Kaisa Tahvanainen

MANAGING REGULATORY RISKS WHEN OUTSOURCING NETWORK-RELATED SERVICES IN THE ELECTRICITY DISTRIBUTION SECTOR

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ABSTRACT

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Managing regulatory risks when outsourcing network-related services in the electricity distribution sector

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Deregulation of the electricity sector liberated the electricity sale and production for competitive forces while in the network business, electricity transmission and distribution, natural monopoly positions were recognised. Deregulation was accompanied by efficiency-oriented thinking on the whole electricity supply industry. For electricity distribution this meant a transition from a public service towards profit-driven business guided by economic regulation. Regulation is the primary means to enforce societal and other goals in the regulated monopoly sector. The design of economic regulation is concerned with two main attributes; end-customer price and quality of electricity distribution services. Regulation limits the costs of the regulated company but also defines the desired quality of monopoly services. The characteristics of the regulatory framework and the incentives it provides are therefore decisive for the electricity distribution sector. Regulation is not a static factor; changes in the regulatory practices cause discontinuity points, which in turn generate risks. A variety of social and environmental concerns together with technological advancements have emphasised the relevance of quality regulation, which is expected to lead to the large-scale replacement of overhead lines with underground cables. The electricity network construction activity is therefore currently witnessing revolutionary changes in its competitive landscape. In a business characterised by high statutory involvement and a high level of sunk costs, recognising and understanding the regulatory risks becomes a key success factor. As a response, electricity distribution companies have turned into outsourcing to attain efficiency and quality goals.

This doctoral thesis addresses the impacts of regulatory risks on electricity network construction, which is a commonly outsourced activity in the electricity distribution network sector. The chosen research approach is characterised as an action analytical research on account of the fact that regulatory risks are greatly dependent on the individual nature of the regulatory regime applied in the electricity distribution sector. The main contribution of this doctoral thesis is to develop a concept for recognising and managing the business risks stemming from economic regulation. The degree of outsourcing in the sector is expected to increase in years to come. The results of the research provide new knowledge to manage the regulatory risks when outsourcing services.

Keywords: electricity distribution, economic regulation, risk, outsourcing

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Lappeenranta, March 2010

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Nomenclature

Roman letters

$C$ unit cost
$C$ unit costs (or prices) for peer group companies
$C_n$ endogenous, controllable costs
$C_x$ exogenous, uncontrollable costs
$d_p$ debt premium
$D$ depreciation expense
$E(R)$ expected return on security
$E(R_m)$ average return on the market
$E(R_m) - R_f$ market risk premium
$f$ revenue or quantity weights for peer group companies
$g$ gearing
$h$ efficiency score
$i$ company
$j$ peer group company
$n$ number
$n$ number of companies in the peer group
$p$ unit price of the regulated service
$P$ overall price cap
$P$ unit price
$q$ quantity of the regulated service
$Q$ quantity sold
$r_d$ cost of dept finance
$r_e$ cost of equity finance
$r_f$ risk-free interest rate
$R_f$ risk-free return
$R$ authorised revenue
$t$ corporate tax, time
$T$ tax expense
$u$ weight of the output parameter
$\mu_0$ non-positive constraint, defining the non-decreasing returns to scale
$
u$ weight of the input parameter
$X$ efficiency factor
$Z$ adjustment factor for events beyond management’s control, measure of change

**Greek letters**

$\alpha$ share of the company’s own cost information
$\beta$ beta value of the security
$\Delta Cust$ change in the number of customers
$\Delta NV$ annual percentage change in the network volume
$\Pi$ total profits

**Acronyms**

ACER Agency for the Cooperation of Energy
CAPM Capital Asset Pricing Model
CCA Chrome copper arsenic
CGA Customer growth adjustment factor (€/customer)
CIS Customer Information System
(C)OLS (Corrected) Ordinary Least Squares
CRS Constant returns to scale
DEA Data Envelopment Analysis
DMS Distribution Management System
DNO Distribution network operator
DP Straight-line depreciation
EC European Commission
EEA Engineering Econometric Analysis
EMA Energy Market Authority
ER Efficiency requirement
ES Efficiency score
EU European Union
GIS Graphical information system
<table>
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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>GIS</td>
<td>Gas insulated switchgear</td>
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<tr>
<td>IC</td>
<td>Interruption costs</td>
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<td>INV</td>
<td>Investment</td>
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<td>IO</td>
<td>Industrial organisation</td>
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<td>MV</td>
<td>Medium-voltage</td>
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<td>NIS</td>
<td>Network information system</td>
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<td>NPV</td>
<td>Net present value of the network</td>
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<td>OE</td>
<td>Operating expenses</td>
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<td>OPEX</td>
<td>Controllable operating costs</td>
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<td>RB</td>
<td>Rate base</td>
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<td>RBV</td>
<td>Resource-based view</td>
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<td>ROR</td>
<td>Rate of return</td>
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<td>ROR</td>
<td>Rate of return regulation</td>
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<td>RPI</td>
<td>Retail price index</td>
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<td>RR</td>
<td>Required revenue</td>
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<td>RR</td>
<td>Reasonable return</td>
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<tr>
<td>RV</td>
<td>Repurchase value of the network</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory, control and data acquisition system</td>
</tr>
<tr>
<td>SF6</td>
<td>Sulphur hexafluoride</td>
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<tr>
<td>SFA</td>
<td>Stochastic Frontier Analysis</td>
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<td>SLD</td>
<td>Straight-line depreciations</td>
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<td>TCE</td>
<td>Transaction Cost Economics</td>
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<td>TFP</td>
<td>Total factor productivity</td>
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<td>TOTEX</td>
<td>Total cost</td>
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<tr>
<td>VRS</td>
<td>Variable returns to scale</td>
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<tr>
<td>VTT</td>
<td>Technical Research Centre of Finland</td>
</tr>
<tr>
<td>WACC</td>
<td>Weighted average cost of capital</td>
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1. Introduction

At the beginning of the 1990s, the European electricity markets were liberalised. The objective of market liberalisation was to improve efficiency in the electricity supply chain, to decrease end-user prices and improve the quality of services. These goals were to be reached by promoting competition where possible, which in the energy sector meant deregulation of electricity generation and sale. Electricity network activities, electricity transmission and distribution, retained their monopoly status but were not unaffected by the liberalisation process. Network businesses have been regarded as a natural monopoly, in which competition is not considered feasible. Instead, networks are regulated in order to prevent network companies or distribution network operators (DNOs) from misusing their monopoly position to the disadvantage of their customers and to root out inefficiencies inherent in the business. Indeed, the changes in electricity markets have introduced pressure to cost and quality improvements.

The design and scope of the regulatory system define the framework according to which the regulated activities are remunerated. Because of the high level of involvement, regulation is also a potential source of risk. Electricity distribution is a business characterised by its assets, which makes it particularly susceptible to economic regulation. A response from the industry to regulatory challenges has been to realign the strategic focus of the business.

1.1. Supply chain in the electricity sector

Energy sector services have traditionally been characterised by public ownership and vertical integration. These elements were believed to secure society’s basic services. Similarly as other infrastructure network industries, such as gas distribution, water and sewer services and district heating, electricity distribution networks typically constitute natural monopolies in their operating areas. However, the level of governmental intervention differs from one sector to another. The electricity distribution networks have two primary functions: to provide any electricity end-user with a reliable and reasonably priced access to electricity, and to form a marketplace for competitive electricity businesses, electricity generation and retailing, according to Figure 1-1. The gas distribution networks are faced with similar requirements (defined in the Gas Market Directive 2003/55/EC), although in many cases, the role of gas
networks is different from the role of electricity networks, for instance, in the sense that electricity is not storable. Water and sewerage systems and district heating networks typically lack the requirement to form a marketplace, mainly on account that competition is restricted for technical reasons. The design of these networks is based on consideration of the local needs and the local use of resources available. Electricity and natural gas supply on the other hand have national trunk lines, which enables efficient use of production capacity and competition on energy.

Figure 1-1. Structure of electricity supply industry.

In the electricity sector, the European Union legislation has defined the framework for market liberalisation, or deregulation, with the objectives of improving efficiency in the electricity supply chain, decreasing end-user prices and improving the quality of services (EC 2003b). Unbundling different functions of electricity supply is required in order to guarantee non-discriminatory pricing and access to networks. For networks, deregulation of energy sector has, in fact, meant strengthening of regulation, a process often referred to as re-regulation.
1.1.1. Electricity distribution sector

Electricity networks are regarded as natural monopolies on the premise that parallel networks in a distribution area are not considered efficient. Further, Gunn and Sharp (1999) define that a natural monopoly is sustainable if there exists a price and output combination such that entry by rival firms is unattractive, while all demand is satisfied and the revenues cover the total costs of production. The sector-specific authorities therefore grant an operating licence to a single distribution network operator to carry out electricity distribution service in its area. According to the Electricity Market Act (386/1995), the system operator shall maintain, operate and develop its electricity system and the connections to other systems in accordance with its customers’ reasonable needs, and to secure the electricity supply of sufficient quality to its customers. The Act also states among other things that the distribution system operator shall connect customers to the electricity distribution system and sell electricity transmission services for reasonable compensation. The costs for services in electricity distribution are raised in the distribution tariff, which makes up approximately 28% of the household customer’s electricity bill (EMA 2009a). Moreover, the power quality and reliability of electricity supply are to a large degree determined by the characteristics of electricity distribution networks. Electricity distribution is therefore an important component in the electricity supply chain.

1.2. Business logic in the electricity distribution business

Electricity distribution companies have been granted monopoly positions and therefore do not face competition. Instead, regulation is relied on to produce competitive-like forces so that end-customers receive electricity distribution services at reasonable prices and sufficient quality. The first aspect of regulation is therefore to protect the end-customers from the possible abuse of distribution companies’ monopoly position, mainly with respect to distribution tariffs. The customers also expect sufficient quality of electricity supply but are not willing to pay for excessive quality levels. While ensuring the reasonableness of regulated electricity distribution services in terms of price and quality, the regulator must provide companies with sufficient means to develop, maintain and operate the network in their areas of responsibility. In the literature on regulation, the holder of the network licence and the subsequent responsibility for providing electricity distribution services to end-customers are often differentiated from the owners (e.g. Viljainen 2005, Eyles et al. 2000, Mohseni 2003). Therefore, the third party
affected by regulation is the network asset owner. The owners of the electricity distribution assets want to make profit on their investment that is in line with the risk involved in the industry. The regulator’s task is to evaluate the expectations of different stakeholders of electricity distribution and incorporate them into the regulatory regime, see Figure 1-2.

According to the directive 2003/54/EC, the national regulatory authorities must ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective. Furthermore, the distribution tariffs should be sufficient to enable the necessary investments in the networks to be carried out in a manner allowing the viability of the networks. The directive does not, however, define any details on how these requirements should be included in the regulation of the electricity distribution business. Rather, the directive leaves room for different interpretations, which means that there are large variations in regulatory models in different countries; regulatory authorities have developed regulatory regimes based for instance on their unique economic, political and environmental conditions and needs. This also gives an insight into the electricity distribution operating environment; economic regulation is dynamic and can be regarded as an on-going process. Regulation is the primary means to enforce societal and other goals in the regulated monopoly sector.

1.2.1. Regulatory interaction

One of the basic challenges in regulation of monopolies is the asymmetry of information between the regulated company and the regulator (e.g. Armstrong and Sappington 2005). Inevitably, the regulated companies have more knowledge over the regulator for instance about
the state of their networks, costs and their ability to carry out regulatory objectives, which the regulator cannot fully observe because of information asymmetry. The role of the regulator, on the other hand, is to encourage companies to provide the information for the purposes of setting and maintaining the regulatory regime. This interaction between the regulator and the regulated company is often referred to as a game. If a regulated company takes advantage of the information asymmetry, it can be considered gaming the regulator, or that the company behaves opportunistically or strategically (Jamash et al. 2004, Gilbert and Newbery 1994). Exploiting the information advantage and optimising the regulatory outcome will maximise the company’s profits. Therefore, the incentives and directing signals that are provided in the regulatory regime are important. However, the regulatory game is played by the guidelines of the regulatory framework.

1.2.2. Regulation approaches

According to Parker (2003), a regulatory risk arises from the nature of the regulatory rules and practices. Or more precisely, the more rule based the regulation is, the less is the scope for regulatory discretion, which is one of the main sources of the regulatory risk, thereby placing great emphasis on the design and implementation of the regulation. Economic regulation is regarded in many instances as one of the single most influential factors in the electricity distribution business (Strausz 2009, Nordgård et al. 2003, DLA Piper 2008, Ernst&Young 2009). The distribution companies and the interested parties should therefore stay informed about the current regulatory practices and future development steps in regulation.

Regulation on the electricity distribution business is primarily concerned with two main goals: the price of end-customer services and the quality the end-customers customers receive. Regulation limits the costs of the regulated company and also defines the desired quality of monopoly services. For the purposes of regulating end-customer prices, two main approaches can be distinguished: regulation of the profit of companies or the prices of monopoly services. In the profit regulation, the regulated company is allowed to collect costs for its services and a profit on investments in monopoly assets. Common examples of these kinds of cost-based regulation methods include cost plus regulation and rate or return regulation. Cost-based regulation methods consider regulation as a constraint of the firm’s profit maximisation
(Kinnunen 2004). These models have been popular in the early stages of regulation, and in the pre-restructuring era (e.g. Jamasb et al. 2004), but they have been found inadequate for the purposes of modern regulatory regimes. Rate of return regulation is shown to encourage companies in overcapitalisation of the regulatory asset base (Averch–Johnson effect). By increasing the regulatory asset base, the regulated companies expect a higher return. Another concern is that companies are not provided with incentives for cost efficiency.

As a response to recognition of the information asymmetry problem, the regulation regimes have moved towards more incentive-based regulation or performance-based regulation (Joskow 2006, Jamasb and Pollitt 2000). The main idea in the incentive regulation methods is to utilise the information advantage that the regulated companies possess; the regulation provides the regulated companies with incentives to cut cost in the hope of retaining more profit for themselves by setting a ceiling for price or revenue. When there is no connection between the revenue cap and performance, maximising profit would mean the same as minimising costs. Price-cap and revenue-cap regulation are examples of these regulatory applications. As a regulation period usually extends over several years, the cost incentive is quite strong. Without additional quality regulation measures, these instruments eventually lead to quality degradation (Ajodhia 2002). Many regulation regimes therefore incorporate incentive schemes for the purposes of encouraging service quality. In fact, various incentive schemes are often included in price or profit regulation. Incentive schemes commonly employ yardstick regulation that rewards the regulated companies for their performance in relation to a benchmark, whether it is the performance of other companies or some other measure.

A common characteristic for incentive-based regulation is that the regulation decisions are made before the regulation period (ex ante) so that the companies are aware of incentives. Incentive regulation has been found to be associated with a higher level of shareholder risk than the cost-based regulation (Alexander et al. 1996). Ex-post regulation evaluates the regulatory outcome afterwards and it is often regarded as being light-handed for giving more latitude to companies.
1.2.3. Other drivers

Economic regulation is the primary means to promote common goals that originate from the prevailing EU legislation and the national legislations in the Member States. The focus is primarily on developing electricity networks as a marketplace, that is, network access conditions and charges, and on promoting the efficiency and quality of network-related services. The electricity distribution business has encountered some other drivers that are aimed at facilitating the functioning of the markets; one of these is the introduction of smart meters with the purpose of increasing competition in the electricity retail market. The network companies are usually the responsible party to manage the metering activity and consequently, to allow the end-customers to control their consumption and to improve energy efficiency. Actions taken to increase the use of renewable energy sources will also have an effect on electricity distribution networks, because the network will have to facilitate the resulting increase in the decentralised small-scale electricity generation units in distribution networks.

Another type of drivers for the electricity distribution industry is the emerging environmental and safety concerns. For example, the impact of magnetic fields, employee safety issues, increasing value of landscape and restrictions on using detrimental chemicals are issues that need to be addressed in network planning and operation. For example Sweden has restricted pole climbing to promote employee safety, and new working methods have been introduced. Cabling electricity networks offers a solution to many of the problems (EC 2003c). The network assets are reaching the end of their lifetimes, and future networks have to be built to meet more demanding expectations. The technology available for building more sophisticated networks is developed, but often, investments may be too high or the technique is still too unreliable to use.

Recently, a particularly strong value has been placed on customer service issues. Public concern over the reliability of electricity supply was instigated by the large disturbances around year 2000, and has since then compelled some authorities to set strict reliability requirements. As a result, distribution companies are formally expected to reduce the anticipated effects of climate change that will increase the occurrence of faults especially in overhead line networks. Society’s pressure for reliable electricity supply is high and therefore, besides imposing
regulations, customer compensations for the loss of electricity supply are widely enforced. One common aspect can be observed; interruptions are now a factual cost item for the electricity distribution industry.

According to Dean et al. (1999), changes in the business environment characteristics have often resulted in changes in business strategies and processes. Some of the external business drivers will have an indirect influence on the electricity distribution business – but even more drivers will have a direct impact through the regulatory regime. The natural monopoly status of electricity distribution sets statutory and regulatory obligations and therefore has a decisive role in implementing new requirements for the business. As companies face more demanding legislative and regulatory requirements, an inevitable change in the strategic orientation of the business logic is to follow.

1.3. Outsourcing in the electricity distribution sector

Literature recognises privatisation as the driving force in restructuring of the electricity distribution sector (Parker 2001, Ghobadian and Viney 2002) and, for instance, according to McAdam et al. (2003), in the U.K., privatisation has been the driving force for identifying processes of the network business, strategically re-organising the business and realising rapid improvements in productivity. Moreover, according to Bartle and Korosec (1996), contracting out is one form of privatisation. However, as Saplacan (2008) points out, among the main catalysts for business reorganisation have been the introduction of competitive forces in the electricity sector and resulting unbundling of operations. The primary means for increasing competition in the electricity distribution sector are economic regulation and reducing the size of the monopoly. As the two main foci of economic regulation have been cost efficiency and quality of supply, purchasing services from competitive markets would intuitively contribute to the directing signals of economic regulation. Hodemaeker and Meijden (2003) recognise the creation of commercial interfaces as a method to minimise regulatory intrusion. Contrarily, arguments against promoting competition by breaking up a dominant incumbent firm into competing units are that the cost advantages from economies of scale will be lost and while more competition is likely to improve allocative efficiency, it will be at the expense of productive efficiency.
During the last decade or so, the electricity distribution industry has witnessed a growing trend in outsourcing, where distribution companies are outsourcing their network-related activities. Main motivations for outsourcing of electricity distribution activities are often specified to be the increasing shareholder value, cost savings and focus on the core business (Eyles et al. 2000, Eurelectric 2003). For the Finnish electricity distribution sector, the expected benefits from outsourcing are better cost management and improved cost efficiency as well as access to additional resources and the possibility to focus on the core business (Aminoff et al. 2009).

The tendency to outsource network-related activities raises a valid question of the factual monopoly activities in the electricity distribution business. For instance according to Viljainen (2005, p. 29), in the electricity distribution business, all the activities cannot be considered to possess monopoly characteristics. Harris (2006, p. 124) sees outsourcing of distribution-related services as a continuation of the unbundling process in the electricity supply industry. He goes on by stating that “any (network) function that can be outsourced can be deregulated” (Harris p. 129). Also in Eurelectric (2008), outsourcing is defined as a part of the restructuring process. For instance, in the U.K., the regulator is inclined to introduce competition into areas where it is in the interest of customers (Openshaw 2003). In fact, metering business has acquired economic significance, and is therefore unbundled from the network activities in the Netherlands and in the U.K. (Künneke and Fens 2006, Morch et al. 2007). But in most cases, there are no regulations concerning the reorganisation of the electricity distribution business. Rather, reorganisation of services is a method to respond to the new challenges of the changing operating environment: network companies have turned to outsourcing in order to achieve the efficiency and/or quality targets set by economic regulation. The extent to which outsourcing is employed will depend on the acceptable level of risk, which in turn is mainly governed by determinants of the regulatory framework.

1.4. Research design

This thesis has two main areas of interest; economic regulation and outsourcing in the electricity distribution sector. Economic regulation is enforced in the industry to ensure the electricity distribution services for society. Economic regulation is the principal means to set goals for the electricity distribution therefore making the interaction between regulation and
industry drivers focal for the research. The risk from economic regulation arises from the fact that regulatory intervention in the business creates uncertainty in operating the electricity distribution business. Network construction and maintenance are commonly outsourced activities in the electricity distribution network sector, similarly as in many other infrastructure network industries such as telecom, water, district heating and gas distribution (Pedersini 2005). Because of the increased efficiency and quality requirements that will lead to the large-scale replacement of overhead lines with underground cables, the electricity network construction activity is currently witnessing revolutionary changes in its competitive landscape. Both the efficiency and quality demands originate from the economic regulation. As a result, the electricity network construction activity in its current state provides a good example to study the emergence and impacts of regulatory risks when network-related services are outsourced to specialised service providers. This is important because the degree of outsourcing in the sector is also expected to significantly increase in years to come.

1.4.1. Research questions and objectives

The underlying research question in this doctoral thesis is how to manage regulatory risks when network-related services are outsourced to specialised service providers. This primary research question is approached by the following secondary research questions:

1) What are the risks stemming from economic regulation of the electricity distribution business?

2) In which way the distribution companies can respond to the regulatory risk?

3) What are the regulatory risks when employing a specialised service provider?

The main objective of this research is to provide means to recognise and manage the business risks in the electricity distribution business stemming from economic regulation. In order to reach the main objective, this thesis analyses the characteristics of the operating environment in which the economic regulation plays a significant role. The analysis gives a basis for identifying the sources of risk for the electricity distribution operation. In particular, special attention is paid to the impact of risk that arises from regulating the quality of services provided by the electricity distribution companies. One of these main risks is due to the fact that
electricity distribution networks are vulnerable to adverse weather events; in the case of large disturbances, particularly the overhead line networks experience interruptions in electricity supply that may have large-scale consequences. This work assumes that the outsourcing of the network-related activities is increasing and that underground cabling is considered a feasible network construction method in areas traditionally regarded as unconventional. Therefore, the objective of this study is to recognise the regulatory risk when implementing outsourcing. The results of the research provide new knowledge for the management of the regulatory risk when outsourcing services in electricity distribution sector.

1.4.2. Research approach

This doctoral thesis is the result of the five-year research at the Laboratory of Electricity Markets and Power Systems at Lappeenranta University of Technology. This thesis combines two research foci; economic regulation and business operations models in the electricity distribution industry. The scope of the research is chosen on grounds that both the service quality regulation and outsourcing will significantly affect the electricity distribution sector in the near future; the first one by defining the requirements for the quality of electricity provided for the end-users, and the second one by being the primary operations model by which most operations in the electricity distribution sector are carried out. Methods to assess the business risks of regulated monopoly companies already exist. The effects of various regulatory practices have been studied from the viewpoint of the systematic risk it imposes on valuation for the regulated companies (Alexander et al. 1996, Alexander et al. 2000, Binder and Norton 1999, Buckland and Fraser 2001, Paleari and Redondi 2005, Grout and Zalewskaja 2006). The studies on the risk exposure of the Finnish electricity distribution sector have relied on international references, as these studies require data from stock market listings, which for the majority of the Finnish distribution companies are not available (FIM 2004). Therefore, the emphasis of this research is on a far less investigated area of the regulatory risk; that is, the asymmetric features of the regulatory risk. The features of the regulatory regime often present an asymmetric risk defined in this thesis as an asymmetric distribution of possible outcomes that result from the regulatory practices and regulatory intervention and that are unique for each individual regulatory setting of the regulated companies. For instance, all the Nordic countries and other European countries have developed regulatory regimes based on their own requirements and needs, which has led to highly specific regulatory regimes.
The research questions require formulating a holistic view of the emerging regulatory risk and understanding its impact on outsourcing in a regulated industry. Therefore, the approach most suited for this research is qualitative. The data available from the research area and the nature of the research questions support the qualitative research approach. Moreover, the study belongs to the hermeneutic paradigm as this paradigm according to Gummesson (1991) concentrates on understanding and interpretation of the subject to be studied. More precisely, the study was carried out by applying the action analytical research method. Action analytical research provides a good platform to study dynamic features of regulatory interaction in the electricity distribution business. According to Olkkonen (1994), action analytical research seeks to gather information relevant for the research area, to interpret and analyse it and recommend changes in order to improve the practices and outcomes in the research area. This research approach provides means to recognise and manage the regulatory risks in a novel way; nevertheless, as it permissible to action analytical research approach verification of the results is left outside this study. The research questions are discussed according to the scheme presented in Figure 1-3.

Figure 1-3. Illustration of the research procedure.
First, for the analyses and classification of risks, a systematic approach is taken. That is, the risks are identified and their importance is evaluated according to predefined principles. Second, the methods are detected by which distribution companies can technically and organisationally prepare for the above-mentioned risks, especially in a case where revolutionary changes in the business environment are taking place. Finally, the effects of the regulatory risk when employing a specialised service provider for network construction are analysed by using electricity network underground cabling as an example.

1.4.3. Research data

The results presented in this doctoral thesis have been drawn from the research that has mainly been carried out in four different research projects. This section gives a review of these projects and the role of the author in them.

The research topic was first approached by examining the characteristics of the operating environment and economic regulation in the Finnish electricity distribution sector. The work was carried out by participatory research mainly in the following research projects: Developments of electricity distribution business (Partanen et al. 2004, Partanen et al. 2005) and Further development of the efficiency measurement model based on the DEA method (Honkapuro et al. 2006). The first project discussed the development opportunities of services business in the electricity distribution business as a response to future challenges. Outsourcing was acknowledged as a potential and effective business model. The outsourcing opportunities and restrictions were considered for individual activities in the electricity distribution value chain. The project used a scenario method for identifying the changes in the electricity distribution business operating environment. The author was involved in compiling the scenarios. The shift towards incentive regulation was considered a factor for innovative business solutions and the emergence of service markets.

An observation of the regulatory development was the increased significance of quality regulation (Tahvanainen et al. 2004). The research data also allowed the comparison of the regulatory characteristics under different regulation models in the Nordic countries and revealed
that the risks associated with individual regulatory systems are different (Tahvanainen et al. 2005). The project (Honkapuro et al. 2006) examined the quality incentives for the Finnish regulatory regime and developed the efficiency benchmarking. The basis for analysis was data submitted to the regulator by distribution companies. The projects revealed that there is a need to further study the method in which the regulation impacts the regulated business and the directing signals it provides. Inadequate understanding of the regulation does not provide means to prepare for the regulatory risks. In this thesis, the regulatory risk is discussed from theoretical perspective in section 2.3. The real-life impacts of regulatory risk in the Finnish electricity distribution sector are presented in Chapter 3. With the developments in the regulation practices and the increased quality awareness resulting from large-scale disturbances, the quality regulation aspect was further emphasized as an interesting research area (Tahvanainen et al. 2007, Tahvanainen et al. 2008)

Another strand of research focused on the emergence of new service provider markets from the re-organisation of the value chain in the electricity distribution industry. The project Challenges in infrastructure management business: Creating competitive advantage in emerging infrastructure network services market (Immonen et al. 2009a, Immonen et al. 2009b) produced a constructive framework for analysing the impacts of network companies’ changing strategic needs on valuable resource configurations of the service providers. The author of this doctoral thesis was one of the main authors in the project. The focus of the project was on the service provider business; however, recognising changes in the value chain is relevant also from the viewpoint of the distribution business. The results of this project comprised the basis for developing a management concept for underground cabling for the electricity distribution companies presented in the empirical part of this thesis.

Outsourcing in the electricity distribution sector in Finland was studied at a more general level in the project Outsourcing services in electricity distribution network industry (Aminoff et al. 2009). The objectives of this project were to determine which network-related activities are purchased from service markets and what are the reasons for outsourcing; the project also analysed the expected benefits and risks of outsourcing, gathered experiences and indications of the future development in outsourcing volumes. The project provided information on the initial stages of outsourcing in the electricity distribution sector in Finland as discussed in Viljainen et
al. (2009). The questionnaires and interviews were used to seek out the best practices of outsourcing. Outsourcing experiences were gathered in a web-based inquiry, in which 30 companies out of 81 Finnish distribution network companies replied, see Trygg et al. (2009). The interviews conducted in both the distribution companies and the service providers provided in-depth knowledge on outsourcing in the sector. The results of this project are used in this thesis to give a general view of the present state of outsourcing in the electricity distribution industry in Finland and to explain some of the characteristics associated with outsourcing. The author of this doctoral thesis was involved in preparing the questionnaire and conducting the interviews. The author participated in analysing the results and was one of the main authors.

The research work has partly been carried out in joint research projects with Tampere University of Technology, the companies in the Finnish electricity distribution industry, the Energy Market Authority and VTT Technical Research Centre of Finland. Numerous researchers representing the Departments of Electrical Engineering, Industrial Management (Technology Business Research Center) at Lappeenranta University of Technology, the Institute of Power Engineering at Tampere University of Technology and VTT Technical Research Centre have participated in the projects that constitute this thesis.

1.4.4. Limitations of the study

This thesis provides a management concept for rural electricity distribution companies engaged in large-scale underground cabling of the existing overhead lines. Within the scope of the research there are issues such as: how to identify the emerging risks after a new regulatory ruling is issued, and how to manage these risks in particular when services are outsourced. The term management in this thesis refers to actions taken to handle or control the regulatory risk when outsourcing network-related services in the electricity distribution sector; it is emphasised that the focus is not on business administration. The research questions are extensive both in terms of what are the regulatory risks, whether outsourcing should be used and to what extent. The chosen research approach does not provide definite answers to how to manage risks arising from the economic regulation of the electricity distribution business. In network construction, the competitive landscape is found to be revolutionary, which gives grounds for a new approach to the network development strategy. Underground cabling is chosen in this study as it provides
weather-resistant networks and thereby provides a good solution to future expectations on the quality of electricity distribution services.

Based on the data available in this study, outsourcing is found to be increasing in the electricity distribution sector in Finland. The risks of outsourcing services as such are left outside the scope of this study as they are already widely covered elsewhere in the literature (e.g. Hallikas et al. 2004, Hallikas et al. 2002). Therefore, this research considers sector-specific features of outsourcing. In this thesis, the term **outsourcing** is generally used to refer to a transfer of a business function or a significant part of it to an external service provider or to an independent business unit within the outsourcing company.

### 1.4.5. Outline of the thesis

This doctoral thesis is organised as follows. Chapter 2 has three agendas. First, the chapter introduces special characteristics of the electricity distribution business that mainly attribute to the dual role of the electricity distribution networks, that is, delivering electricity to the end-customers and facilitating the functioning of the electricity markets. While the attributes of the operating environment are in a decisive role for the electricity distribution business, the design and implementation of the regulatory system can be argued to have a great influence on the business risk experienced by the distribution companies. The regulation models have inherent properties that affect the risk and distribution of risk between the interest groups. The chapter finally discusses the theory of outsourcing. Chapter 3 elaborates on economic regulation and the role of a regulatory risk in the electricity distribution business in Finland. Electricity distribution is a highly capital intensive business, and the asset lifetimes are long, which emphasises the importance of preparing for the perceived risk. The aspects of the Finnish regulation regime are discussed by developing a systematic approach to analyse the risk components of economic regulation. Chapter 4 identifies the implications of regulatory risk for the network construction activity. Empirical evidence of outsourcing in the Finnish distribution business is applied in the work. Finally, Chapter 5 presents an operational principle for responding to and managing regulatory risks by employing specialised service providers. Chapter 6 provides the concluding remarks.
2. **On economic regulation, business risks and outsourcing**

The aim of electricity market restructuring is to root out inefficiencies throughout the supply chain by introducing competition where feasible, that is, in electricity production and sale. Electricity distribution networks provide a platform for competition, and are therefore granted a legal natural monopoly position in the electricity supply chain. From society’s point of view, there are concerns of possible misuse of the monopoly power as well as inefficiencies of operation, and therefore, adopting a regulatory regime for the electricity distribution business is considered necessary in order to secure reasonable end-user prices and a sufficient quality of supply.

Regulation of electricity distribution business is a challenging task of balancing the expectations of the end-customers, the regulated companies and the owners of the business. There are several approaches for regulating the electricity distribution business. Often, the regulatory regime is a product of the sector-specific regulator’s adaptation of the basic profit or price regulation method where various incentive schemes are included. For instance, economic regulation typically looks at prices and quality separately, but in practical implementations, there is a dependency between the two: there is a risk that the regulated companies do not cover their true costs in the regulatory framework, or that the required quality cannot be provided for electricity end-users. This is an example of the interaction between the regulation and the electricity distribution business, which causes uncertainties. Primarily, two types of regulatory risks can be distinguished; a risk from regulatory systems and a regulatory intervention risk. Different regulatory systems have inherent features that contribute to the risk experienced by the companies, but also changes in the regulation result in discontinuity points in the development of business environment, and this causes risks. This chapter discusses the prevailing and emerging characteristics of electricity distribution, the regulatory approaches to the electricity distribution business and the aspects of regulatory intervention in the relationship between the regulator and the regulated company. The impact of externalities is often transferred to realigning of the strategy and organisation of the company. Therefore, the end of this chapter discusses the issue of outsourcing services.
2.1. Operating environment in the electricity distribution business

The function of an electricity distribution system is to deliver electrical energy from transmission substations or small generating stations to each customer, transforming to a suitable voltage where necessary (Lakervi and Holmes 1995). The electricity distribution system delivers energy throughout the regional network (110 kV, 45 kV), transforming substations (110/20 kV, 45/20 kV), medium-voltage networks (20 kV), from distribution substations (20/0.4 kV) to low-voltage networks (0.4 kV) and end-customers. The operation is strongly characterised by external factors in network expansion and operation design. The Finnish distributing networks are valued at a repurchase value of 13.56 billion euros (Hänninen 2008). Together with long asset lifetimes (up to 30–50 years), it is commonly considered that the expensive assets are most efficiently utilised by a single actor in order to obtain a socially optimal quantity of output at a low unit cost, and that electricity distribution is, therefore, characterised by existence of economies of scale or economies of scope and a high level of sunk costs, which inevitably results in a natural monopoly (Parker 1999).

The electricity distribution sector has recently experienced a group of challenges. Development trends in the industry increasingly have a bearing on the operating environment faced by the regulated electricity network companies. Significant changes in the electricity distribution industry have been associated with legislative and regulatory amendments that have been enforced by the electricity market reform. The impact is not always limited to the statutory or regulatory framework but issues such as society’s dependence on continuous supply of electricity and growing concern over environment are gaining response from the industry. Therefore, despite the explicit natural monopoly status provided for the industry and the resulting public constraints, the externalities have a bearing on the business logic of the sector.

2.1.1. Legal and statutory framework

A fundamental change in the legal framework of the electricity supply industry has taken place in Europe over the past decade. The first electricity market directive (96/92/EC) issued by the European Parliament and the Council of the European Union set the common rules for electricity market opening. The Nordic countries were among the first to open their national
electricity markets. The Electricity Market Act in Finland was issued already in 1995. The goal of the market opening was to increase efficiency and competition in the sector. Although the main focus in the market restructuring was on market liberalisation, also the electricity network sector was significantly affected; electricity networks were to form a marketplace for the competitive electricity business. In order to secure the non-discriminatory and equal rights of all the parties involved in the market, formal regulation of the network operations was considered necessary.

A few years after the initial market opening, the need for additional requirements for accelerating market opening became evident. In 2003, a new directive (2003/54/EC) concerning the common rules for the internal electricity markets was issued. The purpose of amending the directive was, among other things, to promote the unbundling of generation and selling from network services and to provide national regulators with sufficient power in every member country. The directive emphasised the role of a national regulatory authority in enforcing non-discriminatory, transparent and fairly priced network access for market participants. Also, the characteristics of electricity supply, such as service obligation issues and security of supply, cannot be left to forces of competition alone, because of the essential nature of electricity services both at an international and local level.

The European-level framework for electricity sector legislation sets minimum requirements for the member countries – the implementation of these requirements to national legislation has many variations and degrees. For instance, the national regulators are responsible for fixing or approving, prior to their entry into force, at least the methodologies used to determine the distribution tariffs. This forced some countries, such as Finland, to modify their existing regulation principles but at the same time, allowed Finland to adhere to ex post regulation, although ex ante regulation is popular in most of the European regulation regimes. The directive also states that the tariffs, or methodologies, should be sufficient to allow the necessary investments in the networks to be carried out in a manner allowing these investments to ensure the viability of the networks. Again, the directive does not give any specifications on how to include these requirements in regulation, but regulators have developed regulations based on their unique conditions.
The third package of legislative measures on the internal energy market objectives continues the path set by the presented framework (COD 2007/0195). It strengthens regional cooperation among regulatory authorities by creating a new agency (Agency for the Cooperation of Energy Regulators, ACER) that among other things assists national regulatory authorities in performing regulatory tasks and will coordinate their action. The customer rights are also furthered for example concerning supplier switching. The directive also strongly promotes the penetration of smart meters in order to facilitate market participation of individual customers.

2.1.2. Industry structure

A typical feature of the electricity distribution sector, particularly in the Nordic countries, is a strong tradition of public ownership in local utilities. The leading guideline in operation was to provide public services for tax-payers. Thomas and Hall (2003) describe it as tacit ‘regulatory bargain’ where utilities could provide a good electricity service to consumers whilst still making fair, but not excessive profits for their owners. Under regulatory bargain, the ownership of utilities was stable with few mergers and acquisitions taking place. The stable operating environment invited company owners to focus decision-making on long-term optimisation rather than short-term profit. The restructuring of electricity market interfered with this regulatory bargain. The unbundling of operations in the electricity industry turned the focus exclusively to the electricity distribution business. The European Union directive (2003/54/EC) requires the distribution system operator to be “independent at least in terms of its legal form, organisation and decision making from other activities not relating to distribution”. This meant splitting up vertical monopoly structures. The aim of unbundling is to avoid discrimination, cross-subsidisation and distortion of competition, and subsequently, network companies retain independency and the network-related cost becomes more transparent.

Restructuring of the electricity market has been found to be a catalyst for mergers in the electricity industry, and penetration of private ownership in the industry characterised by extensive municipal ownership. In Finland, the current number of approximately 90 companies is a result of acquisitions by international actors in the turn of the 1990s (ET 2009a). The majority of the Finnish electricity distribution companies are municipally owned. A concern in connection with the increased private ownership is that the publicly funded network assets are
transferred as a risk-free holding to new owners without sufficient monetary and social compensations (Commerce Committee 1994). But even without acquisitions, the valuation of network asset may have contributed to the another perceived effect of unbundling of the electricity sector, that is, corporatisation. Harris (2006, p. 125) defines corporatisation as a process by which publicly owned companies with public service franchise and purpose start to behave like investor-owned companies. Electricity distribution companies have, in fact, increasingly shifted toward profit-oriented thinking even under public ownership.

2.1.3. Industry drivers

The EU’s energy policy sets out clear objectives for sustainable, competitive and secure energy (COM 2008). The primary objectives, 20 % reduction in greenhouse gas emissions, 20 % share of renewable energy in the EU final energy consumption and 20 % improvement in energy efficiency by 2020 are a concern also for the electricity distribution networks. The increasing number of small-scale renewable sources in more decentralised power generation, incorporating new energy demand technologies such as smart metering, and changing demand patterns as a result of climate change or energy efficiency measures, will be partly facilitated by the distribution networks. Reaching the above-mentioned target for a competitive European-wide electricity market is still an ongoing process. Moreover, a priority is to address the growing precariousness of Europe’s energy supply security (EC 2008a). With successful regulation, necessary investments in the electricity networks would be encouraged, and thus, the functioning of the markets and the security of supply would be guaranteed. In the following, the effects of recent development trends on the electricity distribution industry are discussed.

2.1.3.1. Security of supply

Security of supply translates to uninterrupted electricity supply in electricity distribution networks. The quality of electricity supply is generally considered to be at a sufficient level in the Nordic countries, and in Finland, the trend in the interruption statistics has been mainly improving, as can be seen from Figure 2-1. Recent increases in the interruption times are partly caused by the major storms in 2001 and difficult snow conditions in the end of 2005. Improvements in the accuracy of the interruption statistics compilation can partly explain the increase.
Despite the seemingly sufficient quality of supply, the quality aspects have gained an important role in the electricity distribution business. There are several reasons explaining this tendency. One major contributing factor for increased attention towards security of supply has been the public opinion. Europe experienced large disturbances at the beginning of 2000, which raised public awareness and debate over the acceptable level of continuity of supply and, ultimately, the question on compensations paid to customers when this acceptable level is not met. In Finland, for instance, the reliability of electricity supply became topical after storms in 2001 had caused severe interruptions in electricity distribution. Consequently, the idea of standard compensations for interruptions longer than 12 hours was introduced in the Electricity Market Act (368/1995). As societies have found themselves more dependent on electricity supply, the pressure to assign regulations on the continuity of supply at an aggregated level of electricity distribution has also become relevant. One practical result has been that the Finnish distribution companies are required to prepare a provision plan for actions in the case of large disturbances.\(^1\) In Sweden, the regulations have set more specific guidelines; interruptions longer than 24 hours are not allowed from 2011 onwards (Swedish Electricity Act 1997). The Finnish electricity distribution industry has been active in setting own regulations concerning acceptable limits for interruption times. The industry recommendations for interruption limits vary between 4–12

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\(^1\) Large disturbances are categorised as incidents where over 20 % of the clientele is lacking electricity supply or failure in a 110 kV line or a 110/20 kV (110/10 kV) substation or a main transformer (Järventausa et al. 2005).
hours based on whether the site is a city or a rural area (ET 2005). Industry regulations are presently being upgraded to better prepare for the current requirements.

Another aspect for the increased quality focus is the foreseen impact of implementing economic regulation that strongly encourages operational costs reductions. Undesired deterioration in quality can result if companies are rewarded for reducing operational costs at the expense of service quality, as discussed in Ajodhia (2002) and Sappington (2005). The assumption is that the companies seek ways to maximise their profits under the regulatory regime. Some publicly owned companies favour delivering high quality services even without existing incentives. Nevertheless, one of the regulator’s tasks is to provide means to maintain the continuous development of the electricity networks in the long term; should the quality of supply be overlooked at the expense of cost reductions, the consequences may be long-lasting. Numerous sector-specific regulators have introduced some form of regulation concerning various aspects of quality; continuity of supply, power quality, and customer service for example (CEER 2008).

2.1.3.2. Environmental issues

Environmental aspects are nowadays frequently present when deciding about energy policies, and the impacts show also in the electricity distribution business, either directly or indirectly. For instance, smart metering, labelling and informative billing based on actual consumption are keys to help individual consumers save energy (EC 2008b). Facilitating these actions usually falls to electricity distribution companies, perhaps the most apparent being the replacement of energy meters by more informative smart meters. Increased customer activity and the demand elasticity that follows are also prerequisites for the efficient use of the existing centralised electricity generation, because they reduce the peak power demand. Furthermore, actions taken to increase the use of renewable energy sources inevitably affect the electricity distribution networks, because they often result in an increase in decentralised small-scale electricity generation connected to the distribution networks. Tools to promote renewable generation are for instance feed-in tariffs and obligations to connect. These kinds of actions will have an impact on the requirement put on distribution networks. For example, when the size of generation units is decreasing, the network configuration may have to be reconsidered; the directions of power flows in a system with a lot of distributed generation are less predictable than those in a centralised system, and protection issues become more challenging.
As for the electricity distribution activity itself, restrictions to use detrimental or polluting chemicals are a part of the environmental protection that changes the way in which distribution networks are built. Especially prohibiting the use of CCA-treated poles will have significant impacts on the distribution networks as suitable replacements are considered. Other possible sources of pollution from networks are oil leakages, SF₆ leakages or magnetic field pollution from the network equipment. Finally, the focus is often on the visual impact of distribution networks, which mainly means a requirement to replace overhead lines with cables. Often this is done for social reasons, but a cable network is also more weather resistant, which means better reliability.

The overall effects of changing climate conditions are rather ambiguous for the electricity distribution operating environment. Extreme weather phenomena are associated with climate change, that is, increased storms and rainfall and changes in snow conditions often make the electricity networks more susceptible to interruptions (Martikainen et al. 2007). This is problematic mainly in rural networks, which consist mainly of overhead lines. City and urban networks are built underground mainly for reasons of land use and security of supply, and therefore the stress of extreme weather conditions is not as high. In Finland, about 42 % of the low-voltage and 23 % of the medium-voltage networks are cabled (EMA 2008a). On the other hand, climate change may also reduce energy consumption as a result of warming weather, or extend the cabling opportunities for areas that are less affected by ground frost.

2.1.3.3. Technical developments

In the electricity distribution business, the introduction of legislative requirements has impelled the use of new technical solutions that often have already been emerging. For instance, as discussed in the previous section, the use of smart meters for an interactive customer interface has been acknowledged for the purposes of energy efficiency and customer service. The European Union directive on energy end-use efficiency and energy services (2006/32/EC) promotes the use of smart meters, and they are currently installed all around Europe. All Finnish energy meters should be replaced by smart meters by 2011, which requires investments up to tens of millions of euros (ET 2009a).
Another large investment in electricity distribution is the topicality of replacing the ageing networks. At that point, the question of the technique selected for building the networks becomes relevant. Underground cabling has gained a firm ground as a popular network construction technique. The decision to use underground cables has commonly been a question of land use; cables are used in places of high importance and high aesthetical value. Improvements in the cable manufacturing and accessories together with more efficient installation methods – mainly cable ploughing – have lowered the construction costs but still, cabling is more expensive than building an overhead network, especially in medium/high-voltage networks (Lassila et al. 2007). Relatively recent developments of using 1 kV low-voltage distribution, pole-mounted switchgear or network data systems are also examples of technological developments available.

2.2. Economic regulation

Harris (2006, p. 137) defines regulation as explicit public or governmental intervention into a market to achieve a public or social objective that the market fails to accomplish on its own. Without the presence of competitive forces, companies can hold inefficiencies or they can take advantage of their monopoly powers by pricing their services opportunistically. As reforms in the competitive segments progress, they call for a regulatory reform of the non-competitive activities (Jamasb et al. 2000). The aim of the regulatory reform is to provide the utilities with incentives to improve their investment and operating efficiency and to ensure that consumers benefit from the efficiency gains.

A sector-specific regulatory body is responsible for setting up economic regulation and, ideally, the regulator is a neutral party between the stakeholders of the electricity distribution business; customers, distribution companies and network owners. The customers are most concerned with delivered electricity that is reasonably priced and of sufficient quality. Distribution companies, in turn, are responsible for developing and maintaining the electricity networks to provide electricity supply for society. The commitment associated with the networks, in terms of large-scale investments and long spans associated with them, is one of the main characteristics of the operation; the performance of today is the result of past investments. The owners expect
adequate compensation that corresponds to the risk involved in their investments. The modern regulation regime balances the three aspects of regulation focus, see Figure 2-2.

![Figure 2-2. Three aspects of regulation focus.](image)

A well-functioning regulatory system avoids high levels of regulatory uncertainty or regulatory risk and should therefore be stable, predictable and transparent. Both the customers and the companies benefit from stable regulation. The characteristics of the regulatory regime determine the incentives powers for the distribution companies. Alexander and Shugart (1999) add that the choice of the regulatory regime has implications for regulatory gaming between the regulator and the regulated company, the risks borne by a company under a regime and their effects and the allocation of risk, and consequently, the volatility of prices. The following presents a brief cross-section of regulatory system variables and some common regulation methods.

### 2.2.1. Regulatory systems

Regulatory systems vary according to the elements of company costs covered by regulation. The following Equation (2.1) gives a generalised idea of the impact of the type of regulatory system on the company profit (Alexander et al. 1996):
\[ \Pi = PQ - C_x(Q) - C_n(Q), \]  

where \( \Pi \) = total profits,  
\( P \) = unit price,  
\( Q \) = quantity sold,  
\( C_x \) = exogenous, uncontrollable costs,  
\( C_n \) = endogenous, controllable costs.

Endogenous costs can be influenced by the regulated company whereas exogenous cost cannot. The cost elements covered by the system determine the basic regulation systems; price cap (\( P \) or \( P, C_x \)), revenue cap (\( PQ \)) and rate of return regulation (\( PQ, C_x, C_n \)). In addition, yardstick regulation and hybrid schemes are widely used.

The choice of regulatory system raises an inevitable question of the differences between the systems. A regulatory decision can be made before (ex ante) or after (ex post) the regulation period. Regulation can also be divided into cost-based approaches, such as rate of return regulation and incentive regulation, such as price cap regulation. Cost-based systems are referred to as bottom-up regulation and incentive systems to top-down regulation, which sets a limit for the price or revenue for the company. Often, bottom-up regulation has been characterised as light-handed. This refers to the degree of freedom of the companies to make individual dispositions. Light-handed ex-post regulation implies that the regulator does not control the network companies in detail in advance, and in some cases it might take a form of regulation by threat of a regulatory action (Gronli 2001). A heavy-handed, ex ante approach, on the other hand, can be considered more precise at the level of regulatory involvement.

2.2.2. Regulatory revenue

The economic risk in electricity distribution is mainly defined through revenue that the firms are allowed to recover in economic regulation. Despite the differences in regulation methods,
they commonly require regulator’s viewpoint on the method by which the regulated firms’ cost components are appraised. These costs include capital costs, operational costs, interruption cost or other relevant costs. Operational costs are divided into costs that company has control over and those that are uncontrollable. Controllable operational costs include costs such as maintenance, personnel and supporting functions. Uncontrollable costs are not subject to regulations and consist of transmission fees for the transmission system operator.

Determining the cost of capital has three steps; 1) determining the regulatory asset base, which, in principle, comprises all investments that have been made to provide the regulated service, 2) setting an adequate allowed rate of return on this rate base based on the risk-adjusted cost of capital and 3) defining depreciations. The methods applied to assess the risk-adjusted cost of capital and to determine the allowed rate of return affect the risk sharing between the regulated firm and consumers on the one hand as well as between debt and equity owners on the other hand (Pedell 2006, p. 78). The following sections discuss the cost of capital in more detail. Interruption costs are discussed in section 2.2.5.

2.2.2.1. Cost of capital

The cost of capital is the price at which companies obtain capital from markets to finance their investments. It is also the return on invested capital the investors expect to earn. A company’s cost of capital can be derived by taking the weighted average cost of debt and the cost of equity to determine the weighted average cost of capital as shown in Equation (2.2).

$$WACC = g \cdot (1-t) \cdot r_d + (1-g) \cdot r_e,$$

(2.2)

where $g$ = gearing or leverage in a company measured as a proportion of debt in the total assets, $g = r_d / (r_e + r_d)$

$t$ = corporate tax

$r_e$ = cost of equity finance

$r_d$ = cost of dept finance.
The estimation of the rate of return has been a major cause of controversy between the regulator and the regulated companies (Parker 1999). For regulation purposes, the cost of capital is determined in capital-market-based approaches. Market-based approaches estimate future capital costs using historical market values by assuming that market data reflect the risk assessments of all market participants and thereby give an objective risk assessment (Pedell 2006 p. 163). The cost of debt is accessible through interest rates that provide forward-looking actions of market expectations for various credit qualities (Jenkinson 2006). The main problems are associated with estimating expected equity returns; there is no market data available, and therefore, it is necessary to use an appropriate asset pricing model to derive an estimate of risk and thereby the cost of equity. For this, Capital Asset Pricing model is often used.

Unless the regulator believes that the distribution companies have an inefficient capital structure, the gearing is determined by dividing the debt by the company’s total invested capital. In fact, for instance De Fraja and Stones (2004) found that although there is no requirement to adjust capital structures according to regulatory parameters, regulated companies clearly have an incentive to do so. However, according to Jenkinson (2006), regulators are more willing to use actual gearing as regulated companies have increasingly become highly geared, but according to Pedell (2006) there is a broad consensus that market values should be used. Debt increases the financial risk, although being cheaper than equity, as it offers the advantage of being tax-efficient. Finally, it is necessary to decide whether to set the cost of capital on a pre-tax or post-tax basis as it has an effect on the behaviour of the regulated companies (Jenkinson 2006).

**Cost of equity**

One the most common models to estimate the cost of equity is Capital Asset Pricing Model, CAPM. Cost of equity is based on the return requirement set by the investors; investors expect higher returns on the security, which entails an increased level of risk. This spells out an increase in the cost of capital for the company. The CAP model represents this relation of the risk and the expected return on security. The expected value of the security is the sum of the risk-free return and the risk premium in Equation (2.3).
\[ E(R_i) = R_f + \beta_i [E(R_m) - R_f], \]  
\[ (2.3) \]

where

- \( E(R_i) \) = expected return on security
- \( R_f \) = risk-free return
- \( \beta_i \) = beta value of the security
- \( E(R_m) \) = average return on the market
- \( E(R_m) - R_f \) = market risk premium.

Risk-free return is obtained from interest such as interest arising from government bonds. Beta is the sensitivity of the asset returns to market returns, and a market premium or a risk premium is the difference between the average market rate of return and the risk-free rate of return. CAPM is theoretically understandable and simple to use, but on the other hand, it has shortcomings that are widely discussed in literature, for instance by Fama and French (2004). The main issues relating to determining parameters for CAPM are a) whether to use the latest market estimates, or whether to apply some longer-term averaging, and b) what maturity to assume (Jenkins 2006). For example, if the risk-free interest rates are continuously and without delay adjusted according to the prevailing rates, the risk will be transferred to consumers, and if the regulated utility does not have a possibility to adjust its rates, the risk will come to capital owners. However, the investment lifetimes are decades in electricity distribution, which creates a large difference if the maturity is based on the time-horizon of the investors. As for the market risk premium, for reasons of consistency, it should be estimated as a premium at the exactly same interest rate as employed by the regulator as the risk-less interest rate (Pedell 2006, p. 171). Unlike in the case of interest rates, market evidence of forward-looking expectations is not available, and so there tends to be a strong reliance on historical evidence as a guide to future expected returns (Jenkinson 2006).

Also, similarly to other components in defining the cost of capital, there is the issue of which time period to use in addition to the question by which method it is calculated. Two fundamental issues in the measurement of beta are of concern; whether the riskiness of the business is constant over time, and whether any change over time in the risk of a regulated
business is endogenous with the regulation itself (Buckland and Fraser 2001). The first point is technical by nature, that is, whether the beta over a certain period of time truly reflects a regulated cost of capital. The second question is whether the regulators are building into their models the risk of the business under regulated conditions, or rather the risk of such a business under hypothetical conditions of competition (Buckland and Fraser 2001). There is also a possibility that an asymmetric risk lowers the level of the company’s expected earning without any impact on beta. Also beta based on historical data would be unmoved by the introduction of a new asymmetric risk as Kolbe and Tye (1996) discuss, and CAPM does not provide an additional asymmetry risk premium to take it into account.

The final point in determining the cost of capital is the evaluation of the risk of the regulated companies. Investors should only require additional returns for bearing non-diversifiable risks, because the risk can be diminished by a diversified investment portfolio. In CAPM, the non-diversifiable risk is measured by a beta coefficient. Beta measures the firm-specific systematic risk in relation to the market portfolio as a whole. One fundamental assumption associated with beta is that the risk involved in investment can be fully measured through beta and the market risk premium. However, owing to the special characteristics of electricity distribution as a business, the risks involved in the business cannot be profiled through market mechanisms. In particular, small companies are not quoted on the stock market – and the ones that are, tend to be large companies that are major international players representing multiple sectors. Therefore, a common approach is to use proxy companies to measure beta for non-listed companies as suggested by Levy (1978), which is often the case in the electricity distribution industry.

Cost of debt

The cost of debt is usually estimated as the sum of the risk-free rate and debt premium that investors require from investments in a company. Equation (2.4) combines the risk-free rate and debt premium estimates to produce the overall cost of debt.
\[ r_d = r_f + d_p, \quad (2.4) \]

where \( r_d \) = cost of debt
\( r_f \) = risk-free interest rate
\( d_p \) = debt premium.

Similarly to determining the risk-free interest rate, issues of appropriate maturity and whether to use spot or longer-term averages apply equally to setting the debt premium. For instance, averaged time series of debt costs or current cost of ratings can be used.

### 2.2.2.2. Regulatory asset base

Investors expect to earn a return (equal to the cost of capital) on market value (Pedell 2006, p. 119). Therefore, market value would be a natural choice for regulatory asset base. But, as Evans and Guthrie (2005) discuss, regulatory asset base cannot equal the market value of the regulated firm, as then a circularity results: the firm’s market value depends on its allowed revenue, which depends on its market value. The cost-based approach, also called original cost or historical cost accounting, values assets at what the firm originally paid for the assets. A historical acquisition cost does not necessarily reflect the true asset value, and therefore assets can also be valued based on exogenous factors; current cost or replacement cost values the assets for the purposes of regulation.

### 2.2.3. Profit regulation

There are two types of profit regulation methods; rate of return regulation and cost-plus regulation. The rate of return (ROR) regulation allows the company to cover its operational and capital costs as well as a return on capital, thus covering all the elements in Equation (2.1). Equation (2.5) shows calculation of the required revenue for the regulated company’s targeted rate of return in year \( t \) from the projected costs, but also the company’s historical costs can be used (Jamasb and Pollitt 2000).
\[ RR_{i,t} = OE_{i,t} + D_{i,t} + T_{i,t} + (RB_{i} \cdot ROR)_{i,t}, \]  

(2.5)

where  
- \( RR_{i} \) = required revenue
- \( OE_{i} \) = operating expenses
- \( D_{i} \) = depreciation expense
- \( T_{i} \) = tax expense
- \( RB_{i} \) = rate base
- \( ROR_{i} \) = rate of return.

ROR regulation has received much criticism for lacking incentives for cost efficiency but rewarding overinvestments as they add to the regulatory asset base. Therefore, the risk for the regulated companies in the rate of regulation is generally perceived to be low. Moreover, this effect occurs only in profit-maximising companies. Municipally owner companies may not pursue profit as a primary goal (Fumagalli et al. 2007a). A regulated company is guaranteed a given rate of return for invested capital and tariffs are adjusted accordingly, and the company bears very little risk for cost changes as they can be passed to customers. The presence of a low risk level is usually accompanied with a low rate of return.

Under cost of service regulation, the regulated companies are allowed to set rates based on the cost of providing service to the customers. Companies are also allowed a reasonable profit and cost for operation, but some form of regulatory scrutiny may be involved.

2.2.3.1. Price cap regulation

Price cap regulation has been favoured because it provides better incentives for efficiency compared with traditionally favoured models, such as ROR. Lower costs of production lead to higher profits even when prices (and therefore revenues) are regulated according to Equations (2.6) and (2.7) (Jamasb and Pollitt 2000). At the start of the regulation period, an initial price for service is determined. For each year, the price cap is calculated based on previous years’ cap
adjusted by the retail price index (RPI) and an efficiency factor X, hence the name RPI-X regulation. Regulation period spans typically from three to five years.

\[ P_{t+1} = P_t \cdot (1 + \text{RPI} - X_t) \pm Z_t \]  
\[ P = \sum p_i q_i, \]  

where  
- \( P_{t+1} \) = price cap  
- \( \text{RPI} \) = retail price index  
- \( X_t \) = efficiency factor  
- \( Z_t \) = measure of changes  
- \( p_i \) = unit price of the regulated service  
- \( q_i \) = quantity of the regulated service.

In its pure form, price cap regulation has no price adjustment mechanism, which means that the companies are exposed to cost variations. The price ceiling may be adjusted using a correction factor \( Z \) to account for the effect of exogenous extraordinary events affecting the utility’s costs (Jamasb and Pollitt 2000). Allowing cost pass-through can easily be seen to reduce the risk but if regulatory discretion is involved, Alexander et al. (1996) point out that there might be an increase in the risk as a result of asymmetric treatment of exogenous costs.

Although price cap can be considered beneficial to attain cost efficiency, it has been associated with an adverse public reaction to some of the profits made (Parker 1997). Also, it has not proved to be much less complex to administer than rate of return regulation. For instance, regulatory reviews are a cause of a dispute, but are needed to correct the inconsistencies in cost levels as well as to pass the appearing efficiency gains along to the customers. On the positive side, price cap regulation sets the prices for a relatively long time period, which provides companies with an opportunity to earn higher profits by making efficiency improvements.
2.2.3.2. Revenue regulation

The revenue cap method regulates the maximum allowable revenue that companies can earn rather that the price of end-customer services. As with price cap regulation, the aim of the regulator is to provide the utility with an incentive to maximise its profits by minimising the costs and allowing the utility to keep the cost savings achieved during the regulatory lag (Jamash and Pollitt 2000). The revenue cap for a given year is shown in Equation (2.8) (Jamash and Pollitt 2000).

\[
\bar{R}_{i,t} = \left( \bar{R}_{i,t-1} + CGA_i \cdot \Delta Cust_i \right) \left( 1 + RPI - X_i \right) \pm Z_i,
\]  

(2.8)

where

- \( R_i \) = authorised revenue
- \( CGA_i \) = customer growth adjustment factor (€/customer)
- \( \Delta Cust_i \) = change in the number of customers
- \( RPI \) = retail price index
- \( X_i \) = efficiency factor
- \( Z_i \) = adjustment factor for events beyond management’s control.

Most commonly, the revenue cap is based on historic costs. Alternatively, authorised revenues could be linked to an observable feature, such as the number of customers, to which fixed cost levels are related (Alexander et al. 1996). This helps to reduce the significance of regulatory reviews. Revenue cap regulation is seen more suited in the cases where the company’s costs are fixed rather than increasing with the number of units sold (Alexander et al. 1996). Revenue regulation transfers the risk of demand fluctuations to the customers and can therefore be considered less risky for utility companies.

2.2.3.3. Yardstick regulation

Yardstick regulation rewards the regulated companies for their performance in relation to a comparable target. Rewards and penalties imposed on companies are based on the selected
thresholds of some performance variable. For example, the mean of the costs of a peer group of firms can serve as a performance benchmark (Jamasb and Pollitt 2000). Equation (2.9) shows the main elements of cost-based yardstick regulation (Jamasb and Pollitt 2000).

\[ P_{i,t} = \alpha_i C_{i,t} + \left[ 1 - \alpha_i \sum_{j=1}^{n} (f_j C_{j,t}) \right] \]

(2.9)

where

- \( P_i \) = overall price cap for a company \( i \)
- \( \alpha_i \) = share of the company’s own cost information (\( \alpha = 0 \) representing pure yardstick regulation)
- \( C_i \) = unit cost of the company
- \( f_i \) = revenue or quantity weights for peer group firms \( j \)
- \( C_{j,t} \) = unit costs (or prices) for peer group companies \( j \)
- \( n \) = number of companies in the peer group.

Yardstick regulation can be used to promote indirect competition among regulated utilities operating in geographically separate markets. The challenges are related to finding appropriate performance measures; they should be accurately observed and verifiable, they should reflect the utilities’ efforts, and moreover, they should be structured to reduce the impact of random variation. In addition, performance measures should be adjusted based on the companies’ varying operating conditions. Developing appropriate yardsticks is resource intensive and requires information that may not be attainable in the early stages of regulation.

2.2.3.4. Other methods

Often, regulators employ a combination of the basic models of regulation; either by merging models into hybrid schemes or by combining a model with the principal regulation model. A hybrid price/revenue cap mimics the balance between fixed and marginal costs, so that the company is given the correct incentives to promote sales and is not exposed to excessive risks.
from demand fluctuations (Alexander et al. 1996). That way, cost efficiency incentives are maintained since the regulated company benefits in full from any cost-reducing activities it undertakes (Alexander et al. 1996). Furthermore, common elements of rate of return regulation are included in price cap regulation: as a company’s profits differ from the agreed level, prices are immediately adjusted downwards/upwards to share the benefits/losses between utilities and customers.

An example of regulation that is often used in connection with other models is profit sharing regulation; it lets the customers to participate in excess profits or profit shortfalls of the utility in a form of ex post refunds or price reductions (Vogelsang 2002). Banded rate of return regulation lets the regulated utility to keep its excess profits and suffer profit shortfalls within a pre-specified band (Vogelsang 2002). This regulation is referred to as a sliding scale regulation.

2.2.4. Efficiency incentives

Cost efficiency is one of the important objectives in economic regulation. For competitive markets, the incentive for efficiency is created by competitors, but for natural monopolies, regulators have to ensure that the cost covered in regulation can be considered efficient. Determining whether the companies’ costs are reasonable would, however, require extensive scrutiny, and with a large number of companies, the task would prove laborious. The need for efficiency measures is emphasised by the fact that economic regulation practices have moved towards more incentive-based regulation, which requires setting the X-factor in RPI-X regulation for instance. Regulators have a variety of techniques available to assess companies’ efficiency, commonly through efficiency benchmarking. Common approaches include defining the inefficiencies of regulated companies by reference to companies that constitute an efficient frontier or some other target at a point in time or over a period of time. An efficient frontier is commonly built by the most efficient firms, against which the relative performance of less efficient companies is measured (Jamash and Pollitt 2003). The problem is often to consider various operating environments as an explanatory variable to efficiency differences.
The most commonly used methods for efficiency benchmarking are programming (nonparametric) or statistical (parametric) techniques. Programming techniques include data envelopment analysis (DEA) and Total Factor Productive (TFP). Statistical approaches include Stochastic Frontier Analysis (SFA) and Corrected Ordinary Least Squares (COLS) or Ordinary Least Squares (OLS). The choice of the benchmarking method is closely followed by deciding on the parameters that represent the performance of the companies in particular methods. Some regulators base their assessment of a company’s efficient cost by determining a reference network by Engineering Economic Analysis (EEA).

As an example, DEA is discussed here in more detail. DEA is a relatively straightforward and understandable method that requires no specification of cost or production functions and has therefore been widely used. It has its disadvantages, such as the influence of outliers and sensitivity to choice of variables, as discussed by Honkapuro (2008). DEA calculates the efficient or best-practice frontier of a given sample of firms. These efficient firms envelop the less efficient firms, which allows to calculate the efficiency of the firms: the firms in the frontier are given an efficiency score of 1, while the firms performing worse receive a score between 0 to 1. DEA models can be input and output oriented, and can be specified as constant returns to scale (CRS) or variable returns to scale (VRS). Output-oriented models maximise the output for a given quantity of input factors. Correspondingly, input-oriented models minimise the input factors required for a given level of output. An input-oriented specification is generally regarded as more applicable to electricity distribution companies, as companies have little control over demand.

After deciding for the method to measure efficiency, the results have to be integrated into the regulation regime. The results can be divided into general or company-specific efficiency requirements. As Jamasb et al. (2004) point out, regulators should recognise that their benchmarking exercise inevitably shapes the efforts and directs considerable resources of the companies towards the make-up and variables of the models.
2.2.5. Quality regulation

Introduction of quality regulation into the regulatory system has often been justified on the basis of continual focus on cost savings in the regulatory regime; cost savings may be achieved at the expense of quality instead of factual efficiency measures. Regaining the quality level once it has deteriorated may require extensive investments. In order to prevent inefficient resource allocation, service quality standards and incentives need to be incorporated in the regulation of the companies (Giannakis et al. 2005). Quality regulation is concerned with three major aspects; continuity of supply, voltage quality and commercial quality.

Standards are often used to regulate commercial quality, that is the nature and quality of customer service provided by the electricity distribution companies (CEER 2005). Standards can be overall or guaranteed standards. Overall standards cover areas of service where it may not be possible to provide individual guarantees but where companies are expected to deliver predetermined levels of service. Overall standards may include for instance connecting new customers to the grid and a minimum performance level to be achieved over a defined period of time (CEER 2005). Guaranteed standards set the minimum service level that must be met in each individual case. If the company does not meet these standards, compensation to the affected customer must be paid. In general, reward and penalty schemes have been employed before minimum quality standards: it is easier to measure average continuity indicators than it is to measure continuity for individual customers (Fumagalli et al. 2007b). Regulating voltage quality is complex and the preferred method has been to employ standards. However, the regulation practices for voltage quality are unestablished.

Quality incentive schemes, on the other hand, link the performance levels of the company to its regulatory revenue. First, the regulator has to decide the parameters, on which it wishes to determine the current and optimal level of quality. The performance is commonly measured as the continuity of supply, that is the number and duration of interruptions. The performance level can be measured at different levels ranging from the system level to the performance delivered to individual customers (Ajodhia 2002). Based on the company performance against this optimal level, there is a reward or a penalty. By specifying service quality targets and associated penalties and rewards, a regulator can induce the regulated company to employ its cost
information advantage to achieve desirable service quality levels at minimum costs (Sappington 2005). The power of the reward or penalty is addressed by the manner in which the quality incentive schemes are implemented. Typically, they are expressed as a percentage of return or price/revenue. Examples of quality incentive schemes are presented in Figure 2-3.

The first scheme in Figure 2-3 sets a fixed penalty for the company if the measured quality declines below a certain level. This is similar to the overall standard approach discussed above. In the second scheme, there is a continuous relation between price and quality (Ajodhia and Hakvoort 2005). Against company’s performance, a corresponding penalty or reward is attached to the allowed price or revenue, for example. In the third scheme, a cap is set to limit the level of penalty or reward for the companies. A cap protects both the companies and the customers from occasional extreme deviations in quality. However, setting a cap is challenging, if the quality is decreasing below the minimum level, because the penalty payment remains the same. Accordingly, quality improvements above the maximum level are not likely to happen, as there is no additional reward. The fourth scheme uses a dead band to damp the effect of annual alterations in quality indices. Setting the limits of a dead band requires regulatory discretion on the expected quality level. As Ajodhia and Hakvoort (2005) point out, dead bands can leave genuine quality changes undetected. As a solution, Ajodhia and Hakvoort (2005) suggest using multi-year averages instead of dead bands.
In addition to formal quality regulation systems, quality may be regulated indirectly. The advantage of indirect quality regulation is that the regulator avoids defining the quality level that is expected from individual companies – a task that is often considered laborious and politically sensitive. Indirect instruments may lack economic consequences but are given in a form of provision plans in the case of large disturbances or exposure to public scrutiny through publicised comparisons of quality indices. Further, a reputation for poor quality spills over to the competitive markets in which regulated companies operate, thus providing greater incentives to invest in quality in the regulated market (Weisman 2005). Public ownership itself may indirectly regulate quality (Ajodhia and Hakvoort 2005). Another example of indirect quality regulation is a case where the quality indices are included in the efficiency benchmarking studies. Although the efficiency benchmarking is a measure of efficient operation, quality indices encourage quality improvements.

2.3. Regulatory drivers

Companies operating in market economies face commercial risks such as changes in demand, new entrants in the markets and increased material costs. Although the monopoly position protects the regulated companies from most of these risks, regulation acts as a substitute for the competitive forces resulting in a new type of business risk, a regulatory risk, that arises from regulation practices. The regulatory risk comes from the method by which the regulation is implemented and the degree of regulatory discretion associated with the regulation. The regulatory discretion can be directed at an individual company for example in the case of extraordinary weather events but also, the concept may be extended to concern regulatory decisions and changes in the regulatory regime. Moreover, as Strauws (2009) suggests, uncertainty about the policy variables is the purest form of a regulatory risk. Regulation is often influenced by political considerations, which may vary, and there is ultimately a diffusion of political will to the regulatory regime. It should be noted that the existence of a regulatory risk does not necessarily require the regulation itself to be uncertain (Pedell 2006, p. 32). In fact, regulation has in many cases a role in protecting companies from external shocks. This is referred to as buffering effect or the Pelzman effect, discussed by Binder and Norton (1999). However, in the case of an invasive regulatory regime, there is a possibility that the regulation prevents companies from reacting to external shocks, which can ultimately expose companies to a considerable risk.
From the regulation methods, pure rate-of-return regulation where the prices are adjusted to allow companies to collect the rate of return resembles closest a case of elimination of regulatory risk and all costs would be treated as pass-through. In real-life regulatory regimes, there are several limitations; time lags, unavailability to obtain information for regulatory purposes or the inability of the regulator to fully commit himself to a predetermined regulatory policy. Moreover, as Pedell (2006, p. 193–194) points out, from the regulator’s perspective, it would not even be desirable to strive for such a regime, as it would eliminate any incentive for efficient investment and operation on the part of the regulated firm. While the previous section discussed the ways in which regulation impacts the distribution companies, the following section present some aspects in the literature that do not consider regulation as an exogenous factor for distribution companies but rather as an interface for the regulated company and the regulator.

2.3.1. Regulation development

Some EU Member States have a long history of formal regulation of the electricity supply sector, whereas others have just quite recently started sector-specific regulation. The implementation of European legislation has had different interpretations, but some indication of the development pattern of economic regulation can be traced, as shown in Figure 2-4. Ex post rate of return regulation has commonly been the first form of regulation. In the post-reform electricity markets, the regulation was described as being too light-handed; incentives for cost efficiency were not notable and the companies under rate of return regulation had a tendency to overinvest. As more powerful incentives for cost efficiency are required, ex ante features in economic regulation take place typically as limitations to prices (revenues). Eventually, the mere focus on costs cannot be considered a sustainable approach because it puts the quality of monopoly services at risk.
The ultimate form of providing incentives for efficiency improvements is introduction of competition. Certainly, not all of the activities in the electricity distribution are monopolistic by nature, and therefore, exposure to competitive forces would bring the most optimal outcome. Besides the development of regulation, Figure 2-4 illustrates the continuous nature of regulation.

2.3.2. Dynamics of regulation

The regulatory regime is a result of an effort involving legislative and statutory interpretation by the regulators. The regulated companies then behave as well as they can in response to the regulatory framework. According to the dynamics of regulation, both the regulator and the management learn about the regulation and the negotiating strategies to adopt (Parker 2001). The confrontation arises from different time aspects of the two parties; assets in electricity distribution commonly have lifetimes of decades whereas regulation periods span typically from one to five years. In such circumstances, the regulatory body does not start with a clean slate; rather, it responds to conditions shaped in part by decisions of the regulated firm (Vickers...
and Yarrow 1988). Moreover, there is a potential conflict between static and dynamic efficiency (Parker 2001): as soon as a regulated utility has irreversibly invested in specific assets, the regulator has an incentive to lower the utility’s rates to the level of short-run decision relevant costs in order to improve efficiency from a static perspective.

The regulated companies have inevitably more knowledge than the regulator concerning certain company-specific factors such as operating circumstances, efficiency potential and investment schedules. Therefore, asymmetry of information gives rise to imperfect incentives, and inefficiency in results (Vickers and Yarrow 1988, p. 92). If the regulator sets incorrect incentive limits for the companies due to uncertainty about the true cost opportunities, there is ultimately a risk of failure for the regulated company. Also, regulation can run companies to economic distress if there are no sufficient funds to carry out regulatory stipulations. Therefore, a function of the regulator is to encourage companies to supply this information so that proper regulatory decisions can be made on prices, profits and the quality of service (Parker 2003). Regulation is often referred to as a game between the regulator and the regulated companies, but also the principal–agent theory has been successfully applied to address the information asymmetry issue. The potential drawback of the regulatory game is that instead of resources being attracted to the areas of the greatest need, with potentially the highest welfare gains, they will be attracted to areas where access is permitted or short-term profit is highest given the regulatory constraints (Parker 2001).

2.3.2.1. Regulatory lag

Time lag in regulation describes the connection between the actual cost and the adjustment of regulation reference parameters for the regulated companies. Longer regulatory lags provide for strong incentives for cost efficiency but may leave the regulated company with a higher monopoly profit. Also, the firm’s incentives to reduce its costs by innovation or superior organisation of factors of production is increased, but long regulatory lags delay the time at which consumers benefit from the higher efficiency (Vickers and Yarrow 1988). The cost efficiency incentives become less powerful at the end of the regulation period because the regulatory review is bound to employ present cost, which would mean that companies face lower prices/costs during the next period. This may lead to a ratchet effect, where the company hides its efficiency in the hope of retaining higher cost levels. In an industry characterised by a
heavy infrastructure, the volatility of cost levels is of particular concern. A short reference period does not necessarily represent the true costs for a company.

As periodic regulatory reviews are a feature of many regulatory regimes, opportunistic behaviour may occur. This also raises time-inconsistency problems as, on the one hand, the regulated firm makes a commitment by making (irreversible) investments in networks while at the same time the regulator cannot ultimately commit to a certain level of return to investors. This does not remove the fact that the regulator has to consider not only the currently prevailing cost of capital but also the future development of the cost of capital (Pedell 2006, p. 166).

2.3.2.2. Circularity

Circularity is a situation where for instance a company’s market value reflects the expectations of future regulatory behaviour, and there is an inherent circularity in determining regulatory parameters based on market appreciations. Circularity also applies to other regulatory cost components as the behaviour of the regulated companies and the regulatory cost components depend on past experience; there is an interdependence over time on the past efficiency gains and/or quality levels. In rate of return regulation, circularity results from the fact that the cost of capital and the market value of the regulated firm both enter into the calculation of rates and, at the same time, are dependent on the design of the regulatory system and process as well as on their handling by the regulator, see Figure 2-5 (Pedell 2006, p. 193). This issue extends to hybrid regulation schemes that employ rate of return regulation.
The regulator has to take into account an appropriate risk-adjusted cost of capital when determining regulatory revenue, and, at the same time, this process is among the major risk drivers or even the most important risk driver for the regulated company (Pedell 2006, p.29). Dependency on whether and in which intervals fluctuations in regulatory parameters are passed on to regulation is a part of the risk experienced by the companies. Setting regulations to cost components other than capital cost is usually more straightforward. Companies’ own historical costs or a reference from peer companies are most likely to be used. When using past observations of the company’s cost, this may lead to a ratchet effect, where the companies hide their true cost levels. Another method is to use data from the companies’ regulatory costs, that is, the costs that the regulation has previously had if they would have realised as such. Furthermore, the estimation periods of individual input parameters in regulation depend on the frequency at which rates are changed and how the regulator wants to share the risk associated with the input parameters between customers and utilities. Uncertainty may be especially high if there is no experience of regulation at all (Pedell 2006, p. 26–27).
2.3.2.3. Commitment

A much discussed subject in the earlier regulatory risk literature is the issue of hold-up or sunk cost (e.g. Evans and Guthrie 2006, Hausman and Myers 2002). Once companies invest, there is a risk of regulatory judgement on whether the investment is efficient or not. The lack of the regulator’s commitment to set prices that allow the firm to recover the sunk investment expenditure raises concerns over lower-than-optimal levels of investment (Baron and Besanko 1987, Urbiztondo 1994). If the regulator chooses to tighten the regulation, the company may not recover its cost of capital. If investors anticipate this, then the cost of capital will be increased to include a premium for a regulatory risk, which may delay the investment. Unless there is a regulatory commitment, the companies face underinvestment incentives, even a risk of expropriation of assets. This is reverse of the Averch-Johnson overinvestment problem.

Practical regulatory regimes usually require some regulatory discretion, and full commitment is not even considered desirable. Rigid regulatory regimes do not allow consideration of exogenous factors as the conditions change. A well-functioning regulatory structure avoids high levels of regulatory risk. The objective of regulation should be to protect the consumer, while providing an environment where the industry can invest with a high degree of confidence that profits legitimately made are not eroded by unpredictable regulation. For instance, according to Parker (2001), where this balance is not achieved, regulation is more likely to seriously damage business development. Gilbert and Newbery (1994) view the regulatory compact as the outcome of a repeated dynamic game that under different regulatory regimes varies in robustness. Finally, the regulatory capture problem deals with the threefold balance between the regulator, the regulated company and society. In some cases, instead of acting on behalf of common interest, the regulator becomes an advocate of the company and can buffer the shocks to the cash flow of the firm.

2.3.3. Asymmetric regulatory features

An asymmetric risk is a risk where loss is not evenly balanced with an equivalent opportunity for gain. For instance, the CAPM in its basic form captures only symmetric movement in changes in the risk levels, and therefore companies are compensated only for these. However, it cannot strictly be assumed that regulation has a symmetric effect on the distribution of the
company’s cash flows. Potential asymmetry is one of the most striking characteristics of a regulatory risk (Pedell 2006, p.40): firstly, this asymmetry can be embedded already ex ante, that is, before the regulated firm invests, in the existing rules of a regulatory system, for example as disallowances of the regulatory rate base. In this case, the regulated company faces a strictly negative risk about the future rate base, and it anticipates that it will earn the allowed rate of return only for a part of its investments. Secondly, if the regulator intervenes ex post, tending either to claw back companies’ abnormal profits and deliver lower prices to customers, or tending to regulatory capture, with companies protected against returns variation, banking gains and driving the cost of capital down by passing downside risk through to customers (Buckland and Fraser 2001).

Asymmetric regulatory risk cannot be considered an appropriate regulatory instrument. Unequal treatment can venture the credibility of regulation. Kolbe et al. (1993) suggest two methods to accommodate the negative risks of regulation to attract investors in the long run. First, the allowed rate of return can be set above the cost of capital through a regulatory risk premium and second, a form of insurance premium can be added as a cost item as a compensation for providing risky services.

2.4. Outsourcing services

Outsourcing is the transfer of services or a significant part of it to a specialised service provider. Deregulation of the electricity markets has been one of the leading drivers for business reorganisation in the electricity distribution sector. As the regulated companies are faced with requirements of the different stakeholders of the electricity markets, a decision on whether to develop required capabilities and resources internally or acquire them elsewhere becomes relevant. The pressure to outsource can therefore be attributed to the prioritisation of financial targets as a result of commercialisation, and, as Thomas and Hall (2003) discuss, to the pressure from economic regulation of electricity distribution on prices, requiring companies to seek cost-cutting and greater operational efficiencies. Outsourcing allows an organisation to take advantage of the strengths of the service providers within the supply market (McIvor 2003).
Hosein (1999) argues that in a new operating environment, the utilities need to identify the value drivers and develop resources or capabilities accordingly. A popular theory to support this view is the resource-based view of the firm (RBV), which relies on the companies’ valuable resources and capabilities to determine the competitive advantage for the firm when facing changes in markets (Barney 1991). Company resources can be defined as assets, capabilities, processes, and knowledge that enable implementing strategies to improve efficiency and effectiveness in relation to market needs (Watjatrakul 2005). The resource-based theory suggests that companies must continually enhance their resources and capabilities to take advantage of changing market conditions (Mahoney and Pandian 1992). Therefore, most corporations focus on their core competencies (Prahalad and Hamel 1990).

A complementary theory for the RBV is the transactions cost economics, TCE by Williamson (1981, 1987, 1991). According to the TCE, the properties of transaction determine the governance structure, and therefore helps companies to determine which of their supportive, non-core functions they should buy and which they should produce or make in-house (Logan 2000). A transaction occurs when a good or a service is transferred across a technologically separable interface (Williamson 1981). Following the transaction cost theory, outsourcing is profitable if the cost of performing the activity in-house exceeds the cost of the tender and the transaction costs related to outsourcing. Because of economies of scale and scope, TCE assumes that the market will always be the lowest-cost producer of a good or service and, alternatively, an internal governance mode is preferred when transaction costs are higher (Watjatrakul 2005). According to TCE, there are three dimensions that determine the governance mode for outsourcing (Watjatrakul 2005): 1) asset specificity refers to the transferability of the assets, both asset and human aspects, that support a given transaction, 2) transaction frequency refers to occasional and recurrent transactions and 3) uncertainty refers to both behavioural uncertainty in performance evaluation and environmental uncertainty. Particularly asset specificity is an important feature in transactions as if investment are specific to the requirements of a particular transaction, the parties are bound for a considerable period (Williamson 1981).
2.4.1. Implementation of outsourcing

According to a survey made by Kremic et al. (2006), commonly sought benefits of outsourcing include realising the same or better service at a lower overall cost, increased flexibility and/or quality, access to the latest technology and best talent, and the ability to focus on the core functions. Potential risks include unrealised savings with a potential for increased costs, employee moral problems, overdependence on a supplier, lost corporate knowledge and future opportunities, and dissatisfied customers (Kremic et al. 2006). The benefits and risks of outsourcing are closely related to the outsourcing objects but also the motivating factor behind outsourcing. Kremic et al. (2006) distinguish between three types of outsourcing; cost, strategy and political. Private industries have commonly been driven by cost and strategy motivations, whereas according to Kakabadse and Kakabadse (2000) political agendas are the driving forces for public organisations.

Despite the compelling arguments, many companies see that the potential losses outweigh the positive implications of outsourcing. Outsourcing companies tend to analyse the processes too narrowly, looking only at direct cost and failing to examine interdependencies that might tip the cost/benefit analysis in favour of keeping the services in-house (Aron and Sing 2005). The benefits of outsourcing are not a given but require an analysis for every activity that is considered to be outsourced and, often, the process of outsourcing defines the final benefits. In a framework by McIvor (2000) the first step is distinguishing between the core and non-core activities in order to ensure the long-term strategic considerations and true benefits. This stage involves identifying and defining the critical skills central to overall strategy. Three features of a core competence are identified (Prahaland and Hamel 1990); a core competence provides a potential access to a wide variety of markets, makes a significant contribution to the perceived customer benefit of the end-product and finally, should be difficult for competitors to copy. Activities contribution can be distinguished between core, core-close and supporting activities (Arnold 2000). The second stage evaluates the company’s competencies in relation to potential external sources. The cost of doing the service in-house then becomes of interest alongside service quality, time and reliability for instance. The company can then evaluate whether the activity should be performed internally, developed internally or outsourced. Such issues are discussed more closely in literature, for instance see McIvor (2008). Companies can position
the purchasing objects according to found opportunities or vulnerabilities and supply as indicated by Kraljic (1983).

2.4.2. Outsourcing options

Despite the natural monopoly status of the electricity distribution business, the management of change in a regulated industry can take forms commonly used in other industries. As Parker (2003) points out, during the reorienting of their businesses, the incumbent companies may be expected to seek for possible economies of scale and scope and higher levels of innovation through acquisitions and alliances. Three basic outsourcing models can be distinguished:

1) Internal outsourcing where the service provider is for instance an independent business unit within a company or a group of companies.

2) External outsourcing where the service provider is independent from the purchasing company.

3) Joint venture where two or more organisations have partnered for mutual objectives.

Arnold (2000) has combined the TCE and RBV to develop a general model for outsourcing decisions according to Figure 2-6. Specificity of an activity is closely related to the strategic importance of a transaction (Arnold 2000). High specificity of transaction indicates a large amount of information to be exchanged before, during and after the exchange of goods and services, that is, high transaction costs. A high asset specificity is based on the company’s core competencies and should be kept under the full responsibility and control of a company. Low specificity of transaction means that only little information has to be exchanged with the transaction partner, and therefore it can be governed with external outsourcing design (Arnold 2000). External outsourcing partners are able to bundle demand and to exploit economics of scale. Medium levels of asset specificity lead to bilateral relations in the form of co-operative alliances between the organisations (McIvor 2003).
Further, the level of outsourcing varies from hiring of contract workers to complete outsourcing – and mixed levels of outsourcing in between (Allen and Chandrashekar 2000). However, Allen and Chandrashekar (2000) state that from a managerial point of view, complete outsourcing is preferable to partial outsourcing. Indeed, the managing of incomplete outsourcing requires more effort and bureaucracy, and there may be problems in fitting different working cultures. Eyles et al. (2000) found that the lack of suitable service acquisition candidates has in many instances led to alliances. According to Olsson and Espling (2004), partnering will improve relations between clients and contractors and integrate competencies, which will lead to an increase in productivity and quality of delivery. Forming alliances is an option but can be risky: strategic alliances are formed for many reasons, as partners entertain various, if not sometimes hidden, often asymmetric and possibly conflicting objectives (Kakabadse and Kakabadse 2000).
2.4.3. Outsourcing roles in the electricity distribution business

Owing to the asset-intensive nature of the business, the relevance of core competencies is demonstrated in combining the network development strategies in the regulatory framework. As the regulatory framework continues to set more demanding performance targets, more companies will consider outsourcing as an option and streamline their organisations and focus on their core-competencies in the hope of efficiency improvements. In the electricity distribution business, the roles and responsibilities of the business are defined as follows (Mohseni 2003, Cornish and Morton 2001, Groen 2003):

- Asset owner sets the overall business goals and parameters for risk, cost and performance, and is responsible for meeting any regulatory legislation.
- Asset manager focuses upon asset strategy and policy definition, risk management, investment and maintenance planning and contract management. It is the asset manager’s task to handle medium- and short-term planning and execution of network activities and manage the delivery of network performance overall in accordance with the long-term goals.
- The service provider operates in competitive markets and is able to produce economies of scale and better use of resources for network-related activities, and provide core skills of scheduling manpower to deliver programmes efficiently and effectively to meet the defined service levels.

There are individual differences in the emphasis of the core business, and as new challenges facing electricity distribution business appear, it is essential to question whether the core competence focus will change as well. Distribution companies may be keen to retain control over activities that provide valuable information about the network assets. Also, the capability development in electricity companies seems to focus on quality issues (Brådd et al. 2006). This, in turn, could lead to a situation in which more and more network-related operations are produced in competitive service markets by independent service providers. On that account, for the service provider markets, offering highly customised services requires the core competence of knowing the customer’s needs, wants and processes (Fließ and Kleinaltenkamp 2000).
2.5. Conclusions on economic regulation, business risks and outsourcing

Electricity distribution business is mainly characterised by its natural monopoly status. The obligation to deliver electricity to customers in their operating area results in operating assets that are long-lived and stranded. Also, owing to the essential nature of the electricity distribution, strong statutory requirements are needed. Formal regulation was introduced along with electricity market restructuring. The focus of regulation is on developing electricity networks as a marketplace for competitive electricity businesses, and promoting the efficiency and quality of the network-related services. In many cases, the sector-specific regulation incorporates the business drivers into the operation of the distribution companies. Therefore, political, economic, social, technical and environmental issues also influence the companies’ operating environment. Regulation is the primary means to promote societies’ common goals regarding the electricity distribution business. The presence of emerging requirements of the different stakeholders of the electricity markets has induced pressure for the distribution companies to reduce their costs and improve performance. Outsourcing is an option as a means to respond to challenger of deregulation as well as prioritisation of financial targets as a result of commercialisation. However, outsourcing should be done with long-term strategic considerations so that actual benefits are attained.

The regulatory regime has a dominant effect on the business risk perceived by the regulated companies. The design characteristics of economic regulation play a crucial role in defining the regulatory outcome. Regulation systems differ according to the scope of cost components covered by regulation and, thus, the risk exposure of the regulated companies is affected. The regulated companies inevitably have more extensive knowledge about their operation, which has led to introduction of incentive-based regulation in order to exploit the information advantage. Regulation design is shaped by the regulatory interaction between the regulated companies’ performance and decisions, and the resulting regulatory regime evolution. The development of regulation is particularly affected by the uncertainties in the policy variables. The divergent views on what can be considered efficient operation or reasonable investments, for example, is a source of regulatory risk. Moreover, some aspects of regulatory involvement may distort the outcome so that the opportunities for gain are not equal to losses for the companies.
3. Regulatory risk in the electricity distribution business in Finland

One of the essential purposes of economic regulation is to protect end-customers from possible monopolistic behaviour. At the same time, companies should be assigned the necessary means to build and maintain electricity distribution services. The conflict between these two viewpoints is often witnessed in the regulatory regime design. Intuitively, together with the monopoly position and the economic regulation, distribution companies can be assumed to be assured a fairly stable demand base, the revenue of which is secured through regulation. However, the varying operating conditions of distribution companies as well as catering different stakeholders of the electricity distribution business makes it difficult to create a regulatory regime that is in compliance with both individual requirements for companies and the monopoly nature of the business. Regulatory risk is a wide term, which can be interpreted a number of ways. The most common is the risk to the companies of being prone to regulatory intervention (Robinson and Taylor 2000). However, the regulation regime itself can be considered to greatly contribute to the risk perceived by the regulated companies. It should be noted that the risk can be either positive or negative by nature.

This chapter considers the factors that contribute to the risk from economic regulation in the electricity distribution business in Finland. The first part of this chapter discusses the evolution of regulation in Finland, while the end of the chapter focuses on the Finnish experiences on regulation and the risk factors involved in various stages of regulation. The purpose of this chapter is 1) to identify the causes of the regulatory risk for the Finnish regulation regime, 2) to analyse their impact and 3) to consider methods to respond to the regulatory risk.

3.1. Evolution of regulation

The development of regulation of the electricity distribution business started in Finland after the deregulation of the electricity markets in 1995. At that time, the Finnish Energy Market Authority (EMA) was also established, and it began to collect and publish data on the distribution sector. The Electricity Market Act (386/1995) stated that distribution pricing shall be reasonable and distribution companies shall act efficiently. On the other hand, the pricing should guarantee sufficient income financing and a solid financial standing. The return should
be sufficient for the requirement to develop network stated also in the Electricity Market Act. The income should cover the reasonable costs of maintaining, using and building of the network while yielding reasonable return for invested capital. In special circumstances such as when planning higher than normal investments, the acceptable price level can be higher. However, the regulator should be able to detect cases where abnormal price levels are a result of inefficiency, overinvestments and an unnecessarily high security of supply level, and ban companies from such pricing. The basic principles of regulatory investigations take into consideration the cost level the company is capable of achieving and not the realised costs as such. The regulatory model chosen by the EMA to investigate the reasonableness of distribution pricing was ex post rate of return regulation.

3.1.1. Regulation 1999–2004

The process for regulating electricity distribution business started after the electricity markets were opened in 1995. The details of regulation were drawn up alongside the first case study in 1999, which became legally valid 2000 as the Supreme Administrative Court ruled on the matter. Investigations were based on complaints made by the customers as well as cases initiated by the authority. The decisions made by the EMA became legally binding after a court verdict, and therefore, the court decisions are important for credibility of the regulation. Regulation was applied in case-specific terms on an annual basis. Therefore, the majority of Finnish distribution companies faced only the threat of regulation and the primary method for regulation was public scrutiny based on publicised data. Indeed, the regulation has been described as being light-handed, but it encouraged distribution companies to decline distribution charges so that further investigations were avoided.

The general concept of the regulation was that the annual calculated profit of a distribution company cannot exceed the allowed return. The regulatory asset base on which the allowed return was determined, was the present value of the network. The book value of the network often does not represent the true present value of the network because of differing depreciation practices in the companies (Viljainen 2005, p. 67–68, Commerce committee 1994). Viljainen (2005, p. 76) also points out that the absence of a uniform system of accounts may have resulted
in strategic behaviour. Present value is determined according to Equation (3.1) with the network repurchase value, age and lifetime.

\[
NPV = \sum_{i=1}^{n} \left( 1 - \frac{age}{lifetime} \right) \cdot RV, \tag{3.1}
\]

where
- \(NPV\) = net present value of the network components
- \(RV\) = repurchase value of the network components
- \(age\) = average age of the network components
- \(lifetime\) = technical-economical lifetime of the network components.

Repurchase value is calculated using regulatory standard prices for network components. To ensure that the distribution companies had adequate incentives for investments, the profit and loss accounts of the company were corrected by the difference between the planned depreciations on network assets and the past three-year average of investments in determining calculated return (EMA 1999). In addition to the fact that the rate of return regulation had significant incentives for investments, quick depreciation opportunity increased this incentive.

The motivation for establishing reasonable return methodology was that the return should consider the small amount of risk involved in the business, low financing costs and the long lifetimes of the network components. The required return is determined according to Equation (3.2).

\[
RR = NPV \cdot WACC, \tag{3.2}
\]

where
- \(RR\) = reasonable return
- \(NPV\) = net present value of the network
- \(WACC\) = weighted average cost of capital.
In the first regulatory decisions, the efficiency evaluations were performed based on comparative parameters such as the number of employees per customers and the cost component in relation to total cost. As the comparisons were carried out for informative purposes only, the EMA introduced a method to measure and enforce cost efficiency in 2000. Efficiency benchmarking was carried out by the Data Envelopment Analysis (DEA) with a variable return to scale version. The parameters used to measure efficiency were operational costs, interruption time, distributed energy, network length and number of customers. Efficiency scores were originally meant to be used in determining the reasonable operational cost level for every company, but legal disagreement prevented the full implementation of the model, and hence, it was only used to reward companies (max. 10 % of the operational cost) that were considered efficient. Although the implementation of efficiency benchmarking was not successful, cost efficiency incentive was accepted as a part of the regulation scheme also for future purposes.

The rate of return regulation relies on the engineering judgements of the companies especially to account for sufficient quality of supply. However, the large disturbances at the beginning of 2000 resulted in a public response that led to an amendment to the Electricity Market Act in 2003 forcing electricity distribution companies to pay compensations for interruptions longer than 12 hours. The standard compensations are defined as a stepwise increasing percentage of the distribution bill (Electricity Market Act 386:1995). The EMA treated compensations as pass-through components, in other words, they are not a part of evaluating reasonableness of pricing, and compensation fees can therefore be seen as an income distribution from a distribution company’s clientele to the affected customers. Therefore, the companies face only the risk of repair costs in large disturbances.

3.1.1.1. Focal points of regulation in 1999–2004

The regulation model in 1999–2004 provided companies with ample incentives to investments. Any investments increased the regulatory asset base and the allowed rate of return. In addition, the three years’ depreciation time for investments in regulation added to this effect. Characteristically for the rate of return regulation, the regulation lacked incentives for cost efficiency. The efforts to introduce efficiency targets focused on operational cost, but the implementation proved difficult. The efficiency studies had an asymmetric effect in regulation –
efficient companies were rewarded even to the point that some were able to increase costs while companies with a lower efficiency score did not benefit from improvements in efficiency (Honkapuro 2008, p. 103).

The regulatory regime of 1999–2004 can be characterised as regulation by threat to which companies have responded by lowering their tariffs (see Figure 3–5). The case-by-case studies imply extensive regulatory discretion, although the regulator adhered to the principles of the decisions made earlier. A major source of risk emerges from the fact that regulation was ex post and was primarily based on complaints by the customers. The fact that regulation is reviewed each year separately can result in volatile results owing to the asset-driven nature of the electricity distribution business. However, the regulatory regime itself can be regarded as light-handed.

3.1.2. Regulation period 2005–2007

After almost six years of case-by-case regulation, the regulatory regime was reformed; the basic concept remained the same but the regulation shifted towards ex ante approach as the regulation period of three (later four) years was established. Consequently, the regulation included all the Finnish companies. The companies were informed beforehand of the regulatory parameters, but the final regulatory decisions were still made ex post (EMA 2005). The change had to be made in order to comply with the European Commission Directive (2003/54/EC) according to which at least the methodologies that are used to calculate the distribution tariffs have to be known before tariffs take effect. Also the regulatory decisions should be made within four months, which made the previous method impracticable. Another major change in the regulation is the refund on overcharges; if the company is found to have overcharged its customers at the end of the regulation period, the customers should be reimbursed by decreased prices during the following regulation period. Correspondingly, if the company has undercharged its customers, an increase in prices is permissible. The reasonableness of returns is, however, investigated annually and companies can change their pricing before the period ends.
Previously, regulation did not necessarily concern all of the companies, and therefore, the regulator proceeded to collect data on the number, age and lifetime of the network components in order to determine the present value of the network at the beginning of the period. Determining the ages of the network components can be a difficult task, and thus, the network components are assumed to be in the middle of their lifetimes if there are no data available to prove otherwise (Partanen et al. 2002). Network component lifetimes are selected from a range supplied by the regulator, and the choices are valid for future regulation periods. The lifetime ranges shown in Table 3-1 are based on surveys and interviews of the distribution companies (Partanen et al. 2002). The age of the Finnish distribution networks is 10–29 years (average is about 19 years) and the collected lifetime expectancy is 28–44 years (Hänninen 2006).

Table 3-1. Useful lifetimes for network components in the Finnish regulatory regime.

<table>
<thead>
<tr>
<th>Network component</th>
<th>Useful lifetime [a]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>110 kV lines</strong></td>
<td></td>
</tr>
<tr>
<td>- 110 kV overhead lines (wood poles)</td>
<td>35–45</td>
</tr>
<tr>
<td>- 110 kV overhead lines (steel poles)</td>
<td>35–60</td>
</tr>
<tr>
<td>- 110 kV cables</td>
<td>30–40</td>
</tr>
<tr>
<td><strong>Primary substations</strong></td>
<td></td>
</tr>
<tr>
<td>- 110 kV switchgear and control gear (GIS)</td>
<td>30–40 (GIS 45)</td>
</tr>
<tr>
<td>- 20 kV switchgear and control gear (GIS)</td>
<td>30–40 (GIS 45)</td>
</tr>
<tr>
<td>- main transformer</td>
<td>30–45</td>
</tr>
<tr>
<td><strong>Medium-voltage lines</strong></td>
<td></td>
</tr>
<tr>
<td>- overhead lines, insulated lines, cables</td>
<td>30–45</td>
</tr>
<tr>
<td><strong>Low-voltage lines</strong></td>
<td></td>
</tr>
<tr>
<td>- aerial bunched cables</td>
<td>25–40</td>
</tr>
<tr>
<td>- cables</td>
<td>30–45</td>
</tr>
<tr>
<td><strong>Distribution substations and distribution transformers</strong></td>
<td></td>
</tr>
<tr>
<td>- pole-mounted distribution substations</td>
<td>25–40</td>
</tr>
<tr>
<td>- pad-mounted and building-mounted distribution substations</td>
<td>30–40</td>
</tr>
<tr>
<td>- distribution transformers</td>
<td>30–40</td>
</tr>
<tr>
<td><strong>Disconnectors</strong></td>
<td></td>
</tr>
<tr>
<td>- disconnectors, remote-controlled disconnectors</td>
<td>25–30</td>
</tr>
<tr>
<td><strong>Distribution automation in the network</strong></td>
<td></td>
</tr>
<tr>
<td>- kWh meters</td>
<td>15–20</td>
</tr>
<tr>
<td><strong>Telecommunications systems</strong></td>
<td></td>
</tr>
<tr>
<td>- kWh meters</td>
<td>15–25</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td></td>
</tr>
<tr>
<td>- kWh meters</td>
<td>10–20</td>
</tr>
<tr>
<td>- kWh meters</td>
<td>5–10</td>
</tr>
</tbody>
</table>
After determining the regulatory asset base at the beginning of the regulation period as shown in Equation (3.1), the present values will change in accordance with the annual investments less the depreciations for the rest of the regulation period, as shown in Equation (3.3) (EMA 2005).

\[
NPV_t = \sum_{i=1}^{n} (NPV_{t-1} + INV_{t-1} - DP_{t-1}),
\]

(3.3)

where \(NPV_t\) = net present value of the network in year \(t\)

\(INV_{t-1}\) = investments calculated by standard cost in year \(t-1\)

\(DP_{t-1}\) = straight-line depreciation in year \(t-1\).

For the purposes of setting up the regulatory asset base, network component standard unit costs had to be determined. The EMA used mainly statistics analysis but for some components the unit costs were determined by consults. Straight-line depreciations in Equation (3.3) present the reasonable depreciations that are determined by straight-line depreciation methodology, dividing the repurchase value of the network by weighted average lifetimes of network components. The same depreciations are used also when adjusting the profit and loss accounts of the distribution companies when determining the calculated profit. To take into account the changes in value of money, NPV is adjusted by the changes in building cost index. The reasonable return on capital that was determined according to Equation 3.2 was between 5.15 % and 6.07 % for limited companies and between 4.73 % and 5.57 % for municipalities.

In order to enforce efficient operation, the EMA applied a general efficiency requirement on controllable operational costs. This efficiency requirement was based on the frontier shift in the DEA during the years 1999–2002, and was 1.3 % taking into account inflation. The general efficiency requirement reflects the efficiency improvement of the most efficient companies, and it is assumed that the less efficient companies can improve their productivity for at least the same percentage as the most efficient ones have done (EMA 2005). To ensure that the reasonable operational costs of the company remain sufficient even if for instance the length of
the network increases or there are changes in the customer number, these costs were adjusted by the annual changes in the network volume. The annual efficiency requirement is calculated according to Equation (3.4).

\[
ER = \left( \frac{101.3}{100 + \Delta NV} - 1 \right) \cdot 100\% ,
\]

where \( ER \) = annual efficiency requirement
\( \Delta NV \) = annual percentage change in the network volume.

The quality of supply remained to have a limited effect on the economic regulation outcome. During the regulation period, the EMA was contemplating to introduce quality incentives and therefore, quality of supply statistics were collected and published. In addition, the EMA had announced that it may intervene in the quality of supply, if it finds that the quality is deteriorating or it is inferior to the quality of other similar companies (EMA 2005).

### 3.1.2.1. Focal points of regulation 2005–2007

The practice of using straight-line depreciations in the regulation, both when determining calculated profit and in calculation of the reasonableness of return, somewhat limits the incentive to overinvest that was found in the years 1999–2004. Although the possibility to depreciate investments in a three-years’ timeframe was abolished, all the investments would still increase the asset base. The regulator defines the asset base using standard unit prices which, in turn, are based on values determined by the industry. Using standard prices is a potential source of windfall gain if a company is able to obtain lower costs, but on the other hand, it can be considered as a reward for efficiency. However, there is also a possibility that the regulatory standard costs are not sufficient to cover the costs. Indeed, rate of return regulation relies heavily on the regulatory asset base. The asset base determined at the beginning of the regulation period 2005–2007 created a basis for the asset base also in the following period bringing stability to the regulatory practices. The importance of network data reported by the companies was consequently accentuated.
The introduction of three years’ regulatory period instead of annual reviews increased the stability of regulation. The regulatory period also enabled companies to retain efficiency gains for the duration of the period, which gives incentives to cut costs. The stability was somewhat weakened by the fact that major incentive schemes were planned for the following regulation period, details of which were not available. Cost information was assumed to be used as the basis of incentive schemes for the next regulation period raising concerns that cost savings will create exaggerated efficiency requirements. The quality aspects of regulation were also anticipated, but not enforced. The standard compensations for interruption over 12 hours were the only form of quality regulation. Using straight-line depreciations to indicate reasonable investment levels gives a certain justification to the network companies to renew their ageing networks, but as mentioned, the regulation lacked long-term commitment.

The final judgements on the regulation period 2005–2007 indicated that nearly not all electricity distribution companies had made use of the opportunities provided by the regulatory framework, that is, they have been found to have undercharged their customers by 340 million euros (EMA 2008b). Eleven companies were found to have overcharged their customers. Although this might indicate that the regulation was still light-handed, the companies may recognise the dynamic aspects of regulation by preparing for future incentive schemes. Most of the distribution companies took the regulatory guidelines to court to legalize the decisions made by EMA. The appeals to the Market Court were about the specifications of the regulatory system. Some of the items in the appeal were accepted by the court and therefore were included in the upcoming regulation. One of the rulings dealt with the definition of the risk in the regulation; the base for determining risk-free return was changed to ten years’ government bonds’ interest rate instead of the intended five years. The changes were recognised in the final regulatory judgement as well as in the following regulation.

3.1.3. Regulation period 2008–2011

Mature regulatory systems commonly include feedback mechanisms designed to consider a company’s performance through an additional penalty/reward system. The EMA has also utilised incentive systems by setting company-specific efficiency targets and incentives for quality improvements for the second regulation period. Otherwise, the regulation will follow the
main guidelines from the first regulation period to assure conformity, especially when determining the regulatory asset base. A change in building cost index is used to account for change in value of money for interruption costs, controllable operational costs, depreciations and NPV. Regulatory accounting parameters and an example of values in 2008 are presented in Table 3-2.

Table 3-2. Parameters for the cost of capital (EMA 2008c).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Year 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax</td>
<td>Corporate income tax</td>
<td>26 %</td>
</tr>
<tr>
<td>Risk-free interest rate</td>
<td>Annual average on 10-year state serial bond May average of the previous year</td>
<td>4.33 %</td>
</tr>
<tr>
<td>Asset beta (equity beta)</td>
<td>$\beta_{\text{ASSET}} = \beta_{\text{EQUITY}} \cdot (1 - \text{Gearing})$</td>
<td>0.395</td>
</tr>
<tr>
<td>Gearing</td>
<td>Fixed (equity/debt)</td>
<td>70 %/ 30%</td>
</tr>
<tr>
<td>Market risk premium</td>
<td></td>
<td>5 %</td>
</tr>
<tr>
<td>Unliquidity premium</td>
<td></td>
<td>0.2 %</td>
</tr>
<tr>
<td>Premium for debt</td>
<td></td>
<td>0.6 %</td>
</tr>
<tr>
<td>Cost of loan</td>
<td>Annual average on 10-year state serial bond + premium</td>
<td>4.93 %</td>
</tr>
<tr>
<td>Reasonable return on equity</td>
<td>CAPM</td>
<td>6.51 %</td>
</tr>
<tr>
<td>Weighted average cost of capital after tax</td>
<td>Limited companies</td>
<td>5.65 %</td>
</tr>
<tr>
<td></td>
<td>Municipal companies (tax not included)</td>
<td>6.15 %</td>
</tr>
</tbody>
</table>

A fixed composition of 30/70 on debt/equity ratio is decided when determining the reasonable return. The regulator has made known that the gearing ratio is not permanent and could change in the future.

3.1.3.1. Quality incentive scheme

Quality of electricity supply has not formally been included in the economic regulation until now as the regulator has found that there is a need to promote quality improving measures; the inconvenience caused by the supply interruptions to customers is considered when determining reasonable return for the distribution companies. The interruption costs experienced by customers are based on customer inquiry (Silvast et al. 2005). In the incentive scheme, the
annual interruption costs are compared with the reference value, which is set independently for each company based on a four-year historical average. The effect of the quality incentive is decided to be capped to half to take into account atypical weather conditions and the limited possibilities of a network company to influence the occurrence of disturbances. Similarly, part of the quality improvement may be awarded to the customers. The effect of the scheme is limited to 10% of the annual reasonable return. The scheme takes into account planned and unplanned interruptions and auto-reclosings, both high-speed and delayed, all valued in Table 3-3.

Table 3-3. Unit costs for electricity supply interruptions (EMA 2007a).

<table>
<thead>
<tr>
<th>Unplanned interruption</th>
<th>Planned interruption</th>
<th>Auto-recloses</th>
</tr>
</thead>
<tbody>
<tr>
<td>€/kW</td>
<td>€/kWh</td>
<td>€/kW</td>
</tr>
<tr>
<td>1.1</td>
<td>11.0</td>
<td>0.5</td>
</tr>
<tr>
<td>6.8</td>
<td>0.55</td>
<td>1.1</td>
</tr>
</tbody>
</table>

The implementation of quality incentive was compromised by the lack of long-term, representative data, and so the target years partly overlap the performance years; the reference value will be determined as the average of the interruption costs from the years 2005–2008 (EMA 2007a). The companies were not fully aware of the final quality targets before the regulation period. On the other hand, the scheme is considered to treat all companies equally and there is no first-mover disadvantage. Collecting regulatory data has now been established, and companies can expect that their quality indices will have an effect on the following regulation periods.

In addition to the independent quality incentive, quality improvements will have more importance because of the adjusted definition of controllable operational cost. The standard compensations paid to customers for an interruption longer than 12 hours are now included in the operational costs and are therefore subject to efficiency requirement. In the regulation period 2005–2007, standard compensations were considered as pass-through costs and could therefore be seen as an income distribution from a distribution company’s clientele to the affected customers.
3.1.3.2. Company-specific efficiency target

For the regulation period 2008–2011, the company-specific efficiency requirement was established. Efficiency requirements are determined using input-oriented efficiency benchmarking, in which a company has to reduce the input components in order to reach the efficiency frontier, input being the sum of the controllable operational cost, straight-line depreciations and interruption costs, that is, the total cost. The applied DEA model is an increasing return to scale version of the model. The model formerly applied for rewarding purposes before year 2005 was variable return to scale, which had disadvantages such as favouring exceptional companies in terms of size. The DEA model is described in Equation (3.5).

\[
h_i = \frac{u_1 \cdot \text{energy}_i + u_2 \cdot \text{network}_i + u_3 \cdot \text{customers}_i - u_0}{v_1 (\text{OPEX}_i + \text{SLD}_i + \text{IC}_i)},
\]

(3.5)

where

- \( h_i \) = DEA score of the company \( i \)
- \( \text{energy}_i \) = value of the delivered energy of the company \( i \)
- \( \text{network}_i \) = total length of the distribution network of the company \( i \)
- \( \text{customers}_i \) = number of customers of the company \( i \)
- \( \text{IC}_i \) = interruption costs of the company \( i \)
- \( \text{OPEX}_i \) = controllable operational costs of the company \( i \)
- \( \text{SLD}_i \) = straight-line depreciations of the company \( i \)
- \( u_{1,3} \) = weight of the output parameter
- \( v_1 \) = weight of the input parameter
- \( u_0 \) = non-positive constraint, defining the non-decreasing returns to scale.

In order to minimise the uncertainty associated with an individual model, the company-specific efficiency scores are determined using the average of DEA and Stochastic Frontier Analysis.
(SFA) methods. The SFA uses the same parameters as DEA, for more details see (Syrjänen and
Vanhanen 2007). Because of the lack of sufficiently representative data for efficiency
benchmarking, the EMA uses an error marginal of 0.84 for setting the efficiency target; the
interruption cost data available for benchmarking purposes are limited to two years. Further, the
regulator regards only the part of the benchmarking input that the network company is seen to
have control over; the efficiency requirement is corrected using the ratio of controllable
operational costs and total costs. The target for efficiency requirements should be attained
within eight years. This is justified on grounds that the opportunity to achieve the required level
of efficiency may take longer than the four-year regulation period regarding for instance
straight-line depreciations. The annual efficiency requirement is determined according to
Equation (3.6).

\[ ER = 1 - \left( 1 - ES \right) \cdot 0.84 \cdot \left( \frac{Opex}{Totex} \right), \]  \hspace{1cm} (3.6)

where \( ER \) = efficiency requirement

\( ES \) = efficiency score

\( Opex \) = operational cost

\( Totex \) = total cost, i.e. the sum of operational costs, straight-line depreciations and
interruption costs.

The company-specific efficiency requirement will target the four-year average of operational
costs (years 2003–2006). The average efficiency requirement is 0.62 %, which spells out 0.23
% of the collected revenue of the Finnish companies (EMA 2007b). In the regulation period
2008–2011, a general efficiency requirement is further applied, set at 2.06 % annually.

3.1.3.3. Focal points of regulation 2008–2011

The regulation period has increased in length (from three to four years), which continues to
provide better commitment for the regulatory practices. The regulatory commitment is also
improved by continuation of regulatory practices established in the prior regulation period. But perhaps the most significant change compared with the previous regulation is the introduction of a quality incentive scheme. The scheme includes valuations for long and short interruptions, which provided a comprehensive view for quality improvements. The quality scheme is capped to account for companies’ vulnerability to large disturbances, and only half of the difference between the reference and the realised interruption cost is accounted to share the benefits/losses between the companies and the customers. There is also an extra incentive for longer interruptions as standard compensation costs are included in the controllable operational costs, and hence they fall under the efficiency target. The quantity of standard compensations is not capped. Overall, the incentives for quality improvements are strong.

Another novelty is the introduction of individual efficiency requirements. The results are obtained from efficiency benchmarking that includes the operational costs, straight-line depreciations and interruption costs in the input parameter, and companies have more holistic incentives to optimise their total costs. However, the efficiency requirement is focused on the operational costs only. Thus, the directing signals of the regulation are somewhat unclear, since the efficiency of the total costs is benchmarked, but the efficiency requirement focuses on the operational costs only as discussed by Honkapuro (2008, p. 161). The regulator’s decision to use a combination of two efficiency benchmarking methods diminishes the uncertainties associated with a single method but on the other hand, this can compromise the transparency of benchmarking. Furthermore, by allowing efficiency targets to be obtained in a time period twice as long as the regulation period companies are provided enough time to respond by developing their operation and ensures, again, continuation of regulatory practices.

3.2. Regulatory risk elements

As described above, the basic principle of economic regulation applied in Finland has remained the same since the EMA ruled on the first case concerning reasonableness of distribution pricing. Despite this, certain characteristics have evolved quite drastically. As there is more experience with economic regulation, the regulator is able to introduce more specific incentives; the quality incentive scheme and efficiency incentives. Rate of return regulation typically relies on the engineering judgement of the companies, but the implementation of more compelling
cost efficiency incentives and the growing importance of various aspects of quality have necessitated formal regulation. Cost efficiency, in turn, has been one of the main goals for regulation early on. Regulatory cost components covered by the regulation together with the linkages of the quality incentive scheme and efficiency targets are illustrated in Figure 3-1.

The Finnish regulation regime 2008–2011 determines the reasonable levels for controllable operational costs and capital costs including depreciations; the companies are, in fact, set with a reasonable revenue. The final regulatory judgement is, still, made on the reasonable level of return after the regulation period.

### 3.2.1. Scope of the regulatory risk

The decisive factor for the regulatory risk is the regulatory regime which is a combination of the regulation model, incentive regulation and also the associated rules and practices relevant in
determining the regulatory profit elements. A change in the regulation is often associated with an element of risk; in particular, introducing new profit elements into the regulatory regime or changes in the definition or the scope of the existing regulatory profit element referred here as regulatory intervention. In the Finnish regulation, the introduction of the quality incentive scheme is an example. Although introducing incentive schemes can be a result of natural developing phases of regulatory practices, the regulatory intervention responds to a need to change regulation. As regulation evolves, both the regulator and the regulated companies become more informed of each other’s intentions; the regulator has more knowledge on cost levels of the industry and the companies are more aware of the methods to influence the regulatory outcome. In more practical terms, the quality of data available for regulatory purposes is more refined and reliable. Moreover, the effects of regulation are not solely due to exogenous factors, but as discussed in Chapter 2, the companies have a role in the regulatory interaction. Three possible sources of the regulatory risk can be distinguished:

(i) Regulation regime.
(ii) Regulatory intervention.
(iii) Maturity of regulation.

For the purposes of developing a method to identify the risk sources of economic regulation, the sources of a regulatory risk in the Finnish regulation are discussed by considering the regulatory regime, incentives schemes, changes in regulatory profit elements and regulatory data in the regulatory period of 2008–2011.

3.2.2. Regulatory regime

The choice between regulation regimes determines the regulatory powers of the regulators. The rate of return regulation is often considered as being low-powered. However, this only holds for pure forms of regulation; hybrid schemes are more difficult to assess, and therefore, case-specific estimations are required. The Finnish regulation has moved towards incentive-based regulation and, essentially, in the direction of higher regulatory powers. It is a characteristic of the incentive regulation that the regulatory cost components are not dependent on the actual costs and the companies are able to freely set their distribution tariffs and individual cost
components as long as the reasonable return is not exceeded. Although the regulation limits individual regulatory cost components, the EMA can oblige the company to change its tariffs so that the allowed profit is not exceeded. The company will make the actual decision concerning the tariff levels and the tariff structure. The regulator is given credibility and power through support from the court decisions, which have been typical of the Finnish regulation. This was needed especially in the early stages of the case-specific regulation regime, but the regulation outlines of the following regulation periods were taken to court as well.

The Finnish regulation has also steadily moved towards providing a more stable business environment for the companies. The main reason for this is longer regulation periods, during which companies are able to retain cost savings. Further, stability is increased by constant methods to assess the regulatory asset base and to extend the efficiency targets beyond the ongoing regulation period to accommodate “inertia” of the business, that is, opportunities for medium- and long-term efficiency. The degree of regulatory discretion has been diminished for the recent regulation period as the regulatory parameters and the regulatory cost component for individual companies are known ex ante. Generally, the ex ante approach provides regulated companies with better tools to prepare for the regulatory risk, as ex post regulation leaves a prospect of regulatory discretion. However, the elimination of all regulatory discretion is not always considered desirable; the regulator may want to respond to unexpected changes in the operating environment or the company-specific circumstances. For example, the regulator may accept company-specific costs for network components when it is justifiable, or some extreme weather conditions may be regarded as force majeure exceptions and be excluded from the standard compensations scheme. In fact, another side to the stability provided by longer regulation periods is that it exposes companies to a prevailing risk level for that duration.

3.2.3. Changes in the regulatory profit elements

The regulatory regime determines the regulatory cost components that are of relevance. While much of the risk exposure can be attributed to the regulatory regime, the design of the cost components is also important to acknowledge; on the basis of which the cost elements in the regulation are determined, consisting mainly of the method employed, the intervals of re-evaluation and regulatory discretion. This feeds back onto how the risks associated with the
development of these input parameters are shared between the regulated company and its customers (Pedell 2006). The following discusses some of the changes in the regulatory profit elements in the regulation period 2008–2011.

3.2.3.1. Operational cost

In the economic regulation, the average of controllable operational costs of the years 2003–2006 is the target for efficiency improvements. Controllable operational costs include materials, accessories and energy purchases (excluding losses), an increase or decrease in stocks, staff costs, rents, other external services and other costs (EMA 2007a). The non-controllable operational costs mainly consist of transmission fees for the transmission system operator, and they are treated as pass-through costs. Operational costs are greatly subject to large variations in the operation environment, for example on account of repair works for large disturbances, as can be seen from Figure 3-2.

![Operational cost development for Finnish electricity distribution companies 1997–2008. Costs have been adjusted to the price level of 2008 by the changes in the consumer price index.](image)

Most noticeable change occurred as the standard compensations for interruptions longer than 12 hours were included in controllable operational costs. The costs may build up in large disturbances for a single company, but in general, standard compensations have accounted approximately under 0.4 % of the operational costs.
3.2.3.2. Regulatory asset base

The regulatory asset base was determined at the beginning of the first regulation period in 2005. The value for the asset base is changed according to annual investments and depreciations in the networks. Therefore, some of the risk is associated with the initial data provided for the regulator in terms of the number of components and the choices in the lifetimes. Presently, the risk is concentrated on changes in the component costs compared with those set by the regulation. Using standard unit prices is a potential source of windfall profit if a company is able to obtain lower costs but on the other hand rewards for efficiency. Unit prices are fixed for the regulation period but are updated in the regulatory review when the prices are changed according to the reported cost development. Some changes in the valuation of cabling prices is presented in Figure 3-3.

Figure 3-3. Development of unit prices of medium voltage underground cable, overhead line, satellite-type transformer and digging trenches in 2005–2010. Prices have been adjusted by the changes in building cost index.

Figure 3-3 compares the changes in the unit prices for network components have taken place in the regulatory review of 2008–2011 for underground cables and overhead lines. As the cabling costs have gone down, a change in the regulatory unit prices can also be seen. Companies are able to retain potential cost savings from the difference between the standard unit and actual cost during the regulation period but changes in the regulatory review can have impact on the...
investments in the regulation and the asset valuation. Other cabling components for which product development is expected to significantly decrease the costs are satellite transformers, and also advancements in cable ploughing technique can bring the cost of digging cable trenches to 2–3 k€/km. One have to bear in mind that updating prices is based on companies that have participated in collecting industry statistics, and therefore changes do not necessarily represent true level of cost changes. The regulatory unit prices are changed accordingly nonetheless.

3.2.3.3. Capital cost

The technical and economic life of the average network asset largely surpasses any regulatory period. Yet, investments have to be undertaken sequentially and costs allocated to an uncertain future, which places attention to the treatment of investments in regulation. Categorisation can be made between investments extending the existing network and replacement investments. As a general rule of the markets, investments are encouraged if the profit exceeds the expected losses. The requirements for operating the natural monopoly may force companies to make investments that cannot be considered economically profitable, but are required by quality or safety regulations. In economic regulation, investments may make profit either directly by increasing the asset base or indirectly through increased performance. The direct impact of investments in the regulation period 2008–2011 for the extension investments is that they increase the net present value and repurchase value of the network. They also increase the network volume factor used to correct the regulatory asset base. A replacement investment, for one thing, increases the net present value only. As for indirect impacts, there certainly is an incentive to make investment decisions which have a positive effect on the company income through operation costs or cost of quality for instance. Moreover, investment have a distinct impact on straight-line depreciations that are used as an input for efficiency benchmarking.

When assessing the reasonableness of return, the small amount of risk involved in the Finnish electricity distribution business, low financing costs and long lifetimes of the network assets have been acknowledged. The basis for capital cost assessment in the regulatory reviews have largely remained the same, particularly the assessment of the risk involved in the business. The changes that have occurred have resulted from court rulings in retrospect. In other words, petitioning has changed the expected capital cost.
3.2.4. Incentive schemes

The purpose of the regulatory reviews is to address issues raised by the public concern, general development of the industry or perceived drawbacks in the regulation regime. The implementation of new incentive schemes includes choosing the method, the applied parameters and finally implementation of the incentive. The implementation includes setting the reference or target level for the measured performance. The two incentive schemes, cost efficiency and quality incentive scheme, base their targets on the previous performance of the company. This often leads to discussion on whether the target presents fully the operating conditions of the companies and, moreover, how the extraordinary events are treated. Therefore, other operation environment characteristics being stable, the companies face new risks through changed regulation.

3.2.4.1. Efficiency benchmarking

Incentives for cost efficiency have been planned in the economic regulation from the beginning of regulation planning in 1995. Until the end of 2004 there was an efficiency bonus for companies performing well in the efficiency benchmarking, which made some companies actively pursue cost efficiency. However, as the efficiency studies were applied to all of the companies, it soon became evident that first-mover position was not favourable; the introduction of a general efficiency requirement on operational cost abolished the advantage of previous cost reductions as the reference values were determined based on historical values. This way, the regulatory regime produced more rigorous efficiency targets to first-movers and companies that were already efficient in the efficiency studies. Respectively, more passive companies and companies that were considered inefficient had an opportunity to meet the efficiency targets by less extensive measures.

The major risk factors concerning the actual efficiency benchmarking are related to the choice of method, the choice of input and output variables, and implementation of the efficiency measures in the regulation. The benchmarking methods used in Finland, DEA and SFA are frontier methods, in which the performance of the companies is measured against a frontier of companies performing best. The frontier methods are used to reduce the performance gap among the companies (Jamash and Pollitt 2000). Therefore, the performance of the companies
that the company is measured against is also a considered factor. Although the parameters used to measure efficiency take characteristics of individual operating environments into account, the possibilities for a group of parameters to represent all unique circumstances are remote. For example, if there are extensive investments on the quality by the other companies, then the company emphasising cost efficiency instead would appear to be inefficient. The relative nature of the methods used, however, alleviates this issue, but the presence of outlier companies\(^2\) can distort measurements.

The efficiency requirement determined by company-specific efficiency benchmarking focuses on operational costs. The EMA has stated that focusing the efficiency target on total cost would be problematic because of the feasibility of limiting depreciations and the lack of sufficient data for the interruption cost (EMA 2007a). This inevitably leads to inconsistency between the measures to improve efficiency and the interface of the regulatory impact. In order to be efficient, the companies have to optimise their total cost, that is, the sum of operational cost, interruption cost and straight-line depreciations. By applying the lump sum of cost components, the choice of the preferred target for efficiency measures is transferred to companies. Of these inputs, the operational costs are an accessible source for improvements. Interruption costs can be influenced for example by investments in more reliable networks, but there the time span of potential efficiency improvements is longer that with operational cost. For the straight-line depreciations the duration of the regulation period will probably not be sufficient to impact the input factor. Moreover, the methods by which depreciations can be influenced are limited to dismantling network or replacing existing components with cheaper ones. Therefore, despite the target for efficiency requirements is not directed at depreciations, the capital costs represented here as depreciations, as a part of an input parameter, give an intricate directing signal, which may lead to underinvestment. The strong directing signal of efficiency benchmarking method is, however, somewhat diluted as the efficiency target is an average of the DEA and the SFA. In addition, there are problems concerning the actual methodologies used in efficiency benchmarking. The impact of methodologies used to determine efficiency measures is discussed more detailed in Syrjänen and Vanhanen (2007) and in Honkapuro (2008).

\(^2\) Outliers have characteristics that differentiate them from average companies.
3.2.4.2. Quality of electricity supply

The incentives for improving the quality of electricity supply in the period 2008–2011 are strong. Measures affecting the quality have three possible outcomes; 1) directly through the quality incentive scheme, 2) through efficiency benchmarking and 3) through controllable operation costs that take standard compensations for interruptions longer than 12 hours into account. In addition, network companies may be compelled to pay compensations for customers for faulty electricity supply and possible immediate damages according to the Electricity Market Act (368/1995).

The purpose of the quality incentive scheme is to direct companies’ efforts to targets that are considered important for society. On the other hand, the quality should not be excessive – a socio-economic optimum is required. The quality incentive scheme covers a wide range of continuity of supply indices by giving a value each of them. The target for interruption costs is determined as an average of the years 2005–2007. This is a relatively short time period to represent the characteristic level of interruptions. For instance, there were no large disturbances at the national level, which would therefore acknowledge the various weather conditions that may occur. For some of the companies, nine years’ quality indices were available, which would give a more representative illustration of the companies’ true quality level. The impact of applying four years’ average instead of using more sample data, in this case nine years’ indices, can have a 0.28 %-unit impact on the allowed return as the interruption figures have ± 37 % deviation on average (Market Court 2008). Overall, the impact of presentability of the target years for interruption costs is unclear. In addition to risks associated with determining the reference for interruption cost, also the level poses a problem. The reference value for some companies is considerably smaller than the maximum cap set at 10 % of the allowed return. Therefore, the companies that have maintained good quality are not able to utilise the full advantages of the quality incentives. This leads to an asymmetric incentive for some of the companies, for which the impact is determined as 0.16 %-unit from the allowed return (Market Court 2008).

Further, similarly to efficiency targets, there are differences in the prevailing target levels; some companies have invested to improve the quality of supply whereas others have not, which gives an advantage to the companies currently improving their performance. The quality incentives
are likely to remain in the following regulation period, thus exposing current performance to future reference, leaving the companies with a choice of investing decisions. Improving quality will therefore result in smaller targets making the benefits of the current actions only short term. Companies are then more exposed to impacts of large disturbances. Companies are able to regain investments in improved quality through depreciations and financing costs which diminishes the risk for future regulation periods. However, the incentive for long-term quality improvements may be compromised if the procedure for the quality incentive remains the same.

3.2.5. Regulation data

When considering introduction of new regulation or regulatory cost components the issue of data availability and the quality of data submitted by the companies for regulation are among the main concerns. This issue of regulatory data is closely connected to the well-recognised problem of information asymmetry in regulation. The more informed the regulator is of the companies’ true cost levels, the less risk is involved. Ideally, the regulator rules on cost performance ex post, but the current legislative framework prohibits this kind of behaviour. In ex ante regulation, in order to avoid the effects of companies’ information advantage, the regulator can either collect information before announcing regulation details or set incentives so that the companies reveal their cost structure. Setting incentives without prior announcement is problematic on account that regulation predictability is diminished.

The issue of data quality affects nearly all aspects of regulation, not only incentive schemes. The EMA has had problems with attaining required data from the companies. Distribution companies have not always been able to produce complete data on assets, that is, age and quantity, which has led to extraordinary measures. For instance, when defining the regulatory asset base, the regulator has battled this issue by allowing companies to use half of the expected lifetime as the network component age, if accurate knowledge is not available. As for quality incentive scheme, the EMA has used overlapping target and performance years, and data are used for as many years as possible to determine the true cost level. Therefore, the incentive scheme does not consider the efficient but rather the realised cost of quality.
Another data-related source of risk is that regulated companies may behave opportunistically when reporting necessary data for regulatory purposes. By misreporting data, the regulated companies can either diminish or exaggerate their cost for their benefit. In the presence of yardstick regulation, companies’ measured performance is relative to other companies’ performance, and thus, there is an increased risk for an individual company if the reported data are incorrect. Also, the issue related to data quality is the choice of reference years (time lag), discussed earlier. For a business where exogenous events in the operating environment such as storms can cause large variations in the cost levels, the number of reference years applied in the current regulation period can be considered quite small. For instance, the reference values of the operational cost, and the interruption cost, are based on the years that did not include large disturbances leaving an elevated risk of extreme weather conditions.

3.2.6. Example: impact of large disturbances

Presently, quality incentives are strong and represent a source of risk for the distribution companies. Incidents, in which this particular risk can realise, are large disturbances. The interruptions have been assigned a value, which through the quality incentive has an effect on the allowed return. The economic effects of large disturbances vary according to the condition of the network and unique operating environment. The impacts of large disturbances are examined by using two different distribution companies. Table 3-4 represents the key figures for the companies for an average year. Company A is a fairly large distribution company operating in rural-like conditions. Company B is a medium-sized or small company whose network is susceptible to storms or heavy snow load on account of overhead lines.
Table 3-4. Key figures for two example companies for an average year.

<table>
<thead>
<tr>
<th></th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory asset base</td>
<td>256 000 k€</td>
<td>42 800 k€</td>
</tr>
<tr>
<td>Allowed return</td>
<td>14 464 k€</td>
<td>2418 k€</td>
</tr>
<tr>
<td>Operational cost</td>
<td>14 800 k€</td>
<td>2 470 k€</td>
</tr>
<tr>
<td>Interruption cost</td>
<td>3 600 k€</td>
<td>600 k€</td>
</tr>
<tr>
<td>Repair cost</td>
<td>315 k€</td>
<td>50 k€</td>
</tr>
</tbody>
</table>

Table 3-5 gives an example of the regulatory risk for two network companies in the case of a large disturbance. Large disturbances are categorised according to Partanen et al. (2006). For a class I storm, the duration of interruption is 48 hours and the proportion of the affected customers is 45% of the total customer number. A class I storm is expected to occur every five years, but the occurrence rate for disturbances is based on expert views and does not necessarily represent actual occurrence probabilities. In a class II storm the interruption lasts five days and 50% of the clientele is affected. Expected probability of a class II storm is every 20 years. By assuming that the extent and cost for large disturbances are equal in the example companies, the economic consequences are as illustrated in Table 3-5 (one sixth of the distributing area of company A is affected by the storms). The cost estimates are based on those presented in Partanen et al (2006). The interruption cost that is considered in regulation accounts for half of the actual cost and the limitation of the quality incentive scheme to 10% of the allowed return.
Table 3-5. Two examples of the costs of large disturbances.

<table>
<thead>
<tr>
<th></th>
<th>Class I storm</th>
<th></th>
<th>Class II storm</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Company A</td>
<td>Company B</td>
<td>Company A</td>
<td>Company B</td>
</tr>
<tr>
<td>Standard compensations</td>
<td>154 k€</td>
<td>154 k€</td>
<td>310 k€</td>
<td>310 k€</td>
</tr>
<tr>
<td>Interruption costs</td>
<td>1019 k€</td>
<td>1019 k€</td>
<td>1829 k€</td>
<td>1829 k€</td>
</tr>
<tr>
<td>Regulatory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>interruption cost</td>
<td>508 k€</td>
<td>214 k€</td>
<td>914 k€</td>
<td>214 k€</td>
</tr>
<tr>
<td>Capped to 10 % of allowed return</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair cost</td>
<td>111 k€</td>
<td>111 k€</td>
<td>337 k€</td>
<td>337 k€</td>
</tr>
<tr>
<td>Total cost per storm</td>
<td>773 k€</td>
<td>506 k€</td>
<td>1561 k€</td>
<td>861 k€</td>
</tr>
</tbody>
</table>

The examples show that if a distribution company faces large storms, the ramifications for the particular year can be noticeable. The company B reaches its cap for the quality incentive scheme for both of the storms; a class I storm decreases the rate of return by 1.12 % and a class II storm by 2 %. Correspondently, company A’s profit is decreased by 0.3 % and 0.61 %. The risk of large disturbances is therefore evident particularly for rural companies, which can, in the worst case, experience interruptions that affect the majority of their overhead networks. As a conclusion, the effects of large disturbances are threefold. The standard compensations and the repair cost of storms increase the operational costs. The interruption cost has a direct influence on the allowed income, and the company-specific efficiency requirement is focused on operational costs. The operational costs are used as an input in the efficiency benchmarking similarly as the interruption costs caused by storms.

Figure 3-4 illustrates the variations in the interruption costs of 2008 in relation to the reference value (average interruption cost 2005–2008) for all Finnish distribution companies.
Annual variations in interruption costs are common, similarly as variations in operational costs. Although the effects of interruption costs are taken into account for the duration of the regulatory period, the risk for a single company to experience large weather events can be considered pronounced.

3.3. Discussion on regulation evolution

The Finnish regulation method has remained nearly the same during the years, but some major developments have occurred influencing the risk level of regulation. One of the most noticeable change has been the decrease in the regulatory discretions. The case-by-case regulatory decisions in Finland during 1999–2004 exposed companies to regulation on an unformed basis, and the regulation process was subject to regulatory discretion. The first regulation judgements relied heavily on independent expert opinions concerning the regulatory asset base. The absent data of the asset base concerning the age and number of components were also an issue as there were no established methods to collect data.
The early judgements entailed an assessment of distribution tariff levels, and the efficiency of operation was determined based on comparisons of key ratios. The impact of these investigations was mainly through social pressure as there were no monetary consequences of condemnatory decisions but merely a recommendation to correct pricing in the future. Although the current regulatory regime includes formal methods to assess efficiency and reliability, and these methods apply to all companies, the introduction of additional profit elements has increased the regulatory risk for the companies. Still, the compensation for the risk exposure of the electricity distribution industry, that is, the beta coefficient has remained at a rather constant level of 0.3. Table 3-6 illustrates the changes in the regulatory risk in Finland.

Table 3-6. Comparison of regulatory variables in the Finnish regulatory regimes.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of regulatory discretion</td>
<td>Large</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td>Regulatory lag</td>
<td>Unspecified, annual inspections</td>
<td>Fixed: 3 year</td>
<td>Fixed: 4 year</td>
</tr>
<tr>
<td>Pass-through costs</td>
<td>Transmission fees</td>
<td>Standard compensations</td>
<td>Transmission fees</td>
</tr>
<tr>
<td></td>
<td>Standard compensations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost components included in the regulatory regime</td>
<td>Operational cost Capital cost</td>
<td>Operational cost Capital cost</td>
<td>Operational cost Capital cost Interruption cost Standard compensations</td>
</tr>
<tr>
<td>Incentive schemes</td>
<td>Informal evaluations</td>
<td>General efficiency requirement</td>
<td>Quality incentive scheme General efficiency requirement Efficiency benchmarking</td>
</tr>
</tbody>
</table>

One noticeable outcome of the regulatory efforts is the end-customer price. Figure 3-5 illustrates the development of distribution prices between 1999 and 2009.
Since the official economic regulation was introduced in 1999, the prices have been declining. The threat of regulatory measures pushed companies to respond by lowering their prices. A slight increase in prices can be seen from 2001 onwards. This dates back to a time period where companies had some experience on the nature of the regulatory regime and felt comfortable in rising prices. The case by case regulation continued until the ex ante regulation took effect in 2005. From that point forward, prices have been seen to decrease. Most of the companies were found to have been undercharged their customers during the regulation period 2005–2008, which would suggest a strong reaction to regulation. From the regulation period 2008–2011 there is little information available so far. The year 2009 would seem to have started, however, with sharp price increases indicating that the companies are regaining the undercharges allotted to them.

3.4. Categorisation of regulatory risks

The regulatory regimes are highly specific for each industry and country. Also, the risk sources are, to some degree, individual for each of the distribution companies. There are some common
characteristics that enable developing a standard approach for assessing the regulatory risk for a regulatory regime. The risk can be assessed in three stages:

1) Identifying regulation cost components based on the regulatory regime.
2) Identifying the relevant risk sources for each regulatory cost component.
3) Assessing the importance of the risk sources.

Based on the presented approach, the scope of the regulatory risk in the Finnish economic regulation in 2008–2011, that is, the regulatory cost components currently existing in the Finnish regulatory regime, operational costs, capital cost and interruption cost, is presented in Table 3-7. The valuation of the recognised risk sources is made on the scale significant – moderate – minor on the basis of importance for the companies.

The valuation for the regulatory risks is based on the synthesis of the regulatory risk elements discussed in previous sections. For example, large annual variations in the operational cost during the reference years for the efficiency target may lead to unexpected efficiency requirement. Therefore, the impact of reference years can be considered significant for the regulatory risk; similarly, exogenous events, such as large disturbances, are also of significance. On the other hand, at present, the risk of regulation concerning investments is considered moderate. The reason is that all investments increase the regulatory asset base and there are no efficiency requirements focused on investments, nor is there any judgement on the necessity of investments. In other words, the network companies are allowed to carry out the investments they consider necessary, and the regulator accepts these investments in the determination of the regulatory asset base. The regulator performs cost control by using standard unit costs for investments in asset base calculations but the fact that these standard costs are partly based on the industry’s own reports alleviates some of the risk associated with them. Some of the risks resulting from regulation are, of course, beyond the control of the companies. The cost of capital, for instance, is determined in the regulatory review where the regulator has the final judgement on the regulatory regime. The prospects in influencing the cost of capital are therefore limited. However, the evaluation of the cost of capital evaluation is highly significant.
Table 3-7. Scope of the regulatory risk for the Finnish economic regulation in the regulation period 2008–2011.

<table>
<thead>
<tr>
<th>Regulatory cost component</th>
<th>Risk source</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational cost</strong></td>
<td>Reference years</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>• The base used for determining reasonable operational cost</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Costs covered in operational cost</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>• Standard costs included</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency benchmarking</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>• Method and parameters used for efficiency benchmarking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Implementing the benchmarking result</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Performance of the companies against which the measurement is done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exogenous events</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>Data quality; availability and quality</td>
<td>Significant</td>
</tr>
<tr>
<td><strong>Capital cost</strong></td>
<td>Allowed rate of return</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>Regulatory regime</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Method and parameters used for determining cost of capital and reasonable return</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regulatory asset base</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Investments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Investments included in the asset base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Standard cost for investments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data quality; availability and quality</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Depreciations</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Investments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Investments included in the asset base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Standard unit cost for investments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Component lifetime</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Interruption cost</strong></td>
<td>Reference years</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>• The base for determining reference years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Costs covered by incentive</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>• Quality indices and their valuation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reference value</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regulative discretion; e.g. force majeure events</td>
<td>Minor</td>
</tr>
<tr>
<td></td>
<td>Exogenous events</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>Data quality; availability and quality</td>
<td>Significant</td>
</tr>
</tbody>
</table>

For the purposes of managing the regulatory risks in the electricity distribution business, identifying and assessing the risks is important, and the second stage is to consider opportunities to respond to them as discussed in the following sections.
3.5. Responding to the regulatory risk

The risk of the economic regulation regime in Finland has increased mainly as a result of a shift towards more incentive-based regulatory practices. The regulatory regime, however, does not compensate the increased risk, and therefore the increase in the regulatory risk is transferred to the companies. The changes are mainly directed at the quality of electricity supply. The most accessible opportunities to influence the regulatory outcome and manage the regulatory risk are:

- to reduce the operational costs so that the company will maximise its regulatory revenue and perform well in the regulatory benchmarking
- to improve network reliability so that the company will retain quality reward and perform well in the regulatory benchmarking
- to reduce the effects of external events and
- to produce data for regulatory purposes so that regulatory cost components will not be distorted.

Because the increased risk is not compensated in the regulation, the companies have to either prepare for the risks or eliminate them. In the presence of strong societal and regulatory requirements for reliable electricity supply, one of the main concerns is how to prepare for the occurrence of large disturbances. Costs originating from large disturbances and in supply interruptions in general are present in nearly all of the regulatory cost components. In order to succeed in the regulatory game, the company can choose a network development strategy that best accommodates secure and low-cost networks for a better regulatory outcome.

3.5.1. Challenges for rural networks

The main driving forces for realigning the network development strategy is the requirement to increase the network tolerance of natural catastrophes. Over half of the electricity supply interruptions are caused by adverse weather events (ET 2009b). Interruptions are particularly found in rural lines as they have been built to run through forest areas, and the line paths have not been designed to sustain trees falling under storms or heavy snow. The possibility of large-
scale disturbance affecting the majority of the distributing system is therefore eminent. Extensive rural distributing areas place a strain on fault repair, which results in both frequent and longer interruptions, whereas in urban or semi-urban areas backup supply connections can be arranged. Underground cabling is used in rural sites that are of high importance. For companies operating in urban or semi-urban areas, the consumption is concentrated on given locations and the cabling rate is higher.

Although the network development needs are here mainly discussed from the viewpoint of avoiding supply interruptions, there are also some other considerations involved. Bare conductors represent a health risk in the case of an accidental contact with them, and there has also been concern over the electromagnetic radiation transmitted by the lines. Landscape protection has also traditionally been one the main reasons for underground cabling, and the expectations for getting rid of overhead line structures may become topical in rural landscapes. Overhead lines require climbing up the poles for construction and maintenance, which has increased demand for emphasised employee protection control, as was the case in Sweden. In addition, the line paths for overhead lines require constant pruning, and have increasingly high acquisition costs. Another cost item for the distribution companies is the replacement and treatment of impregnated, aged wood poles; furthermore, the use of impregnating substances in poles has been prohibited for human and environmental safety reasons. Finding suitable replacements for poles that have to be treated as toxic waste is yet another cause for concern. Tightening safety and environmental regulations ultimately make the overhead lines increasingly more expensive to build and maintain. Restrictions concerning safety of distribution networks may well be among the decisive factors for the future of overhead lines, especially as the restrictions are expected to tighten in the future. The distribution companies have also anticipated shortage of capable employees particularly in network construction and maintenance, partly because of retirement (EMA 2009b).

3.5.2. Developing networks

As a response to changes in the operating environment and regulatory risk, the companies have a variety of network development strategies at their disposal. Often, increasing reliability is costly and requires a comprehensive approach in network construction and operation to be fully
beneficial. As Lakervi and Holmes (1995) point out, it is often cheaper as a whole to make some provision for the possibility of more stricter regulations in the future than to make major revisions to the distribution networks or their associated auxiliary systems at some later date. The overall objective for distribution network design is to minimise the lifetime cost of the network within the given technical boundaries, that is, to find an optimum for capital, operational (maintenance, repair and network losses) and interruption costs for the network lifetime. The basis for development is the existing rural network layout and a condition that without any actions to improve performance, the company will fall behind in the frontier of forerunners and inevitably, the funds allotted by regulatory measures will decrease.

Table 3-8 presents the advantages and disadvantages for some of the commonly used methods to improve reliability in overhead networks. More reliable network structures are: underground cabling, 1 kV low-voltage lines (Kaipia et al. 2006), covered conductors or building overhead lines alongside roads. There are also other methods, such as using pole-mounted switchgear, low-cost 110/20 kV primary substations, building light 110 kV lines and increasing network automation. Methods to improve network reliability in a cost-effective way are always case specific and depend mainly on the network topology, consumption in the area and the set reliability requirements; therefore, often more than a single option is used. Reliability can also be improved by maintenance solutions or by using reserve power and back-up connections. When choosing the appropriate methods to improve network reliability, cost-benefit analysis is used to determine appropriate actions for network development.
Table 3-8. Assessment of some methods to improve reliability in electricity networks (Partanen et al. 2006).

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground cabling</td>
<td>Limited exposure to natural agents. Installation can be done in parallel to existing feeder line. Ongoing development for better underground cabling productivity. Landscape considerations.</td>
<td>Expensive and laborious to install. Durability of cables in rural-area conditions unknown. Fault locating and repair times long. Increases the earth fault currents and capacitive reactive power. Rigid network topology.</td>
</tr>
<tr>
<td>0.4/1/20 kV network system</td>
<td>Investments and maintenance costs lower than compared with the traditional 20 kV system. Narrower line paths. Suitable for small-load branches. Smaller distribution areas improve reliability. If cabling is used; limited exposure to natural agents.</td>
<td>Increases the number of transformers. Leads practically to a new network topology. Limited long-term experience. Rigid response to load growth.</td>
</tr>
<tr>
<td>Rebuilding lines alongside roads</td>
<td>Increased tolerance against natural agents. Better location of faults and maintenance opportunities. Compensations for land use diminished. Installation can be done in parallel to existing feeder line.</td>
<td>Obtaining a building permit may be difficult. Possibly longer lines. Possibly increased cost of overhead line technique.</td>
</tr>
<tr>
<td>Covered conductor lines</td>
<td>Better resistance to natural forces. Less high-speed or delayed automatic reclosings. Narrow line paths.</td>
<td>Requires manual control of faults. Unexpected faults as a result of insulation material deterioration.</td>
</tr>
</tbody>
</table>

Overhead lines that are located in the forests and fields to facilitate the shortest lines in order to reach investment savings are vulnerable to weather conditions, and rebuilding lines alongside roads provides better reliability and maintenance access. Cabling or moving still functional overhead lines to roadsides generates replacement costs, while maintaining or improving the reliability of existing overhead lines by pruning will entail operational cost. The investment costs of the covered conductors are far higher compared with those of the bare conductors, and the decreased maintenance cost will not cover the difference in economic considerations.
(Martikainen et al. 2007). When compared with using overhead lines in rural network conditions, full-scale underground cabling is the most expensive network development solution (Lassila et al. 2007). The profitability of underground cabling is related to the density of consumption; traditionally, underground cabling is used in urban areas, and consumption in rural areas has been too low. Martikainen et al. (2007) also come to a conclusion that based on the present knowledge, storms and snow loads will not increase to such an extent that an underground cable would be economically profitable on rural feeders. However, when the reliability of electricity supply is concerned, it provides the best solution: the fault frequency of an underground cable is 20–50 % compared with an overhead line (Partanen et al. 2006). As the amount of ageing network assets is increasing, the mere replacement of the existing overhead networks can lead to an unsustainable situation regarding the required network performance.

Some large Finnish companies have announced that they will be transferring primarily to underground cabling (Vattenfall 2009) or prefer underground cabling (e.g. Tompuri 2007). The present rate of underground cabling in low-voltage networks is approximately 42 % and in medium-voltage networks 22.6 % (EMA 2008a). Transition to cabling as the primary means to build and replace overhead network structures can partly be explained by companies’ anticipation of an increase in society’s demand for reliability. In Sweden, the regulations for avoiding large-scale effects of natural catastrophes has led to a situation in which the distribution companies increasingly see the underground cable networks as practically the only alternative when considering network solutions. As a result of the storm Gudrun, interruptions longer than 24 hours were prohibited by law in Sweden (Swedish Electricity Act 1997:857). Such compelling regulations are not yet foreseen in Finland, but for companies facing network renewal for instance, the aim can be to anticipate such strong, compelling regulations. Overall, cabling is considered a potential solution to improve network reliability (EC 2003c). Another factor for cabling as a principal network development method can be attributed to the individual capabilities of the companies. Some companies can be better equipped to carry out cabling in a cost-efficient manner, for example by taking advantage of practices or business connections of affiliates in other countries or by successful tendering. In the last-mentioned case, service providers specialised in ploughing may have an advantage in providing new, low-cost solutions. New technological developments, such as ploughing or advances in cable technology, have expedited network renewal. If the cabling technique can be developed to correspond the cost of building overhead lines, transition to cabling as the primary method of network construction
will be likely, as indicated in Figure 3-3. The proven, progressive practices in cabling will eventually become accessible by the generality of the distribution companies. This will provide means to consider full-scale cabling even in rural distribution areas in preventing effects of adverse weather.

3.5.3. Full-scale cabling of rural networks

Nowadays, it is common that electricity network companies are formally expected to reduce the impacts of adverse weather phenomena on electricity end-users and compensate any inconvenience directly to the electricity end-users. Consequently, regulation of electricity distribution business may lower the threshold to build networks more weather resistant, which in turn means increased underground cabling. Some of the safety and environmental challenges can be noticeably reduced by underground cabling; cables transmit weaker electromagnetic fields compared with overhead lines, and the risk of electric shock is smaller.

Full-scale cabling in rural distribution networks requires commitment to the regulation regime, and the companies have to be prepared for all of the risks involved in it. Distribution companies have extensive knowledge and experience on traditional technologies in network development, mainly concerning overhead networks that do not meet the reliability and other future needs discussed above. Moreover, as a result of their natural monopoly position, companies have adopted practices most convenient to them with limited external forces influencing the decision-making process. The regulated company can reduce its own commitment by choosing a production technology that requires less and less specific capital as a response to a higher perceived regulatory risk (Pedell 2006, p. 47). When rebuilding the aging networks, underground cable networks appear to be a more and more tempting solution as reliability aspects of electricity distribution have been the leading principle in network design. As the resources and capabilities that are needed to carry out full-scale cabling are possessed only by a few companies, outsourcing to obtain the necessary resources appears as an attractive option.

Increasing the use of underground cables especially in rural areas does not always have only positive impacts. In terms of load growth, different rural areas vary significantly; from areas
with a heavy load growth to areas with little or no growth. By laying cables underground, network companies face risks of load changes or relocations, and further, changing the network topology is more challenging in underground cable networks. In an urban environment, networks may have to be rebuilt to facilitate changing city structures, but for a radial network in the suburban or rural areas, this is not a cost-effective alternative. Another consideration is the growing popularity of holiday homes in rural areas, where the number of new connections is rising. These dwellings are also more frequently used for round-the-year living. The design of rural networks may also be affected by increasing support and propagation of distributed generation, which, on the other hand, requires new, reliable connections; nevertheless, the detailed requirements for the nature and size of distributed generation may pose challenges for rigid cable networks.

3.5.3.1. New technical capabilities

The increased use of underground cables has partly been enabled by improvements in cable manufacturing and installation techniques. The technology advancement such as development in solid insulations, optimisation in cable design, and the use of pre-moulded cable accessories have reduced the cost of underground cables. With more frequent use of underground cabling outside urban areas, the cost for network construction becomes even more relevant. Today, ploughing has become a cost-efficient way of building distribution networks in rural areas. For low-voltage networks, the cost of cable ploughing is approximately 50 % less than digging trenches in rural settlements (Partanen et al. 2006).

Strong driving forces in quality regulation can require speedy and effective response from the distribution companies. In some cases, traditional methods in cabling do not offer realistic solutions to installation speed and quantity needed, and thus one of the key factors in achieving cost-efficient solutions has been cable ploughing. Traditionally, underground cables have been placed into trenches that are dug beforehand, but now, ploughing combines these two working phases. Ploughing is mostly carried out in low-voltage networks; in rural areas, ploughing low-voltage cable can be even cheaper than digging trenches (Lakervi and Partanen 2006). In fact, ploughing has made low-voltage cabling in some rural areas more profitable than using traditional overhead line structures. Ploughing in medium-voltage networks has not attained this kind of position. Rather, it has been restrained on account of lacking experience and suitable
cable types. Medium-voltage cables are heavier and more robust, and some have too soft sheathing for ploughing purposes (Ilves 2007). For this reason, ploughing the medium-voltage network is considered to be more expensive than in low-voltage networks and requires often preploughing. It is expected that by developing medium-voltage ploughing techniques and cable types, cabling can be made cost-effective at a more general level. In principle, ploughing can be done in most locations that do not require extensive land processing: ploughing is not feasible in stony or rocky soil. An uneven surface or indirect routing can cause strain on the installed cable and soil imperfections can also affect cable durability. Ploughing is easily performed alongside roads or in the road bed in urban areas. The Highways Act (503/2005), however, gives the road management authority full control over the use of roadsides in rural areas. Cabling must therefore be done with due regard for road maintenance needs, which can in some cases diminish the full benefits of ploughing.

3.6. Conclusions on the regulatory risk in the electricity distribution business in Finland

Economic regulation is one of the most important risk components in the electricity distribution business: as a result of the natural monopoly status, all risks are realised through regulation. This leaves the regulation itself as a major source of risk. The choice of the regulation model applied has a significant influence, but as can be seen from the experiences of the Finnish regulatory practices, introduction of efficiency and quality incentives has raised the risk. The opportunities for a distribution company to control the regulatory risk may primarily be considered to focus on pursuing cost efficiency, improving quality of electricity supply and reporting data necessary for regulation purposes.

In order for the electricity distribution networks to service the future needs, the networks have to be more cost efficient, more reliable and to meet the safety and environmental requirements. In particular, costs from large disturbances have a strong presence in regulation making it desirable to avoid any interruptions in order to minimise the interruption costs. The drivers are not merely regulatory and statutory – also the customer service aspect has been emphasised as a driving force. There are various methods to improve network reliability, but underground cabling is perhaps the most extensive for normal operation as well as in large disturbances. Extensive changes in the network structure require a significant increase in investments because
of the high cost of underground cabling in rural networks. Economic regulation provides incentives for improving service quality and efficiency in operation, but presently, they are not sufficient to act as a sole promoter for large-scale reliability improvement actions. A contributing factor can therefore be characterised partly as social but nonetheless preparing for prospective regulatory requirements with expected reduction in cabling prices. The primary methods by which the Finnish electricity distribution companies can respond to business risks are illustrated in Figure 3-6: 1) choosing an optimal network development strategy and 2) reorganising the organisation.

Figure 3-6. Responding to the business risks in electricity distribution.

Technical considerations can prevent the effects of regulatory risks, whereas improving and reorganising the organisation facilitate in managing the effects of risks. Responding to the regulatory risk requires knowledge and resources that may not be presently available. Electricity distribution companies have turned some network activities over to the competitive market in the hope of gaining advantage in the regulatory game.
4. **Outsourcing in the Finnish electricity distribution sector**

Outsourcing has been a growing trend among the Finnish electricity distribution companies (Aminoff et al. 2009). Similar findings are gathered around Europe, for example according to Tarren et al. (2009). Pressure to outsource can be attributed to the prioritisation of financial targets as a result of commercialisation or privatisation in the electricity distribution business but also, distribution companies have turned to outsourcing in order to achieve the efficiency targets set by economic regulation (Thomas and Hall 2003). Saplacan (2008) follows another line of thinking where the implementation of unbundling rules has induced some noticeable changes on the frontier between the core distribution activity and other potentially competitive activities (of electricity distribution). One individual contributing factor cannot be placed for outsourcing network-related activities but, nonetheless, the outsourcing has gained popularity in the electricity distribution sector and claimed its place as an optional operations model.

Outsourcing has been applied to most of the network-related activities but the requirements for utilising service markets are different for various network-related activities. For example, network construction is often one of the early outsourcing objects because the complexity of transferring the activity to a service provider is low and available service market supply rarely poses problems. For activities in which the strategic value is emphasised, such as network planning, the availability of qualified external resources can be challenging, and also, the risks in outsourcing are high. The evaluation of the activities’ risk positioning for outsourcing potential is not static by nature. This chapter first discusses the value chain for network-related activities. Then, the impact of emphasised quality in electricity distribution and the resulting regulations for network construction is examined. For instance, as the quality requirements in economic regulation are growing stronger, providing for quality improving measures will change the expectations placed upon activities, and consequently, the management of the outsourcing process will also be affected. The impact of regulation is further extended to the related activities on account of strong interdependencies between the network-related activities. Finally, experiences from outsourcing in the Finnish electricity distribution sector are presented to give an indication of the present state of outsourcing.
4.1. Value chain for network-related activities

The electricity distribution services are concerned with activities needed to deliver electricity to end-customers, that is, network planning and construction, network operation and maintenance, metering the delivered energy and the condition of the network, and finally, customer service for matters of customer connection and billing, as shown in Figure 4-1. In order to guarantee the short-term and long-term availability of the services, network companies are expected to develop and maintain their networks in accordance with societies’ needs for a desired quality at reasonable costs.

The basis for every network-related activity in electricity distribution is network planning. Network development strategies or long-term planning are used to define the network development and timetables for network investments. The service life for network components typically spans up to 50 years, placing expectations on decisions on how the networks will meet the future needs. The nature of the other network planning activities is more functional; network design typically involves parts of the network operating area, field planning of a particular line section and construction design related to specific network structures. The development of the distribution network aims at meeting new network requirements or rebuilding parts of the network that are becoming obsolete. Electricity networks are constructed according to these network design and development plans.

Figure 4-1. Electricity network-related activities (*billing, contracts, connection agreements, **fault contact centre, voltage quality issues).
Network construction consists of building overhead or cable networks and other network components. Some companies have a high-voltage network for which they are responsible in their operating areas. These regional networks (110 kV) require different kind of knowledge and are therefore considered separately from distribution networks. Similarly, the construction of a substation also requires skills that are not frequently employed. Finally, warehousing and logistics are related to the supply of network construction material. Distribution companies may have an interest to store some critical network components for the security of supply purposes.

Operating the electricity distribution network consists of monitoring and operating the network from a central control room, both in everyday operation and in fault situations. Maintenance and fault repair operations, instead, are labour-intensive. Condition inspections are included in the operation and maintenance activity as they provide critical information from the network assets and are therefore needed especially for preventive maintenance. Condition inspections require manual labour whereas condition monitoring is here included in the metering activity. Condition monitoring measures the condition of network components mainly for the purposes of maintenance which, in turn, can be used as a basis for network rebuilding decisions.

Currently, the mass-replacement of energy meters to automatically-read smart meters is a large undertaking concerning the electricity distribution sector. The focal task for energy metering still remains the same – providing energy usage data for the end-customers for billing, but data are also provided to all the necessary market participants; electricity sellers, customers and authorities, and for balance settlement. Customer service is the interface between the distribution companies and end-customers where two distinct aspects can be distinguished; technical customer service is often related to customer’s connection such as supply interruptions or voltage quality, whereas commercial customer service is associated with issues such as billing or connection agreement.

4.1.1. Dependencies between activities

The value chain characteristics of electricity distribution signify strong interdependencies between the network-related activities. The main concern is that activities need information
from other activities in order to be carried out. When deciding for underground cabling, the routing for the network is determined in the network planning activity, which therefore contributes to whether or not ploughing can be used. Therefore, high interdependencies can result in hidden cost for the activities that remain in the organisation.

Several network activities employ the information provided by the system output. The information needs in carrying out activities are relevant for both normal operation and fault situations, and are often managed by focal information systems. The information systems are highly connected, and designed to cater the electricity distribution value chain. Outsourcing parts of this process can disrupt the information system dependencies as they are not designed to cater the needs of single activities. Furthermore, the strong interdependencies between activities may be informal by nature. The information provided by electricians working with the networks or information gathered from other interest groups is often difficult to record. The critical information flows may expand outside the electricity distribution value chain: interest groups must be contacted for issues such as safety, municipal planning, land use, environment and regulation issues, particularly in the network planning stages. The practices regarding the use of information systems and reporting network-related data in these kinds of situations vary between the companies to some degree. Securing the information flows in outsourcing is therefore problematic.

3 Network information system (NIS) is used in network design, construction and maintenance activities, and is therefore central for the business. Supervisory, control and data acquisition system SCADA provides information from network current state for the use of distribution management system DMS, and both systems are used for operating the networks. Customer information system (CIS) is used for customer relations management and billing. In addition, companies may employ financial management systems, personnel information systems and material management systems.
4.1.2. Recognising changes in the competitive environment of activities

The position of the network-related activities in the electricity distribution value chain can be affected by external driving forces. For the purposes of considering outsourcing network-related activities in the electricity distribution business, the effects of the emergent driving forces for quality regulation can further be explored at an activity level. On account of unique characteristics of activities, the drivers in the electricity distribution business environment have a divergent impact on them.

The impact of external drivers can be portrayed by a framework by Barney (1986) where firms face three competitive stages over time. According to the framework, industries begin as a result of revolutions in markets or technologies, consumer demands or other attributes (Schumpeterian revolution). The revolutionary change defines the character of competition in an industry by defining the technological and market bases for competition, the organisational resources and assets that are strategically valuable and those that are irrelevant. Because revolutions are imperfectly anticipated by the firms, the revolution defines which of the organisation’s abilities and assets are valuable and, in turn, which are no longer valuable. The firms that possess valuable skills and assets may retain their advantage for some period, and thrive. After this, the following two stages of competition become more relevant; competition defined either by resources available to firms or the structure of the industry. The resource-based stage focuses on the unique assets and capabilities of individual firms (Chamberlinian economies), while in the industrial organisation competition (IO) the return to the firms is determined by the structure of the industry, that is, barriers to entry, the degree of product differentiation, elasticity of demand, and number and relative size of the firms.

Electricity distribution has traditionally been considered to be a mature business where the focus is on cost efficiency – this competitive stage of the business predominantly resembles IO competition. Some of the activities in the electricity distribution value chain are currently experiencing changes that can be expected to impact their competitive environment. These activities are considered to be in a revolutionary state of competition, where new actors are entering the markets and there is subsequent redistribution of the markets. For example, increasing rate of underground cabling can induce a revolutionary change in network
construction for certain network areas. For the electricity distribution business, economic regulation is one of the important driving forces in the competitive environment. Because of the strong interdependencies in the network-related activities, the changing competitive environment in network construction is further witnessed in related activities such as network design, operation, maintenance and fault repair. Further, network construction is a widely outsourced activity – the effects of revolutionary changes are not limited to the regulated network business but the service provider markets will have to accommodate revolutionary forces.

4.1.3. Network construction

In electricity network construction, competition has been characterised as structural for some time already. However, the situation has recently begun to change as traditional overhead lines are increasingly being replaced by underground cables. The ongoing and emerging changes do not always result in a revolution in the competitive environment. Instead, in many sites, cabling is already well established. In order for revolutionary competition to emerge, the following criteria have to be met: 1) there is a significant increase in the volumes of cable network construction, 2) new construction technology is utilised in putting the cables underground, and 3) cable networks are constructed in areas where there is no previous experience regarding the said activity (i.e. in rural areas with a radial network topology). As a result, the competitive environment in this particular activity has changed from structural into revolutionary, as illustrated in Figure 4-2.
Recognising a change in the activity level is crucial in order to be able to respond to it. As Prahalad and Hamel (1990) point out, core competencies are built through a process of continuous improvement and enhancement. Therefore, as the competitive state of an activity changes, companies without strategically valuable skills must either acquire them or face shortcoming in the business environment, and most importantly in the regulatory game. In time, the shift in the competitive state will return to structural for network construction and the distribution company will either acquire the required skills for themselves permanently or transfer to purchasing services from competitive markets.

4.2. Experiences on outsourcing

The use of outsourcing or purchasing services in the Finnish electricity distribution sector has become a common approach. As can be seen from Figure 4-3, there are two points of elevated activity in the numbers of new cases of service purchasing in the Finnish electricity distribution sector: The first one overlaps the electricity market reform in 1995. Although the deregulation did not expose the network sector to competitive forces, the unbundling turned the focus on the electricity distribution network business. The owners’ increased awareness of the value of the network assets resulted in reorganisation of the network-related activities, and the increased
utilisation of the service in the competitive markets. Furthermore, economic regulation allowed
the owners to expect profitable business within the economic regulation framework by seeking
efficiency improvements. In the turn of the 2000, economic regulation began to take effect and
focused on cost efficiency. Moreover, as companies were making ownership and other
restructuring decisions at an industry level, opportunities to introduce new operations models
emerged. By examining the dependencies of the electricity market events and outsourcing
initiatives, outsourcing can be described as a method to respond to external driving forces in the
sector.

![Number of new outsourcing cases in the Finnish electricity distribution sector (Aminoff et al. 2009).](image)

Figure 4-3. Number of new outsourcing cases in the Finnish electricity distribution sector (Aminoff et al. 2009).

After deciding to use the external markets, the next step for a network company is to define the
method by which services are to be purchased. For the Finnish electricity distribution network
companies, unbundling activities and transforming them into independent business units can be
described as a typical way to implement outsourcing (Aminoff et al. 2009). In this kind of
incomplete outsourcing, network companies retain some control over their service providers,
for instance, through shared ownership.
4.2.1. Present state

Table 4-1 categorises the principal modes of operation in network-related activities in the Finnish electricity distribution sector.

Table 4-1. Principal mode of operation\(^4\) in electricity-network-related activities in Finland (Aminoff et al. 2009).

<table>
<thead>
<tr>
<th>In-house activities</th>
<th>Activities acquired from business unit within organisation</th>
<th>Outsourced activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network development strategies</td>
<td>Condition inspections</td>
<td>Regional network contracting</td>
</tr>
<tr>
<td>Network design</td>
<td>Commercial customer service</td>
<td>Constructing overhead line</td>
</tr>
<tr>
<td>Field planning</td>
<td></td>
<td>Constructing cable line</td>
</tr>
<tr>
<td>Construction planning</td>
<td></td>
<td>Substation constructing</td>
</tr>
<tr>
<td>Control room activities</td>
<td></td>
<td>Storage and logistics</td>
</tr>
<tr>
<td>Technical customer services</td>
<td></td>
<td>Fault repair</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMR and databases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy meter rollouts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Balance settlement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Condition monitoring</td>
</tr>
</tbody>
</table>

Outsourcing has typically been initiated in network-construction-related activities, followed later by other services, such as the operation and maintenance of the networks. Acquiring these services is generally considered non-complex and there is an opportunity to reacquire them. Activities concerning network planning are commonly considered core activities for network companies; in particular, network development strategies are seldom outsourced. In fact, the network strategy is considered to be an activity that cannot be outsourced. Companies often employ several methods when performing activities.

\(^4\) Mode of operation is considered principal if over 50% of the activity is carried out in the aforementioned manner.
4.2.2. Expectations

From the distribution company perspective, the most important benefits of outsourcing were considered to be access to augmented staff, increased focus on core functions, cost savings and access to the best practices. Figure 4-4 illustrates the assessments of expected benefits in outsourcing network-related activities. The service providers were asked to assess the issue from the electricity distribution business point of view. The two viewpoints differ in the respect that the service providers did not emphasise the importance of augmented staff as much as the distribution companies. On the other hand, the service providers felt that their services helped more in reducing fixed costs and reduced the number of negotiations and negotiation partners.

Figure 4-4. Expected benefits from service purchasing and their significance (Aminoff et al. 2009).

Ali-Yrkkö (2006) obtained similar findings in the Finnish manufacturing industry and other private sector companies. Outsourcing motives in the survey were: acquiring additional capacity and knowledge, increased flexibility, cost savings and focusing were the most common motives for outsourcing. The congruent results of the Aminoff et al. (2009) and Ali-Yrkkö (2006) are that the companies’ primary motivation for outsourcing is to increase resources without having
to invest themselves and one of the most popular driver for outsourcing, the cost savings, are only the third important factor.

Figure 4-5 illustrates the assessments of expected risks in outsourcing network-related activities. The distribution companies found that the most important risks were: the number of service providers can be too small for real competition to emerge, cost savings may remain unrealised, information systems do not support service purchasing, and the relations between the orderer and the supplier may be poor.

Figure 4-5. Expected risks from service purchasing and their significance (Aminoff et al. 2009).
For service markets limited in size, the lack of competition is a concern. Owing to the geographically-bound nature of certain network-related activities, such as fault repair, the issue of availability of service providers will always be crucial. For the electricity distribution industry, an interesting characteristic is that functioning service markets do not necessarily exist at the start, but rather, markets have to be created by active participation of the network companies. However, the market size can limit the market sustainability. The risk of unrealised cost savings can materialise if the activity continues to bear hidden cost in the organisation on account of for instance close information flows between the core activities and the outsourced activity. In electricity distribution, information systems play an important role in providing more efficient network design and operation, and therefore distribution companies are concerned about their role in providing necessary linkages between outsourced activities. Incompatibility of information systems represents a challenge for service purchasing; the problem concerns mainly the closed interfaces and may constrain efficient service purchasing. From the service provider viewpoint, the risk related to information systems is not as important.

4.2.3. Outsourcing results

Experiences from purchasing network-related services in the Finnish electricity distribution sector have been positive both in achievement of goals set for service purchasing as well as satisfaction in the purchasing process. Aminoff et al. (2009) found that the method of implementation is related to perceived success in outsourcing, see Table 4-2.

Table 4-2. Satisfaction in outsourcing network-related services (Aminoff et al. 2009).

<table>
<thead>
<tr>
<th>Services acquired from independent service provider</th>
<th>Extremely satisfied</th>
<th>Satisfied</th>
<th>Neutral</th>
<th>Unsatisfied</th>
<th>Extremely unsatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services acquired from business unit within organisation</td>
<td>-</td>
<td>62 %</td>
<td>38 %</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Respondents acquiring services from a business unit within the organisation were less pleased with their experiences. None were, however, dissatisfied unlike with using an independent
service provider. From this, it would be easy to conclude that service procurement from an independent service provider would be preferred, but active participation from distribution companies in service provider operation is seen as a way to secure for instance the information needed by the core competencies.

One requisite for successful outsourcing is that there are enough qualified service providers, among which the network company may choose its supplier. However, some Finnish electricity distribution network companies have started service purchasing even though they have received a tender from only one qualified supplier. Therefore, having to rely on limited market offerings has not affected the achievement of goals, which have been reached during the first three years of service purchasing. The achievement of goals of service purchasing in relation to the number of qualified service providers at the start of the process is illustrated in Table 4-3.

Table 4-3. Achievement of goals of service purchasing in relation to the number of qualified service providers at the launch of service purchasing (Aminoff et al. 2009).

<table>
<thead>
<tr>
<th>Number of service providers at the start</th>
<th>1</th>
<th>≥ 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals were reached during the first three years</td>
<td>25 %</td>
<td>67 %</td>
</tr>
<tr>
<td>Goals have not been reached at all</td>
<td>3 %</td>
<td>5 %</td>
</tr>
</tbody>
</table>

The experiences from network companies provided only some indication of unsuccessful service procurements. Setbacks were mostly regarded as hindrances typical of the early stages of operation or lack of experience and knowledge on outsourcing. The good achievement of goals may also be explained by the objective of outsourcing. Augmented staff may be more easily attained whereas improvements in network operation take more time and effort.

4.2.4. Future development steps

The outsourcing experiences suggest that the maturity of the service provision in the Finnish electricity distribution industry does not necessarily represent advanced stages. However,
outsourcing is expected to increase significantly in the future. The increase is currently focusing on expanding the volume of service purchasing, not as much on new openings for purchasing services. Presenting more extensive entities for tendering has also been seen to advance as an operations model. One of the next expected developments in service procurement are expanding the boundaries in service provision, that is, the use of independent service providers is expected to increase, see Figure 4-6.

![Expected development of service purchasing in activities purchased mainly from independent service providers from the present situation to year 2015 (Aminoff et al. 2009).](image)

Figure 4-6. Expected development of service purchasing in activities purchased mainly from independent service providers from the present situation to year 2015 (Aminoff et al. 2009).

A growing proportion of the network-related activities is expected to be produced by the service markets, construction of cable lines being among them. For this reason, the distribution companies have to consider how the regulatory risks impact the outsourcing, and what are the methods to respond to the regulatory risk through orderer-supplier relationship.
4.3. Outsourcing cabling in rural areas

Because the electricity network construction activity is in the state of revolution owing to the conversion from overhead lines to underground cable networks, a relevant question is also whether a network company is willing to invest in building new capabilities and resources to continue performing the construction activity in-house. An alternative is to utilise the market option to acquire the needed construction works, shifting the focus of competencies from network construction to purchasing services. Experiences of outsourcing rural cabling as the primary method of construction are not covered in the experiences discussed above. The frequently outsourced activities such as constructing overhead lines have quite established practices whereas rural underground cabling is a novel approach to network construction when executed on a full scale. Therefore, the essential question in rural cabling is not the availability of augmented staff but the relevant capabilities.

For the outsourcing process, the major uncertainty is related to the lack of reference; neither distribution companies nor the specialised service providers have yet taken on extensive cabling projects in rural areas which means that companies contemplating to outsource cabling are not capable of comparing their own cost of performing the activity with that of the service provider. Distribution companies are often insufficiently aware of the cost of performing existing activities (Aminoff et al. 2009), which may hinder new undertaking such as cabling. Establishing cost savings may not therefore be the primary motive in outsourcing. For the service markets, the lack of reference means also that the market offering is less developed. The capabilities and resources for constructing overhead networks is readily available but the rural cabling experience is cumulated to few individual, specialised operators. Furthermore, the required capabilities are not limited to ploughing – most likely, special soil conditions require adaptation of experience on cable line excavation.

The basic nature of the services provided remains the same as both overhead and cable construction are performed seasonally with the emphasis on labour. The maturity for the overhead line construction services has led to spot transactions whereas the status for rural cabling is more complex and strategically important, which may initiate close supplier relationships. The cabling concept that is developed in the empirical part of the thesis provides
an example how to respond to increasing reliability requirements in economic regulation by combining network planning, construction and maintenance and fault repair into a concept that employs specialised service providers. The logic is that bundling of activities may attract specialised suppliers to rural areas for stable revenue, so that distribution companies gain access to the best practices rather than develop capabilities themselves. The risks of outsourcing rural cabling are discussed in more detail in the following section.

4.4. Expanding the focus of reorganisation

One of the options for distribution companies to reorient their activities is diversification. According to Parker (2003), the regulated companies have capitalised the growing knowledge over the regulated activities to seek competitive advantage in another regulated business areas, or, diversified into non-regulated but related activities. This has been the result of developed core competencies in regulatory knowledge. However, a more conservative reorganisation strategy is to exploit operational synergies of network activities in other infrastructure industries, such as district heating, water and sewerage, telecommunications or gas. Hosein (1999) sees multi-utility approaches as a result of rebundling of vertically unbundled operation in gas, electricity and water industries. For instance, in the U.K., the electricity industry witnessed a growing interest in a broadened business portfolio as a result of the electricity market reform (Openshaw 2003). However, the early experiences have not proven to be successful (Ghobadian and Viney 2002). In Finland, the multi-utility approach has been believed to take off, but so far, the experiences of combining some aspects of electricity, district heating and water and sewerage activities have not sought growth but efficient working models within limited areas.

4.5. Conclusions on outsourcing in the Finnish electricity distribution sector

Most commonly outsourced activities in the Finnish electricity distribution sector include network construction, maintenance and metering activities. Activities such as network development strategies or network design are often considered core competencies for electricity distribution. These activities are considered to possess information flows valuable to the operation of network business, and they should therefore be kept in-house. The focus on core
competencies along with an access to additional resources, better management of cost and improved cost efficiency are often named as important goals of outsourcing. The number and scale of outsourcing is expected to grow, which puts strain on the management of the outsourcing process. This chapter discussed the changes in the competitive positioning of network construction as a result of strong industry drivers mainly concerning quality regulation. Recognising activity-level changes is crucial because they indicate revolutionary changes that require a response if a distribution company wants to succeed in the regulatory framework. Changes that have made underground cabling a potential method for network construction in rural network areas can be considered revolutionary.

For the Finnish electricity distribution business, the buyer is in many instances the initiator in creating a supplier who is able to meet the expectations. The relationship between the buyer and the supplier remains close, and a common risk is that the organisation continues to bear hidden costs. In other words, the organisation is unable to get rid of all the costs originating from performing the activity in-house. In the electricity distribution network sector, a significant source of concern is also that the service markets do not develop as expected. This means that there may not be enough service providers from which the network companies can choose their suppliers, or that the service providers are unable to meet the expectations of the network companies. The experiences of using the external markets as a method to respond to the operating environment changes have been positive. The goals set for outsourcing have been achieved despite unfavourable initial circumstances. The past success does not reduce the fact that there are risks involved in outsourcing services and responding to operation environment challenges, particularly as outsourcing is expected to increase. However, as the distribution companies face the need for network development, employing specialised services providers in underground cabling of rural networks provides an alternative response.
5. Responding to regulatory risks: management concept for rural underground cabling

The changes in the competitive setting of electricity distribution construction are characterised by elements of revolution. Because of the strong interdependencies found in the electricity distribution, changes are not limited to the affected activity; as network construction is in a state of revolution and the network company chooses to proceed according to the prevailing driving forces, the effects are realised also in the supporting functions. Transition to higher volumes of underground cabling in rural electricity distribution networks will have significant ramifications to the regulatory risk experienced by distribution companies, not merely as an increase in network reliability but also as an increase in sunk costs. The initial investment costs will be high and the ability to accommodate changes in the network topology is weaker compared with some other network development methods. Also, fault repair costs are typically higher. In order to dilute the negative effects while obtaining a competitive advantage in the regulatory framework, there is a rationale for employing a comprehensive approach when responding to the revolutionary changes in rural network construction.

The distribution companies have a variety of tools available to respond to upcoming challenges, and the choice is often a matter of employing a combination of available capabilities and resources. The purpose of this chapter is to introduce a management method for underground cabling in rural electricity distribution networks by employing specialised service providers. First, the strategic importance of rural cabling-related activities is presented, secondly, the risk sources for outsourcing cabling-related activities in rural network conditions are discussed, and finally, a management concept for regulatory risk is introduced.

5.1. Transition to full-scale cabling

The future development in underground cabling will eventually expand the focus of undergrounding to semi-rural and rural areas in order for distribution companies to prevent the impacts of supply interruptions, large disturbances and the resulting regulatory risk. The combination of increased cabling and new cabling environment requires skills that in many
respects are not yet fully employed in the electricity network sector. Especially, planning of rural networks requires a specific planning approach; one of the most important factors being that it ultimately enables networks to be constructed efficiently. The construction methods that are used in underground cabling are also of importance. Not only does ploughing greatly define the cost of construction but also the quality of cables, which translates into maintenance and fault repair costs. Maintenance and condition monitoring for cable networks are always important on account of difficult access to cables and long repair times. For sparsely populated areas instead, radial underground cable networks require a different kind of approach in maintenance. Therefore, enforcing underground cabling as a primary means of replacing and extending a distribution network will require new approaches in network planning, construction, maintenance and fault repair activities as illustrated in Figure 5-1. The three activities constitute an entity where interdependencies between information and resource management are high, and therefore require close interaction.
Figure 5-1. Linkages between activities in underground cabling.

In order to facilitate successful reorientation of business, distribution companies will have to assess what kinds of skills and resources are required in the new operating environment: How do the network planning practices change when underground cabling replaces overhead lines? What is the most efficient way of laying cables underground? What kind of maintenance and fault repair concepts are needed to minimise electricity supply interruptions in radial underground cable networks? And finally, what kind of allocation between supplier and in-house performance would be appropriate for particular activities?
5.2. Strategic importance of activities

When considering outsourcing of network-related activities, two distinct properties are of relevance; the strategic importance of an activity and the transferability of the resources related to the activity. Strategic importance refers to the activity’s contribution to the terms of core competencies. In particular, strategic importance expresses the unique features of the activity for long-term business development. Transferability of function is, in turn, determined by the technical complexity of transferring the activity to a service provider and the activity’s interdependencies with other activities and with core activities in particular. The transferability is also affected by the maturity of service markets, which is specified as the number of service providers and their capabilities. Figure 5-2 illustrates an analysis of resources related to cabling. The activities are positioned based on a synthesis of research data; however, the valuation of the strategic importance of activities has subjective variations and, therefore, the figure involves the researcher’s own interpretation.

![Figure 5-2. Resource analysis of activities related to planning, construction, maintenance and fault repair in cable networks.](image)
Activities such as network development strategies and network design are considered to be strategically highly important. These activities frequently employ critical information from other activities to plan extension and replacement investments, which often can be quite complex. The network development strategies are core competencies as they require decision making that has long-lasting ramifications in a asset-driven business. The strategic importance of network design is categorised to be lower than that of the network development strategies; nevertheless, its strategic relevance is great as it provides access to the operational level of activities. Thus, network design is a core-close activity. The positioning of field planning is not as unambiguous: the activity is relatively straightforward but can prove decisive for carrying out ploughing.

Activities related to network construction are typically categorised strategically low. Work planning, storage and logistics are closely bundled to other construction activities, such as excavation work, electrical connections work and commissioning inspections. There is plenty of experience on outsourcing network construction, and the market offering is good, which would suggest that complexity of transaction is low. Commissioning inspections are categorised to be more complex and strategically important than other construction activities because of the pronounced quality of cable networks as well as required capabilities and coordination with other activities.

The activities in network operation are typically company specific and require the use of companies’ own information systems, which results in complexity of transactions. An activity such as fault situation management is critical because the faults have to be isolated and restored, located and repaired as quickly as possible in order to avoid interruption costs from accumulating. Transferring these activities to a service provider is complex, but nonetheless, network companies have been able to procure these services. Spare part management in fault situations is relatively easy to carry out but the timely delivery can cause logistical problems. To avoid interruptions, reserve power may also be employed (e.g. by spare cables or aggregates). Maintenance activities provide valuable information on network assets and are hence strategically important. However, performing maintenance tasks, commissioning inspections and preventive maintenance is considered be less complex than the network design activity for instance in Figure 5-2.
5.3. Risks for outsourcing cabling

Recognition of the revolutionary state of competition in network construction that has originated from replacement of overhead lines by underground cables provides an opportunity to utilise the available service provider capabilities and resources in obtaining an advantage in the regulatory framework. Although the experiences from outsourcing various network-related activities have been mainly positive for the Finnish distribution companies, the transition to outsourcing of full-scale cabling involves management of additional risks. Even though the design concept and working methods for network construction may change, strong interdependencies between the activities in network construction will continue to have a bearing in electricity distribution operation. A comprehensive approach in outsourcing considers aspects related to the distribution companies’ in-house operations, management of the outsourcing relationship and the service provider’s performance. The following discusses aspects of outsourcing underground cabling activities that have been identified as major risk sources during this research. The risks have been categorised under service market functioning, efforts in outsourcing organisation, and finally, the economic regulation.

5.3.1. Service market functioning

The first criterion for successful outsourcing is the existence of functioning service markets. Distribution companies have been able to provide market supply by outsourcing activities and the related resources, and they have relied on the service market offering when they have started the outsourcing, sometimes with as few as one qualified service provider. In rural network areas instead, the distinct capabilities related to cabling may prevent from applying this option. The number of service providers is the key issue for development of functioning service markets in the long-term, but also the service providers will have to be qualified for the current needs of the companies. Particularly for geographically bound activities, such as excavation work or fault repair, the service provider capabilities regarding local terrain knowledge or efficient working methods, for instance, are key aspects in field planning or efficient use of ploughing. Economies of scale are emphasised for the larger service providers but, on the other hand, small service providers may be able to produce local resources where the volumes of purchased activities are small.
If there is lack of capable service providers, companies may become dependent on a single supplier, or competition does not drive service providers to develop operation, and the buyer is not able to benefit from the best practices in the industry. Distorted competition may also be a result of close relationships with the service providers, that is, the distribution companies’ existing or past ownership in the service provider companies. According to Aminoff et al. (2009), distribution companies have actively made efforts to reduce ownership in the service business, by encouraging suppliers to expand their operating area and by tailoring their tenders to enable more market offering. The companies’ individual volumes are not sufficient to sustain viable service markets over long periods of time especially in rural areas, and for an activity that requires a novel approach, the maturity of markets is more difficult to obtain. Therefore, changing supply market conditions have an impact on the level of risk exposure of a single activity.

5.3.2. Own organisation

Outsourcing requires a lot of effort from the purchasing party, most essentially purchasing competence. An important precondition for successful outsourcing is detailed definition of the service, that is, productisation of purchased services. It involves a process description that is produced by allocating resources to service providers, defining the required level of performance and related information streams. As productisation is completed, the distribution company is aware of the impacts of outsourcing on its operation. Otherwise, there is a risk of outsourcing critical information or even core competencies. According to Kakabadse and Kakabadse (2000), the business risk in relation to outsourcing is particularly concerned with the ability to reverse the outsourcing decisions if necessary. When entering into a new network development strategy, insourcing inevitably becomes less straightforward. The productisation of the service can limit the risk of rural cabling. Specification of the services by a third party has in many instances created a good starting ground for negotiations, as indicated by Samdal et al. (2009). Detailed definition of services applies as the distribution companies have gradually expanded their outsourcing focus from individual purchases to entities of services.

One significant aspect of outsourcing is the cost of performing the activities. The costs of entering into full-scale cabling and transferring services outside the boundaries of the
distribution company are to some degree uncertain as there is no pre-existing information on activity-based cost accounting. This also applies to quality criteria as it will have more profound and versatile importance, compared with more cost-driven criteria for outsourcing of overhead lines, for instance. Once the decision to outsource is made, a relevant system is built to follow up quality and cost performance indicators, and, subsequently, to manage the outsourcing relationship. These must be drafted in a contract to cover all aspects of cabling ranging from the quality of cables, the quality in cabling and maintenance of the network. On the other hand, too rigorous an agreement hinders the service provider from creating innovations and decreases the efficiency. After all, one of the main reasons for service purchasing is the supplier’s capability to produce the service better than the distribution company. Therefore, joint development plans would provide access to service provider operation, and help to secure critical information from the network.

5.3.3. Economic regulation

An important aspect of regulation is that it is continuously evolving to meet the current drivers for industry goals. Therefore, it is important for the distribution companies to learn how to manage their businesses within the regulatory framework. The relationship between economic regulation and its consequences upon the management of purchasing services has not been a relevant issue as the companies are free to reorganise their businesses. As for the choice in network development, the commitment in using full-scale cabling is also to be weighted. The current regulatory framework has good incentives for quality improving investments, which for rural cabling can imply replacement investments. Ultimately, the management of the regulatory risk is the sole responsibility of the distribution company even though it can be influenced in a controlled manner through contractual procedures to service providers. Purchased services are a cost item that for regulatory benefit should be carried out in a more efficient manner than in-house.

The impact of economic regulation can, in time, reflect to the outsourcing relationship. Combining the use of service purchasing with the regulatory framework may lead to redefinition of the strategy in parallel with the regulatory review cycle. If the incentives are dramatically altered during the regulatory review, the financial input made by the company in
purchasing services will be endangered. On the other hand, if the outsourcing relationship is successful, remaining in contract with the same service provider can bring continuous improvement in quality and cost. For instance, the connection between good performance in efficiency benchmarking studies and service purchasing is not straightforward. Chanel (2008) suggests that the highest-performing distribution companies tend to outsource network-related activities, but on the other hand, they most likely have better capabilities to do so.

A general assumption in outsourcing is that the quality produced is improved in hands of the service provider. The capabilities for rural cabling activity are specific and in order to employ the resources efficiently, service providers are presumably in a favourable position to develop methods, capabilities and equipment within the economies of scale and scope. If a service provider is able to guarantee the level of quality in the network construction and network operation, the decision to use a service provider will be easier as the regulatory risk will be distributed. Quality assurance from the service provider would require a reliable installation technique and knowledge on properties of different cable materials and their behaviour in the given environment. Presently, there is little experience on cable durability in the underground cabling of rural areas. Another assumption in outsourcing is that the supplier will deliver the level of service specified in the contract. In practice, downward pressure on prices is exerted through competitive tendering, and so contractors may develop a corresponding incentive to minimise the service delivered (Thomas and Hall 2003). One conclusion is, therefore, that outsourcing of services should lead to introduction of quality, health and safety monitoring systems that monitor activity performance.

5.3.4. Summary of outsourcing risks for cabling services

Outsourcing of underground cabling involves risks that are typical of outsourcing of any network-related activity. Table 5-1 summarises the key risks in outsourcing of underground cabling services in rural network areas. The key risks are determined by assessing the relevancy of risks in Figure 4-5 with factors of rural outsourcing of cabling discussed above.
Table 5-1. Summary of the key risks in outsourcing of underground cabling in rural networks for the distribution company.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing the outsourcing process</td>
<td>Preparation of the outsourced entity and performance criteria, analysing outsourcing alternatives and managing the outsourcing relationship</td>
</tr>
<tr>
<td>Loss of core competence</td>
<td>Moving to a new network development strategy that is performed by a service provider may lead to the loss of core competence</td>
</tr>
<tr>
<td>Critical information flows break</td>
<td>Distribution company may lose critical information from network activities by employing a service provider</td>
</tr>
<tr>
<td>Service market functioning</td>
<td>Distribution companies have been able to create service supply locally but the long-term availability of capable service providers for a comprehensive approach in cabling may become an issue</td>
</tr>
</tbody>
</table>
| Quality of cabling                        | • The expected network component lifetimes are unknown for rural network conditions  
• Installation has a significant impact on the cost of cabling and the expected lifetimes of the network components                                   |
| Fault situation management               | New practices required for fault situation management in cabled networks                                                                                                                                     |
| Unrealised cost savings                  | Experiences of full-scale underground cabling in rural areas are few – insufficient knowledge over own cost of undergrounding in-house                                                                            |

A means for distribution company to influence service market functioning is to increase tendering, but also communicating the requirements for the services has been seen as an important stimulus for competition. A shift from internal outsourcing to the use of independent service providers is also believed to improve service market functioning. One expected outcome for outsourcing is to obtain a similar level of service regardless of the sourcing option. This is reached by clearly defining the processes and the resources attached to them; the content of activity, the required human and equipment resources and information flows. Not all activities can be outsourced, but a combination of a service provider and in-house-performed activities enables the option with the lowest total cost and the highest value contribution. The ability to plan activities in such a way that will both enable efficient use of resources and improved quality of services would benefit in responding to the regulatory risk. Network companies are not familiar with the full potentials or disadvantages of ploughing, which can delay the
implementation of the new technology. If a service provider is able to guarantee the level of quality in the network construction and operation, the risk of contracting out cabling in rural areas is alleviated.

5.4. Concept for cabling activities

The utilisation of outsourcing in underground cabling of rural networks means that the companies do not need to engage themselves in the new technology and working methods, but they can focus on their core activities and managing the outsourcing process. The analysis of the required resources and competencies is divided into four segments. Firstly, in order to fully understand the nature of the operation, the content is defined together with the human and equipment resources needed for implementation of the operation. Secondly, the information needed to perform the operation and the information produced by the operation are determined along with the operation producing it. The linkages between the activities can be strong, and for this reason, the connections between the operations are crucial to acknowledge. For instance, fault repair in cable networks benefits from the necessary maintenance wells designed in network planning, and network maintenance may become easier as a result of well-constructed and inspected cable networks. Against this, when considering what kind of operations model the company should employ, the main question is, does the operation represent the characteristics of a core operation. Some of operations are fully manageable by a service provider, whereas others require special attention from the network companies or are even inaccessible from the supplier. An opportunity to acquire services from the service market to a particular operation is one of the key elements in this consideration. Also the agreement type for each operation and the basis for billing are given. All of the activities, that is, planning, construction, maintenance and repair, substantially benefit from the support of one another, and the nature of the activities requires linkages to other activities, but can naturally also be performed individually.
5.4.1. Planning

For the purposes of an underground cabling management concept for rural areas, network planning is a crucial activity. Cable network design requires thorough consideration for instance to take into account the more complex nature of fault locating and repair. The process for a cabling concept starts by selecting the strategy for cabling; different solutions to carry out cabling have varying effects on the quality of supply depending on the order in which the cabling is performed. For instance, the end-customers can expect quick improvements in supply reliability if cabling is initiated from the substation end of the line. Cabling starting from the oldest part of the network or from the part that is most susceptible to interruptions are also both effective cabling strategies, but the speed and the level of reliability are not as good as when starting the cabling from the substation end. Eventually, strategies aiming at full-scale cable networks will improve network reliability and protect against the risk of large disturbances. The use of overhead lines and covered conductors will be marginal for the cabling management concept, but some overhead construction competence is required as it is not possible to completely switch to cables instantly.

Experience on rural cable network planning is not very common, and configurations other than those used in urban areas, such as pole-mounted distribution substations installed at the pole foot, medium-voltage cable distribution cabinets, medium-voltage ring main units, and light distribution substations are needed for the best results. A new branch line requires special switchgear; ring main units or branching from the distribution substation at the medium-voltage level, whereas in the low-voltage network, a cable distribution cabinet is needed. As the undergrounding rate and the load density in parts of rural areas are increasing, the network structural solutions approach urban network structures, such as distribution substation solutions.

The cable networks are more rigid compared with overhead networks; however, the distribution companies’ prospects to influence load relocations in network planning are limited. In this sense, cabling is a tradeoff for better reliability. As a result of cabling, the increase in earth fault currents should be taken into account. Additionally, location and repair of faults can be more difficult than in overhead networks; the nature of fault and maintenance operations requires specific knowledge, thereby posing new challenges for the personnel. Because the repair times are longer in cable networks, auxiliary connections will be important. Rural medium-voltage networks are mainly ring systems, but they are operated as radial systems. Low-voltage
networks are constructed and operated as radial systems because of the long distances between end-customers. In overhead networks, the manual circuit breakers are located at the beginning of the line and in ring networks so that a possible fault can be isolated.

Table 5-2 presents the operational principle for managing regulatory risks in cabling in rural areas. The principle includes description of the content of activity, the input and output information of the activity, the preferred operations model and the type of agreement and billing.
<table>
<thead>
<tr>
<th>Content of activity</th>
<th>Input and output information</th>
<th>Operations model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Network development strategies</strong></td>
<td>Planning and developing MV networks and substations. Investments and their impact on return. Comparative estimations of the preferred order of investments, impacts on reliability indices and tariffs.</td>
<td>* Input information: network maintenance, growth estimates, technical development, municipal planning, economic regulation, changes in the operating environment, owner and other stakeholder needs. * Output information: framework for network design (NIS)</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: senior business management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Required tools: business development tool[^5]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* DNO role: active management is required</td>
<td></td>
</tr>
<tr>
<td><strong>Network design</strong></td>
<td>Implementing network development strategies, designing/renewing parts of network on technical and economical basis, land usage issues</td>
<td>* Input: network development strategies, network condition data (age, condition, fault frequencies), load data, electrical tolerance, municipal planning (NIS, CIS, GIS)</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: design engineers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Required tools: NIS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* DNO role: active participation is often required</td>
<td></td>
</tr>
<tr>
<td><strong>Field planning</strong></td>
<td>Planning network routing in terrain, land usage issues</td>
<td>* Input: network development plans, network structures and routes (network planning), terrain information (NIS, GIS, logistics, location of other infra)</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: design engineers, terrain experts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Required tools: soil investigation tool</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* DNO role: active participation is not required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Output: network routing in terrain (location, branches, line extensions, transformers)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Output: activity development and construction plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIS = customer information system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GIS = graphical information system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIS = network information system (including databases and planning tools)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[^5]: An example of business development tool can be found in Lassila (2009).
In Table 5-1, network development strategies are defined as a core operation for the electricity distribution companies. The task of this activity is to make informed decisions about the network development by primarily evaluating the impacts of investment strategies on the regulatory outcome. The activity can, and has been, purchased on a project basis but, however, the final decision-making must be in the hands of the distribution company. Network design would be preferred to be outsourced in the cabling management concept. The reason is that the operator performing the network construction, maintenance and fault repair tasks must be able to influence the aspects of regulatory risk in the orderer-supplier relationship. The capability development of network design will most likely shift towards field planning, especially in rural areas. Cable ploughing is an advantageous choice whenever possible, but the technique involves certain soil quality requirements: the quality of cable ploughing depends essentially on the soil and should be carried out carefully. Therefore, defining the routes where ploughing can be utilised is crucial. This kind of expertise often requires knowledge on local circumstances and can be purchased for example from local contractors performing the ploughing. The opportunity to make use of other groups familiar with soil, such as forest management associations, could be further investigated. Another consideration for outsourcing planning activities is that the company can rely on service providers’ existing relationships with other interests groups, such as road administration, for efficient practices in rural cabling.

5.4.2. Construction

Construction of overhead lines has been considered quicker than underground cable lines. European Commission (2003) has estimated that building overhead lines is approximately five times quicker than digging trenches for underground cables. Ploughing of underground cables has changed the situation in favour of cabling; the speed of ploughing is as high as several kilometres per day, depending on the soil. In some cases, building an overhead line can be even slower. This has been the main success factor for ploughing. The difference in cabling speed gives advantage in terms of operational costs as the project times are shorter and less human and equipment resources are required. Nevertheless, the success of ploughing is eventually determined by the quality of cabling.
The expertise required in cable ploughing is considerably different from traditional digging of trenches. Cables are easily damaged at installation, which introduces a risk to the distribution companies, which rely on their networks’ ability to generate revenue for a long time in the future. Therefore, quality assurance in network construction should be addressed in the service contract. Contracting out both network construction and maintenance would be the obvious way for a service provider to be able to offer such a guarantee. It would bring competitive advantage for the service provider because the quality of cable ploughing is one of the main concerns that the network companies face when considering full-scale use of ploughing. For the service provider, it requires a reliable installation technique and knowledge on the properties of different cable materials. There is uncertainty related to the robustness of the cables in the new environment as the condition of ploughed cables has not been verified for long periods of time. Selecting the right type of cable, installation technique and maintenance routine have an effect on the long-term network performance. Table 5-3 presents the operational principle for managing the regulatory risks for network construction. The principle includes the content of activity, the input and output information of the activity, the preferred operations model and the type of agreement and billing.
Table 5-3. Network construction activities in the cabling management concept.

<table>
<thead>
<tr>
<th>Content of activity</th>
<th>Input and output information</th>
<th>Operations model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work planning</strong></td>
<td>* Planning of network structures and the construction execution</td>
<td>* Supplier-performed operation</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: project managers</td>
<td>* Possible to outsource</td>
</tr>
<tr>
<td></td>
<td>* Required tools: project management tools</td>
<td>* Market offering is moderate</td>
</tr>
<tr>
<td></td>
<td>* DNO role: active participation is not required</td>
<td>* Agreements: project-specific</td>
</tr>
<tr>
<td></td>
<td>* Input: network routing information (NIS, field planning), availability of material (logistics,</td>
<td>* Basis for billing: €/h</td>
</tr>
<tr>
<td></td>
<td>stock databases), available manpower (personnel information system) and equipment resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Output: project plan including the designed network structure, component lists and requirements (material management system), working hours for manpower, working hours for special equipment, project status follow-up</td>
<td></td>
</tr>
<tr>
<td><strong>Storage and logistics</strong></td>
<td>* Managing stock and ordering supplies</td>
<td>* Supplier-performed operation</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: purchasing manager, stockmen</td>
<td>* Possible to outsource to firms that are specialised in logistics</td>
</tr>
<tr>
<td></td>
<td>* Required tools: stock database, logistics tools</td>
<td>* Market offering is moderate</td>
</tr>
<tr>
<td></td>
<td>* DNO role: active participation is not required</td>
<td>* Agreements: service agreements</td>
</tr>
<tr>
<td></td>
<td>* Input: component lists and requirements (work planning, status of excavation work)</td>
<td>* Basis for billing: annual invoicing + activity based</td>
</tr>
<tr>
<td></td>
<td>* Output: timetables, work orders, material orders and deliveries (material management system), stock information (excavation work)</td>
<td></td>
</tr>
<tr>
<td><strong>Excavation work</strong></td>
<td>* Digging trenches and burying cables or ploughing cables underground</td>
<td>* Supplier-performed operation</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: ploughing/excavation equipment operators</td>
<td>* Possible to outsource to firms that are specialised in excavation or ploughing</td>
</tr>
<tr>
<td></td>
<td>* Required tools: diggers, ploughing diggers</td>
<td>* Market offering is good but experience on rural ploughing is limited</td>
</tr>
<tr>
<td></td>
<td>* DNO role: active participation is not required</td>
<td>* Agreements: project-specific</td>
</tr>
<tr>
<td></td>
<td>* Input: project plans (work planning), works information, excavation manpower, excavation equipment</td>
<td>* Basis for billing: €/m</td>
</tr>
<tr>
<td></td>
<td>* Output: cable trenches, ploughed networks, network location information (NIS)</td>
<td></td>
</tr>
<tr>
<td><strong>Electrical connection work</strong></td>
<td>* Connecting cable terminals to the related network components</td>
<td>* Supplier-performed operation</td>
</tr>
<tr>
<td></td>
<td>* Required human resources: authorised electricians</td>
<td>* Possible to outsource to individual contractors or firms that are specialised in distribution network operations</td>
</tr>
<tr>
<td></td>
<td>* Required tools: installation tools</td>
<td>* Market offering is good</td>
</tr>
<tr>
<td></td>
<td>* DNO role: active participation is not required</td>
<td>* Agreements: project-specific</td>
</tr>
<tr>
<td></td>
<td>* Input: cable location information (NIS, network planning)</td>
<td>* Basis for billing: €/h</td>
</tr>
<tr>
<td></td>
<td>* Output: operation-ready networks</td>
<td></td>
</tr>
</tbody>
</table>
Table 5-3. Network construction activities in the cabling concept (continued).

<table>
<thead>
<tr>
<th>Content of activity</th>
<th>Input and output information</th>
<th>Operations model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning inspections</td>
<td>· Inspecting the operability and functioning of cable components</td>
<td>· Supplier-performed operation</td>
</tr>
<tr>
<td></td>
<td>· Required human resources: authorised electricians</td>
<td>· Possible to outsource to individual contractors or firms that are specialised in distribution network operations</td>
</tr>
<tr>
<td></td>
<td>· Required tools: insulation resistance meters, echometers</td>
<td>· Market offering is moderate</td>
</tr>
<tr>
<td></td>
<td>· DNO role: active participation is not required, some control of the outcome is required</td>
<td>· Agreements: project-specific</td>
</tr>
<tr>
<td></td>
<td>· Input: information on targets that need to be inspected for service (electrical connections work, work planning)</td>
<td>· Basis for billing: €/target</td>
</tr>
<tr>
<td></td>
<td>· Output: measurement data (NIS), authorisation to energise cables, certificates, warranties</td>
<td></td>
</tr>
</tbody>
</table>

NIS = networks information system (including databases and planning tools)

In Table 5-3, most of the activities are categorised as supplier-performed operations. Competition exists in the network construction service markets which facilitates purchasing of rural cabling construction services. In cable network construction, there is a number of local entrepreneurs who have gained experience in ploughing, but the scale of operation is typically small. Network companies have not yet built an efficient process for cable network construction that would on a larger scale utilise the local subcontractors that have the knowledge on local conditions necessary for successful usage of ploughing. The efficient use of local entrepreneurs that already may have acquired knowledge on ploughing could be incorporated in the cabling concept, which may eventually lead to a new approach to network construction in general. The local contractors usually own their equipment and have expertise on the subject, such as whether ploughing can be employed. The problem is that job assignments are available only for a part of the year. It may be difficult to gain acceptance for an operations model according to which local contractors work only in summer time. Nonetheless, the existing markets in construction provide opportunities for the distribution company or the service provider to make spot acquisitions.

The activities in the management concept for network constriction are selected because they require efficient lead-times. Storage and logistics services are not specific for the electricity distribution and, therefore, may be purchased from a specialised service provider. Service agreements are therefore the most suitable form of agreement. Commissioning inspections on
the other hand involve special capabilities related to cable installations that can be individually purchased, mainly in the form of certificates and warranties. Because of that, the complexity of activities is higher similarly as the strategic importance of the activity. For the other activities, performance-based billing (€/h, €/m) is used as the content and amount of work involved can be sufficiently defined and the status of the activities is expected to remain the same.

5.4.3. Maintenance and fault repair

The purpose of maintenance is to preserve the operating condition of the network and minimise fault repair costs. Cable networks are not subject to weather conditions unlike covered overhead lines and overhead lines, and therefore maintenance and fault repair tasks require a different approach. Nonetheless, investing in maintenance has a definite positive impact on the quality and economic efficiency of cable networks. Once the cable networks have been constructed, the focus will shift more to preventive maintenance because it helps to reduce interruption costs and fault repair costs.

One of the most problematic issues in using underground cables is location and repair of faults. Under normal operating conditions, fault repair in an overhead network costs approximately 1600 €/fault whereas in a cable network the cost for a single fault is 3200 €/fault in more demanding repair conditions (Partanen et al. 2006). Altogether, it can be estimated that cable network maintenance accounts for approximately 100 €/km,a in normal operation taking fault frequencies into consideration (including maintenance and fault repair). Although the fault rates in cable networks are only 10–50 % of those in overhead networks (Lakervi and Partanen 2006), fault repair in cable networks is considerably expensive (approximately double), and in rural areas the repairs take longer because of long distances. For the maintenance activity, this implies that the number of maintenance actions decreases together with the need for work force. This does not, however, reduce the need for local presence and short response times in the case of faults. The need for special equipment and diagnostics skills for locating faults will also play a more important role.
As repair times can become substantial in cable networks, preventing the occurrence of long interruptions is important. In urban areas, cable networks are usually ring connected, which enables back-up feeders from alternative sources. In rural areas, a radial network is more practical because of long distances that can also complicate the use of back-up connections. Building back-up connections would have to be taken into consideration already at planning stages, but alternative ways to restore electricity supply, using ancillary cables or mobile reserve power sources can be employed at any point in time. Both are, however, temporary solutions. Table 5-4 presents the operation principle for managing regulatory risks in rural cabling. The principle includes the content of activity, the input and output information of the activity, preferred operations model and the type of agreement and billing.

Table 5-4. Maintenance and fault repair activities in the cabling management concept.

<table>
<thead>
<tr>
<th>Content of activity</th>
<th>Input and output information</th>
<th>Operations model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preventive maintenance</strong></td>
<td>· Cable and network condition monitoring and measures to ensure operating condition of network components&lt;br&gt;· Required human resources: authorised electricians, diagnostics personnel&lt;br&gt;· Required tools: diagnostics tools, maintenance and diagnostics applications&lt;br&gt;· DNO role: active participation is sometimes required, defines the maintenance strategy</td>
<td>· Input: cable information (NIS, age, type), maintenance programs from network development strategies&lt;br&gt;· Output: report on network component condition, experiences on regular maintenance routines (NIS)</td>
</tr>
<tr>
<td><strong>Spare part management</strong></td>
<td>· Managing network component spare parts for outage situations&lt;br&gt;· Required human resources: purchasing manager, stockmen&lt;br&gt;· Required tools: warehouse equipments, stock database&lt;br&gt;· DNO role: active participation is not required</td>
<td>· Input: prognosis on spare part consumption, current level of spare parts (logistics database)&lt;br&gt;· Output: spare parts (spare cables, aggregates) for fault situations, consumption information on spare parts (material management system)</td>
</tr>
</tbody>
</table>
Table 5-4. Maintenance and fault repair activities in the cabling management concept (2/3 continued).

<table>
<thead>
<tr>
<th>Content of activity</th>
<th>Input and output information</th>
<th>Operations model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fault situation management</strong></td>
<td>· Managing fault situations; arranging fault isolation, fault location, reserve power management and fault repair</td>
<td>· Supplier-performed operation</td>
</tr>
<tr>
<td></td>
<td>· Required human resources: control room operator (authorised electrician)</td>
<td>· Possible to buy from firms that are specialised in network operation services</td>
</tr>
<tr>
<td></td>
<td>· Required tools: DMS</td>
<td>· Market offering is limited</td>
</tr>
<tr>
<td></td>
<td>· DNO role: active participation is required</td>
<td>· Agreements: service-level agreements</td>
</tr>
<tr>
<td></td>
<td>Input: indication of fault (SCADA), network present state (DMS)</td>
<td>· Basis for billing: annual invoicing + €/activity</td>
</tr>
<tr>
<td></td>
<td>Output: fault isolation and restoration, reserve power management. Indication of fault location (work force, customer service), work orders for fault repair (manpower and equipment).</td>
<td></td>
</tr>
<tr>
<td><strong>Fault isolation and restoration</strong></td>
<td>· Supplier-performed operation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Long-distance fault isolation, arranging back-up connections</td>
<td>· Possible to outsource to firms that are specialised in network operation services</td>
</tr>
<tr>
<td></td>
<td>· Required human resources: control room operator (authorised electrician)</td>
<td>· Market offering is limited</td>
</tr>
<tr>
<td></td>
<td>· Required tools: DMS</td>
<td>· Agreements: service-level agreements</td>
</tr>
<tr>
<td></td>
<td>· DNO role: active participation is not required</td>
<td>· Basis for billing: annual invoicing + €/activity</td>
</tr>
<tr>
<td></td>
<td>Input: network present state (DMS), operation of fault detectors (SCADA), initial fault location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output: fault isolated to minimise supply disturbances</td>
<td></td>
</tr>
<tr>
<td><strong>Fault isolation and restoration</strong></td>
<td>· Supplier-performed operation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Manual fault isolation, arranging back-up connections and reserve power</td>
<td>· Possible to outsource to firms that are specialised in network operation services</td>
</tr>
<tr>
<td></td>
<td>· Required human resources: control room operator and field personnel (authorised electrician)</td>
<td>· Market offering is limited</td>
</tr>
<tr>
<td></td>
<td>· Required tools: DMS</td>
<td>· Agreements: service agreements</td>
</tr>
<tr>
<td></td>
<td>· DNO role: active participation is not required</td>
<td>· Basis for billing: annual invoicing + €/activity</td>
</tr>
<tr>
<td></td>
<td>Input: network present state (DMS), initial fault location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output: faulted cable isolated from network, safety at work ensured (fault repair)</td>
<td></td>
</tr>
<tr>
<td><strong>Reserve power management</strong></td>
<td>· Supplier-performed operation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Managing extra reserve power equipment on site as needed by aggregates and spare cables</td>
<td>· Possible to buy from firms that are specialised in stock management</td>
</tr>
<tr>
<td></td>
<td>· Required human resources: authorised electrician, transport personnel for equipment</td>
<td>· Market offering is good</td>
</tr>
<tr>
<td></td>
<td>· Required tools: reserve power aggregates and spare cables, transport</td>
<td>· Agreements: service-level agreements</td>
</tr>
<tr>
<td></td>
<td>· DNO role: active participation is required in defining strategy for the activity</td>
<td>· Basis for billing: annual invoicing + €/activity</td>
</tr>
<tr>
<td></td>
<td>Input: fault locations, amount of consumption (DMS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output: temporary electricity supply for selected end-users (DMS)</td>
<td></td>
</tr>
</tbody>
</table>
Table 5-4. Maintenance and fault repair activities in the cabling management concept (3/3 continued).

<table>
<thead>
<tr>
<th>Content of activity</th>
<th>Input and output information</th>
<th>Operations model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fault location</strong> (on-site)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Locating faults on site by visual observation or by impulse response measurements</td>
<td>· Input: faulted cable sections, cable data (NIS)</td>
<td>· Supplier-performed operation</td>
</tr>
<tr>
<td>· Required human resources: authorised electrician</td>
<td>· Output: stating the nature of the fault and its exact location</td>
<td>· Possible to outsource to individual experts or firms that are specialised in fault diagnostics</td>
</tr>
<tr>
<td>· Required tools: cable-display equipment, excavation equipment, fault diagnostics; echometers, impulse response measurements, loss tangent measurements</td>
<td></td>
<td>· Market offering is good</td>
</tr>
<tr>
<td>· DNO role: active participation is not required</td>
<td></td>
<td>· Agreements: service agreements</td>
</tr>
<tr>
<td></td>
<td>· Input: faulted cable sections, cable data (NIS)</td>
<td>· Basis for billing: annual invoicing + €/activity</td>
</tr>
<tr>
<td></td>
<td>· Output: stating the nature of the fault and its exact location</td>
<td></td>
</tr>
<tr>
<td><strong>Fault repair</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>· Exploration of damaged network parts, repair of indicated faults in the network</td>
<td>· Input: exact fault location, cable data (NIS)</td>
<td>· Supplier-performed operation</td>
</tr>
<tr>
<td>· Required human resources: authorised electrician</td>
<td>· Output: cable ready for commissioning inspections</td>
<td>· Possible to outsource to firms that offer network operative services</td>
</tr>
<tr>
<td>· Required tools: tools for repairing different cables and fault types</td>
<td></td>
<td>· Market offering is good</td>
</tr>
<tr>
<td>· DNO role: active participation is not required</td>
<td></td>
<td>· Agreements: service agreements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· Basis for billing: annual invoicing + €/activity</td>
</tr>
</tbody>
</table>

DMS = distribution management system  
NIS = network information system  
SCADA= Supervisory Control and Data Acquisition

For the maintenance and fault repair activities in the cabling management concept, the requirement for new capabilities is particularly emphasised. The need for new diagnostics tools and knowledge for cable networks is high. These activities are also difficult to transfer to service providers. Therefore, for the most crucial activities; preventive maintenance, fault situation management, fault isolation and reserve power management, service-level agreements are placed so that the regulatory risk can be managed. In particular, fault situation management can tie together the information flows between the supplier and the distribution company, which requires detailed description of the operations and information. Spot acquisitions for maintenance and fault repair activities can be employed, but the requirements for critical information between the activities can be higher than for construction activities. However, reserve power management and fault repair can be individually purchasing, particularly if distances in the distributing area are long.
5.5. Conclusions on responding to regulatory risks

This chapter introduced a concept for switching over to full-scale underground cabling in rural network areas by employing a combination of purchased and in-house resources and competencies. Managing the process of outsourcing of cabling activities includes an assessment of the nature of the activities, the risks involved both in using outsourcing as a reorganisation tool and in changing over to a new network development strategy. Managing the regulatory risk when facing more demanding quality regulations consists of three stages. First, capabilities and the resources attached to cabling-related activities are identified. Secondly, the input and output information for the activity is required to identify the dependencies between the activities. A detailed profile of the activities helps to secure critical information feeds to the electricity distribution business. Finally, the operations model is selected. If the activity is outsourced, the agreement type and basis for billing are determined.

The concept included network design, construction, maintenance and repair activities that have been selected because of high interdependencies between them. Design of network development strategies, network design and field planning are activities that are considered core competencies of the electricity distribution business. It is possible to acquire additional resources by utilising service providers, but the control over these activities should benefit the value creation of the network business. Network construction, maintenance and fault repair activities are prospective candidates for outsourcing. Activities tendered for outsourcing should form an entity of underground-cabling-related activities in order to attract offering, and, in order for the service provider to benefit from economies of scale and scope. Especially in cable ploughing and fault repair, by employing a specialised service provider, alternative ways of arranging working can further be explored. For example, a service provider can utilise a chain of local subcontractors for activities requiring local knowledge or service.
6. **Concluding remarks**

The deregulation of electricity distribution sector from other electricity sector functions required formal economic regulation of the natural monopoly business. Regulation is the primary means to promote societies’ common goals regarding the electricity distribution business. The focus of regulation is on promoting the efficient use of network assets so that customers can enjoy network services of sufficient quality. In particular, the growing awareness and concern of society’s dependency on continuous electricity supply has induced major changes in the legal and statutory framework of electricity distribution. The electricity distribution business is mainly characterised by its natural monopoly status; the task of delivering electricity to the customers in the companies’ operating area results in operating assets that are long-lived and stranded. Inevitably, there is a conflict between the regulator view of the reasonable funds for electricity distribution services and what companies consider appropriate. The economic regulation compensates for the risk associated with providing electricity distribution services. This does not, however, cover all aspects of risks – the risk from economic regulation itself has become a significant factor. As the regulatory framework in Finland has evolved to introduce more persuasive incentives in terms of cost efficiency and quality of electricity supply, the companies have to consider how best to manage their businesses. In order to meet the society expectations, the networks have to be more reliable and employ network assets efficiently with respect to the future needs. The distribution companies have to re-conceptualise the basis on which they do business and develop their strategies accordingly. In many instances, this will involve using service purchasing as an option.

6.1. **Contributions of the study**

The result of the study is a concept for managing large-scale underground cabling of rural distribution networks. The study provides new knowledge to the management of regulatory risks when outsourcing services in the electricity distribution sector. The impacts of quality regulation is a less studied area in the regulatory risk literature as it is relatively recently introduced into the regulatory regimes. Studies on regulatory risk have focused on systematic risk (Alexander et al. 1996, Alexander et al. 2000, Binder and Norton 1999, Buckland and Fraser 2001, Paleari and Redondi 2005). Methods used to regulate natural monopolies are often
applications of the basic regulation methods that take into account unique characteristics of the
country in question (Viljainen 2005). Similarly, the contributions of this study are country and
industry specific; this study provides new knowledge on outsourcing in the regulated electricity
distribution sector. In other industries, regulation is often not an issue in outsourcing studies,
whereas when outsourcing network-related activities in the electricity distribution sector,
economic regulation is an additional element to consider.

The main contribution of this doctoral thesis is developing a concept for managing regulatory
risks when outsourcing network-related services in the electricity distribution sector in Finland.
The concept answers the main research question of how to manage regulatory risks when
outsourcing network-related activities to specialised service providers. Additional contributions
of this study can be summarised as follows:

1) Analysis and classification of the regulatory risks in the Finnish electricity distribution
   business by adopting a systematic approach.
2) Identification of the methods by which distribution companies can technically and
   organisationally prepare for the above-mentioned risks, especially in a case where
   revolutionary changes in the business environment are detected.
3) Analysis of the effects of regulatory risk when employing a specialised service
   provider for network construction.
4) Policy for large-scale underground cabling that responds to the recognised risks of the
   business environment.

The following sections answers the research questions presented in section 1.4.1.

6.1.1. Business risk in the electricity distribution business

This chapter answers the research question:

1) What are the risks stemming from economic regulation of the electricity distribution
   business?
Economic regulation is enforced in order to prevent a possible misuse of monopoly powers and to root out inefficiencies. Although the legal, social, environmental and economic factors together with technical advancements continually shape the operation environment producing challenges for the electricity distribution business, the most decisive goals of the society are realised through the regulatory framework. The basic model of economic regulation applied in Finland has remained the same but, nonetheless, incentive elements in efficiency and quality have evolved quite drastically. This has been manifested in an increase in regulatory risk. As there is more experience of economic regulation, the regulator is able to introduce more specific incentives, the quality incentive scheme and company-specific efficiency incentives. However, the differences in the operating conditions of the distribution companies make it hard to create a regulation regime attentive to the individual requirements for the companies and at the same time provide reasonable return for the industry as a whole. This conflict creates uncertainty about the expected return on the business. Three aspects of regulatory risk can be distinguished: a risk from the regulatory system, a risk from regulatory intervention and a risk from maturity of the regulatory interaction between the regulated companies and the regulator.

The most intrusive risk in economic regulation has concerned the quality of electricity supply. The networks need to be prepared for the effects of climate change and ever-growing dependency on continuous electricity supply. This development pattern is reinforced by tightening safety and environmental regulations that ultimately make the overhead lines more and more expensive to build and maintain. For instance, large-scale disturbances led to the introduction of standard compensations paid to the affected customers for interruptions longer than 12 hours. In addition, the quality incentive scheme and efficiency benchmarking considers supply interruptions in defining the reasonable revenue for distribution companies. Therefore, especially the large disturbances present a source of risk in the current regulatory framework. This thesis shows that the most accessible opportunities for distribution companies to influence their regulatory outcome in terms of risk are operational costs and interruption cost components. Another essential factor is the quality of data upon which the regulatory practices are ultimately based. Incentives are commonly based on benchmarks between the companies, and if the quality of the provided data is insufficient, misreported or does not represent the true level of operation, the incentives may become distorted.
Presently, economic regulation is not sufficient to act as a sole promoter of large-scale cabling in rural networks. The main contributing factor can therefore be characterised as social but, nonetheless, a risk realises through economic regulation. Recognising the social signal can give indication of prospective regulatory requirements. The evolution of the regulatory risk in the Finnish electricity distribution industry has meant that economic regulation must be increasingly included in the decision-making in the electricity distribution companies.

6.1.2. Responding to the perceived risks

This chapter answers the research questions:

2) In which way can the distribution companies prepare for the regulatory risk?

3) What are the regulatory risks when employing a specialised service provider?

The outcome for the distribution companies in the regulatory framework depends on the companies’ ability to understand the incentives and adapt their operation accordingly. Responding to these business risks requires an optimal network development strategy or development of the organisation. There are various methods to improve network reliability, but underground cabling is perhaps the most extensive one both for normal operation and in large disturbances. Underground cabling is a well-known network construction technique. An increase in cabling volumes is still expected partly because of developments in ploughing and improved profitability of the technique that has enabled underground cabling even in rural areas. The increasing use of underground cabling especially in rural areas does not always have only positive impacts. In terms of load growth, different areas vary significantly; from areas with a heavy load growth to areas with little or no growth. By laying cables underground, network companies may face risks of load changes or relocations, and further, alterations in the network topology become more challenging. Transition to full-scale underground cabling also means that the effects are realised in the related activities, mainly in network design, maintenance and operation. The effects of full-scale cabling for instance on maintenance activity will result in difficulties in locating and repairing faults. At the same time, any interruption in electricity distribution is extremely costly to the network company because interruption costs are directly linked to their regulated revenues, which puts special emphasis on
the design activity. Therefore, implementing a more reliable network development strategy poses new risks to the electricity distribution business.

The effects of the business drivers for network construction can be considered revolutionary. For full-scale cabling of rural networks, this requires resources and capabilities that are not yet developed and therefore, if such resources and capabilities are not acquired, the companies may face the risk of lagging behind the forerunners in the industry. This will have a negative effect on the regulatory outcome in particular. Turning to a specialised service provider is an option for managing the risks. Outsourcing of the network-related activities is an option used in the Finnish electricity distribution industry with positive experiences. However, as the business risks are great, key risk factors for using a service option have to be determined. In general, non-functioning service markets, unrealised cost savings and problems with information systems represent the most important challenges for service purchasing, but for cabling services, perhaps the major concern is the quality of cabling. Most of the risks for using service purchasing are managed through a service contract: a detailed description of the purchased service, which at the same time leaves opportunities for the service provider to develop its operation will help to guarantee a certain level of service and make use of the service provider expertise. As a response to the regulatory risk and the challenges of the new operating environment, the electricity distribution industry must choose an optimal network development strategy and improve or reorganise its own organisations. Figure 6-1 illustrates the risk management process for the electricity distribution sector.
Figure 6-1. Risk management process in the electricity distribution.

The process of recognising risks from sector development trends and drivers, assessing their impact against business characteristics and economic regulation and managing the risk by network development strategies or reorganising network-related services is constantly ongoing.

### 6.1.3. Developing a business process

Managing business risks in network-related activities that are considered revolutionary may require knowledge and resources that can either be developed internally or acquired elsewhere. In this thesis, a concept for efficient management of underground cabling of rural distribution network is presented. The basis for the concept approach is in managing the risks that have been identified for electricity distribution through cabling of the networks and employing a specialised service provider. If rural electricity networks are cabled in full, the consequences for the future business risks have to be considered. Therefore, a rationale for employing a comprehensive approach in responding to the prevailing business drivers is beneficial. Using underground cabling as a primary means of the network development strategy includes activities in network planning, construction, maintenance and fault repair. These activities have
high interdependencies and require constant information from each other. For instance, cable network fault repair benefits from the necessary maintenance wells designed in network planning, and network maintenance may become easier as a result of well-constructed and inspected cable networks.

Employing specialised service providers with appropriate resources is an option available and used for managing new requirements. For the cabling concept, a preferred governance mode for each of the subactivities under network planning, construction, maintenance and fault repair is proposed. The concept management will require detailed definition of the content of purchased services, required resources for performing the activity, the information feeds to and from the activity and the governance type. Some activities benefit from economies of scale, and specialised knowledge or resources available for the service provider. These activities include network construction, maintenance and fault repair activities. Some activities will remain core competencies for the distribution companies because of their value for developing the business. Commonly, these are network design activities. However, the preferred level of service provision is dependent on the risk that the company is willing to accept.

6.2. Assessment of the research

In an action analytical research, emphasis is placed on interpretation of the results. Therefore, the research presented in the previous chapters is here assessed with respect to the relevancy, validity, reliability and generalisability of the research.

6.2.1. Relevancy

The research on responding to the risk of quality regulation by means of service provision presented in this thesis is relevant for two primary reasons. First, economic regulation concerning quality issues is expected to have a more prominent role in the future regulatory regimes on account of increased quality expectations from society. Second, the rate of outsourcing network-related activities is expected to increase in the future. The presented data of the experiences from outsourcing in the Finnish electricity distribution sector indicate that
companies are content with outsourcing, the set goals have been achieved, and functioning of
the service markets were seen to be good thus giving grounds for further exploring outsourcing
as a operations model.

6.2.2. Validity

The validity of the research describes the research method’s ability to measure what it was
intended to measure. This research presents cabling as the primary means to respond to quality
regulation by employing a specialised service provider in cabling of rural networks. The
importance of responding to increasing quality needs in society has been realised in quality
regulation. Underground cabling provides reliable networks and is therefore an effective
method to manage the regulatory risk. Moreover, securing critical functions of society by
cabling will be of paramount importance regardless of regulation. Full-scale cabling will entail
new risks for the electricity distribution business that have been proposed to be managed with
the concept approach. The underlying reasoning for outsourcing services in the concept is that
there are benefits involved in employing the service markets rather than producing the services
in-house.

The concept approach in purchasing services in large-scale undergrounding of electricity
distribution networks is found to be advantageous in answering regulatory risks for three
reasons. First, cabling of rural distribution areas requires knowledge and working methods that
are not presently possessed by the distribution companies therefore making the utilisation of
service markets a rational option. Service providers often have access to resources that enable
speedy implementation of large-scale cabling. Second, cabling-related activities are highly
interdependent, which results in a high level of information flows between the activities.
Furthermore, in order to meet the future expectations for weather-resistant and reliable
electricity supply, the change is first considered in network planning. In turn, planning
determines the applicable methods of network construction, which then determine the
characteristics and execution of maintenance and fault repair. The three activities form a
compact entity that is recommended to be treated as a whole. Thirdly, the concept approach to
large-scale cabling provides means both for asking for tenders and tendering for cabling. As the
cabling procedure is known in detail, the process of outsourcing becomes easier. This enables
the service provider to copy the concept to achieve economies of scale and scope thereby making outsourcing tempting also for distribution companies that have necessary resources to carry out cabling of the networks.

This research is valid for the prevailing regulatory parameters, which means that if the regulation method or its focus changes, the conclusions presented in this thesis will have to be revised. This does not compromise the validity of the research method as economic regulation is dynamic by nature.

6.2.3. Reliability

Reliability of the research means that same results can be attained by different research methods or different researchers conducting the research. The results of this thesis were obtained mostly from four different research projects. Given the qualitative research approach in this thesis, the researcher’s influence on interpretation of the phenomena cannot be ignored.

This thesis is built on two assumptions; increasing relevance of quality regulation and outsourcing in the electricity distribution sector. The first one has been evident from Finnish and international experiences. However, the assumption on continuation of the tightening of quality regulation is an interpretation made by the author of this doctoral thesis. Development in the electricity sector can steer the regulatory foci; nevertheless, reliable electricity distribution networks will continue to form the backbone of the electricity markets. Also the categorisation of regulatory risks is somewhat problematic because of different operation circumstances of the companies, preparedness of the companies to respond to the regulatory requirements and varying views on the importance of regulatory risks.

Outsourcing was studied in Finland with questionnaires and interviews. When conducting the enquiries, the researcher’s influence can be seen in phrasing of the questions. The questionnaire response rate was considered quite representative in terms of distribution network length and total number of customers connected to the electricity distribution networks in Finland. It was
observed that a web-based questionnaire concerning outsourcing may invite answers from companies already active in outsourcing. However, outsourcing can be expected to become popular in the electricity distribution sector. The reliability of the research could have been improved by directly combining the interaction of outsourcing and regulatory risk in the questionnaire.

The researcher’s influence is perhaps most evident when describing the interdependencies between the activities chosen for the cabling concept. Within the course of this study, the definitions and outlines of the network-related activities were found to vary notably between the distribution companies, thereby giving room in the research scope. The profitability of underground cabling is also dependent on the soil, development in cable materials and labour among others. The benefits of cabling against disturbances are nonetheless strong. Underground cabling as the sole network construction method does not exclude other methods that can be used to build a more reliable network. Finally, verifying the cabling concept in practice is left for future work. Testing the concept in real life could give an additional level of reliability for the results; nonetheless, the result of this research can be regarded sufficient.

6.2.4. Generalisability

Generalisability of the research defines how well the research results can be transferred to other settings. According to Olkkonen (1994), the results obtained by using action-analytical research are especially associated with the problem of generalisability. This study is highly specific for the electricity distribution business and is valid for the regulatory regime currently applied in Finland with a special reference to electricity distribution companies operating in rural distribution areas that face large-scale network renovation needs. For example, urban distribution networks currently have high cabling rates and therefore cannot be considered to be subject to revolutionary changes in network construction. Applying the concept approach to cabling on the other hand can be advantageous regardless of whether outsourcing is used. Clearly defined tasks and information flows can improve organisation operation.
The research procedure presented in Figure 1-3 can be applied to activities other than network cabling. It is left to the companies to make their decisions whether revolutionary changes in a given activity are detected and whether some or all activities should be outsourced. The driving forces for cabling are strong and cannot be expected to be found in all regulatory decisions. Companies can however use the procedure to identify less compelling driving forces in order to become a forerunner in their field. Again, the concept approach can be used to accumulate larger entities for tendering.

6.2.5. Future work

The business drivers in electricity distribution will continue to evolve and change their emphasis for the distribution companies. Accordingly, the industry will continue to develop to meet the expectations of the new or changed business drivers. One of the ongoing developments in the industry is the customer requirements for new energy services, such as providing real-time consumption data or energy usage information. Presently, the energy services will require more utilisation of automatic meter reading equipment as well as new business models for efficient implementation of statutory requirements concerning the matter. Another interesting future prospect for electricity distribution networks is the changing role of the electricity network for instance in providing small-scale electricity production or full-scale facilitation of the use of electric cars. These aspects will be governed by society’s needs, technological developments and necessary statutory or authority regulations, and can therefore develop into revolutionary driving forces. The role of the distribution companies as the enabler of society’s goals will again bring challenges as well as opportunities to the business. Companies can develop their organisations to excel in the regulated business environment, and possibly even provide services to other distribution companies, or employ specialised service providers. An interesting aspect is also the multi-utility approach in electricity, gas, district heating, water and sewerage activities, where large-scale potential is yet to be realised.
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