

Public service perspectives on reforms of electricity distribution and supply: a modular analysis

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Abstract

This article analyzes organisational change in electricity distribution and retail and its impact on public service issues. Organisational change results from the European electricity directives which have imposed major changes on electricity distribution. The EU Electricity directive (2003/54/EC) has required the legal unbundling of electricity distribution networks by July 1st 2007. Organisational change also results from an adaptation of distribution and supply companies to the newly competitive environment in the electricity sector. This has resulted in a diversity of organizational choices across Europe. While most analyses of reforms have focused on the wholesale level, a better understanding of reforms conducted at the retail level is needed, especially to analyse their impact on public service issues. We first propose a modular approach to analyse the impact of reforms on reorganizations in the distribution and retail business. We then analyze two important aspects of public service, the regulation of quality of supply and the protection of vulnerable customers.

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Introduction

While the focus on electricity reforms has mainly been placed on the introduction of competition in electricity markets, the issue of public service has received less attention in economic research during the last years. However, electricity directives do not ignore this question. According to the European directive 2003/54/EC, “All Community industry and commerce (...) and all Community citizens that enjoy the economic benefits of the internal market should also be able to enjoy high levels of consumer protection, and in particular households and, where Member States deem it appropriate, small enterprises should also be able to enjoy public service guarantees, in particular with regard to security of supply and reasonable tariffs, for reasons of fairness, competitiveness and indirectly to create employment.” These ideas are pushed further in the proposal for a third legislative package of September 2007. According to this proposal, energy regulators “must (...) be granted the powers to decide, irrespective of the application of competition rules, on any appropriate measures promoting effective competition necessary for the proper functioning of the market; *as well as ensure high standards of universal and public service in compliance with market opening, the protection of vulnerable customers, and that consumer protection measures are fully effective*”. Thus, according to the European Commission, competition in the electricity sector has to be compatible with the maintaining of high levels of public service.

In addition, according to a recent communication of the European Commission’s concerning public services (European Commission, 2007), “*services of general economic interest should be responsive and delivered as closely as possible to citizens and businesses*”. Adopting a perspective centred on citizens and consumers supposes to know what effects reforms have on them, which requires that a wider perspective than a view centred on the functioning of competition in wholesale markets be adopted. This requires especially that the effects of reforms at the retail level, which is the part of reforms having a direct influence on the small customers, be examined. Therefore, a view of competitive reforms centred on their properties at the wholesale level is not adequate to analyse public service issues.

Following the European electricity directive of 2003, we consider that public service issues are related to two main questions. The first question is quality of supply to small customers, which relates to both technical characteristics of electricity supplied (i.e. continuity of supply and a constant frequency of electricity) and to commercial aspects, i.e. the commercial service rendered to consumers (for example rapidity of response, handling of complaints, etc.). The second question is affordability of energy for vulnerable consumers, i.e. the measures put in place to guarantee that these consumers can afford a level of electricity consumption which is necessary to satisfy their basic energy needs.

Public policies in these two domains have been in place for many years. In France for example, the concept of public service has been defined by Duguit in 1928. For Duguit, “public service” could be defined as *“any activity whose realization has to be ensured, ruled and controlled by the governants because the realization of this activity is indispensable to the realization and the development of social interdependency, and because, by its very nature, it cannot be realized totally by the intervention of the governing force.”* In many countries, public services principles have been applied, which consisted in a set of obligations imposed to suppliers. These included the obligation to supply all customers, equality of treatment of all customers, continuity of supply, as well as rules related to a “fair” rate of return (Stoffaës, 1994). However, during the last years, the context of realization of public service has been modified by the introduction of competition (Brémond, 2003). In electricity distribution and supply, the pre-reform context was characterized by (often public) monopolies, where the definition of public service tasks could be realized bilaterally between the state and the monopoly. In a context where electricity distribution and supply are opened to competition, this is not possible anymore: public service objectives have to be defined in a more formal manner, as well as the question of their financing.

The electricity reforms initiated by the European directives 96/92/EC and 2003/54/EC have led to organisational changes that have, among others, affected the organisation of electricity distribution and retail businesses. This raises the question of how public services will be supplied in a context where firms are not anymore organized as

monopolies. The unbundling rules contained in the electricity directives have imposed the separation of distribution and supply from production and transmission, and also a separation between distribution networks and supply, in order to allow a non-discriminatory access of all suppliers to the final customers. These rules have led to far reaching reorganisations of distribution and supply businesses. New organisational forms have emerged, and their efficiency has not been systematically studied. The public service rendered by these businesses should logically be affected by these reorganisations. Public service issues are debated in the electricity sector (FNCCR, 2004) as well as issues of customer protection (European Commission, 2007). However, the links between reorganisations of electricity distribution and supply and public service concerns have not been analysed.

The aim of this paper is to analyze organisational change in the distribution and retail segment, as well as its impact on the public service rendered by distribution and supply companies. Organisational change has to be analysed as the European electricity directives have imposed major changes on electricity distribution. When supply is separated from distribution, and when different activities related to distribution are realized by different entities, which will *in fine* be responsible for the quality of electricity distribution? When supply is organized within large entities without proximity to the consumer, how can a proper treatment of vulnerable consumers be ensured?

The first section proposes a theoretical framework to analyze organisational change, which decomposes distribution and supply activities into different “modules” (Baldwin, 2007). This modular framework will be used as a basis to examine the diversity of organisational choices in different European countries. The second section discusses the impact of the modular reorganizations of electricity distribution and supply on public service policies, especially concerning quality of supply and protection of small consumers.

1. Post-reform organizational reconfigurations of European electricity distribution and supply

The objective of competitive reforms in the electricity sector is to improve the overall efficiency of the sector by creating competition where possible. This has led to a general prescription where competitive activities had to be separated from the networks, which were assumed to be natural monopolies. While this general prescription has transposed to distribution and supply activities, the reorganizations that occurred in these activities suggest that the logic of restructuring is a more complex one. The aim of this section is to shed light on the organisational questions raised by reforms in distribution and supply. We start by a discussion of the shortcomings of traditional analysis of natural monopoly in electricity distribution. We then present an alternative framework to analyze organizational issues in distribution and supply activities, which is a modular framework. Finally, we analyse the restructuring of these activities in three European countries.

1.1. What natural monopoly analyses fail to explain

Electricity distribution is traditionally assumed to be a natural monopoly. Therefore, the introduction of competition in the distribution and retail segment can only be limited to those activities which do not have natural monopoly characteristics. Since the British reform of 1990, it is well known that some parts of the value chain in distribution and supply can be organized in a competitive manner, while other parts remain monopolistic. Nevertheless, since the beginning of the 1990's, it seems that the frontier between monopolistic and competitive activities has evolved. This raises the question of what exactly is the natural monopoly of electricity distribution.

There has been a huge theoretical literature on natural monopoly in network sectors (Joskow 2005, Lévêque 1998,). However, the tests of natural monopoly characteristics of electricity distribution have not been properly adapted to the recent evolution of this activity. Most of these analyses, including the most recent ones (Kinnunen 2003, Viljainen 2005, Ajodhia 2006a), use cost estimations for integrated distributors. They do

not consider the separation between the network activities, which are most likely a natural monopoly, and the supply function, which can be organized competitively.

The most representative contributions of a new type of approach, which tries to identify the location of the natural monopoly, are Salvanes and Tjotta (1998) with their natural monopoly test of electricity distribution in Norway, and Gunn and Sharp (1999) who analyze the case of New Zealand. However, these studies are not detailed enough for clarifying the nature of distribution. In the light of the current evolutions of this business, three main limitations of these studies can be identified (Saplacan, 2008).

The first limitation is related to unbundling. The unbundling of distribution from the supply activity has been imposed by the European Directive 96/92/CE and reinforced by the second Directive 2003/54/CE. The aim was to stimulate competition in a sector that has historically been vertically integrated. The two European directives have thus led to a reorganization of the distribution business and therefore to changes in the cost structure of the companies. Salvanes and Tjotta (1998) do not address the question of unbundling between distribution and supply for their study makes no difference between them. However, they emphasize that the network infrastructure is the main factor driving the natural monopoly character of distribution. But in the absence of separation from supply, the characteristics of this activity remain unclear.

The second limitation is related to the cost structure of distribution companies. An evaluation of their costs should take into account the fixed costs as well as the variable costs, i.e. the cost of capital and operating costs. While Gunn and Sharp (1999) make a clear distinction between supply, as a competitive activity, and distribution, as an electricity delivery activity, their model isn't clear enough on the differentiation between capital and operational costs.

The third limitation is related to the current transformations of organizational forms of distribution companies. After a first stage of separation between distribution and supply businesses, organizational forms of distributors have continued to change. As a consequence of stronger regulatory incentives, network operators have externalized some functions related to the operation of their networks. Therefore, new organizational models

have emerged in electricity distribution, with integrated network owners operating their networks on the one hand, and disintegrated forms of network ownership and operation on the other hand. These evolutions raise the question whether electricity distribution, excluding supply activities, should be further decomposed, some parts of this business being potentially competitive and distinct from the “core” natural monopoly business. If this is the case, then analysing distribution with a single cost function will no longer be accurate.

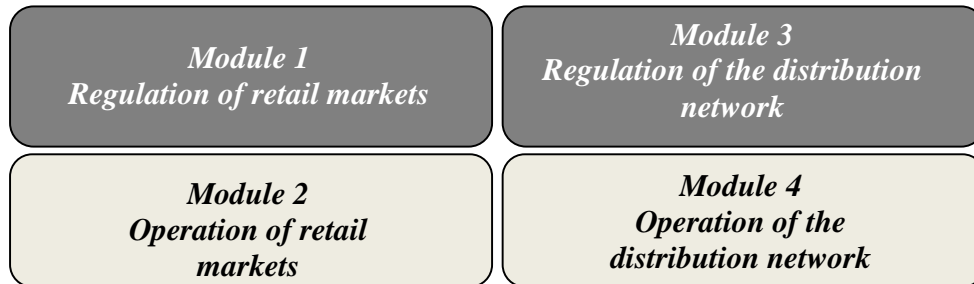
These limitations suggest that the traditional natural monopoly framework has to be complemented by other analyses of the electricity distribution and supply businesses. A more detailed understanding of distribution activities is required to highlight what is at stake in the current transformations of this sector.

1.2. The modular nature of distribution and supply reforms

As the traditional natural monopoly approach of electricity distribution and supply fails to explain the new organisational changes in these activities, we use a modular approach (Baldwin, 2007) to analyze in greater detail the different tasks associated with distribution and supply and highlight what are the interdependencies among them. In this type of approach, reforms of distribution and supply can be split into different “modules” which can be analyzed independently one from each other. Each module forms a coherent whole and can be organized in different ways. The modules combine to each other more loosely, and are sometimes independent from each other. When interdependencies exist among modules, they can be considered as linked one with each other by relations of “weak institutional complementarity” (Pagano, 2005, Aoki, 2001), suggesting that some combinations are more efficient than others.

Thus, a variety of systems can exist, as different variants of modules can be combined with each other. Figure 1 gives a representation of a modular decomposition of distribution and supply activities made of two “regulatory” modules and two “operational” modules.

Figure 1: a modular representation of reforms in distribution and retail



The first two modules are related to the retail business, i.e. activities which have no natural monopoly character, and the last two modules are related to the distribution business, i.e. activities which partially have natural monopoly characteristics.

The first regulatory module relates to the *regulation of retail markets*. It consists in the set of rules established by public bodies (legislator or regulator) to monitor the transactions on retail markets. Even in competitive electricity markets, these rules continue to exist to a certain extent. The rules related to the regulation of supply conditions and tariffs already existed in the formerly regulated markets and they often continue to exist after the transition to competition. For example, the customers who have not switched to competitive suppliers are still benefiting from regulated tariffs and conditions. The public service rules on access to energy stipulate that each consumer has the right to be served, since electricity is an essential service. For certain customers, access to energy is ensured through social tariffs. To allow each consumer to be served in a competitive electricity market, a supplier of last resort can be designated, who is generally the incumbent supplier in a given region.

The second module relates to the *operation of the retail markets*, the organization of customer services of the electricity supplier. It concerns all commercial relations with the final customers including customer relations, phone centre, billing and commercial advice to customers. This module is a non-technical one, as it does not require a specific technical knowledge. It involves relatively frequent relations with the customer.

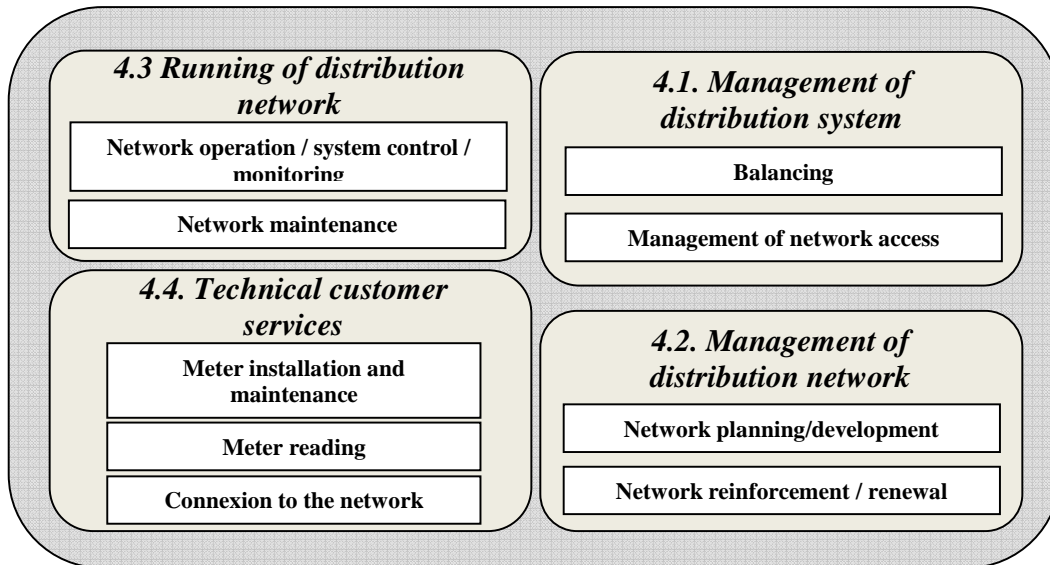
The third module is *regulation of the distribution network*. It groups three sets of rules established by public bodies to determine the structural characteristics of the distribution

business and the type of regulation imposed to natural monopoly activities. A first set defines the property regime of distribution networks. This regime is often inherited from the historical organization of distribution. The property regimes are different from one country to another. For example, in France, the property regime is defined by the “concession contracts” between local authorities and the network operators. According to French concession rules, the municipalities own the networks, although most investments are realized by distribution operators. On the contrary, in Germany, the property regime is totally different, since the network operators also own the networks. A second set of rules relates to the unbundling regime between distribution and supply. Unbundling is considered as an essential condition for truly competitive retail markets (ERGEG, 2007). Unbundling choices of different countries also play an important role for the organizational properties of distribution and supply. Finally, the third second set of rules relates to regulation of distribution networks. While in some countries, like Germany, distribution network regulation is only subject to an approval of the regulator based on costs declared by network operators, in other countries, like the UK, distribution activities are subject to incentive schemes. We then identify five “operational” modules which correspond to the different tasks of distributors and suppliers.

The fourth module relates to the *operation of the distribution network*. As it groups several different tasks, it has to be decomposed into sub-modules which correspond to the different tasks of distributors (cf. Figure 2).

Figure 2: the module of operation of the distribution network

Module 4: Operation of the distribution network



A first sub-module (4.1) relates to the management of the distribution system. A first task relates to “management of network access”, i.e. giving third parties access to the distributor’s network. A second task is “balancing” of electricity flows and settlement⁴.

A second sub-module (4.2) relates to the management of the distribution network. This includes two main tasks: the planning and development of the network and and to the network reinforcement and renewal. The reinforcement and renewal is realised according to the decisions concerning “network planning” and requires a certain level of knowledge of the local conditions, in order to realize the most adapted investments for ensuring a good technical quality of supply.

⁴ This task is necessary because of the lack of control of distributors over the electricity flows on their grids. On the one hand, the network operators do not control the consumption flows on their network. And these consumptions are not paid at their “real-time” price. On the other hand, the network operators buy their electricity from the transmission operator at wholesale prices. Therefore, the function of balancing is to “reconcile” the physical and financial flows on the network.

A third sub-module (4.3) is the running of the distribution network. It can be decomposed in two tasks. The “network maintenance” designates all activities necessary to the maintaining of the actual performances of the network. This requires a high level of knowledge of the network’s local characteristics. The “network operation/system monitoring and control” designates all activities necessary to the supervision of network conditions in real time. This essentially consists in directing the electricity flows on the network. It requires a real time access to information on electricity flows and network configuration.

The fourth sub-module (4.4) groups technical services to customers. We distinguish different types of customer services. The service of “meter reading” requires no specific technical skills and it is realised frequently, once or twice a year. The service of “meter installation and maintenance” requires higher technical skills. It is realised with a relatively low frequency. Finally, the service of “connexion to the network” requires a direct technical intervention at the customer’s home, which intervenes with a low frequency, typically when a new house is built and connected to the network.

This modular representation of reforms in distribution and supply can be used to explain the diversity of reforms. Each of the modules can be designed in different ways, and variants of the different modules can be combined one with each other. One consequence of this modular organization is that each national reform can be seen as a particular combination of different variants of our modules. However, the variety of reforms is limited by institutional complementarities.

Different types of institutional complementarities are possible. (1) Firstly, there are complementarities between regulatory modules and operational modules. For example, the regulation of access to energy influences the management of customer relations. (2) Secondly, some complementarities exist between and within operational sub-modules. For example, the “Network planning” is linked with the “Network development, reinforcement and renewal”, “Network maintenance”. Similarly, there exist some interdependencies between the “Management of the distribution network” and “Running of the distribution network”. The institutional complementarities are due to the fact that decisions within each sub-module influence the other sub-modules. For example, if

decisions on network renewal are delayed, this impacts the need of maintenance. (3) The question whether there exist some complementarities between “retail” and “network” module has been much debated in the context of unbundling of distributors⁵.

These interdependencies have organizational implications. If sub-modules are separated while strong coordination needs exist between them, the question of coordination becomes crucial. In case of separation of modules, the risks of opportunistic behavior by parties responsible for running them can increase due to the fact that in case of organizational separation, it gets more difficult to assign responsibilities. For example, in case of a decrease of quality of supply, the entity responsible for this decrease is difficult to locate, as bad quality can result from a bad coordination among them. Therefore, if these sub-modules are separated, some efforts must be devoted to the coordination among them in order to maintain a sufficient level of quality.

As each module can be designed in an autonomous manner, modularity gives the possibility to combine variants of modules in several manners. This suggests that a large diversity of organizational forms is possible, as different organizational modules can be combined in several ways (Dubois, 2007). However, this diversity is subject to some constraints. We discuss two main constraints. The first one is related to the local character of distribution activities, what Williamson (1985) calls site specificity. If activities have a local character, the possibility of changing their organizational form could be limited due to the need of being present locally. The second constraint is related to externalization. The potential of externalizing parts of the distribution and supply businesses could be limited by technical interdependencies between modules or sub-modules, which render a strong coordination among them necessary.

The local character of the modules is very different for the modules and sub-modules we have identified.

⁵ For example, in the Netherlands, the distributors were strongly opposed to an unbundling of these activities, arguing that some complementarities existed between activities (Künneke et al., 2007). However, Künneke et al. do not develop what is the precise nature of the complementarities, and suggest that part of them relate to financial aspects rather than to truly operational complementarities.

The module of “Operation of the distribution network” seems to have a local character, which is a consequence of the geographical specificity of each distribution network⁶. However, the description of different sub-modules are not similar concerning their local character. For example, the “Management of the distribution system” can be done at a relatively centralized level. The balancing and management of network access have non-local character, since they are mainly decisional processes without direct intervention on the network or to the customer’s site. On the contrary, the “Technical customer services” require proximity with customers and therefore have a stronger local character. The connection of customers to the network, the meter installation or maintenance and the meter reading are tasks demanding for physical intervention of a distribution company’s employee to the client’s residence. They generally need to be done rapidly. Therefore, these services must be organized on a local basis, as this is the only way to ensure a sufficient level of quality (i.e. rapidity). The sub-module of “Management of the distribution network” involves the network planning activity, which requires good knowledge of the demand structure and of the environmental conditions. However, this activity demands for no direct intervention, since it is only a decision process to be transmitted further to the module of “Running of the distribution network” sub-module. Therefore, to analyse which tasks of this module need to be done at a local level, it is necessary to differentiate between the sub-modules.

The module of “Commercial customer services” has a less local character since it doesn’t require direct intervention at the client’s residence. However, local centres can play an important role, for example for the most vulnerable customers who go to these centres to pay their bills, or when they experience difficulties of payment. The supplier’s call centres are usually designed for taking calls from large regions, or even for serving at a national level. As about the billing activity, it only requires the software programme to calculate each client’s consumption, without any direct intervention, and is also designed for the whole of the clients of a distribution company.

⁶ For example, plane or mountain networks have different configurations, as well as rural or urban networks. The characteristics of the demand (for example load density) are also specific to each network. In order to ensure a good quality of supply, a good knowledge of these characteristics is required, as well as a capacity to intervene quickly on the network.

The possibility of externalising modules or sub-modules is more difficult to analyze, as it cannot necessarily be evaluated *per se*. Therefore, to discuss this property we rely on case studies, especially France and the UK.

The module of “Commercial customer services” is the core activity of a supplier and thus difficult to externalize. Within the module of “Technical customer services” several activities can be externalized. For example, in the UK, the “Meter installation and maintenance” activities are entirely done by specialised service providers, while the “Meter reading” is at the charge of the distribution company. The “Management of the distribution network” sub-module could be externalized, even if the “Network planning” sub module seems difficult to externalize. However, even this activity can be externalized. For example, a UK firm, PowerTeam Electrical Services, is specialized in planning, building and developing distribution or transmission networks (lines, high voltage substations etc.). However, this firm also provides activities of the “Running of the distribution network” sub-module, illustrating the strong interdependencies between them. The “Management of the distribution system” sub-module can also be externalized. An example is Citiworks in Germany, a service provider which has been created by municipal utilities (*Stadtwerke*), and offers services like “Balancing” and “Management of the network access”.

Finally, it seems that when the “Running of the distribution network” sub-module is externalized, this is done as a whole and in combination with the “Management of the distribution network”. For example, 24seven, which is part of LE Group, is specialized in supplying network operation services in UK and Germany (city of Kiel). The externalization of this module remains however an open question.

Further developments of this modular analysis are needed to fully understand their implications on the way of organizing distribution and supply businesses. However, the previous discussion shows that there is some place for organizational diversity in electricity distribution. And the organizational choices driven by the search for efficiency

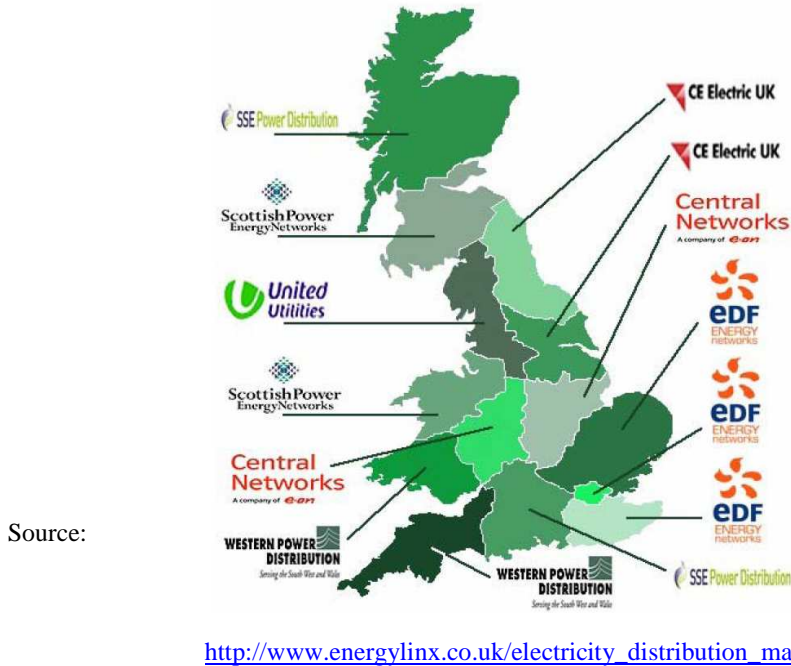
have led to different organizational choices in European distribution and supply. We use our modular framework to analyse these changes in different countries.

1.3. The lines of organisational change in European distribution and supply

In the UK, electricity distribution has been split into 12 regional electricity companies (RECs) as a consequence of the reform of 1990. At that time, each REC owned and operated the distribution network in its area, and each had a supply business which mostly consisted of metering, billing and contract management (Jamash et al., 2007). With the introduction of full retail competition, in 1999, the RECs could supply electricity outside their franchise area, and in 2000, the Utilities Act imposed legal separation between supply and distribution activities. Currently, distributors, operate distribution networks. They are owned by 7 independent companies. Over 18 suppliers appeared in the reform process. However, most of them are held by distributors⁷. As the UK electricity system is geographically fragmented (see Figure 3), the search for efficiency took place at the level of each distributor, in the form of externalization of some activities.

⁷ As indicated by Jamash et al. (2007), at the beginning of 2007 only two Distribution Network Operators were in different ownership from their former supply businesses.

Figure 3: The UK distribution system

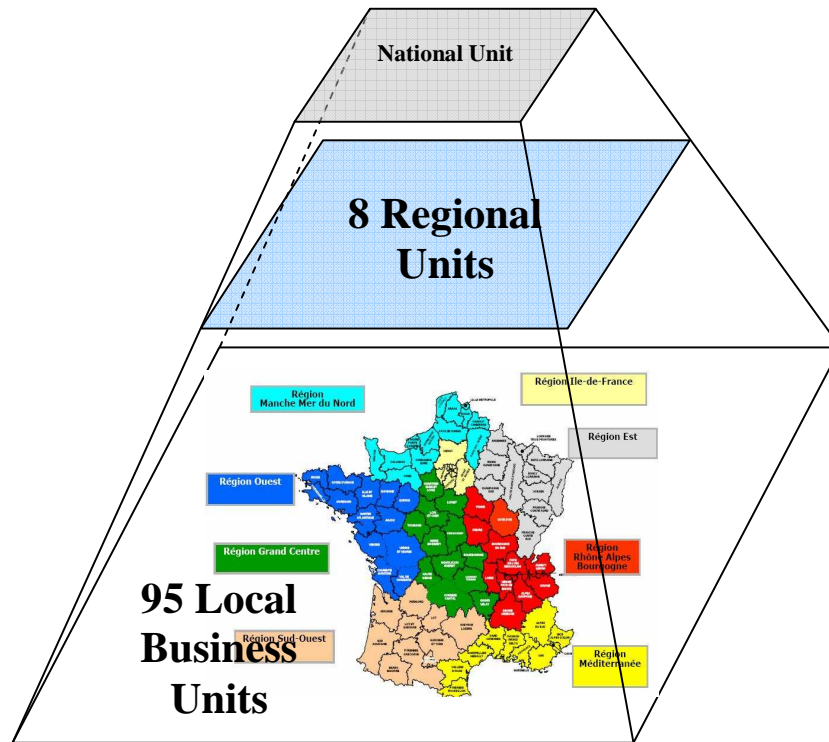


One characteristic of organizational change of distribution was the externalization of meter reading, i.e. a part of our module of “Technical customer services”, which is now done by independent firms. In addition, some companies have changed their scope of activities, being present in some segments only. For example, London Electricity Group⁸ owns and operates the public distribution network of London city as well as it operates the distribution network of Eastern England, without owning the infrastructure. This group has though a specific function, that of a specialized entrepreneur in supplying network operation services.

In France, several modifications of electricity distribution and supply have taken place. As EDF is a distributor of 95 % of electricity in France, it grouped some activities at a supra-local, and even supra-regional level (see Figure 4).

⁸ LE Group is entirely owned by EDF International (www.le-group.co.uk).

Figure 4: The organisation of EDF Distribution Branch



Source: <http://www.edfdistribution.fr/130001i/le-distributeur-EDF.html>

The search for efficiency has conducted EDF to standardize local units' activities and to search for scale economies, some modules like commercial services being grouped in bigger regional entities, reflecting the low level of control exerted by local public authorities on the organization of these businesses, the regulation of the distribution business being a national concern in spite of the municipalities owning the distribution networks. Finally, some tasks, like maintenance and reparations at the connection with high-voltage transport level or the connection to the high-voltage transport network, have been externalized to third parties. Thus, the reorganization of the French electricity distribution has mainly consisted in grouping those activities that are not intrinsically local at a higher level.

Compared to the UK and France, Germany is an intermediary position. On the one hand, large distributors, like E.ON (who was traditionally not operating directly in this

segment), have progressively reorganized their supply activities to form bigger regional entities. Starting from a pre-reform situation where E.ON was holding participations in independently operated regional distributors, E.ON progressively increased its share in these companies. In a second stage, these entities were progressively grouped within bigger entities. On the other hand, the municipal companies started externalizing some activities, creating for example a specialized company, Citiworks, a service company active in the management of network access and in balancing management. Thus, the German distributors have adopted different strategies of reorganizing their activities, depending on their possibilities to group activities in supra-local units and to externalize some parts of their business. This intra-German diversity also reflects the low intensity of national legal constraints on the organization of these businesses, probably due to the historical role of municipal utilities in a federal environment.

Modularity changes the way to analyse reforms. As illustrated by different European countries, in practice, distribution and supply activities can be reorganised in a variety of ways. In a competitive environment, distributors and suppliers adopt new strategies in their search for efficiency. Possible means to improve their efficiency include reorganizing their businesses. As shown by the actual practice, some operational sub-modules might be better and/or more efficiently produced by specialized service producers than by the distribution companies themselves. Sharing or externalizing activities⁹ enables the distributors to increasingly focus on their core business, the managing and running the network sub-modules. Nevertheless, realizing efficiency gains would require that there are enough external providers in the service markets. How do these transformations impact the public service characteristics of electricity distribution and supply? That is what the next section tries to explore.

⁹ As the French example shows it, EDF local business units share several activities

2. Policy implications of a modular separation of distribution activities

Before electricity reforms, distribution business has enjoyed the natural monopoly status without having to face the same efficiency requirements as today¹⁰. Therefore, imposing “public service” requirement to electricity distribution companies was relatively unproblematic. Service objectives could be imposed to the integrated distribution and supply companies, and the financing of the public service was less problematic in that uncompetitive environment. In the new organisation of the sector, the reorganization of activities questions the way of realizing public service (Brémond, 2003, FNCCR, 2004). We here discuss two dimensions of public service in electricity distribution and supply. The first one relates to the quality and continuity of supply, which requires some regulatory action. The second one relates to affordability of energy for small customers. Especially vulnerable customers must be protected as they probably benefit less from competition than the big customers. On these two dimensions, the realisation of public service objectives crucially depends on the characteristics of the regulatory modules of reforms.

2.1. Ensuring quality of supply

Service quality is an important issue in electricity distribution and retail and it is characterized as “*the measure for the ability of the network to continuously meet the demand from consumers*” (Ajodhia 2006). It has three dimensions (commercial, continuity and voltage quality) (Ajodhia, 2006; CEER, 2005) and it results from the interplay of several of our operational modules.

Quality of supply in the context of reorganisations of distribution and supply

Consumers are highly sensitive to all aspects of service quality: they value timeliness in dealing with their requests (commercial quality), the reliability of the electricity supply (continuity of supply), and also the characteristics of the supply voltage (voltage quality).

¹⁰ Jamasb et al. (2007) review the literature on post-reform efficiency improvements of electricity distribution.

Voltage quality (or power quality) is determined by the physical quality of the voltage waveform¹¹ (CEER 2001). This dimension is mainly influenced by the “Operation of the distribution network” module. Commercial quality is related to individual agreements between the distributor and the consumers¹². It is influenced both by the “Commercial customer services” and “Technical customer services” modules. Continuity of supply (or reliability) is results from the coordinated functioning of all sub-modules of the “Operation of the distribution network” module. From the three quality dimensions, reliability is generally considered the core value of electricity service provision, since any service interruption temporarily ceases the provision of electricity and therewith directly affects consumers. Service quality is also influenced by the regulatory modules we defined above. Both theory and empirical evidence indicate that when a regulator imposes revenue ceilings that are weakly related to realized costs, the firm’s incentives to deliver efficient levels of service quality may be lowered (Sappington, 2005; Ter-Martirosyan, 2003). Consequently, the price cap or revenue cap regulations have recently been supplemented by service quality regulation in several European countries (CEER, 2005) in order to protect consumers against quality degradation that might result from the reforms.

Measures to ensure quality of supply

Overviews of quality controls are contained in DTE (2002) and CEER (2001; 2005). Generally speaking, two classes of quality controls can be distinguished (Ajodhia, 2006). Firstly, indirect quality controls aim to provide consumers with information about the firm’s quality performance and create institutions through which these better-informed consumers can demand or pressurize the firm to deliver an appropriate quality level. The second class of quality controls concerns direct controls. The regulator provides the firm with direct financial incentives (penalties or rewards) in order to provide an appropriate quality level. Minimum standards and incentive schemes are both forms of direct controls. The main difference between the two classes of quality controls relates to the

¹¹ For example variations in frequency, fluctuations in voltage magnitude, voltage variations, waveform distortion, etc.

¹² Examples of such agreements are the conditions for connection of new consumers, “installation of measuring equipment, regular transactions such as billing and meter readings and sporadic transactions such as responding to problems and complaints” (Ajodhia 2006).

role of the regulator (Ajodhia, 2006). Under indirect controls, the role of the regulator is primarily one of an information provider between firms and consumers. In contrast, under direct controls, the regulator plays an active role, develops a view of what quality levels to aim at and provides the firm with incentives to reach these.

Generally, incentive regulation of distributors is made by imposing on the firms some requirements concerning efficiency improvements. For example, in the UK, this is done by imposing price caps which include an X-factor. However, this X-factor is generally set only on the basis of an assessment of the firm's costs. In addition regulators apply separate quality controls that aim to drive quality into desirable directions (Ajodhia, 2006). In practice, quality is often regulated through minimum standard requirements (CEER, 2005) as it is difficult to determine a "production function" of quality of service¹³ because of the influence of technical choices of the past (Glachant et al. 2006, Ajodhia 2006). Thus, the three dimension of service quality are related to the combined influence of regulatory and operational modules. Distribution service quality failures rising from the coordination of operational modules rely on load characteristics of the demand and on the structure of the network infrastructure itself (Doulet 1995).

In the UK, quality of service has been regulated through guaranteed standards of performance between 1990 and 2000. These standards entitle consumers to compensation if consumers breach them. Since 2000, the regulator introduced an incentive-based regime for quality regulation. However, designing these incentives is not an easy task. For example, in the UK, the regulator has treated Opex, Capex and service quality separately, which may provide firms with distorted incentives, as they were receiving greater benefits from saving Opex than by an equal amount of Capex (Giannakis et al., 2005).

¹³ For example, if a distributor would choose investing in two new substations on a distribution network branch (instead of one) the number of incidents on that branch could be divided by two. Furthermore, adding two automatic remote control switches on each network branch departure, could divide by three the number of incidents. As a result, the number of incidents will be diminished by $(2 * 3)$ and thus, the service interruptions will also be diminished. It is a typical quality of service level enhancement by investing in network components.

What effect of these measures?

In the context of reorganization of distribution and supply and incentive regulation methods, three informational problems play an important role (Ajodhia, 2006). Firstly, there is the problem of measuring quality. Clearly, if the regulator could not measure quality, it would not be possible to perform an integrated cost and quality analysis. The second problem is that of measuring the relation between cost and quality. Generally speaking, higher costs (e.g. more investments) will produce higher quality levels. However, quantifying this relation is complex as it may differ as a function of the location of the network and change over time. These spatial and temporal variations would need to be taken into account in the development of the price-cap scheme. Furthermore, quality costs would also depend on the output level of the firm as well as on the firm's productivity level. The third informational problem is that of measuring consumer demand for quality. Investments in quality would only be economic if this creates a net benefit to society i.e. consumer willingness to pay for quality improvement is larger than the costs of realizing these improvements. To identify whether this is the case and what quality level should be aimed at, information about consumer demand for quality is needed.

Investment is the key factor that allows the distributors to continuously respond to the consumers' demand. Thus, in the context of reforms, when regulators impose strong incentives to cost reductions (Fumagalli et al. 2007), the firms might have more incentives to reduce costs than to enhance (or even keep) the quality level of the service they provide (Hart et al., 1997) which makes the effects of reforms on quality of service mitigated. These effects are illustrated by the example of France, where local authorities own the network infrastructure, the franchisee network operator being EDF. The French municipalities have defined a model of franchise contract in cooperation with EDF. According to this contract, EDF is responsible for renewing all network parts and for reinforcing the high voltage parts of the network (HTA)¹⁴. The local authorities are responsible for renewing the low voltage parts of the distribution network (BT). This is

¹⁴ High voltage in France is the 20kV distribution network (HTA), while low voltage is the 400 / 230V network (BT)

coherent with EDF's main interest which is investing in the high voltage parts of the distribution network (HTA) since a supply interruption in this part of the network would affect more consumers than on the BT part. A first reason is that, on the HTA network, one of the network's starting points from the substation will supply at least 1.000 customers, while on the BT network such a starting point will only supply 40 – 50 customers (Glachant et al. 2006). A second reason is that, on the BT network, most of the incidents appear at the customer's connection level (customer's site) and can be repaired without cutting the line. This could also explain that the network operator can choose to make more frequent interventions instead of investing in this part of the network, thus preferring maintenance over investment. A third reason is given by the way EDF's level of quality is estimated. A same amount invested in the HTA network or in the BT network would not have the same effects over the quality indicators if these ones are a function of number of customers. Investing in an urban area would have a bigger impact on the average value of customer interruptions than investing in a rural area¹⁵.

In our modular representation of reforms, the reinforcement and the renewal are parts of a same sub-module, the "Network reinforcement/renewal". Separating responsibilities in the execution of a sub-module of remaining distribution business would ask for coordination between the entities responsible for each sub-module. As the "production" of service quality and its relation with the amount of investment is hard to evaluate, it could become difficult to designate the responsible for a possible deterioration of the quality of service. Therefore, the role of the regulatory modules is crucial in this configuration where different entities share the responsibility for quality.

The regulation of service quality is however still an ongoing method to be better apprehended (Ajodhia 2006). Regulating service quality is a difficult task for a number of reasons. Complications derive first from the fact that service quality is multi-dimensional. Second, the ideal level of quality depends on consumer preferences, and these can vary widely. Furthermore, measuring quality can be difficult since consumer behavior can affect the quality of the network (Ajodhia 2006, Doulet 1995). As a result, different means are used to induce regulated firms to deliver the desired levels of service quality in

¹⁵ The customer density is higher in urban areas than in rural areas.

different quality dimensions. When quality dimensions are observable by the regulator, the instruments employed to modify the firms' behavior normally include minimum quality standards and financial incentive schemes (CEER 2005).

2.2. Protecting small customers

The opening of electricity markets to residential customers in the EU since July 2007 raises the question of whether small customers will really benefit from the market opening. Experiences of countries having opened their electricity markets for residential customers for several years suggest that competition would not benefit to all of them. In the residential market, competition is most likely to benefit to the biggest customers, who are buying both gas and electricity (Mollard, 2007). These customers can benefit from competition by switching to a new dual fuel supplier. Besides this market segment, a large number of customers are less likely to benefit from retail competition. The poorer customers are especially vulnerable. First, they are less prone to switching supplier as they are less informed than other customers and also less attractive from the suppliers' point of view, and less likely to receive attractive competing offers. Second, they are also the most vulnerable to price increases¹⁶. Therefore, the public service in electricity should be especially directed towards these customers.

The rules concerning customer protection are part of our regulatory module "Regulation of retail markets". In Europe, there seems to be a consensus that a certain level of protection of small customers is necessary in liberalised electricity markets because competition alone cannot ensure consumers' best interests (Commission, 2007). The electricity directive of 2003 provides for the universal right to be supplied with electricity. In addition, the directive gives the Member states additional possibilities of imposing public service obligations to companies operating in the electricity sector. The responsibility of defining the precise public service obligations is thus a national one. We analyse what are the forms taken by these obligations in different European countries and discuss the current practices in the light of our modular framework.

¹⁶ This is reinforced by the weight of their energy bills in their budgets. In the UK, these customers are therefore a specific target for policies. Customers who have to spend more than ten percent of their income to heat their homes adequately are called "fuel poor".

The diversity of measures towards vulnerable customers

The European diversity of policies in favour of small customers is a logical consequence of the national specificities regarding electricity distribution and supply. To illustrate this diversity, we briefly present the policies towards vulnerable customers in three countries, France, UK and Germany.

In France, the modular reorganisation of distribution and supply activities has been characterised by the search of economies of scale in the module of “Commercial Customer services” and an organisational unbundling of distribution and supply. The measures towards vulnerable customers are principally directed towards customers with difficulties of payment. Before the market opening, the policies towards these customers were traditionally defined by the electricity supplier EDF and the local authorities¹⁷. During the last years, several legislative measures have been taken to formalise the protection of customers with difficulties of payment. A decree of the Ministry of economics¹⁸ defines the conditions under which consumers can benefit from a special social tariff (*tarif de première nécessité*, or TPN). Another decree of the Ministry of economics¹⁹ defines the procedure applicable to consumers in difficulties of payment. This decree is complementary with EDF’s internal procedures. In order to avoid disconnections of these customers, EDF proposes a minimum service²⁰ of energy supply, where the capacity of the customer’s installation is limited to 3 kVA. This procedure is complemented by the action of the municipalities’ social services, which can help the customers paying their energy bills, using funds of the solidarity fund FSL. This brief presentation show how France has developed more formalised mechanisms to help vulnerable customers during the last years. These new mechanisms are involving the legislator and the local administrations, which are now playing a more important role in

¹⁷ A special fund, the “Fonds Solidarité Energie” existed until 2004. The resources of this fund were used by the municipalities. Since 2004, it has been included in the “Fonds Solidarité Logement”, which is administrated at the level of the Départements.

¹⁸ Décret n° 2004-325 du 8 avril 2004 relatif à la tarification spéciale de l’électricité comme produit de première nécessité.

¹⁹ Décret n° 2005-971 du 10 août 2005 relatif à la procédure applicable en cas d’impayés des factures d’électricité.

²⁰ This service is called “Service de Maintien de l’Energie” (SME) and it restricts the customer’s consumption capacity. If the customer’s difficulties of payment persist, then his consumption capacity is further restricted, to 1 kVA. This mechanism is called “Service Minimum” (SMI).

addition to EDF. Thus, there is now a more formal regulatory activity in the regulation of supply conditions to vulnerable customers.

In the UK, the market opening for residential customers has started in 1999, leading to a reorganisation of the retail market. Some changes in the regulation supply markets, especially concerning vulnerable customers have been implemented at the same time, although one major change in the supply market occurred in the second half of the 1980s'. At that time, prepayment meters were introduced. These meters give customers a greater control over their electricity bills. The use of prepayment meters has also the effect of reducing the number of customer disconnections made by the suppliers, these disconnections being replaced by "voluntary" self-disconnections of customers. While the introduction of prepayment meters has mechanically reduced the number of disconnections, this does however not solve the problem of fuel poverty, which is very important in the UK. Since 2001, the British government has developed a fuel poverty strategy²¹ that aims at reducing the number of "fuel poor" customers until 2010. This is an illustration of the British reform strategy, which consisted in developing competition in the electricity sector, simultaneously increasing the regulatory oversight over this activity, by defining public service objectives for the sector. In addition to these measures, all suppliers propose social tariffs and have developed innovative "social" products to address fuel poverty (Ofgem, 2007).

Finally, in Germany, the measures towards vulnerable customers are neither developed by the distribution and supply companies²² like in France, nor by the regulator like in the UK²³. Therefore, the measures towards vulnerable energy customers are mainly implemented by the municipalities. These measures are not specific to energy

²¹ "(...) speedy progress was made on the issue of fuel poverty, with an inter-ministerial group being set up in 1999 and a fuel poverty strategy appearing in 2001, after a consultation process. The goal of this strategy (Department of Trade and Industry (DTI), 2001) was to seek an end to the problem of fuel poverty in vulnerable households by 2010. In broad terms this strategy aimed at improving the energy efficiency of fuel poor households, the maintenance of downward pressure on fuel bills, the encouraging of industry initiatives to help the fuel poor (presumably meaning tariff schemes and payment schemes) and general action to tackle poverty and social exclusion. The progress or otherwise of these policies was to be assessed by a Fuel Poverty Advisory Group, who would publish annual reports on the issues." (Graham, 2006)

²² With the exception of E.ON Bayern, who proposes a social tariff to customers with low incomes in his area since September 2006.

²³ In Germany, the regulator for energy is only responsible for the control of network access conditions and network tariffs.

consumption, but are part of a larger policy towards vulnerable households (especially pensioners and disabled). Vulnerable customers mainly benefit from payments from the municipalities in order to help them paying their energy bills. For example, in 2006, the monthly payment for electricity (excluding electricity for heating) has been fixed by the federal parliament at 20.74 euro per month for a one-person household (Dünhoff et al., 2006). In addition to these public measures, some voluntary measures (for example advice to customers) have been put in place at a local level especially by associations.

What effect of these measures?

In France, the objective of the new rules concerning vulnerable customers was to help the customers with payment difficulties. We have no national data concerning customer disconnection and the use of SME, SMI and TPN. However, Sipperec, which groups 80 municipalities in the region of Paris publishes data on the customers with difficulties of payment. The evolution of the number of beneficiaries of different support mechanisms suggests that EDF has made more use of all of these measures (Sipperec, 2007). During the same period, the number of supply interruptions has also increased. The increased use of support mechanisms as well as the increase of the number of supply interruptions between 2002 and 2005 suggests that the reorganisation of EDF's distribution and supply activities has led to a more severe application of the rules to vulnerable customers. However, another explanation could be a general increase of the numbers of vulnerable customers.

In the UK, the effects of the fuel poverty strategy are not so clear. On the one hand, the development of prepayment meters has led to a sharp reduction of the number of supply interruptions, from tens of thousands in the 1980s' to less than 800 in 2004 (Graham, 2006). But a significant proportion of these customers report self-disconnections from the network²⁴. On the other hand, the number of "fuel poor" has been drastically reduced between 1996 and 2004, from nearly 6.5 million households in 1996 to 2 million of households in 2004. But a part of this decrease has been a result of overall energy price decreases. Therefore, the number of "fuel poor" has again increased after 2004, reaching 3.5 million in 2006 (Energy Retail Association, 2007). However, the effects of the

²⁴ This proportion has been estimated at 24 % (Electricity Association, 2001)

electricity reform on the small and especially vulnerable customers could be limited, due to the parallel development of regulatory policies in favour of these customers.

In Germany, there exists no general evaluation of the number of “fuel poor” customers. The issue of fuel poverty is however an important one, given the large number of poor households²⁵ and the increase of energy costs. Between 1998 and 2006, the electricity prices for households increased by more than 26 %, while the public payments to vulnerable customers increased only by 7,2 % (Dünnhoff et al., 2006)

Customer protection in the context of reorganisations of distribution and supply

The previous discussion suggests that there exists a huge diversity of measures towards vulnerable customers. However, the process of competitive reform and reorganisation of distribution and supply businesses has been a source of additional threats for these customers who are facing increased energy bills. The effects of reorganisations of the distribution and supply business across Europe have not been examined in the literature. The example of the three countries we examined suggests that an effective protection of vulnerable customers needs a certain development of formal public regulations, i.e. obligations for the companies. But measures towards vulnerable customers also need to be implemented locally, as the treatment of each customer must be a personalised one. This increases the probability of success of these measures, which are sometimes difficult to implement²⁶ because of barriers to adoption.

The reorganisation of distribution and supply businesses thus raises different questions. One question relates to the strategy of grouping some activities, especially the commercial customer services, within large regional entities. If customer protection requires some proximity with customers, will suppliers still be able to adequately propose services to vulnerable customers if they are organised in large regional entities? Another question relates to the relation between technical customer services and commercial services in unbundled systems. The unbundling could for example impact the companies’

²⁵ In 2003, the number of “poor” people was estimated at 11 million (people below a poverty line, i.e. having a revenue below 938 euro per month) (Dünnhoff et al., 2006).

²⁶ For example, in France, only a part of the potential beneficiaries of the social tariffs (TPN) have actually used them.

behaviour of disconnecting customers. As the technical entities that disconnect customers for non-payment are not integrated anymore with the commercial services, the number of disconnections could increase due to the “agency relation” that now exists between the two services. Whether this really increases the number of disconnections has to be examined in practice. If this was the case, alternative methods for dealing with vulnerable customers (prepayment meters, or “intelligent” meters) should be examined further.

This discussion of the potential problems generated by a reorganisation of distribution also raises the question of the appropriateness of basing future customer protection rules on the use of market mechanisms (Commission, 2007). Of course, it is desirable to improve contract structures in order to allow customers to switch their supplier. However, some small consumers could prove unable to fully benefit from competition on the retail markets, and would thus be exposed to future price increases. Therefore, the protection of small customers remains an important question.

The examples of public service policies related to quality of supply and to the protection of vulnerable consumers show that separation of monopolistic and competitive activities could bring up coordination issues and divergence in interests of implicated parties. Unbundling of distribution and retail businesses should thus be accompanied by several regulatory measures. Firstly, a careful design of the regulatory modules is needed in order to ensure proper incentives to the network operator to maintain a given level of quality of supply²⁷ and to ensure public service for vulnerable customers. Secondly, our modular framework and the actual practice underline the need for coordination between modules and between companies taking part to the distribution activities. Specialized service producers of less specific modules (like “Commercial customer services” module, or the “Metering” sub-module) or sharing responsibilities for more specific modules (like “Network maintenance” sub-module) might be a way through achieving efficiency, but coordination among modules, including coordination among the parties’ interests should not be left aside²⁸. Thirdly, harmonising the regulation principles on these practices

²⁷ Cf. Sappington (2005), who suggests distinguishing whether this one is owner or a franchisee. Introduction of competition and regulatory requirements could also induce a more detailed control from the franchisor in the case the owner and the operator of the distribution network are not the same company.

²⁸ The example of rail industry in UK (Staropoli-Yvrande 2003) shows that pushing separation of activities to an extreme could not bring the expected results, as the separated modules of this industry were

would contribute to strengthening the public service dimension of these activities. However, as distribution and supply have strong national specificities, this imposes some limitations on the harmonisation of rules.

Conclusion

In this paper, we have proposed a modular representation of reforms in electricity distribution and retail. This representation is useful to examine the recent reorganisations of this segment of activity and their impact on public service issues. The identification of the properties of the different modules of distribution and retail allows to identify what are the main constraints on reorganising these activities. We have shown that these constraints relate to two factors. First, the fact that some activities have a strong site specificity. Second, the existence of coordination interdependencies among modules. Modularity suggests that the restructuring of these activities can be realized in many different manners, and sometimes go farther than what is imposed by the European unbundling rules. Therefore, there is still some divergence among European distributors concerning the way their activities are organised.

The type of modular approach we used also applies to some questions related to public service issues. For example, which entity will in fine be responsible for the quality of electricity distribution in a context where supply is separated from distribution and where different activities related to distribution are realized by different entities? Or: can a proper treatment of vulnerable consumers still be ensured when supply is organized within large entities without proximity to the consumer? In a context of unbundling and reorganisation of distribution and supply, the provision of public service in the form of a constant quality of supply and of measures of protection of vulnerable consumers, sometimes requires to adjust organisational forms in order to respond to these objectives.

Few studies have so far analyzed these issues. We are conscious that our findings are preliminary, and need additional empirical validation. Further analyses of the relationships between the organizational evolution of the distribution companies, public

reintegrated by the network operators for solving coordination problems that implied too high transaction costs and too many inefficiencies related to the losing too many scale economies.

service obligations, service quality, ownership, and managerial behavior are needed to shed more light on this relatively unexplored research topic.

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