Council of European Energy Regulators

Working Group on Quality of Electricity Supply

QUALITY OF ELECTRICITY SUPPLY: INITIAL BENCHMARKING ON ACTUAL LEVELS, STANDARDS AND REGULATORY STRATEGIES

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Autorità per l'energia elettrica e il gas

FOREWORD

On January 2000, the Council of European Energy Regulators (CEER) formed a Working Group on Quality of Electricity Supply, aimed at comparing quality levels, standards and regulation strategies for electricity supply in European countries.

The main objectives to be achieved by the Working Group were defined as follows:

1. Comparing strategies and experiences in implementing quality of service regulation in each country represented in the Working Group.
2. Identifying of the quality of service indicators/standards used in each country; description of the way information is collected and standards are computed; selection of possible standards that could be used for comparison of utilities from different EU countries.
3. Performing a first benchmarking study on quality of service.
4. Identifying of possible recommendations to be made to international bodies concerning quality of service benchmarking studies.

The following outputs of the Working Group were proposed:

1. Identification of quality of service indicators/standards used in each EU country. Description of the way information is collected and standards are computed. Selection of the indicators/standards to be used in the first benchmarking study.
2. Year 2000 quality of service benchmarking study.
3. Recommendations of the joint Working Group for improving the reliability of future benchmarking studies.

Identification of the regulatory bodies interested in participating in the Working Group was completed in February 2000, and activities started the following month. In April a meeting was held in The Hague to share information on quality of supply standards and regulation in each country, and to define the work programme. At the end of September 2000 a second meeting was held in Oslo to discuss the draft final report, that was submitted to the CEER in the Florence meeting, November 2000. On the draft final report comments and suggestions have been collected by all the CEER members. The final version has been approved in the CEER Lisbon meeting, December 2000.

PARTICIPANTS

Officials from Italy, The Netherlands, Norway, Spain, Portugal, United Kingdom and the European Commission actively participated in the activities of the Working Group. Participants were as follows:

• Roberto Malaman (Chairman)	AEEG	Italy
• José Afonso	ERSE	Portugal
• Rudi Hakvoort	DTE	The Netherlands
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• Arturo Romero	CNE	Spain
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• Bonifacio Garcia-porras	EC/DG-TREN	European Commission (observer)

The report is the result of the joint activity of all participants.
Chapters of the report were written by:

Introduction:	Roberto Malaman
Chapter 2 and Annex 2:	José Afonso
Chapter 3 and Annex 3:	Luca Lo Schiavo
Chapter 4 and Annex 4:	Ruud Vrolijk
Annex 1:	Arturo Romero
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Participants thank the CEER Chairman Jorge Vasconcelos and CEER members for their active role in promoting the Working Group and their interest in its activities.

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EXECUTIVE SUMMARY

The Council of European Energy Regulators Working Group on Quality of Electricity Supply has been set up to consider how quality of supply is regulated in EU countries. After identifying Group members in February 2000, the Group has met twice, in April and September 2000. Its objectives were:

- Comparing strategies and experience in implementing quality of service regulation;
- Identifying and describing quality of service indicators and selecting possible comparators;
- Performing a first benchmarking study on quality of service; and
- Identifying possible recommendations to international bodies about quality of service benchmarking.

The Group has achieved some but not all of its objectives. It has identified that each of the countries which participated in the Group has a broadly similar approach to the types of standards used to define quality of service. These include commercial quality standards relating to customer service; continuity of supply quality standards which mainly related to the reliability of electricity supply; and some voltage quality standards which define the level of quality of the delivered product.

The concepts of Guaranteed standards of performance (which relate to individual service delivery and carry a penalty payment) and Overall standards (which govern overall target performance for a service item) are widely used in Group member countries. Nevertheless, there are significant differences between countries in the definition of standards and the required performance levels.

Continuity of supply monitoring is carried out in most countries but the definitions and standards of reporting differ considerably. As a result it has not been possible to perform accurate benchmarking studies on continuity of supply indicators. The crude comparisons which are possible indicate significant differences in performance between countries. Some of these may be attributable to exogenous factors like geography, customer density and network configuration. Further work is needed on how regulators can establish the value which customers place on continuity of supply.

Voltage quality is not as heavily regulated as commercial quality and continuity of supply in any of the Group members countries. The Group identified a need for further work to facilitate the development of appropriate international standards in future.

The Group recommends enlargement of Group membership, along with further work on transparency and consistency of reporting on quality issues.

1.1 What is quality of electricity supply?

Quality provided to final customers in the supply of electricity results from a range of quality factors. These arise from different sectors of the electricity industry. This report focuses on those quality dimensions which are linked to distribution and supply.

Quality of service in electricity supply has a number of different dimensions, which can be grouped under three general headings: commercial relationships between a supplier and a user; continuity of supply; and voltage quality.

- *Commercial quality* concerns the quality of relationships between a supplier and a user. It is important to a potential customer before selecting a supplier, and starts from the day the customer asks for information or makes a request to be connected to the network. Commercial quality covers many aspects of the relationship, but only some of them can be measured and regulated through standards or other instruments. Standards can relate to the overall provision of services (often called Overall standards) or to the delivery of services to individual customers (often called Guaranteed standards); Guaranteed standards are usually associated to some kind of reimbursement to the user in the event of non-compliance. Standards can be defined, for example, in terms of the maximum time to provide supply, metering, reading and billing, information supply, telephone enquiry responses, appointments, customers' complaints, emergency services and others.
- *Continuity of supply* is characterised by the number and duration of interruptions[1]. Several indicators are used to evaluate the continuity of supply in transmission and distribution networks. Regulation can aim to compensate customers for very long supply interruptions[1], keep restoration times under control and at create incentives to reduce the total number and duration of interruptions (and disincentives to increase them). Different methods and accuracies of measuring interruptions and in assigning liability for each of them create problems in regulating continuity of supply.
- *Voltage quality* is becoming an important issue for distributors and customers in some countries, both because of the sensitivity of end-user equipment and the increasing concern of some end-users. Industrial equipment is claimed to have be-

1 Electric system reliability also depends on "adequacy", i.e. the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and unscheduled outages of system facilities (definition from NARUC, the U.S. National Association of Regulatory Utility Commissioners). Adequacy problems are not discussed in this report.

come more vulnerable to voltage distortion, while at the same time the use of electronic devices in homes and small businesses has increased the sensitivity of a greater number of users. The main parameters of voltage quality are frequency, voltage magnitude and its variation, voltage dips, temporary or transient overvoltages and harmonic distortion. European Standard EN 50160 lists the main voltage characteristics in low and medium voltage networks, under normal operating conditions.

Each user has his own particular preferences for quality factors, depending on his circumstances. Some users have said "Reliability is the key component of all our sourcing. ... Cheap electricity that does not arrive has no value[2]". Some industrial users accept planned or unplanned interruptions against price reduction. Some quality factors can be varied for individual customers, while others are not individually adjustable and can only be measured and regulated at the system level.

1.2 The importance of quality of supply regulation

Economic regulation of utilities usually focuses on price regulation, with relatively less attention to performance standards and social obligations. On the other hand, technical rules are not generally concerned with economic aspects and cost-efficiency. The linkage of economic and technical regulation after liberalisation presents a challenge for regulators.

Price regulation involves different incentives for quality of supply. In rate-of-return regulation, companies usually define their own investment and quality levels. According to economic theory, this should create an implicit incentive to over-invest[3] in quality and no incentive towards cost-efficiency. In practice excess quality does not seem to be the main effect of rate-of-return regulation; an imbalance between different aspects of quality may sometimes arise, not necessarily reflecting customer preference, but rather the preferences of system operators.

Simple price-cap regimes could incentivise a regulated company to reduce its quality of supply by cutting investments, maintenance, or personnel with the aim of increasing its profits. Both rate-of-return and price-cap regulation have therefore to be accompanied by some kind

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2 J. T. Ewing (Procter & Gamble) *Is Anyone Listening?*, in A. Faruqui and R. Malko (eds.), "Customer Choice: Finding Value in Retail Electricity Markets", PUR, Virginia, 1999, page 137.

3 Over investment under rate-of-return regulation is usually mentioned as Averch-Johnson "over capitalisation" effect (see H. Averch and L. Johnson, *The behaviour of the firm under regulatory constraints*, in "American Economic Review", 52, December 1962).

of regulation of quality of supply, with the aim of avoiding distorted or excessive investment in the former case, and to prevent a decrease of quality in the latter. Regulation can also encourage appropriate changes in quality in response to customer demands.

Utility regulation must include a clear definition of the "product" supplied to the customer; price regulation without quality regulation may give unintended and misleading incentives to quality levels. Some authors claim to have found evidence to suggest a fall in quality following the introduction of price-cap controls where no specific provision was made for quality regulation[4]. Quality incentives can ensure that cost cuts are not achieved at the expense of lower quality. This is particularly important as some aspects of quality have a long recovery time after deterioration. For this reason, quality regulation should be introduced at restructuring or during price control reviews to avoid unexpected quality reductions.

For the reasons given above, Performance-Based Regulation[5] frequently includes quality incentives, even where price regulation was originally introduced without quality-saving or quality-promotion mechanisms.

Quality of service regulation is a governmental responsibility in some countries like Spain and Portugal; in other countries it is among the responsibilities of independent regulators.

1.3 Principles and mechanisms for quality regulation

Economic theory suggests that perfect incentives for quality would arise where prices adjust continuously to the level of quality supplied. In theory this result can be reached by incorporating a quality-sensitive factor in the price-cap formula[6]. However, this solution is impossible to implement for all relevant quality factors[7] and does not guarantee a minimum quality level to consumers. As a result regulators use a wide range of other mechanisms. The most commonly used are:

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4 See section 4 in L. Rovizzi and D. Thompson, *The Regulation of Product Quality in the Public Utilities*, in M. Bishop, J. Kay, C. Mayer (eds.), "The Regulatory Challenge", Oxford University Press, Oxford and New York, 1995.

5 Performance Based Regulation (PBR) is any rate-setting mechanism which attempts to link rewards (generally profits) to desired results or targets. PBR sets rates, or components of rates, for a period of time based on external indices rather than a utility's cost-of-service.

6 See for example J. Vickers and G. Yarrow, *Privatisation: An Economic Analysis,* Cambridge University Press, 1988.

7 See V. Foster, *Non-price issues in utility regulation: performance standards and social considerations*, Lecture to the International Training Program on Utility Regulation and Strategies, PURC, University of Florida, June 1999.

- comparative publication of quality performance between companies, or yardstick competition to stimulate competitive behaviour. Yardstick competition requires clear and detailed rules for measurement methods and data;
- overall and guaranteed standards of performance;
- economic penalties if standards are not met. Penalties have to be high enough to create an incentive to maintain standards, and can be paid to affected customers or into a fund for quality promotion programmes;
- other sanctions like written warnings, licence modification or licence withdrawal;
- tariff reduction or other economic penalties which affect companies' revenues or profits. Performance indicators used for Performance-Based Regulation can be introduced in the price-cap formula by using a specific Q factor and may include different quality factors, consumer satisfaction indices or employees' health and safety indicators[8];
- incentives to promote step changes in quality levels.

Quality of supply regulation should focus on those dimensions of service quality which are:

- important to consumers;
- controllable by firms; and
- measurable by regulators.

Importance to consumers can be measured through quality satisfaction surveys and information on quality requirements from different customer groups.

Responsibility for commercial quality, continuity of supply and voltage quality is a central issue because the final quality level for consumers usually reflects the behaviour of several players; regulators should clearly distinguish responsibilities of all players and use appropriate instruments for each of them.

Performance can be measured at the local or national level; regulated companies normally perform measurements, while the regulatory body sets measurement rules and checks measurement procedures.

Modern quality regulation strategies tend to focus on outputs (effects on customers) rather than input or expenditure. Regulatory bodies should not intervene in choosing technical solutions or deciding investment plans; if outputs are measurable the regulator should focus on them. If outputs are regulated, suppliers' balance sheets could benefit from cost efficiency in quality management. In this way, quality management has become a strategic issue for electricity suppliers.

8 Consumer satisfaction indexes and employees' health and safety indicators are used or are proposed to be used in some U.S. States.

Quality standards should reflect users' preferences and requirements, and their willingness to pay for quality. Consumers' willingness to pay can be estimated but results tend to be variable, depending on the methodology adopted[9].

Quality regulation is usually based on seeking a reasonable balance between costs and benefits from the information available to regulators, remembering that costs may be heterogeneous for companies and geographical areas, while benefits for users can be individually differentiated. Quality regulation must be regularly monitored and reviewed. Standards should be periodically adjusted if necessary. Penalties and incentives must also be reviewed, usually at the same time as price control reviews.

1.4 Quality regulation and competition

Competition is replacing monopoly in some sectors of the electricity industry. Transmission and distribution of electricity are natural monopolies, while generation and supply can be open to competition. Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity accelerated the liberalisation of supply for eligible customers. In some European countries all customers can choose their supplier of electricity or will be able to do so in a few years.

According to the Directive, "...Member States may impose on undertakings operating in the electricity sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and to environmental protection. Such obligations must be clearly defined, transparent, non-discriminatory and verifiable..." (Article 3.2).

While Performance-Based Regulation has been applied to vertically integrated utilities in the past, during the transition to retail competition the focus of regulation should shift away from generation-related objectives such as improved power plant performance, and consider transmission and distribution related objectives such as quality of service and least-cost T&D planning[10]. In some European countries Performance-Based Regulation and liberalisation have been introduced together. Regulation of transmission and distribution quality factors can change after the opening of the electricity market to competition.

9 The problem is widely discussed by environmental economists, which are trying to use techniques such as hedonic prices, contingent valuation and others to estimate the value of environmental damage or environmental resources to be used as a guidance for policy makers.

10 Performance-Based Regulation under liberalisation is widely discussed in B. Biewald and others, *Performance-Based Regulation in a Restructured Electric Industry*, Report to the NARUC, Washington, November 1997.

According to the European Commission, "Where liberalisation – particularly at the domestic level – has taken place, experience indicates that such standards increase for two reasons. First, the grant of a license to sell electricity is always made subject to conditions. Some of the conditions provide minimum service standards. National regulators, year-by-year, increase and expand their standards. Second, as service standards represent one important area upon which companies compete, competition leads to their improvements. This results in standards increasing above those minimum levels set by regulators or governments. Thus, the legislative framework within which the progressive liberalisation of the electricity and gas industry is taking place in Europe has the dual objective of lowering prices and maintaining and even increasing services of public interest. Experience clearly demonstrates that with, where necessary, appropriate regulatory measures in place, such services of public interest can not only be maintained, but increased in a competitive market place"[11].

Where market competition replaces monopoly regimes, quality competition should replace quality regulation. Complete withdrawal of the regulator is not usually possible because while some quality factors can be individually negotiated, others cannot. Some quality factors are linked to safety or can generate environmental externalities, so that public service obligations may be relevant.

Finally, quality competition requires transparency and comparability. The regulator can help consumers to choose by increasing the degree of available information from organisations which contribute to delivering quality to customers.

1.5 Scope and structure of the report

Commercial quality, continuity of supply and voltage quality are considered in chapters 2, 3 and 4. Each of these chapters contains a description of relevant quality factors, initial benchmarking of quality actual levels, standards introduced by regulators, and comparison of specific regulatory approaches and national strategies. The effects of liberalisation on quality regulation are noted when relevant.

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11 Communication from the Commission *Services of general interest in Europe,* COM/2000/0580 final, September 2000, Annex I.

Chapter 5 contains the conclusions reached by the Working Group against each of the four objectives of the terms of references, and some suggestions for next steps.

Annex 1 contains basic statistics on national electricity systems. Benchmarking tables on quality standards are presented in annexes 2, 3, and 4 respectively for commercial quality, continuity of supply and voltage quality. Annex 5 gives an insight into existing studies regarding the value which customers place on quality.

2. COMMERCIAL QUALITY REGULATION

2.1 Commercial quality main factors

Commercial quality is directly associated with transactions between companies and their customers. The transactions include not only the sale of electricity, but also the contacts that are established between companies and new or existing customers. Before the beginning of supply, several transactions occur between a potential customer and a company. These and later transactions during the contract can be made subject to a set of relevant quality factors which determine a company's performance.

Commercial transactions between a company and a customer may be classified as follows:

- Transactions related to conditions of supply like information about connection to the network and prices associated with the supply. These transactions occur before the supply contract comes into force.
- Transactions which occur during the contract validity and which are implicitly purchased with the product itself, such as billing, payment arrangements and response to customers' queries and claims. These kind of transactions can be divided into regular and occasional transactions. Regular transactions refer to transactions like billing and regular meter readings. Certain transactions between company and customer are only occasionally necessary, when the customer has a reason to contact the company with a query or a complaint. The quality of these transactions can be measured by the time taken for the company to respond but other important factors include how the matter was handled and if it was settled satisfactorily.

Table 2.1 indicates some of the transactions that are usually associated with standards adopted in several countries.

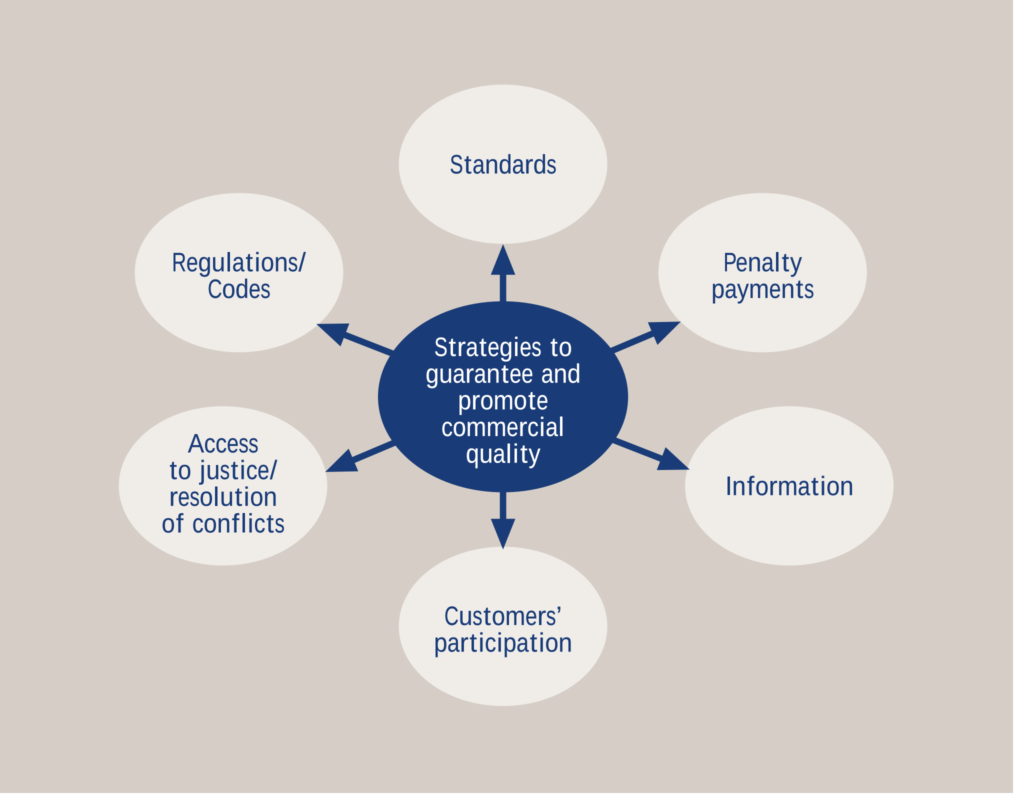
TABLE 2.1 MAIN TRANSACTIONS BETWEEN COMPANIES AND CUSTOMERS		
TRANSACTIONS BEFORE SUPPLY	TRANSACTIONS DURING CONTRACT VALIDITY	
	REGULAR TRANSACTIONS	OCCASIONAL TRANSACTIONS
• Connection (supply and meter)	• Accuracy of estimated bills	• Responding to failure of supplier's fuse
• Estimating charges*	• Actual meter readings	• Voltage complaints
• Execution of works*	• Service at customer centres	• Meter problems
	• Telephone service	• Queries on charges and payments
		• Appointment scheduling
		• Responding to customer's claims
		• Responding to customer's letters (information requests)
		• Estimating charges*
		• Execution of works*

* Applicable to both types of transactions

A complete list of existing standards in each country is given in Annex 2. This shows that in every country the largest number of quality of service standards is associated with occasional transactions that occur during contract validity.

2.2 Strategies to guarantee and promote commercial quality

Analysis of the information collected indicates some common themes of quality of service regulation in the six countries reviewed. The following diagram shows six aspects of quality of service regulation that have an important role in guaranteeing commercial quality.



Regulations / Codes

Commercial quality is ensured by the use of regulations or codes to differing extents in each country. Regulators are responsible for the publication of regulations in the United Kingdom, the Netherlands, Italy and Norway. In Portugal and Spain this responsibility falls to the Government and regulatory bodies must verify the application of the codes.

General conditions of energy supply contracts establish rights and duties which aim to guarantee adequate commercial quality. In Spain, Italy, Portugal and the United Kingdom the general supply contract conditions are regulated and cover subjects like billing, metering and power control, payments, complaints and disputes resolution. In the Netherlands and Norway, the priority is to regulate contracts related to network access.

Standards

Performance standards are beneficial in ensuring that customers receive certain minimum levels of quality of service. With the exception of Norway, all countries base commercial quality regulation on setting up standards.

Table 2.2 shows that commercial quality requirements are expressed in different ways from country to country.

TABLE 2.2 COMMERCIAL QUALITY STANDARDS/REQUIREMENTS	
Guaranteed and Overall Standards	Italy, Portugal, Spain and United Kingdom
Indicative Standards	Netherlands
General requirements	Norway

The definition of different standards and the benchmarking of commercial quality standards is described in section 2.3.

Penalty payments

Whenever guaranteed standards are not met, companies should make penalty payments to the customers affected. The levels of penalty payments established in the four countries which use guaranteed standards are given in section 2.4.

Information

Consumer information is a central aspect of commercial quality. Information dissemination is an important way to promote quality of service. Despite very different regulatory frameworks, information for consumers is a central concern in each of the countries reviewed.

Methods of provision include the publication of leaflets, newspapers, Internet sites and providing data with electricity bills. In Italy, Norway and Spain, there are regulations which establish the minimum information to be published in bills. For instance, the last 12 months' consumption must be included, as well as the average daily expenditure.

Companies also use bill transmittal to communicate other information which may be of interest to electricity consumers.

Customer participation

Customer participation is an important issue in each of the six countries. Strategies to encourage customer participation can include the following:

- Diverse ways of contacting companies (customers centres, call centres, etc).
- Standards associated with time of response to claims and requests for information.
- Active participation of consumers' associations in the development of electricity sector regulation.

In the United Kingdom, Gas and Electricity Consumers' Committees are specially active and have an important role in handling consumers' claims and information requests. In Portugal and Spain, consumer associations are represented in the regulatory bodies' consultative councils.

Access to justice / resolution of conflicts

Resolution of conflicts is an important issue for companies and customers. Table 2.3 shows the regulatory framework for resolution of conflicts in each country. This indicates the different roles of regulatory bodies regarding resolution of conflicts, as well as identifying other responsible bodies.

TABLE 2.3 RESOLUTION OF CONFLICTS

	REGULATORY BODY			OTHER ENTITIES
	VOLUNTARY MECHANISMS		POWER TO SETTLE DISPUTES	
	MEDIATION/ CONCILIATION	ARBITRATION		
ITALY	YES	YES	YES	• Arbitration and Mediation Centres • Courts
NETHERLANDS	NO	NO	NO	• National Dispute Settlement Committee • Competition Authority
NORWAY	YES	NO	YES	• Arbitration Centre managed by Norwegian Electricity Association in cooperation with the consumers' associations
PORTUGAL	YES	NO	NO	• Consumers' Associations • Arbitration Centres • General Directorate of Energy • Courts
SPAIN	NO	NO	NO	• Autonomous Governments
UNITED KINGDOM	YES	NO	YES	• Gas and Electricity Customers' Committees

With the exception of the Netherlands and Spain, regulatory bodies of the remaining four countries have some powers in the resolution of disputes.

Whilst mediation and conciliation are extrajudicial mechanisms used in four countries, arbitration is used only by the Italian regulator.

In the United Kingdom, Italy and Norway, regulatory bodies have powers to settle disputes between companies and customers.

In the Netherlands and Norway there are conflict resolution centres specialising in disputes in the electricity sector, created with the support of the companies and consumers' associations. It is also important to mention the role of Gas and Electricity Customers' Committees in the United Kingdom.

2.3 Commercial quality standards

In Italy, Portugal, Spain and United Kingdom there are two types of standards:

- *Guaranteed Standards*, which set minimum service levels to be achieved in individual cases. If the company does not meet these standards, compensation at fixed rates is payable to the individuals concerned.

  The definition of guaranteed standards includes the following attributes:

  1) Service covered (e.g. estimating charges).
  2) Required performance level – usually with a response time (e.g. 5 working days).
  3) Penalty payment to be paid to a customer who fails to receive this level of service (e.g. 20 euros).

- *Overall Standards*, which cover areas of service where it may not be possible to give individual guarantees but where companies are expected to deliver predetermined levels of service. Overall standards do not carry penalty payments but are fundamental to monitoring and promoting quality of service.

  Overall standards are defined as follows:

  1) Service covered (e.g. connecting new customers' premises to electricity distribution system).
  2) Minimum performance level (usually a percentage) to be achieved over a defined period (e.g. 90% of cases should be connected within 20 working days, over a one year period).

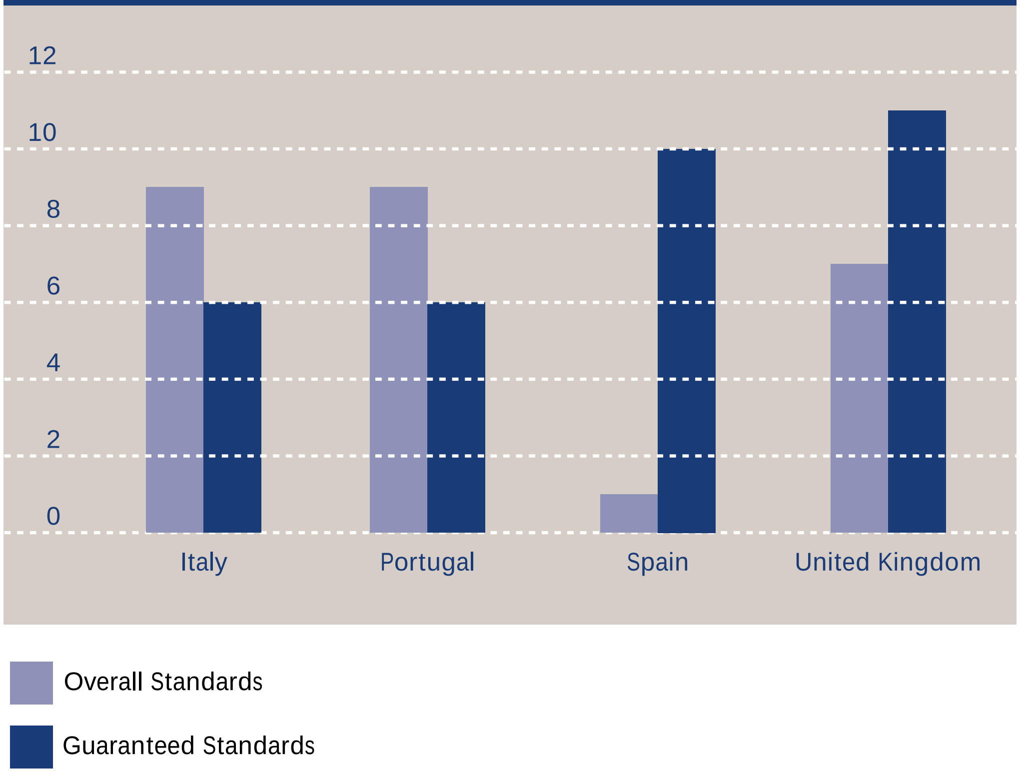
In the Netherlands some indicative standards have been established. This kind of standard includes only the two first attributes of a guaranteed standard. They set minimum quality levels to be guaranteed to each individual customer but penalty payments are not yet defined.

In Norway, commercial quality requirements are established through the distribution companies' licences. Obligations are described in general terms without setting up commercial quality standards as described above.

Only the United Kingdom and Italy have quality of service standards in force. In Portugal, the Quality of Service Code recently approved will come into force from January 1st, 2001. In Spain, publication of quality of service regulations is expected soon. As indicated above, Norway has no commercial standards and in the Netherlands commercial quality standards are only indicative.

Analysis of the information enclosed in Annex 2 leads to results shown in the following figure.

FIG. 2.1 NUMBER OF OVERALL AND GUARANTEED STANDARD



In Italy and Portugal, there are more overall than guaranteed standards, while in Spain and United Kingdom this position is reversed.The United Kingdom is the country with most standards in force (19), consisting of eleven guaranteed and eight overall standards.

The number and service areas covered by guaranteed standards differ from country to country.There could be several reasons for this:

- Importance to customers: areas of service of particular importance to customers should be regulated by guaranteed standards and corresponding penalty payments.

- Ability to deliver the standard: if the performance level is dependent on factors outside a company's control, guaranteed standards are not normally appropriate.
- Information on the present performance level: it is difficult to set up guaranteed standards without accurate information about present performance.
- Prevention of opportunistic behaviour by customers or companies.
- Early stages in the life-cycle of regulation: often means less complex regulatory systems with a small number of standards.

Some of the commercial quality standards are also considered in the continuity of supply analysis (see Annex 3.1). Standards like "response time to failure of a suppliers' fuse" or "restoring electricity after faults" are important in evaluating commercial quality and continuity of supply.

Comparisons of commercial quality between countries is complicated for several reasons including:

- Lack of information about existing commercial quality performance levels (only partially available for Italy and United Kingdom).
- Operating environments are not homogeneous and performance can be affected by factors such as geography and climate.
- Different legal and regulatory frameworks.
- Different market organisations – numbers and types of companies.
- Different degrees of market liberalisation.
- Current standards are based largely on historical factors (e.g. current standards in Italy were defined to substitute for standards established in the revoked "Carte dei Servizi". In this kind of situation the setting of new performance levels is often dependent on previous practice and performance).
- The definition of standards is not exactly the same country by country (see Annex 2).

The lack of information about actual levels of commercial quality is an obstacle to comparing performance in different countries. All comparisons presented in this chapter are based on published standards and not on actual performance levels of commercial quality of service.

Although standards are not always directly comparable, the following table shows that there are eight standards (guaranteed and indicative) which are used in at least three countries. The complete list of standards used in each country is in Annex 2.

The required performance level for "reconnection following lack of payment" is one calendar day in Italy and Spain, and one working day in Portugal.

The following Figures show the different required performance levels for the remaining seven common guaranteed standards. In some countries (e.g. Spain), different performance levels are defined for some standards depending on customer size or complexity of services (see Annex 2). For all countries, the Figures show the best values of the required performance levels of standards (guaranteed and indicative).

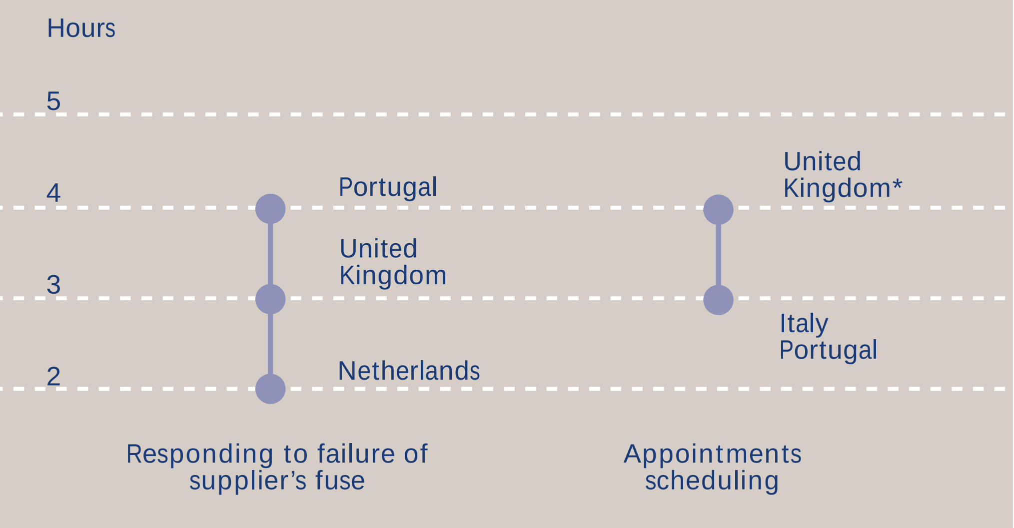
TABLE 2.4 MOST COMMON STANDARDS (GUARANTEED AND INDICATIVE)

STANDARD	ITALY (1)	NETHERLANDS (2)	PORTUGAL (3)	SPAIN (4)	UNITED KINGDOM (1)
Reconnection following lack of payment	●		●	●	
Responding to failure of supplier's fuse		●	●		●
Appointments scheduling (time band)	●		●		●
Estimating charges	●			●	●
Meter problems		●	●	●	●
Queries on charges and payments		●	●	●	●
Execution of simple works	●	●		●	
Connection activation (supply and meter)	●			●	●

(1) enforced
(2) proposal – indicative standards
(3) into force in 2001
(4) proposal – guaranteed standards

In the case of responding to failure of a supplier's fuse, the most demanding standard is in the Netherlands (2 hours) and the least demanding standard is in Portugal (4 hours).
The arrangements of visits to customers shows a narrower difference between the most demanding and the least demanding performance levels. The time band for appointments scheduling is 3 hours in Italy and Portugal. In the United Kingdom companies must offer the morning or afternoon for appointments scheduling, or a two hour band at customer request.

FIG. 2.2 COMPARISION OF COMMERCIAL QUALITY STANDARDS (1)



*Companies must offer the morning or afternoon, or within a two hour band at customer request

The United Kingdom and Spain consistently have more demanding levels on matters like responding to queries on charges and payments, meter problems, providing estimates for charges for simple works. Italy and Portugal have less demanding performance levels for these standards.

FIG. 2.3 COMPARISION OF COMMERCIAL QUALITY STANDARDS (2)

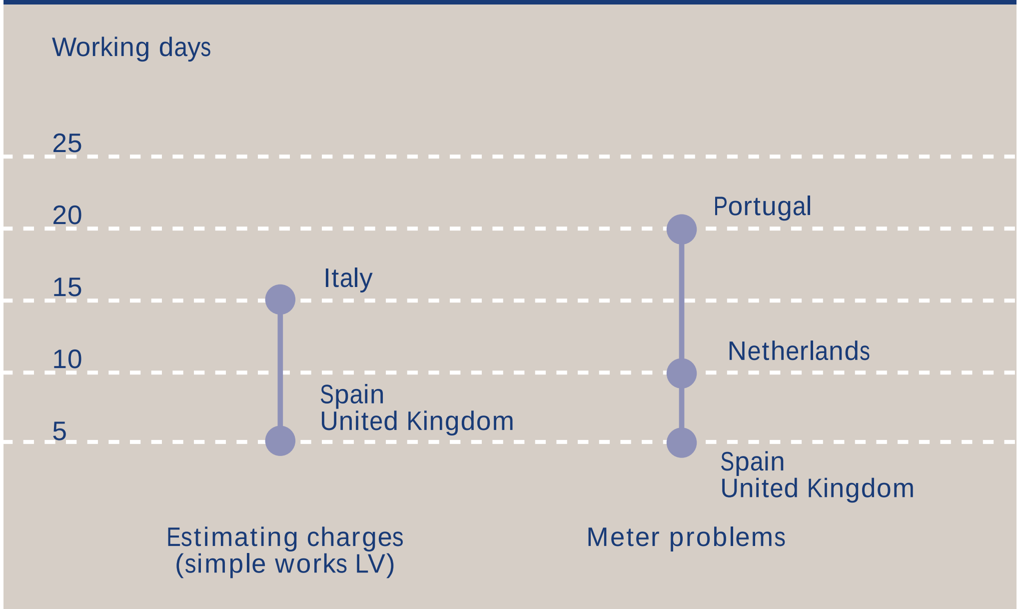
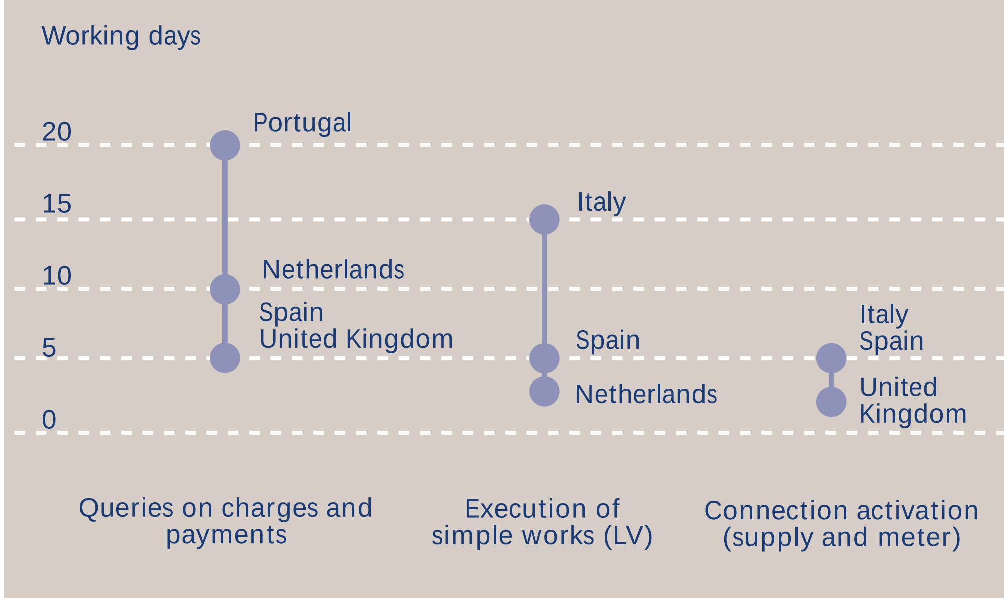


FIG. 2.4 COMPARISION OF COMMERCIAL QUALITY STANDARDS (3)



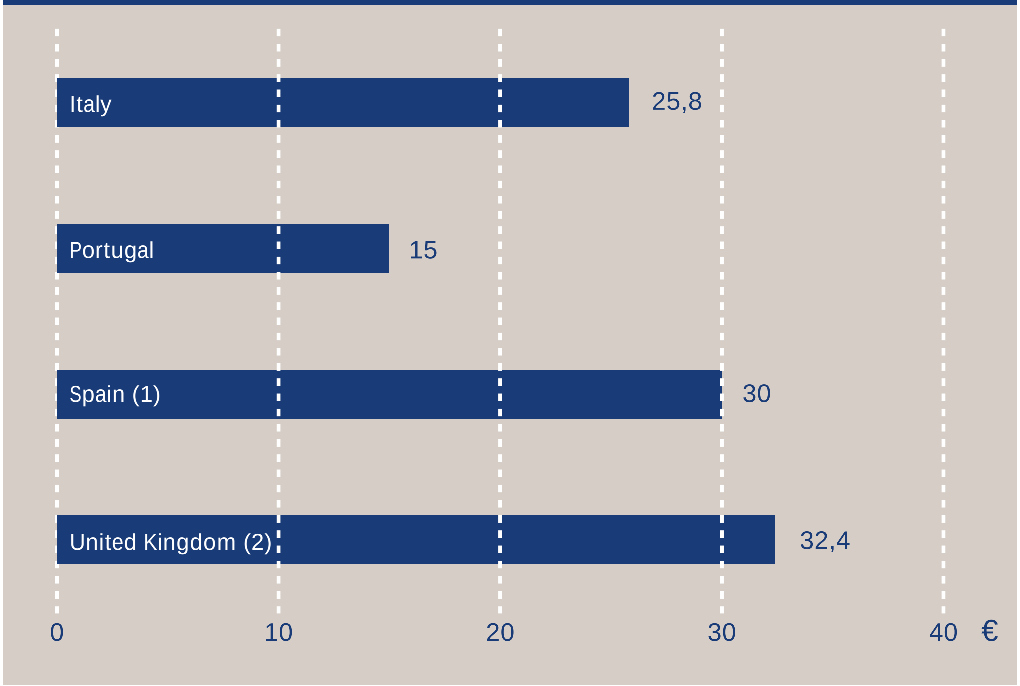
2.4 Penalty payments

Penalty payments have the following main functions:

- To give customers some compensation when companies fail to provide the level of service required (guaranteed standards).
- To give customers an indication that commitments to quality of service are effective.
- To penalise poor performance by companies and give incentives to improve quality of service.

Payments to customers for non-compliance with guaranteed standards differ from country to country. This can be seen in the following Figure, which shows a significant difference between Portugal and the remaining countries. The values are expressed in Euro.

FIG. 2.5 PENALTY PAYMENTS - LV DOMESTIC CUSTOMER (EUROS)



(1) Penalty payments can be 5000 PTS (~30 euros) or 10% of the invoice

(2) The most common penalty value is £20 (~32.4 euros). There are two guaranteed standards with different penalty payments (£40 and £50)

There are also different approaches to the payment of penalties (see table 2.5). For Italy, Spain and some standards in the UK, the payment is automatic. For other standards in UK and for all the commercial guaranteed standards in Portugal, customers must claim for the compensation payment if a standard is not met. In the Netherlands, penalty payments are not yet defined.

TABLE 2.5 PENALTY PAYMENTS

AUTOMATIC	Italy, Spain, United Kingdom*
CLAIMED	Portugal, United Kingdom*

* Some payments are automatic; others must be claimed.

2.5 Effects of liberalisation

By 2005 the EU Commission predicts that most Western European markets will be fully open. The six countries analysed in this document are at different stages of liberalisation.

The effects of liberalisation on commercial quality have not yet been studied in detail. Commercial quality regulation in countries with higher degrees of liberalisation seems to be based on the principle that commercial quality provided by suppliers for eligible customers will be left to the market. Standards tend to be set only for monopoly services.

Liberalisation has shown the importance of the following features:

- Non-discrimination in network access.
- Behaviour by dominant incumbents.
- Cost and time to transfer to a new supplier.
- Doorstep selling techniques.

When a utility's retail marketing affiliate operates in the utility's service territory, there are two possible areas of regulatory concern:

- The utility's control over the distribution system, to which potential retail competitors must have access to reach their customers.
- Behavioural rules must be developed to provide an assurance that the utility will treat all competitors, including its own energy marketing affiliate, on an equal basis.

2.6 Customers with special needs

Customers with special needs fall into the following groups:

- Customers who need extra quality.
- Vulnerable customers – the elderly or disabled, customers with very low incomes, etc. While in Italy and Portugal the concept of vulnerable customers is associated with customers with health problems, in the United Kingdom there is a broader concept which includes the elderly and customers with very low incomes.

While the first group of customers can find answers to their needs in the competitive market, there is a need for explicit regulation to ensure that vulnerable customers receive an adequate level of quality of service.

Growing competition between suppliers encourages the customization of quality according to customers' specific requirements and expectations. Individual needs can be met by contracts freely negotiated between suppliers and customers.

The regulatory framework for vulnerable customers is quite different from country to country. In Spain, the Netherlands and Norway there are no specific regulations; in the United Kingdom, Italy and Portugal special obligations are imposed on electricity companies to ensure protection of vulnerable customers.

3. CONTINUITY OF SUPPLY REGULATION

3.1 Continuity of supply main dimensions

Continuity of supply is a complex issue. Several types of interruptions of supply are possible, and several ways to measure continuity of supply have been developed. Different users have different sensitivities to each type of interruption; from the distributor's point of view, costs to measure and control interruptions vary according to the type of interruption, the voltage level and the available technology (including communications and remote control systems). Against this background, regulators have to be selective in choosing which aspects of continuity to focus on.

The main features of continuity of supply are as follows:

- The type of interruption: planned or unplanned interruptions. A number of customer satisfaction surveys have highlighted that users appreciate adequate notice of planned interruptions. Properly notified planned interruptions are generally rated as less severe by the affected users. Planned interruptions which are not notified to customers should be recorded as unplanned interruptions.
- The duration of each interruption: short or long interruptions. The European technical standard EN 50160 defines interruptions that last more than 3 minutes as "long interruptions", and others as "short interruptions". In some countries, very short interruptions, due to automatic reclosure systems that operate in less than a few seconds are referred to as "transient interruptions". Short and transient interruptions can produce equipment damage. Voltage dips or sags can also cause damage but these are not referred to as interruptions, rather as voltage quality which is discussed in chapter 4.
- The voltage levels of faults and other causes of interruptions: low/medium/high voltage. The interruption of supply to final customers can originate at any voltage level in the system. Customers connected at low voltage networks (LV, <1kV) are affected by interruptions due to faults in low voltage, medium voltage (MV), high voltage (HV) networks and transmission networks, while users connected to medium voltage network are not affected by interruptions due to faults in the LV network. In HV and transmission networks, not all faults cause interruptions to final customers, because of the network design.
- The type of continuity indicators: number or duration of outages. The cumulative yearly duration of interruptions per customer, generally referred to as Customer Minutes Lost (CML) or System Average Interruption Duration Index (SAIDI),

indicates how long in a year energy is not supplied (average per customer). The number of outages per customer in a year, termed customer interruptions (CI) or SAIFI, System Average Interruption Frequency Index, indicates how many times in a year energy is not supplied. Some users are more sensitive to the cumulative duration, whilst other users are more sensitive to the frequency of outages. Energy not supplied (ENS) is linked to CML and is a more sophisticated indicator because it takes into account the disconnected power.

The main results of a comparative analysis of available measurements and current regulation against the above features are shown in table 3.1, which focuses on interruptions arising from distribution networks.

The comparative analysis in table 3.1 shows that regulators have generally approached continuity issues starting from long interruptions affecting LV customers, treating planned and unplanned interruptions separately. In several countries both the number and the duration of outages are available for each indicator, but the choice of the indicator used varies by country. In many countries short interruptions (and sometimes transient ones) are or will be recorded as well.

TABLE 3.1 MAIN CONTINUITY OF SUPPLY FACTORS IN DISTRIBUTION NETWORKS				
COUNTRY	PLANNED VS UNPLANNED INTERRUPTIONS	LONG VS SHORT INTERRUPTIONS	VOLTAGE LEVELS	NUMBER VS DURATION INDICATORS
ITALY	Recording: both; Regulation: only unplanned	Recording: both; Regulation: only long	Recording: at all voltage levels; Regulation: only for MV/LV users; (in future also for HV users)	Currently available: both; Regulation: at present only duration (CML), number likely to be regulated in future.
NETHERLANDS	Recording: only unplanned	Recording: only long	Recording: at all voltage levels	Currently available: only duration (CML)
NORWAY	Recording and proposed regulation: both;	Recording and proposed regulation: only long	Recording and proposed regulation: only above 1 kV	Currently available: only duration (CML)
PORTUGAL	Recording and regulation (from 2001): both unplanned and planned	Recording: only long (at present >1'); Regulation (from 2001): only long (>3')	Recording: only above 1 kV Proposed regulation for all users (HV/MV/LV)	Currently available: only duration for all interruptions longer than 1' (TIEPI) Regulation: TIEPI and from 2002 also CML and CI
SPAIN	Recording: both; Proposed regulation: only unplanned	Recording and regulation: only long	Recording: only above 1 kV; Proposed regulation for all users (HV/MV/LV)	Currently available: only duration (TIEPI); Proposed regulation of both indicators (CML and CI)
UNITED KINGDOM	Recording and regulation of both types of outages	Recording and regulation: at present only long (>1'); short (>1") outages to be recorded in future	Recording of interruptions at all voltage levels; actual regulation for all users (HV/MV/LV)	Currently available: both number (CI) and duration (CML)

Notes:

CI: Customer interruption per year (equivalent to SAIFI, System Average Interruption Frequency Index)

CML: Customer minutes lost per year (equivalent to SAIDI, System Average Interruption Duration Index)

TIEPI: hours lost per year, weighted by the installed transformer capacity for MV users and – only for Spain – on the contracted power for MV users

3.2 Benchmarking of actual levels of continuity of supply

Because of different measurement practices in EU countries, available data on actual levels of continuity of supply are not always comparable. Nevertheless, benchmarking of continuity actual levels can be attempted if some assumptions are made before comparing data:

- First, the scope of benchmarking must be narrowed to long unplanned interruptions, generally defined as outages longer than 3' (note that in the UK and Portugal the same term is used for outages longer than 1'). Out of the six countries, only Portugal does not have data split between planned and unplanned outages.
- Second, in some countries available data are for interruptions at all voltage levels, while in other countries (Norway, Spain and Portugal) only interruptions originating in networks above 1kV are monitored. These countries appear in an optimistic light in the comparisons.
- Third, and perhaps most important, continuity indicators are not always defined in a comparable way. Continuity indicators are always obtained as weighted averages, the most important difference is between continuity indicators weighted by the number of customers (used in the United Kingdom, Italy, Norway and the Netherlands) and continuity indicators weighted by the power affected (used in Spain and Portugal). In very general terms, continuity indicators weighted by power affected provide better comparative data than continuity indicators weighted by numbers of customers, because large customers are likely to have fewer and shorter interruptions than small customers[12].

Tables 3.2-A, 3.2-B and 3.3 show actual continuity levels for long unplanned interruptions. Unless otherwise indicated, figures refer to LV customers and include long (>3') interruptions at all voltage levels and from every cause (including Acts of God).

Tables contain data from the six countries participating at the Working Group, Sweden, where the Regulator (STEM) collects continuity data from annual reports submitted by all local network licence holders, and France (published EdF figures[13]).

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12 In Italy, it has been possible to compare the two series of indicators (weighted on customers and weighted on power) for the years 1996-1999. The comparison shows that measuring continuity with continuity indicators weighted on number of customers produces figures at least 20% smaller than the figures provided by the continuity indicators weighted on number of customers, other things being equal.

13 The Working Group wishes to thank Mr. Alain Doulet and Mr. Jean-Paul Horson, EdF, for their kind cooperation.

TABLE 3.2-A YEARLY AVERAGE DURATION OF INTERRUPTIONS: COUNTRIES USING CUSTOMER-WEIGHTED INDICATORS

COUNTRY	AVERAGE CUSTOMER MINUTES LOST PER YEAR			
	1996	1997	1998	1999
ITALY (1)	272	209	196	191
NETHERLANDS (2)	26	18	21	25
NORWAY	170	205	130	180
UK	72	75	70	63
SWEDEN		79	66	152
FRANCE (3)	74	56	46	57[3]

(1) Only Enel (93% of LV users); data for 1999 subject to verification.
(2) Only interruptions above 1kV
(3) Storms excluded in 1999 (455 min. lost storms included)

TABLE 3.2-B YEARLY AVERAGE DURATION OF INTERRUPTIONS: COUNTRIES USING POWER-WEIGHTED INDICATORS

COUNTRY	AVERAGE HOURS LOST PER YEAR			
	1996	1997	1998	1999
SPAIN (1)	2.66	2.79	2.11	2.61
PORTUGAL (2)	6.30	9.40	8.33	6.08

(1) Only interruptions above 1kV
(2) Only interruptions above 1 kV; planned outages included; data for 1996, 1997 and 1998 correspond to one region of Portugal (Lisbon and Tagus Valley); data for 1999 refer to the whole mainland of Portugal

TABLE 3.3 YEARLY NUMBER OF INTERRUPTIONS PER LV CUSTOMER: COUNTRIES USING CUSTOMER-WEIGHTED INDICATORS

COUNTRY	AVERAGE CUSTOMER INTERRUPTIONS PER YEAR			
	1996	1997	1998	1999
ITALY (1)	4.8	4.6	4.1	3.8
NETHERLANDS	0.14	0.10	0.11	0.14
UK (2)	0.82	0.82	0.73	0.77
SWEDEN		4.3	0.7	1.2
FRANCE	1.60	1.31	1.22	1.26

(1) Only Enel (93% of LV users); data for 1999 subject to verification
(2) Includes outages longer than 1'

In most countries some data are available at a regional or district (province) level. In Italy and Spain data are collected separately for areas with defined geographical characteristics. Different geographical classifications are used in these two countries.
With the exception of the Netherlands, disaggregated data show sharp differences among regions and among districts in all countries where they are available. In Italy and Spain the geographical classifications can help to explain differences which arise for geographical reasons.

3.3 Strategies to guarantee and promote continuity of supply

Regulators pursue two main objectives for continuity of supply: to guarantee that each user can be provided with at least at a minimum level of quality, and to promote quality improvement across the system. The two objectives are relatively independent of each other but they must be considered together. There are two main approaches:

- The "quality of supply" approach focuses on the individual level of continuity for each user and consists of setting standards to avoid continuity falling below a minimum threshold (e.g. maximum duration of interruptions). This approach requires that continuity be recorded at the customer level. It can be used more easily for high and medium voltage level customers rather than for those supplied at low voltage level.
- The "quality of system" approach focuses on overall continuity through the measurement of average performance. It does not require the recording of interruptions for each customer. In this approach, regulation involves setting overall standards to ensure target average continuity levels in a given area.

Regulators generally combine the two approaches, but the way they do this varies significantly between countries. For instance, Italy and Norway started from the quality of system approach, and Italy intends to develop quality of supply rules for major users at least. The United Kingdom started with quality of supply guaranteed standards and quality of system overall standards, and is now developing incentives for quality improvement related to customer-oriented outputs. In Spain and Portugal the two approaches have been combined in new regulations (although the Government has not yet approved the Spanish regulator's proposal). In the Netherlands, quality of system is presently monitored only with indicative values. A prescriptive quality of supply guaranteed standard may be introduced in the future. The liberalisation of electricity markets can offer new solutions to the combination of the two approaches as discussed in paragraph 3.6.

In making their decisions about continuity of supply regulation, regulators must address some common preliminary problems before setting standards:

- Measurement of interruptions: different kinds of continuity indicators can be adopted, as seen in the previous paragraph, and companies can have different recording practices even if they appear to use the same indicator. Consistency in measurement among different companies is a primary requirement for continuity of supply regulation.
- Responsibility for interruptions: some interruptions do not result from the activities of the distributor. For instance, some interruptions can be caused by users, third parties, or other system operators.
- Severe weather and “acts of God”: many interruptions are due to weather effects, especially lightning, strong wind and heavy snow. Weather effects can vary from one year to another and from one area to another. Exceptional conditions, often referred to as “acts of God” or “force majeure”, are so rare that it is often argued that it is not economic to design networks to withstand such events; as a result it is claimed that interruptions due to acts of God should not be subject to standards.
- Differences in geographical characteristics and network structure: overhead wires are cheaper but more vulnerable than underground cables. Underground cables are often economically justified only if there is an adequate load density. For these reasons, many regulators divide the territory using some form of customer or load density indicator.

The above issues have been tackled in different ways by EU regulators. This hinders benchmarking of continuity standards because continuity figures are not always comparable between different countries. For instance, there is not a common way of taking geographical differences into account: in some countries (Italy and Spain) continuity indicators take account of population density, but using different classifications; in other countries customer density (Portugal) or load density (Norway) is used; in remaining countries the geographical classification is not defined, although the problem may be acknowledged by the regulator, as in a proposed classification based on network characteristics (United Kingdom).

3.4 Continuity of supply standards

There are four main area covered by continuity of supply standards already enforced or envisaged in the six countries:

- Individual customer standards: this type of continuity of supply standard is intended to guarantee that individual customers will not suffer interruptions longer than a fixed threshold, or that the number of interruptions in a year is limited. Guaranteed individual customer standards are at present enforced only in the UK (maximum duration of interruption: 18 hours). In Portugal standards on maximum yearly rate of interruption and maximum cumulative duration of interruption (over a year) will be in force from 2001 and it is likely that other individual customer standards will be set in other countries (Italy, Netherlands, Spain) in the future.
- Average standards: this kind of continuity of supply standard is used to improve quality in a given area, but it does not guarantee that each individual customer in the area receives a particular continuity level. National standards have been set in Italy and Netherlands, even if at present they are only indicative values without prescriptive effect; enforceable zonal standards are already enforced in Italy, and envisaged in Portugal from 2001 and in Spain in the future.
- Yearly rate of improvement standards: this type of continuity of supply standard is intended to impose a path of improvement on companies. Generally, improvement standards are differentiated according to the starting level and/or the track of past performance. In Italy improvement standards ranging from 0 to 16% according to the starting level are enforced and linked to penalties and incentives for companies; in the UK improvement standards have been imposed in price control reviews.
- Worst-served customer standards: another way to set continuity of supply standards is to define the maximum percentage of users subject to a maximum number of interruptions (or minutes lost) in one year. Standards of this type could be introduced soon in the UK and Italy.

Table 3.4 summarises the main continuity standards in force – or about to be adopted – in the six countries. Annex 3 contains a more complete benchmarking of standard levels and more measurement details.

Regulators impose different types of continuity standards depending on their main objectives. Individual and worst-served customer standards often take the form of guaranteed standards, but they require individual measurement of interruptions which can be difficult and costly. Average standards and yearly rate of improvement standards are more relevant to promoting overall improvement or to maintaining quality and can be used to adjust continuity differentials between regions

TABLE 3.4 MAIN TYPES OF STANDARDS FOR CONTINUITY OF SUPPLY				
COUNTRY	INDIVIDUAL CUSTOMER STANDARDS	ZONAL AVERAGE STANDARDS	YEARLY RATE OF IMPROVEMENT STANDARDS	WORST-SERVED CUSTOMER STANDARDS
ITALY	Max. duration of interruption for HV and MV customers (*Likely in the future)*	Avg. Customer minutes lost * *(At present only as indicative targets, likely in the future as enforced standard)*	Minimum yearly improvement standards differentiated according to the starting level *(enforced)*	Overall standard *(possible in the future)*
NETHERLANDS	Max. duration of interruption for each customer *(Likely in the future)*	Avg. customer minutes lost *(At present only as indicative targets)*	None	None
NORWAY	None	None	None	None
PORTUGAL	Max. number of interruptions and maximum duration (over one year) for every customer** *(to be enforced from 2001)*	Standard of duration (TIEPI, *from 2001;* SAIDI, *from 2002)*, and standard of number *(*SAIFI, *from 2002)* **	None	None
SPAIN	Max. number and max. duration of interruption for each customer** *(Proposed)*	Max. customer minutes lost and max. average number of interruption ** *(Proposed)*	None	None
UNITED KINGDOM	Max. duration of interruption for each customer *(Enforced)*	None	Minimum yearly improvement differentiated according to the starting level and past performance improvement	Overall standard *(likely in the future)*

Notes:

* Standards differentiated according to geographical classification.

** Standards differentiated according to voltage level and geographical classification.

3.5 Effects of continuity of supply regulation

Continuity of supply regulation can have direct economic impact or indirect effects resulting from publicity about performance. The most common publicity effect is obtained through comparative publication of actual performance figures. Comparative publishing already happens or is going to happen in each of the six countries, although there are differences in the way it is implemented. For example, in Italy, the UK, Norway and from 2001 Portugal, the regulator is responsible for publishing continuity data, whilst currently in the Netherlands and in Spain companies or their associations publish this data. In addition, in Portugal and the UK each company has to publish an annual report on quality of service. In Spain it is envisaged that the Ministry will perform the comparative publication, and in Norway the association of electric companies also collects data about faults and interruptions.

The main economic impacts can be of three types:

- Penalty payments to customers: the most common way to give economic effect to continuity of supply standards is to impose penalty payments to customers when standards are not met. Penalty payments are already enforced in the UK, will be enacted from 2001 in Portugal and in Italy (limited to some districts), and are envisaged in Spain and the Netherlands. Generally, penalty payments are attached to individual customer standards, with the exception of Italy, where the penalties are linked to zonal standards; in this case, if the average performance level exceeds the zonal average standard, all the customers of the district receive a payment which depends on their annual consumption. This means that even zonal standards can be guaranteed.
- Link between tariff and continuity: Performance-Based Regulation can be realised, linking tariff levels to actual continuity levels. This has been in place in Italy since 2000, is planned in Norway from 2001 and should be introduced in the UK from 2002. In the two countries in which the link between tariff and continuity has already been defined, it has quite different characteristics:
  - In Italy, companies that do not achieve the yearly improvement standards must pay a penalty; companies that exceed the yearly improvement standards receive an incentive payment. Penalties and incentives are proportional to the difference between standard and actual level for the relevant year in each district with the same customer density. Penalties fund incentives; the balance is ensured through a levy obtained by adjusting the price cap formula (RPI-X+Q).
  - In Norway, starting from 2001 the allowed income will be adjusted by NVE according to the cost of energy not supplied. If the company increases quality, allowed income increases, while if the company reduces quality, its revenue will

be reduced. The cost per kWh not supplied varies according to type of customer (household/industry) and the type of interruption (planned/unplanned).
 – In the United Kingdom, proposals are under development; about 2% of companies' revenues will be at risk if they fail performance criteria including some quality measures.

- Special recovery plans: in Portugal and Spain special plans are envisaged for companies that do not manage to comply with continuity standards. Plans are proposed by companies themselves, are approved by national government and in Spain also by regional governments, and are generally funded through the tariff.

Table 3.5 summarises economic and non-economic effects of continuity of supply regulation in the six countries.

TABLE 3.5 EFFECTS OF CONTINUITY OF SUPPLY REGULATION

COUNTRY	ECONOMIC EFFECTS			NON-ECONOMIC EFFECTS
	PENALTY PAYMENTS TO COSTUMERS	LINK BETWEEN TARIFF AND CONTINUITY	SPECIAL RECOVERY PLANS	COMPARATIVE PUBLISHING
ITALY	from 2001 in some districts	enforced		Regulator
NETHERLANDS	foreseen			Companies
NORWAY		proposal		Regulator
PORTUGAL	from 2001		from 2001	Regulator, from 2001
SPAIN	proposal		enforced	Companies, Ministry in future
UNITED KINGDOM	enforced	projected		Regulator

In addition to the features shown in the above table, some other regulatory policies contain incentives to reduce interruptions. For instance, in Spain distribution companies must buy electricity for their non-eligible customers. So, they submit demand bids to the Market Operator. If the real demand is not equal to the scheduled one, the distributor must pay for the deviation; a network failure can lead to a higher deviation cost. This is another incentive to maintain continuity.

3.6 Effects of liberalisation

Continuity of supply is largely related to transmission and distribution activities which remain monopolies even in a liberalised market structure. Nevertheless, some market mechanisms can also be developed for continuity of supply.

In a liberalised market, eligible customers can be offered prices that include some specially tailored services. Suppliers can contract with distribution companies to provide special continuity standards in return for payments in addition to the wheeling tariff. Suppliers can seek to recover the extra costs in their final prices to eligible customers. Distributors can be allowed to offer special tariffs including to non-eligible customers. Special tariffs can be related to continuity standards higher than the minimum standards legally required. In such cases, the relevant customer has to pay the appropriate charges. In some countries, such as Italy, special tariffs for non-eligible customers linked to extra services are explicitly envisaged in regulation; distributors must offer special tariffs without any discrimination and any special tariff must be approved by the regulator before it is offered to non-eligible customers.

These market mechanisms are possible but not widespread in all six countries, even in countries where liberalisation was introduced some years ago, particularly the UK. Regulators must ensure that special quality contracts do not hide discriminatory behaviour by the distribution companies.

3.7 Implementation and control issues

Regulators need to pay attention to implementation and control issues, to ensure the maximum level of comparability between different distribution companies, and between operating units within each company. The most important implementation and control issues are as follows:

- timing and costs for distribution companies to implement remote control systems or Customer Information Systems/Outage Management Systems (CIS/OMS), to identify and record LV customers affected by interruptions;
- common rules to estimate numbers of customers affected in LV networks, if no OMS is required. This must take account of geographical differences and fault identification and repair practices;
- regular internal audits by distribution companies and sample audits by the regulator;
- accuracy and precision indicators to assist in auditing and to inform decisions about sanctions;
- sanctions on distribution companies for inaccurate recording or imprecise calculation of continuity indicators.

4. VOLTAGE QUALITY REGULATION

4.1 Voltage quality main characteristics

The term voltage quality, or power quality, is an umbrella concept for a variety of disturbances in a power system. The quality of delivered electricity is difficult to define and quantify. The quality is mainly determined by the quality of the voltage waveform as it is impossible to control the currents drawn by customer loads. Voltage quality is not only the responsibility of the network operator but also, in certain respects, depends on producers and customers. Generally voltage quality covers a range of factors including interruptions, but in this report interruptions are considered separately in Chapter 3.
There are several technical standards for voltage quality criteria, but in the end the quality is directly and indirectly determined by the ability of customer equipment to perform properly[14]. However customer awareness about power quality is highly subjective. A good definition of voltage quality should therefore incorporate the impact of the (lack of) quality on the customer. In practice technical parameters like frequency, or harmonics are used to indicate the voltage quality. The relevant phenomena and the criteria or standards for these are discussed below.

Phenomena

Although definitions are not fully consistent in literature and standards, the most relevant quality phenomena are the same. For power systems these phenomena are:

- frequency variations
- (Fluctuations of) voltage magnitude
- Short-duration voltage variations (dips, swells and short interruptions)
- Long-duration voltage variations (over- or under-voltages)
- Transients (temporarily transient overvoltages)
- Unbalance
- Waveform distortion (harmonics, interharmonics and DC components)
- Mains signalling
- Interruptions (see chapter 3)

14 R. C. Dugan et al., *Electrical Power Systems Quality,* 1996.

In studying the available standards, especially EN 50160, exact levels of compliance are stated for only a few phenomena. For most phenomena only indicative values are given. It is left to the user to define the exact levels of quality. This is probably the reason that actual data on voltage quality for benchmarking purposes is either unavailable or limited in scope.

Standards

Standards for voltage quality can be issued by standardisation bodies through a consensus process or by regulators after a consultation process.

To compare the standards for voltage quality in participating countries, the definitions and criteria for the phenomena should be the same. The use of international technical standards can be of help in this context. This paragraph focuses on the technical standards that may be used by regulators to issue "regulation" standards.

At the international level, the International Electrotechnical Commission (IEC) classifies electromagnetic disturbances in conducted and radiated phenomena and gives definition in the technical standard IEC 50 (161) International Electrotechnical Vocabulary, Chapter 161 Electromagnetic Compatibility. The IEC has also issued the technical standard IEC 1000-2-1 "Description of Environment – Electromagnetic Environment for Low frequency Conducted Disturbances and Signalling in Public Power Supply Systems, (EMC)", which gives some compatibility levels for the phenomena mentioned in the title.

The European Committee for Electrotechnical Standardisation (CENELEC) issued the standard EN 50160: 1999 "Voltage characteristics of electricity supplied by public distribution systems" (see annex 3.2). This standard gives the main characteristics of the voltage at the customers supply terminals under normal operating conditions. These characteristics vary in a manner that is random with time and location and therefore the standard permits the levels of the characteristics to be exceeded. For some characteristics only indicative values are given.

For the purpose of this report the following definition of voltage quality was adopted from European Standard 50160: "the characteristics of the supply voltage concerning: frequency, magnitude, waveform and symmetry of the phases".

4.2 Importance of voltage quality

Voltage quality is sometimes considered as a difficult subject that is only of interest to engineers; so why should regulators address this seemingly purely technical issue? The reason is that voltage quality has a growing economic impact on the customer and the network operators. The costs associated with "lack of quality" can be large, especially for industrial customers. If for example a production line trips, it may take several hours to restart with severe financial consequences.

Growing importance

Usually voltage quality is considered at the customer's connection point. However, the reasons for the growing importance of voltage quality lie not within the power system itself but are closely related to the developments in customers' equipment. Some important examples are:

- customer equipment contains more microprocessor controls and power electronic devices which can be sensitive to variations in voltage quality;
- the growing importance of higher energy efficiency has led to an increase in the number of adjustable motor drives and shunt capacitors which generate harmonics on the power system;
- processes and equipment have become more interconnected and interrelated which can make them more vulnerable to failure of one component;
- customers are becoming more aware about the issue of voltage quality and becoming more demanding in that respect.

Utilities want to meet customer demands and expectations. With the introduction of competition between them it is important for a utility to maintain its customers' confidence.
Where the financial consequences of solving voltage quality problems affect the economic position of the network operator, voltage quality becomes an issue for the regulator.

4.3 Existing regulation of voltage quality

An international comparison was made on present regulation of voltage quality (see table 4.1). In most countries voltage quality is regulated to some extent at the national (system) level.
In Italy, Portugal, Spain and the Netherlands regulation is based on parts of EN 50160. The UK uses some quality levels for frequency, magnitude and harmonics, which are similar to this standard. In Norway hardly any voltage regulations exist.
Although EN 50160 gives (indicative) values for many of the phenomena, it is only applicable at voltage levels up to 35 kV. For higher levels no standards exist; in the Netherlands, Italy and Portugal some criteria from EN 50160 are extended to voltage levels of 50 kV and higher.
Detailed results of present regulation of voltage quality can be found in Annex 4. The main conclusions of the comparative analysis are the following:

- Most countries have some form of voltage regulation, which applies uniformly at a national level. There are no penalties for not meeting the standard. For LV and MV, parts of EN 50160 are often used as a standard. For higher voltage levels only sim-

TABLE 4.1 VOLTAGE QUALITY: COMPARISON OF PRESENT REGULATION

	ITALY	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	UNITED KINGDOM
Is voltage quality part of the regulation in your country?	YES	YES	NO	YES	YES	YES
Is voltage quality regulated on system level?	YES	YES	NO	YES	NO	YES
Is voltage quality regulated on individual level?	YES	YES	NO	YES	YES	YES
Is there a (financial) penalty when the standards are not met?	NO	NO	NO	NO	NO	YES
Does the voltage quality regulation apply uniformly in your country?	YES	YES	YES	YES	YES	YES
Is the voltage quality (also) regulated per region or zone?	NO	NO	NO	NO	NO	YES
Is the European standard EN 50160 imposed by regulation?	NO	YES	NO, Except for one level	YES	YES	NO
If yes, please indicate the voltage levels:		All levels	22 kV	Up to 45 kV	Up to 36 kV	
Is the voltage quality also regulated for voltage levels > 35 kV?	YES, partly	YES	NO	YES	YES	YES

ple criteria, some derived from EN 50160 like frequency and voltage magnitude, are used as standards.

- Although a limited number of characteristics are regulated in most countries, there are no explicit standards for the majority of voltage quality phenomena.

4.4 Future regulation of voltage quality

In most countries the potential impact of “lack of quality” is growing. It is therefore likely that more measuring equipment will be placed in the network and at customer connection points. There is also a need for better standards. Since, in most countries, the financial consequences of poor voltage quality may increase, the regulator may use economic incentives to guarantee minimum quality levels. At the system level the voltage quality may be regulated by introducing a “Q-factor” in price-cap regulation. At the local level voltage quality may be better be regulated by other means, for example through connection agreements.

5. CONCLUSIONS

The CEER Working Group on quality of supply comprises officials from regulators in Italy, Netherlands, Norway, Portugal, Spain and the United Kingdom with a representative from the EU Commission. The conclusions reached by the Group include general principles as well as specific conclusions against the terms of reference of the Working Group.

On general principles, the participants agree about the importance of a continued exchange of information on actual quality levels, standards, regulatory mechanisms and strategies. Regulation of quality is important in Performance-Based Regulation which often includes quality incentives even in those countries where price regulation was originally introduced without quality regulation mechanisms.

Quality of service is a complex issue. The three main aspects – commercial quality (including quality of transactions with users, including billing, metering and on-demand services); continuity of supply (number and duration of interruptions); and voltage quality (technical characteristics of delivered voltage) – have been considered separately by the Working Group. Quality of service results from several parts of the electricity delivery system, particularly distribution and supply. Regulation of distribution-related quality parameters is likely to continue, but there may be less regulatory intervention in supply-related factors as electricity supply markets become more competitive.

The Working Group reached initial conclusions on each of the four objectives in its terms of reference. These are:

- Comparing strategies and experiences in implementing quality of service regulation;
- identifying quality of service indicators and selecting possible standards as comparators;
- performing a first benchmarking study on quality of service; and
- identifying possible recommendations to international bodies about quality of service benchmarking.

Each of these is considered in turn below.

5.1 Comparing strategies and experiences in quality of service regulation

All countries adopt a generally similar approach to quality of service regulation. At the highest level there is a mixture of standards and indicators for commercial quality, continuity of supply and voltage quality. Most countries have implemented standards in the first two categories but not widely in the third category. There is qualitative evidence that different users value aspects of quality of service in different ways. The valuation which customers place on quality should influence the behaviour of regulators but this remains a largely unexplored issue.

Although quality regulation in EU countries has the same main objectives, such as customer protection while seeking overall quality improvement, strategies adopted differ from one country to another. There is consensus on the effectiveness of publishing comparative data as increasing reliance is being placed on such data for regulatory purposes. It is important that data requirements are clearly defined and robust and that companies' quality records are audited.

5.2 Identifying quality of service indicators and selecting possible standards as comparators

The following types of standards are widely applied in most countries reviewed. Standards have been proposed for Spain and these will come into effect in the near future:

- Guaranteed standards – which set targets to be achieved for service delivery in the case of individual customers – are a common tool, although countries have selected performance levels using different criteria; for instance in the UK the Guaranteed standard for maximum duration of interruption is 18 hours for all users, while in the Netherlands, the regulator proposes to set a 4 hour standard. In Italy different levels will be set at different voltage levels. Guaranteed standards are always linked to penalty payments, which can be either automatic or subject to customers' claim. Annexes to this report contain a list of existing and projected Guaranteed standards. Eight Guaranteed standards will apply in at least three of the countries reviewed.
- Overall standards – which set standards to be achieved on a company-wide level – are a useful tool in promoting quality improvement. They are called "Indicative Standards" in the Netherlands and "General Requirements" in Norway. Such standards have been or will be implemented in each of the countries reviewed; in some

country these standards are linked to some economic effects. Overall standards are more widely used than Guaranteed standards in Italy and Portugal, while in the Netherlands, Spain and the UK Guaranteed standards are more common.

A link between quality (particularly continuity of supply) and tariff is likely to be introduced in three countries in the near future. Italy introduced such a link in 2000, Norway will do it in 2001 and the UK is likely to do so in 2002. Although the detailed regulatory mechanisms differ, they share the principle that a part of the companies' revenue will be at risk depending on performance against quality standards. In the UK this will be limited to 2%; in Italy the exposure could be greater than this and in Norway no limit is envisaged.

Several commercial quality standards are commonly applied and can be used as comparators. These include most of the standards listed in Annex 2. Continuity of supply standards are more diverse and indicators can presently only be used in simple comparisons of performance. Annex 3 contains a comparison of continuity standards. Annex 4 contains details of voltage quality standards.

5.3 Performing a first benchmarking study

Although many standards can apparently be used as comparators, the Group found it difficult to perform benchmarking studies because in practice there are often differences in definition and application.

Nevertheless, some headline comparisons are possible and these are reported in chapters 2, 3 and 4. On commercial quality standards, benchmarking shows that for some standards there is a significant difference in performance targets. For example, in areas like responding to queries on charges and payments, and executing simple works, ratios of 4:1 exist in the response periods for the countries examined. On the other hand, some other response times, for example responding to failure of a supplier fuse or scheduling appointments, have much lower performance ratios, typically 1.5-2:1. No single country of those reviewed sets standards or penalties at a level consistently higher or lower than in other countries.

On technical quality standards, there is a wide variability of definition and reporting standards. But crude comparisons of performance levels can be made particularly with regard to customer minutes lost and customer interruptions. These show that the Netherlands has the best performance followed by the UK. A wide spread of performance is evident between countries. Some of the factors which influence this are population density, geography, network configuration, and the use of overhead lines or underground cables. It has not been possible to assess the quantitative effect of these factors.

5.4 Identifying recommendations for future benchmarking

The Group agrees that the following factors will be important in improving future benchmarking studies:

- Increased transparency of reporting both by companies and regulators to facilitate setting appropriate quality standards by national regulators.
- Increased exchange of information between regulators; perhaps by continuing the activities of the Working Group or by other means, for example annual data exchange.
- The adoption of at least one continuity of supply indicator for customer minutes lost (cumulative duration per LV customer), and one indicator for the average yearly number of interruptions per LV customer, calculated as weighted averages using the number of affected customers as the weight. These indicators should include all interruptions at all voltage levels with separate reporting of the type (planned or unplanned) and duration of each interruption.
- On voltage quality there should be better co-ordination between national regulatory bodies and international technical standards bodies to facilitate the development of appropriate international standards in future.
- There should be further work to evaluate and compare factors which can affect benchmarking studies including identification of company responsibility, force majeure, severe weather effects and geographical dissagregation.

5.5 Next steps

The Group recommends that the following future activities are considered:

- Publication of this report to promote discussion of quality of service regulation amongst EU and non-EU regulators.
- Submission of the findings of the Group for discussion at a suitable forthcoming international conference on regulatory issues.
- Enlargement of the membership of the Working Group to include members from other countries.
- Evaluation of evidence about the value which customers place on quality of service - particularly continuity of supply.
- Analysis of the effects of liberalisation on commercial quality standards.
- Encouragement of transparency and consistency of quality of service auditing.
- Consideration of the role of regulators with respect to power quality contracts.

ANNEX 1

BASIC FIGURES ON NATIONAL ELECTRIC SYSTEMS						
INDICATOR	ITALY	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	UNITED KINGDOM
YEAR	1999	1999	1998	1999	1999	1999
NUMBER OF DISTRIBUTION COMPANIES	195	21	200	15	Around 450	14
NUMBER OF CUSTOMERS	32,510,000	7,231,389	2,436,332	5,291,418	20,456,442	27,033,000
LV	32,400,000	7,213,105	2,436,195	5,273,278	20,390,709	
MV	110,000	18,284		18,140	65,733	
ENERGY (GWh)	188,000	70,819	71,000	28,426	128,290	276,006
LV	105,000	44,257	71,000	17,785	78,175	195,389
MV	83,000	26,562		10,641	50,115	80,617
AREA (km2)	301,000	33,939	386,958	88,797	506,000	228,705
LV+MV DISTRIBUTION LINES (km)	1,030,900	247,257	277,183	174,208	571,246	750,360
OVERHEAD DISTRIBUTION LINES (%)	38%	0%	64%	81%	80%	39%
UNDERGROUND DISTRIBUTION LINES (%)	62%	100%	35% (+1% sea lines)	19%	20%	61%

BASIC FIGURES ON NATIONAL ELECTRIC SYSTEMS – NOTES TO THE TABLE

	ITALY	NETHERLANDS	NORWAY	PORTUGAL	SPAIN	UNITED KINGDOM
NUMBER OF DISTRIBUTION COMPANIES	Distributed energy by two largest companies: 94%	Distributed energy by two largest companies: Almost 50%	Distributed energy by two largest companies: 14%	EDP distribution companies (4) and 11 small distributors. Distributed energy by EDP companies: 99%	Distributed energy by two largest companies: 80%	Distributed energy by two largest companies: 21%(10.9% and 10,2% respectively)
NUMBER OF CUSTOMERS			LV includes MV			Includes 375.534 in LV and 374.826 in MV
ENERGY (GWh)			LV includes MV			
DISTRIBUTION LINES (km)	Only Enel; includes 328.200 in MV and 702.700 in LV					
VOLTAGE LEVELS						
Low voltage	< 1kV	< 1kV	< 1 kV	≤1 kV	< 1 kV	< 1 kV
Medium voltage	1-35 kV	1-25 kV	11kV and 22kV	1-45 kV	1-36 kV	1-22 kV
High voltage	35-150 kV	>= 25 kV	45kV, 66kV, 132kV,220k, 300kV and 420kV	HV: 45-110 kV EHV: >110 kV	>36 kV	> 22 kV

ANNEX 2

COMMERCIAL QUALITY STANDARDS					
SERVICE	ITALY	NETHERLANDS	PORTUGAL	SPAIN	UNITED KINGDOM
Responding to failure of supplier's fuse		IS Within 2 hours	GS • Within 4 hours; 5 hours in rural areas		GS • 3hrs weekdays • 4hrs weekends
Restoring/ reconnecting supply		IS Within 4 hours	OS • 80% within 4 hours		GS • 18hrs OS • 85-95% in 3hrs • 100%in 24hrs
Connection (supply and meter)	GS • LV: Within 5 working days • MV: Within 7 working days		OS • 90% within 2 working daysfollowing contract sign	GS • Within 5 working days following contract sign	GS • 2 days domestic • 4 days non-domestic OS • 100% in 30 days domestic, 40 days non-domestic
Estimating Charges	GS • LV: Within 15 working days for simple works		OS • LV: 95% within 20 working days for simlpe works	GS • LV (new supplies): a) Supplies< 15 kW: within 5 days b) Other supplies without Substation investment: within 10 days c) Other supplies with Substation investment: within a range of 20 to 30 days • MVHV (new supplies): a) 1-66 kV: within 40 days b)>66 kV: within 60 days	GS • 5 days simple jobs • 15 days other jobs

GS – Guaranteed Standards; OS – Overall Standards; IS – Indicative standards

continued

(CONTINUED) COMMERCIAL QUALITY STANDARDS

SERVICE	ITALY	NETHERLANDS	PORTUGAL	SPAIN	UNITED KINGDOM
Notice of supply interruption		IS • LV: 3 working days MV+HV: 10 working days		OS • Minimun of 24 hours before interruption	GS • 5 days
Voltage complaints	OS • 90% LV and 95% MV reply within 10 working days		GS • Respond or visit within 20 working days		GS • Reply within 5days or visit within 7days
Meter problems	OS • 90% LV and 95% MV reply within 10 working days	IS • Within 10 working days	GS • Visit within 20 working days	GS • Customers < 15 kW: within 5 working days • Rest: within 15 working days	GS • Reply within 5days or visit within 7days
Queries on charges and payments	OS • 90% LV and 95% MV within 15 working days	IS • Within 10 working days	GS • Respond within 20 working days	GS • Customers < 15 kW: within 5 working days • Rest: within 15 working days	GS • 5 days to reply and pay
Appointments scheduling	GS • Within 3 hours range	IS • 3 – 5 working days	GS • Within 3 hours range		GS • AM or PM, or timed if customer requests
Payments notice under standards					GS • 10 days to pay
Prepayment meter fault					GS • 3 hrs weekdays • 4 hrs weekends
Correction of voltage faults					OS • 100% in 6 months
Visits to customers who required a meter move	GS • Included in execution of simple works				OS • 100% in 15 days
Meters changed when required					OS • 100% in 10 days

GS – Guaranteed Standards; OS – Overall Standards; IS – Indicative standards

continued

(CONTINUED) COMMERCIAL QUALITY STANDARDS

SERVICE	ITALY	NETHERLANDS	PORTUGAL	SPAIN	UNITED KINGDOM
Number of meter readings within a year	OS • 95% LV and 95% MV with at least 1 within a year		OS • 98% with, at least 1, within a year	GS • Minimun of 6 times per year	OS • 100%, one reading per year
Response to customers letters	OS • 90% LV and 95% MV within 20 working days	IS • Within 10 working days	OS • 90% within 20 working days		OS • 100% in 10 days
Response to customer claims	OS • 90% LV and 95% MV within 20 working days	IS • Within 10 working days	OS • 95% within 20 working days	GS • Customers < 15 kW: within 5 working days • Rest: within 15 working days	
Execution of simple works	GS • Within 15 working days for LV customers	IS • LV: Within 3 working days when supply at other customers needs no interruption; • Other: Within 10 working days	OS • 95% within 30 working days for LV customers	GS • LV (new supplies): Without LV network extension: within 5 working days following connection rates payment • With LV network extension: within 30 working days following connection rates payment	
Desactivation on customer's request	GS • LV: Within 5 working days • MV: Within 7 working days			GS • Within a month	
Reconnection following lack of payment	GS • Within 1 working day (including Saturday)		GS • LV: until 5 PM next working days • Non-LV: within 8 hours	GS • A maximum of 24 hours after paying the bill	OS 100% by end of the day

GS – Guaranteed Standards; OS – Overall Standards; IS – Indicative standards

continued

(CONTINUED) COMMERCIAL QUALITY STANDARDS

SERVICE	ITALY	NETHERLANDS	PORTUGAL	SPAIN	UNITED KINGDOM
Estimating charges for complex works	OS • 85% LV and 80% MV within 40 working days				
Execution of complex works	OS •85% LV and 80% MV within 60 working days	IS • Start within 10 working days		GS • LV (new supplies): a) With 1 MV/LV substation: within 60 working days following connection rates payment b) With more than 1 MV/LV substation: within 80 working days following connection rates payment • MV-HV (new supplies): a) 1-66 kV Customers: within 80 working days following connection rates payment Rest: Deadlines depend on work complexity	
Accuracy of bills made on estimations	OS • domestic: Δ<150% 85% LV house hold and • non-domestic: Δ<250% LV industry (*)				
Attendance in customers centres			OS • 90% within 30 minutes		
Attendance in telephone service			OS • 75% within 60 seconds		

GS – Guaranteed Standards; OS – Overall Standards; IS – Indicative standards

$$(*)\ \Delta = \frac{\text{Actual consumption - } \sum \text{Paid estimation- average estimation}}{\text{average estimation}}$$

ANNEX 3

1 – DURATION OF INTERUPTION PER CUSTOMER PER SINGLE OUTAGE				
COUNTRY	STANDARD	USERS INVOLVED	TYPE OF STANDARD AND EFFECTS	EXCLUSIONS
UK (enforced)	• Respond to failure of a suppliers' fuse: within 3 hours on a working day, 4 hours on any other day if any notification during working hours • Restoring electricity supplies after faults: within 18 hours • Minimum percentage of supplies to be reconnected following faults: within 3 hours, 85-95% depending on company; within 18 hours, 99%	• All users • All users • All users	• Single-customer guaranteed standard; Penalty payment used to be by claim, now automatic • As above • Overall standard	• Any failure of a company to make a Guaranteed standard payment is open to determination by the regulator (Ofgem) but companies can claim exclusions for Exceptional Circumstances (not defined).
ITALY (proposal)	• Restoring electricity supplies after single-user faults: Maximum time to be defined • Restoring electricity supplies after faults: Maximum time to be defined	• Only LV users • Only MV and HV users	• Single-customer guaranteed standards; Penalty payment to be defined, automatic	Excluded Acts of God (strictly defined)
NETHERLANDS (proposal)	• Restoring electricity supplies after faults: within 4 hours	• All users	Single-customer guaranteed standards; Penalty payment to be defined, automatic	
PORTUGAL (proposal)	• Respond to failure of suppliers' fuse: within 4 hours, 5 hours in rural areas • Restoring electricity supplies after faults: 80% within 4 hours	• All users • MV and LV users	• Single-customer guaranteed standards; Penalty payment by claim • Overall standard	• None • Acts of God, planned interruptions and short unplanned interruptions

2 – NUMBER OF INTERRUPTIONS PER CUSTOMER PER YEAR

COUNTRY	STANDARD	USERS INVOLVED	TYPE OF STANDARD AND EFFECTS	EXCLUSIONS
UK (enforced)	• Maximum number of interruptions per customer per year: to be defined • Percentage of customers who suffer more than N interruptions per year: to be defined	• All users • All users	• Guaranteed standard; Penalty payment to be defined • Overall standard	• To be defined
SPAIN (proposal)	• Maximum number of interruptions per LV customer per year: 12 (urban); 15 (semiurban); 18 (rural concentrated); 24 (rural sparse) • Maximum number of interruptions per MV customer per year: 8 (urban); 12 (semiurban); 16 (rural concentrated); 20 (rural sparse) • Maximum NIEPI (interruptions per installed kW): 4 (urban); 6 (semiurban); 10 (rural concentrated); 15 (rural sparse)	• LV users • MV users • LV and MV users	• Guaranteed standards; penalty payment related to number of interruptions in excess of the standard; • Guaranteed standards; penalty payment related to number of interruptions in excess of the standard; • Overall standard	• Only long interruptions (t>3min) Exclusions: acts of God and third party actions
PORTUGAL (proposal)	• Maximum number of interruptions per LV customer per year: 12 (zones A); 26 (zones B); 46 (zones C) • Maximum number of interruptions per MV customer per year: 8 (zones A); 20 (zones B); 40 (zones C) • Maximum number of interruptions per HV customer per year: 8 • Maximum number of interruptions per EHV customer per year: 3	• LV users • MV users • HV users • EHV users	Guaranteed standards; penalty payment are related to number of interruptions in excess of the standard and are by claim. In addition, some overall standards without penalty payments have been set (SAIFI-MV and SAIFI-LV)	• Only long interruptions (t>3min) For exclusions, see below Table C

For the definition of geographical classification, see table B below

3 - YEARLY DURATION OF INTERRUPTION

COUNTRY	STANDARD	USERS INVOLVED	TYPE OF STANDARD AND EFFECTS	EXCLUSIONS
NETHERLANDS (indicative standard)	• Customer minutes lost: 20 minutes	• All users	• Overall standard, only indicative	
ITALY (indicative standard)	• Customer minutes lost: 30 minutes (urban), 45 minutes (semiurban), 60 minutes (rural)	• MV and LV users	• Overall standard, only indicative; likely to be enforced in a few years	Excluded acts of God and third party action
SPAIN (proposal)	• Max. hours of interruption per customer per year: LV:6, MV:4 (urban); LV:10, MV: 8 (semiurban); LV:15, MV:12 (rural concentrated); LV:20, MV:16 (rural sparse) • Average TIEPI (hours lost per kW installed): 2 (urban); 4 (semiurban); 8 (rural concentr.); 12 (rural sparse) • 80 percentile TIEPI (value that is not overcome by 80% of municipalities): 3 (urban); 6 (semiurban); 12 (rural concentrated); 18 (rural sparse)	• LV and MV users • LV and MV users • LV and MV users	• Guaranteed standards; penalty payment are related to outage hours in excess of the standard and are by claim • Overall standard • Overall worst-served standard	Excluded acts of God and third party action
PORTUGAL (from 1.1.2001)	• Max. hours of interruption per customer per year: LV:6, MV:4 (zones A); LV:10, MV:8 (zones B); LV:25, MV:20 (zones C) • Max. hours of interruption per HV customer per year: EHV: 1; HV: 4 • Average TIEPI (hours lost per kW installed): 3 (zones A); 6 (zones B); 24 (zones C)	• MV and LV users • EHV and HV users • LV and MV users	• Guaranteed standards; penalty payment are related to outage hours in excess of the standard and are by claim • Overall standard (In addition, other overall standards without penalty payments have been set: SAIDI-MV and SAIDI-LV)	• Only long interruptions (t>3min) For exclusions, see below Table C

For the definition of geographical classification, see table B below

4 – IMPROVEMENT STANDARDS

COUNTRY	STANDARD	USERS INVOLVED	TYPE OF STANDARD AND EFFECTS	EXCLUSIONS
ITALY (enforced)	• Minimum rate of improvement in customer minutes lost: ranging from 0 to 16% yearly according to starting level and territorial density (see below table A)	MV and LV users	Overall standard with economic effect (link to tariff)	Excluded acts of God and third party action (see below Table C)
UK (enforced)	• Minimum rate of improvement in customer minutes lost and in customer interruptions: ranging 5 to 10% over 5 years	All users	Target figures for end of price control in 2005	None but subject to statistical analysis to exclude exceptional conditions

A - YEARLY IMPROVEMENT STANDARDS IN ITALY

STARTING LEVEL OF YEARLY DURATION OF INTERRUPTION PER LV CUSTOMER (2-YEAR AVERAGE, NET FORCE MAJEURE AND USERS/THIRD PARTIES' RESPONSIBILITIES)			YEARLY RATE OF IMPROVEMENT REQUIRED
HIGH DENSITY DISTRICTS (URBAN)	MEDIUM DENSITY DISTRICTS (SUBURBAN)	LOW DENSITY DISTRICTS (RURAL)	
< 30 minutes lost	< 45 minutes lost	< 60 minutes lost	0%
31 – 60 minutes lost	46 - 90 minutes lost	61 - 120 minutes lost	5%
61 – 90 minutes lost	91 - 135 minutes lost	121 - 180 minutes lost	8%
91 – 120 minutes lost	136 - 180 minutes lost	181 - 240 minutes lost	10%
121 – 150 minutes lost	181 - 270 minutes lost	241 - 360 minutes lost	13%
> 151 minutes lost	> 271 minutes lost	> 361 minutes lost	16%

5 – OTHER STANDARDS				
COUNTRY	STANDARD	USERS INVOLVED	TYPE OF STANDARD AND EFFECTS	EXCLUSIONS
UK (enforced)	• Minimum notice for planned interruptions: at least 5 days notice	All users	Guaranteed standard; penalty payment by claim	
UK (proposal)	• Respond to no-supply telephone calls within specified time: to be defined	All users	Overall standards	
PORTUGAL (enforced)	• Minimum notice for planned interruptions: at least 36 hours notice	All users	Regulatory disposition; sanctions could be imposed by ERSE under the terms of law	

B – GEOGRAPHICAL CLASSIFICATIONS	
PORTUGAL	Zones A: localities with more than 25 thousand customers Zones B: localities with less than 25 thousand and more than 5 thousand customers Zones C: localities with less than 5 thousand customers
SPAIN	Urban zones: Supplies Group>20.000 (included capital cities) Sub-urban zones: 2.000 < Supplies Group < 20.000 Rural Concentrated zones: 200 < Supplies Group < 2.000 Rural Sparse zones: Supplies Group<200 and disperse supplies
ITALY	High density zones: municipalities with more than 50.000 inhabitants, except parts subject to Authority approval on companies' request (*) Medium density zones: municipalities with less than 50.000 and more than 5.000 inhabitants Low density zones: municipalities with less than 5.000 inhabitants

(*) Only for major cities (more than 50.000 inhab.; about 100 cities) a special procedure has been adopted to distinguish different subareas within the same municipality: companies may claim the Authority to consider some parts of the municipality as low or medium density, if there are documented differences in load density

C – DEFINITION OF ACTS OF GOD	
PORTUGAL	In the calculation of standards, which leads to penalty payments, are excluded all interruptions caused by: • fortuitous reasons or force majeure, • public interest, • service reasons, • safety reasons, • agreements with the client, • facts attributable to the client. In the Quality of Service Code the following situations are considered as “force majeure”: • general strike; • public order altercation • fire • earthquake • flooding • wind of exceptional intensity • direct lightning strikes • sabotage • malefaction • duly proven third party intervention.
ITALY	For the verification of yearly improvement standards the interruptions caused by following are not included: • force majeure: - acts of public authorities - natural disasters - severe weather conditions only if design requirements are exceeded • external causes: - damages by third parties - interruptions caused by users - loss of supply from national transmission grid - loss of supply from other distributors
UK	Any failure of a company to make a Guaranteed standard payment is open to determination by the regulator (Ofgem) but companies can claim exclusions for Exceptional Circumstances (not defined).

ANNEX 4

1 - VOLTAGE QUALITY STANDARDS						
VOLTAGE QUALITY	ITALY	NETHERLANDS	NORWAY*	PORTUGAL*	SPAIN	UNITED KINGDOM
Frequency	EN 50160	EN 50160 with fc=±1% (99,5 % of the year)	Not regulated	EN 50160	EN 50160	fc=±1%fn
Voltage magnitude	EN 50160	EN 50160 with minor adjustments	22 kV; other levels: not regulated	≤45 kV: EN 50160; > 45 kV: Uc=±5%Un	LV & MV: Uc=±7%Un > MV: n.a.	LV (230V): Uc=+10% / -6%Un > LV: Uc=±10%Un
Fluctuations of voltage magnitude	EN 50160	EN 50160 with levels for 99,5% of the week	Not regulated	Uc=±5%	No explicit levels	No explicit levels
Voltage dips	Not yet regulated	EN 50160	Not regulated	≤45 kV: EN 50160; > 45 kV: n.a.	No explicit levels	No explicit levels
Temporary or transient overvoltages	Not yet regulated	EN 50160	Not regulated	Not regulated	No explicit levels	No explicit levels
Unbalance of three phase voltages	EN 50160	EN 50160 with levels for 99,5% of the week	Not regulated	≤45 kV: EN 50160; > 45 kV, indicative values: U- ≤2% (95% of the week, 10 min RMS)	No explicit levels	No explicit levels
Harmonic distortion of the voltage waveform	EN 50160	EN 50160 with levels for 99,5% of the week	Not regulated	≤45 kV: EN 50160; > 45 kV: indicative values	No explicit levels	THD < 5% at 275 and 400 kV, no explicit levels for lower voltages
Interharmonic voltages	Not regulated	Not regulated	Not regulated	Not regulated	No explicit levels	No explicit levels
Mains signalling voltage	EN 50160	EN 50160	Not regulated	Not regulated	No explicit levels	No explicit levels
DC components	Not regulated	Not regulated	Not regulated	Not regulated	No explicit levels	No explicit levels

2 - VOLTAGE QUALITY: SUMMARY OF TECHNICAL STANDARD EN 50160; 1999 "VOLTAGE CHARACTERISTICS OF ELECTRICITY SUPPLIED BY PUBLIC DISTRIBUTION SYSTEMS"

TOPIC	LOW VOLTAGE	MEDIUM VOLTAGE
Frequency	49.5-50.5 Hz (99,5% of the year) or 47-52 Hz (all year)	49.5-50.5Hz (99,5% of the year) or 47-52 Hz (all year)
Magnitude	Un ±10% (95% of the week, 10 min RMS) Un +10/-15% (100% of the week, 10 min RMS)	Uc±10% (95% of the week, 10 min RMS)
Fluctuations of voltage magnitude	+5% up to +10% some times per day Flicker: Plt ≤1 (95% of the week)	+4% up to +6% some times per day Flicker: Plt ≤1 (95% of the week)
Voltage Unbalance	U- ≤ 2%(95% of the week, 10 min RMS); 3% in some areas	U- ≤ 2%(95% of the week, 10 min RMS); 3% in some areas
Harmonic voltage	U_3≤5%, U_5≤6%, U_7≤5%, U_{11}≤3.5%, U_{13}≤3% and THD≤8% (95% of the week, 10 min RMS)	U_3≤5%, U_5≤6%, U≤£5%, U_{11}≤3.5%, U_{13}≤3% and THD≤8% (95% of the week, 10 min RMS)
Voltage dips	Indicative: up to a few tens to up to one thousand	indicative: up to a few tens to up to one thousand
Short interruptions	Indicative: up to a few tens to up to a few hundred to a few hundred	indicative: up to a few tens to up
Long interruptions	Indicative: (interrupt.>3 min) annual frequency 10 up to 50, depending on area	indicative: (interrupt.>3 min) annual frequency 10 up to 50, depending on area

ANNEX 5

Regulators in most countries have to some extent addressed the importance of quality of the services provided by utilities. Quality of service includes both technical quality of supply (e.g. number and duration of long interruptions) and commercial quality (e.g. billing, metering, customer information).

The main aim in regulating both technical and commercial quality is to give utilities incentives to provide an optimal level of service. Optimal levels are obtained as the result of minimizing the cost of investment and operational costs related to quality improvement and the costs suffered by customers as a result of quality degradation.

While physical indicators on quality of supply, such as number and duration of long interruptions and minutes of lost supply by customer, number of outages per year etc. are available in most countries little is known about the monetary value placed upon quality of supply by customers. The major challenge is therefore in determining the cost suffered by the customers if quality deteriorates, or the value of quality to customers.

Value of quality can be described as the loss in the customers utility due to e.g. an interruption in the power supply, or as the sum the customer would be willing to pay to avoid the same interruption.

It is not easy to determine customers' valuations of quality directly. Attention has focussed instead on evaluating the impacts or (economic) losses resulting from e.g. long interruptions. It is however important to bear in mind that interruption costs are not equal to value of quality but are instead a proxy for it. Interruption costs may vary from customer to customer as a function of a number of factors (i.e. dependency on electricity, nature and timing of the disturbance and the economic value of the activity being disrupted). In addition depending on their requirements each customer may place different values on quality of supply at different times of day, week, or year.

Common methods for estimating customer interruption costs are case studies and customer surveys.

Case studies base estimates on historical interruptions and the resulting direct and indirect cost of the interruption to customers. The method is in most cases combined with a customer survey.

The survey method is based on asking the customers to estimate the costs or losses they have or would have incurred due to interruptions. Direct costs are relatively easy to determine for commercial and industrial categories. In contrast, residential sector costs are relatively more difficult to estimate since these are likely to be dominated by subjective and less directly measurable effects such as inconvenience. In some surveys customers have been asked about their willingness to pay for quality improvements or their readiness to accept lower quality at a lower price.

The Working Group has listed some relevant literature on the subject. The figures on customer interruption costs that can be found in the listed literature may not be directly applicable in other countries. There is reason to believe that these cost will vary from country to country. There is also reason to believe that customer interruption costs may have changed over the last decade as a result of increased dependency on electrical power, e.g. for computers and electrical household appliances.

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