage of such a system is that through these negotiations, a market price will be set for the encountered damage. Big users, e.g. large businesses, could use the liability instrument because the costs of lawsuits could be smaller than the eventual price that a network operator will have to pay for the encountered damage. However, for large numbers of small interruptions, liability is not a suitable instrument.

Standardised Compensation
Standardised compensation means that users who experience a certain degree of interruption are paid a standard amount of money. For example, the Dutch technical codes specify that a household receives €35 from its network operator if the duration of an interruption exceeds four hours.[27] The advantage of such a rule is that it is clear for all parties involved, including customers. However, following this rule, users who experience an interruption with a duration of less than four hours do not receive any compensation. This means that network operators are given incentives to keep interruption durations under four hours, and once the four hours have passed, they do not receive any further incentives. Furthermore, the administrative burden for the network operators is relatively high. From the point of view of incentive regulation, therefore, this is a sub-optimal form of output regulation.

[27] Paragraph 6.3 of the Netcode.

Quality regulation through a q-factor

In a system of quality regulation through a q-factor, the tariffs of all users of a network are adjusted based on the average delivered quality of the network.[28] The aim of such a system is to give an incentive to network operators to find the optimal quality level, where the cost of an additional investment in quality equals the (average) value of the additional quality as perceived by end users. In a similar way to the x-factor in a tariff yardstick competition model, network operators compete with each other on quality. Any differences between the estimated and realized q-factors are taken into account in the next regulatory period. The advantage of such a model is that it gives correct incentives to network operators. The disadvantage is that customers who have not encountered any damage are also compensated, and that it is more difficult to understand than liability claims or standard compensations.

In what follows, we will explain the way in which DTe has set up a system of output regulation for quality based on a q-factor.

5.4. SETTING THE Q-FACTOR

The introduction of a q-factor in the Dutch regulatory framework did not happen overnight. There was intensive interaction with the network operators before the implementation of the q-factor in the second regulatory period (from 2004 onwards). As early as the end of 2002, DTe communicated its intention to introduce yardstick competition for distribution network operators, which included both a cost and quality component.[29] In order to implement such a quality component of regulation, two types of information are needed: the cost of quality investments and the valuation of quality by end users. Since the former are known to network operators, DTe initiated a large-scale study on customers' valuation of continuity of supply. The study was executed by *Stichting voor Economisch Onderzoek (SEO),* an academic consultancy. The main question SEO had to answer was how customers in the Netherlands valued a unit of interruption duration. In order to get representative answers, the study involved more than 12,000 households and 2,500 small businesses.[30]

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28 In the Dutch case, the q-factor only applies to low-voltage networks (50 kV and below).

29 DTe*, Informatie- en consultatiedocument Maatstafconcurrentie* (2002), www.dte.nl.

30 The method for this quantification is based on the report of Stichting voor Economisch Onderzoek '*Op prijs gesteld, maar ook kwaliteit*', Baarsma et al., 2004.

Box 1. Method of analysis SEO

What is the perceived value of a unit of interruption duration for Dutch customers? SEO used the method of conjoint analysis to answer this question. Following this methodology, respondents are not asked directly how they value an interruption, since in that case they could answer strategically to protest against interruptions in electricity supply.
Instead, SEO gave respondents cards describing situations characterised by different lengths of interruption durations and frequencies of interruptions. Each card also has a financial attribute. For example, in the summer on a Wednesday afternoon you experience an electricity interruption of two hours. In return, you receive compensation of 5% of your electricity bill. The respondent is asked to give a mark for each card that is presented to him. The higher the mark, the more the respondent accepts the financial compensation for the given situation.[31]

From autumn 2003 until summer 2004, DTe and network operators interacted on a monthly basis to discuss the methodology of the quality component, based on draft SEO reports. At the end, SEO presented results that could be used to set up a detailed methodology. For example, the value of the continuity of supply was differentiated for each day of the week as well as for every season. In addition, the value was different for households and small businesses. Network operators were sceptical about the administrative burden they might face in order to implement this methodology. Eventually, DTe and the network operators agreed to implement a less complex method: continuity of supply was only valued differently for households and small businesses. The main reason for DTe was that the other differentiations had a relatively small effect on the revenues of network operators. It turned out that a weighted average valuation of interruptions would suffice for the purpose of this regulation.

In order to establish a q-factor, continuity of supply is defined by the international quality indicator System Average Interruption Duration Index (SAIDI). In the system of yardstick competition, the quality of a firm's network is compared to the average quality of all electricity distribution networks in the Netherlands. Any deviation from the average quality is valued at 22 eurocents per minute per customer.[32]

31 For more information (in Dutch) on the method used by SEO, see B.E. Baarsma et al., 'Net goed: prijs van de kwaliteit van het elektriciteitsnet', *ESB* 25/6/2004, pp. 298-301.

32 The calculation of 22 eurocent per minute per customer for an interruption duration is based on the method described in Appendix A of DTe (12/10/2004), *Besluit tot vaststelling van de methode tot vaststelling van de kwaliteitsterm ingevolgde artikel 41, eerste lid, van de Elektriciteitswet 1998 voor de jaren 2004 tot en met 2006*, www.dte.nl.

Deviations from the average quality level are incorporated in the tariffs for all end users through a q-factor. The q-factor is the degree of change in the next year's revenue of a firm compared to that of the year before. A positive q-factor of, e.g., 5 means that a firm's revenue may increase by 5%.[33] Network operators with a higher than average quality receive extra revenues through higher tariffs, because the q-factor is positive. Similarly, network operators with less than average quality will have to lower their tariffs, because the q-factor is negative.

Such a method of regulation only works if the interruption data provided by network operators are administrated correctly and are comparable. Network operators have registered and compared interruption data on a voluntary basis since the 1970s. Over the last few years, all network operators have reported these data to DTe. Currently, the primary and secondary legislation prescribe the way in which network operators have to register interruption data.[34] Since the beginning of 2005, network operators have been obliged to guarantee the quality of their registration processes, for instance through certification. This was needed in order to avoid firms with better registration processes being punished through relatively higher measured interruptions. On top of that, at the insistence of DTe the joint network operators introduced a national telephone number in 2004 for consumers who experience interruptions. A database is kept of the logged calls. In this way, DTe can verify the number (but not the duration) of interruptions.

The instrument of quality regulation through a q-factor is illustrated by the following, simplified example. Suppose that the set of regulated companies consists of three electricity distribution network operators A, B and C with the same characteristics as in section 3.3. In addition, suppose that during the same regulatory period as in section 3.3 the average SAIDI and the average number of customers are as illustrated below.

Company	A	B	C
SAIDI (minutes)	20	30	25
Number of customers	1	1	1

Then, the average SAIDI is 25 minutes ((20+30+25)/3)[35] per customer. In this example company A would receive additional revenues of 1.1 ((25-20)*22 eurocents),

33 Because the revenues of year t equal the revenues in year t-1 multiplied by (1+cpi-x+q) a q-factor of 5 is not exactly an increase of 5% in the revenues. This would be the case if the revenues in year t-1 would be multiplied by (1+cpi-x)*(1+q).

34 Paragraph 6.1 of the Netcode.

35 The average would normally be weighted by the number of end users. Since in this example A, B and C have the same number of end users, an unweighted average yields the correct result.

company B would have a cut in its revenues by 1.1 (25-30)*22 eurocents), while company C would not receive any more or less because of its quality level. The q-factor can simply be calculated by the ratio of these gains and the allowed revenue. This is illustrated below.

Company	A	B	C
Additional revenues through quality	1.1	-1.1	0
Allowed revenue	100	100	100
q-factor	1.1	-1.1	0

When these results are combined with the result of additional profits for productivity gains from section 3.3 it can be concluded that it is worthwhile for a company to manage its quality level. As can be seen in this example, a company that has profits because of high productivity (company B) can lose profits if its quality level is below average.

Company	A	B	C
Additional profit by productivity	-2.5	2.5	-7.5
Additional profit by quality	1.1	-1.1	0
Combined profit	-1.4	1.4	-7.5

Quality regulation through a q-factor is a good complementary measure to the standardised compensation for interruption durations of less than four hours. Because the marginal costs of a reduction in interruptions is set equal to the (average) valuation that society gives to such a quality improvement, it gives proper incentives to the network operators. Furthermore, the administrative burden for the network operators is relatively low. The downside is that an individual user receives an average amount of compensation for his network's performance, regardless of whether he has actually experienced this average, and that it takes a number of years before the financial incentive actually applies.

6. CONCLUDING REMARKS

One cannot regulate price without influencing quality. Therefore, both legislators and regulators should take the regulation of quality explicitly into account. Since a network operator is generally in a better position to make operational decisions than a regulator, price and quality regulation should be based as much as possible on output.

Furthermore, such regulation should give incentives to network operators to maximize the total surplus. Since price and quality are mutually dependent, the best way to provide such incentives is through an integrated regulatory system for price and quality. In the Netherlands, DTe has introduced an integrated price-quality yardstick competition model for electricity distribution.

Such a system can work for electricity because the quality indicator SAIDI is relatively easy to measure and generally accepted. Furthermore, there is some degree of freedom for network operators to try and find the optimum price-quality level. For gas distribution, the situation is clearly different. There, the main indicators are the number of explosions and the number of lethal leakages, and the optimum for both is simply zero.

Even in electricity distribution, there is a need for a gradual and careful approach. The indicator used does not catch all aspects of quality, there is a time lag before lack of investment becomes clear at the output level, and it is not clear that the valuations that consumers give in an initial study really reflect their preferences. Therefore, additional quality regulation is needed on input, process and output, both *ex ante* and as a potential last resort through direct intervention.

Finally, it should be pointed out that in our experience, regulating an energy market is in general more a matter of the process of regulating than of a perfect system of regulation that can be applied once and for all. Circumstances change quickly, both in the market and legally, and there are significant lessons to be learnt for all parties involved – not least for the regulator.