UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE

ELECTRIC POWER INDUSTRY

Master's Thesis

ANALYSIS OF

DISTRIBUTION SYSTEM OPERATOR

UNBUNDLING

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Supervisor: David Trebolle Trebolle

Madrid, July 2014

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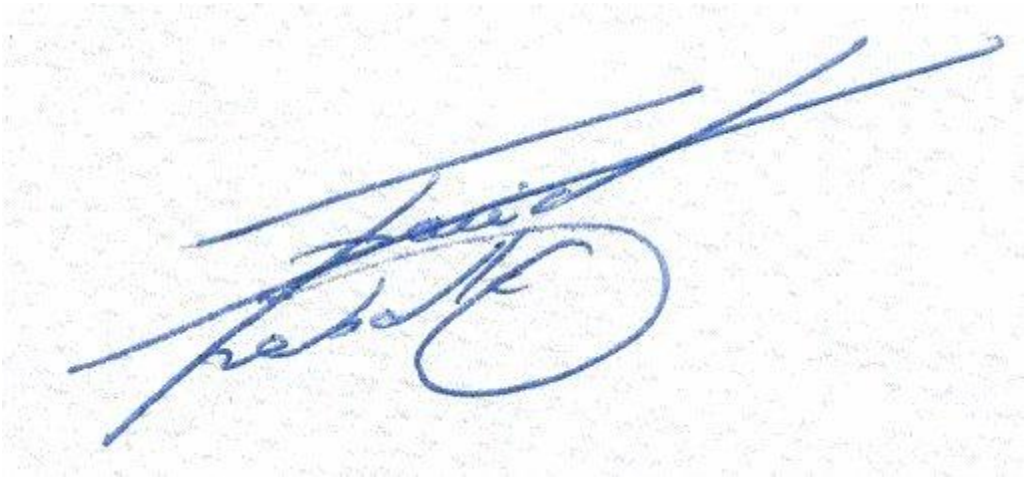

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Abstract

One of the key regulatory changes as consequence of the liberalisation of the electricity industry has been the unbundling regime. This organisation model aims to separate the potentially competitive core activities from the natural monopoly distribution and transmission activities and other coordination activities like system and market operation.

Since then, European Directives oblige Member States to adopt unbundling requirements in the electricity sector. In particular since the European Commission proposed the option of full ownership unbundling for Transmission System Operators (TSO), there is some uncertainty around Distribution System Operators (DSO) unbundling.

In light of all this changes, this Master Thesis reviews the regulatory and legislative context for unbundling in Distribution System Operators, in both Europe and Spain. Besides, identifies the current performance of distribution companies, mainly in terms of distributed power, customers served, market influence and compliance of unbundling requirements. Moreover, analyses how some particular countries have experienced the implementation of unbundling regime. All this experiences reveal a still clear insufficient level of Distribution System Operators unbundling and as a consequence a seriously limit on network operation effectiveness and market well-functioning.

In addition, a regulatory methodology is proposed for allowing Regulatory Authorities to monitor the unbundling process. This approach analyses the performance of current unbundling regime in the distribution business and provides regulatory changes when needed. A set of Key Performance Indicators (KPIs) and a benchmarking technique (Data Envelopment Analysis-DEA) are the tools identified to measure the companies' behaviour towards their organisation model. These tools provide regulators an acknowledgement of the performance of Distribution System Operators and rank the companies according to efficiency ratios.

To test the robustness of the methodology designed, a case study is carried out. In particular, this practical survey aims to contribute to the discussion on current model of unbundling in Spanish electricity distributors in comparison with other European distributors with both similar and different unbundling regimes. In this study, 10 Distribution System Operators, from 6 European Member States, are benchmarked by using DEA model. The results or technical efficiency scores rank distribution companies according to efficient frontier firms. The main two findings rated Legal Unbundling DSOs slightly more efficient in terms of costs, and Ownership Unbundling DSOs remarkable more efficient in terms of market orientation.

Finally, this report contributes providing regulatory recommendations. Structural target solutions are defined with the aim that Spanish distribution companies contribute to a competitive electricity market and at the same time allow them to operate under cost-efficient conditions with the aim of increasing their efficiency.

Resumen

Uno de los principales cambios normativos consecuencia de la liberalización del sector eléctrico ha sido el régimen de separación de actividades. Este modelo de organización tiene como objetivo separar las actividades competitivas de los monopolios naturales de distribución y transporte y otras actividades de coordinación como la operación del sistema y del mercado eléctrico.

Desde entonces, las Directivas Europeas obligan a los Estados Miembros a adoptar la separación de actividades en el sector eléctrico. Desde que la Comisión Europea propuso la opción de separación de la propiedad para los operadores de la red transporte (TSO), existe cierta incertidumbre en torno a los operadores de red de distribución (DSO) en materia de separación.

En base a estos cambios, esta Tesis de Master revisa el marco normativo y legislativo de la separación de actividades para los operadores de sistemas de distribución, tanto en Europa como España. Además, identifica el desempeño actual de las empresas de distribución, principalmente en términos de energía distribuida, clientes, influencia en el mercado y el cumplimiento de los requisitos de separación. Por otra parte, analiza cómo han experimentado algunos países la aplicación del régimen de separación. Todas estas experiencias ponen de manifiesto un claro nivel insuficiente de separación de actividades de los operadores de redes de distribución y como consecuencia un serio límite en la eficiencia de la operación de la red y en el funcionamiento del mercado.

Se propone por lo tanto una metodología que permita a los reguladores supervisar el proceso de separación de actividades. Esta metodología analiza el rendimiento del régimen de separación actual en el negocio de distribución y proporciona cambios regulatorios cuando sea necesario. Un conjunto de indicadores clave de rendimiento (KPI) y una técnica de evaluación comparativa (Análisis Envolvente de Datos-DEA) son los instrumentos identificados para medir el comportamiento de las empresas según su modelo de organización. Estas herramientas permiten a los reguladores conocer el funcionamiento de los operadores de redes de distribución y clasificar a las empresas en función de los ratios de eficiencia.

Para comprobar la solidez de la metodología diseñada, se lleva a cabo un caso práctico. En particular, este caso práctico tiene como objetivo contribuir a la discusión sobre el modelo actual de separación de las distribuidoras eléctricas españolas en comparación con otros distribuidores europeos con diferentes regímenes de separación. Para este estudio se han seleccionado 10 operadores de la red de distribución, de 6 Estados Miembros de Europa, y se compara su comportamiento utilizando el modelo DEA. Los resultados o eficiencia técnica clasifican a las empresas de distribución de acuerdo con las empresas que forman la frontera eficiente. Las dos principales conclusiones obtenidas son, por un lado los distribuidores con separación legal resultan ligeramente más eficientes en términos de costos, y los distribuidores con separación de la propiedad presentan una notable eficiencia en las variables del mercado.

Por último, este informe contribuye proporcionando recomendaciones regulatorias. Se proponen unos objetivos estructurales de separación de actividades para que las empresas de distribución españolas contribuyan a un mercado eléctrico competitivo y al mismo tiempo les permita operar la red en condiciones rentables, con el objetivo de aumentar su eficiencia.

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Chapter 1
Introduction

1. Introduction

1.1 Motivation

This Master Thesis under the title “Analysis of Distribution System Operator Unbundling”, was supervised by David Trebolle Trebolle and done by Maria Aurora Urbina Rodríguez with the aim of conclude the Official Master`s Degree in the Electric Power Industry at University of Comillas in Madrid throughout the academic year 2013-2014.

As the deregulation process has split the electricity product from the electricity service. A good well-functioning of this process involves clear rules of activities unbundling. It is known that the current unbundling regime still leads to an ineffective separation of networks from competitive activities. This provides an inherent risk of discrimination not only in the operation of the network but also in the competition of electricity markets.

Therefore, this report try to analyse the current state of unbundling regime in distribution companies and discuss what could be the most effective tools that ensure an effective unbundling as a key requirement for functioning electricity markets, achieve fair competition and finally a secure price and continuous service.

1.2 Objectives

The main final outcome of this Thesis will be focus on setting regulatory recommendations to Distribution System Operators about best structures that maximize the value of all stakeholders regarding electricity network unbundling requirements.

Therefore the Thesis aims to achieve following objectives:

1. Analyse if current distribution unbundling performance is fully satisfactory through the present state of electricity distribution in Europe and in Spain

2. Propose a methodology that allows the assessment of the unbundling regime in electricity distribution

    2.1. Identify the most accurate tool that supports the analysis of unbundling

    2.2. Identify the most suitable key indexes that give information about the unbundling performance.

The existing frameworks are not specified enough to serve this purposes. This constitutes a substantial research gap which needs to be clarifying in order to resolve the challenges outlined above.

1.3 Structure of the report

The report is organized in 7 Chapters and each Chapter in several Sections.

The study begins identifying the Master Thesis motivation and main objectives for getting the expected results. The unbundling concept and also the different degrees of separation set by legislation are defined in Chapter 2. Then, Chapter 3 set the state of art based on studies already developed in terms of unbundling in order to be updated with available progress and be able to establish proposals beyond current background. The present state of electricity distribution, from point of view of regulation and both for European and Spanish context is the subject of Chapter 4. This Chapter reviews not only legislation and what the current status of implementation is, but also tries to discover if current requirements will be enough to ensure an efficient network business unbundling based on practical experiences. Chapter 5 then define a regulatory methodology to assess the performance of current unbundling regime in distribution companies. Besides, a practical application of this approach is applied to a real case, allowing the development of regulatory guidelines and recommendations for the best performance of distribution companies.

Final conclusions are performed in Chapter 6. And Chapter 7 collects the references mentioned in the report and identifies the glossary to make easier the understanding of the report.

Chapter 2
Unbundling

2. Unbundling

2.1 Vertical and Horizontal integration

Historically, energy utilities have been vertically integrated since their origin. It is likely to be due to, at least in part, the need of coordination among production stages that characterize their technology. This is especially evident for electricity, for its nature of non-storable good, it is necessary to have a constant balance between demand and production. This goal is probably less hard to achieve under a vertically integrated structure. However, the recent regulatory tendency is to promote vertical unbundling of the transmission and distribution network, which still show relevant natural monopoly features, from production and trade side.

If the existence of a sufficient number of competitors is essential for the development and maintenance of effective competition in any industry, also in the case of the electrical sector, the effective separation between regulated activities (transmission and distribution) and competitive ones (generation and trading) in case of vertical integrated companies, has been used as a solution to avoid anti-competitive behaviour of the incumbent firm and becomes relevant for the development of competition. On the other hand, the integration of companies, that belongs to the same kind of business, lead to decreasing the number of effective competitors in the market, developing the appearance of practices to fix prices or splitting market shares.

How companies are organised and behaved should be regulated, because directly affect the market structure, therefore also impact on the level of market competition and finally on the economic performance. The efficient economic performance of a market is based on preventing anti-competitive behaviours or modifying the structures that favour them.

When a firm operates in different branches of the same industry, but remaining at the same level of the production chain, it is called horizontal integration (either between generation or distribution products for instance). In many cases horizontal integration is mainly related to multi-utilities, as a way to foster competition. Whereas referring to vertical integration (between generation and network business for instance) means that a firm operates at successive levels in the production chain. Both cases are shown in following figure [Figure 1].

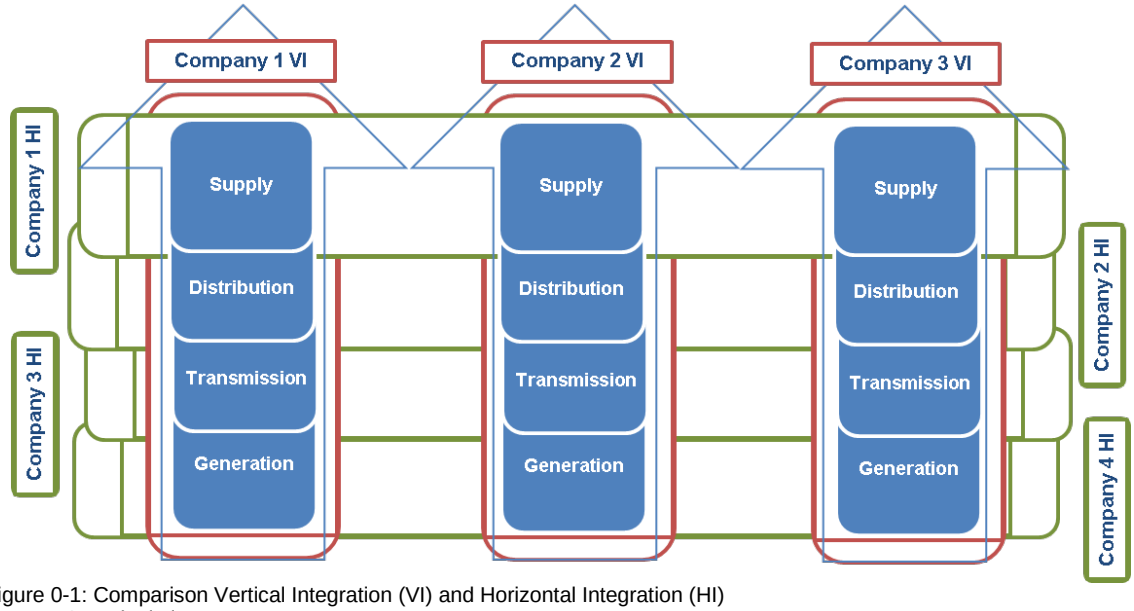

Figure 0-1: Comparison Vertical Integration (VI) and Horizontal Integration (HI)
Source: Own depiction

Thus, vertically integrated companies tend to hinder the entry of new competitors. On the one hand, may develop the ability to perform cross-subsidies between regulated activities and the activities carried out in a competitive scenario. Furthermore, a vertically integrated company could be incentivized to favour its own competitive business, leading to uncompetitive behaviour for their competitors.

Horizontal concentration could be partially mitigated by creating a large number of competitors, for instance splitting large companies into smaller units, decreasing the level of market power. This intervention was implemented by UK in the 90s, and it seems to be the most effective way when new entries are blocked.

However, the efficient number of firms operating in the market and their degree of vertical integration mainly depends on economies of scale. Thus, if the economies of scale associated with operations and product diversification are limited or negligible, splitting firms in smaller units in order to create a sufficient number of competitors, have a positive effect on market performance. By contrast, if these economies are significant, splitting into smaller units lead to less production efficiency that could undermine the expected benefits of creating a more competitive market functioning.

The regulator should assess the potential increase of efficiency resulting from the introduction of competition, as a result of a possible vertical or horizontal unbundling, outweighing the costs due to loss of economies of scale and diversification.

Both, vertical integration and horizontal concentration benefits are related to improving coordination in system operation and investments and reducing transaction costs. But not always, as stated before, this kind of concentrations lead to improvements but also could lead to anti-competitive behaviours.

A high level of concentration together with vertical integrated electrical companies remains one of the most important problems of the Spanish electricity market, due to the opportunities for anti-competitive behaviours that companies might adopt.

Present report will be focused on the definition and evaluation of vertical unbundling from electricity distribution point of view. From now on, when unbundling is mentioned refers only to vertical unbundling.

2.2 Description and types of Unbundling

Liberalised energy market requires an appropriate market structure where an effective competition can be promoted. In a market, where some activities are potentially competitive but others, such monopolistic network, an undesirable opportunistic behaviour could be created and physical monopolist networks tend to abuse of its control to discriminate between production and trading activities from its competitors. This discrimination can take several inconveniences such as technical barriers, manipulated access tariffs and capacity availability, etc.

In order to increase equality in market access and mitigate the incentives for discriminating against competitors, it is necessary both to unbundle the transmission and distribution activities from its core activities of production and supply.

"Unbundling" means the "process of breaking apart something into smaller parts." This concept could be used in different contexts, also regarding electric power industry, due to rules adopted in the liberalisation process of electrical sector. The aim of unbundling in this case is to separate the potentially competitive core activities from the natural monopoly distribution and transmission activities and other coordination activities like system and market operation.

Competitive core activities include generation and trade business, whereas network functions refer to both distribution system responsible for operating, maintaining and developing a secure, reliable and efficient electricity distribution system and also to transmission system responsible for ensuring a secure, reliable and efficient electricity system and the availability of all necessary ancillary services.

For the purpose of allowing for more competition, welfare-enhancing, and to prevent vertically integrated companies, the European Commission (EC) has required its Member States to separate their network activities from generation and retailing business. These requirements are based on three main Directives for common rules on electricity markets. Besides, these regulations seek for an unbundling regime that should be effective in removing any conflict of interests between producers, suppliers and network operators. Also, should be effective in creating incentives for necessary investments and guarantee the access of new market entrants under a transparent and efficient regulatory regime.

Those alternatives have been proposed in response to the changing needs of the electric power industry as it moves from a structure of vertically integrated monopolies to one of unbundled undertakings. Although each of these types has different configurations and

responsibilities, they do share common functional objectives that respond to the needs of today's increasingly competitive environment. A comparison between different possibilities of unbundling, from a vertical integrated scheme to fully unbundled company, is shown on following figure [Figure 2].

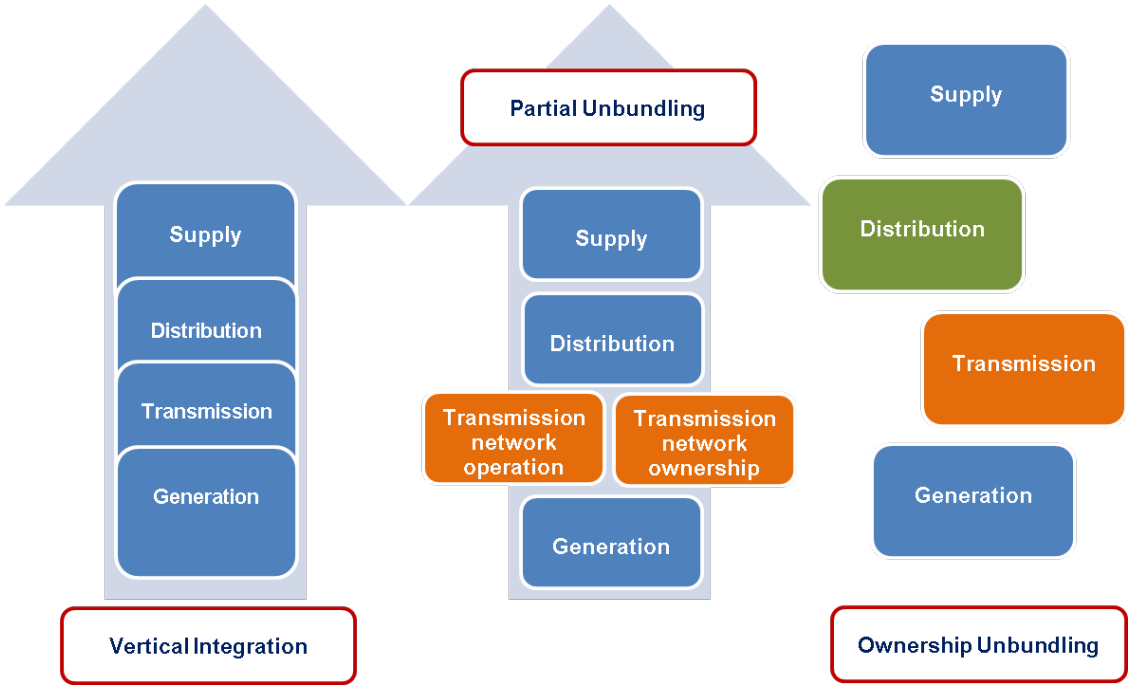

Figure 0-2: Comparison of unbundling organisation models
Source: Own depiction

According to the European Directive 2003/54/EC (Second package of Directives), the time for national transposition requirements vary with respect to transmission and distribution. Transmission System Operators (TSOs) were to have been legally unbundled as of July 2004, whereas the deadline for Distribution System operators (DSOs) is July 2007. This means that, in theory, the unbundling of transmission and distribution networks should be finished, but in some cases is still in progress.

Then, towards Third Energy Package of the Directives [Directive, 2009], unbundling provisions at this time have to be complied with by March 2012. Since then, transmission business must decide whether to implement exclusively the Ownership Unbundling (OU) model, or leave to the TSO a choice between the different models required for them (ISO or ITO). European Commission relies on OU, as the effective and stable way to solve the inherent conflict of interest and to ensure security of supply, and the most effective tool to promote investments in infrastructure in a non-discriminatory way, fair access to the network for new entrants and transparency in the market.

2.2.1 Types of Unbundling

The EC obliges Member States from a partial (functional and legal) separation to a complete (ownership) unbundling, taking unbundling the form of different types and degrees of separation [Figure 3]:

i. Accounting unbundling is the least drastic form of unbundling. Separate financial accounts must be kept for the network activities and core activities to prevent cross subsidization, but shared operational activities under one company;
ii. Functional or Management unbundling requires, in addition to keeping separate accounts, the separation of operational and management activities. Staff is assigned to different business divisions that function independently from other business activities, but could be still managed from a central holding;
iii. Legal unbundling requires that network and core activities be put in separate legal entities. Common ownership of network and generation assets is allowed as long as the grid is operated by an independent affiliate in a non-discriminatory way. Also, means that network activities shall be independent in terms of its organisation and decision making from the other activities not related to distribution. It is a less rigorous measure where network activities are organised in a separate legal entity, which might, however, function in a holding company together with production and sales activities;
iv. Ownership Unbundling (OU) is the most drastic form of unbundling. Competitive and network functions have to be owned by independent entities, so does not belong same holding. These entities are not allowed to hold shares in both activities. Although is the most rigorous regulatory measure because entirely separate network from other stages and prohibit a company that manage grid to produce and sell electricity, it is considered as the most effective approach from EC.

Ownership Unbundling of electricity and gas networks has recently become a key issue in European energy market liberalisation. Some countries are in the process of extending Ownership Unbundling even further, to electricity and gas distribution networks (in Europe for instance the case of The Netherlands),as happened in 1999 in New Zealand with the creation of independent electricity distribution network companies.

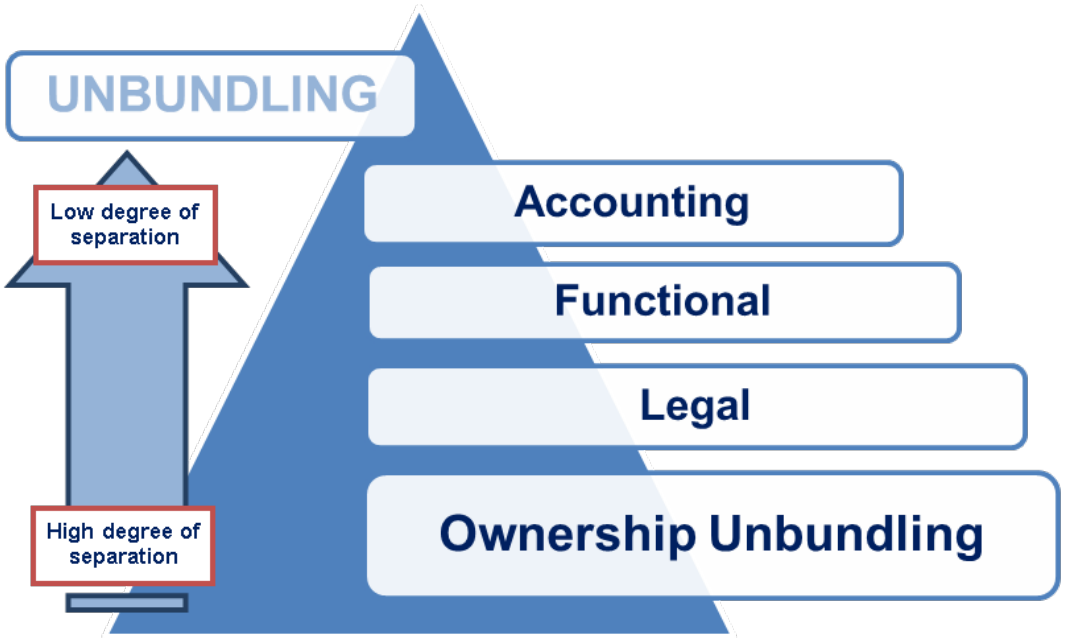

Figure 0-3: Comparison of unbundling regimes
Source: Own depiction

For Distribution Networks in particular, unbundling requirements are currently focused on legal, functional and operational separation from other actors in the supply chain, known as legal and functional unbundling regime. In essence distribution companies must be independent at least in terms of its legal form, organisation and decision making from other activities not related to distribution to ensure that they are preventing from taking advantage of their vertical integration competitive position on the market. Those rules shall not create an obligation to separate the ownership of assets of the distribution system operator from the vertically integrated undertaking.

By contrast, for Transmission Networks, unbundling requirements focus on whether to implement Ownership Unbundling (OU) regime, where no supply and production company would be allowed to hold a majority share in a Transmission System Operator (network own and management), or leave to the TSO a choice between Independent System Operator (ISO) where the supply company can still own the physical network and leave the entire operation, maintenance and investment to an independent company or Independent Transmission Operator (ITO), in this case the supply company can own and operate the network, but the management of the network must be done by a subsidiary of the parent company.

Unbundling requirements are mentioned towards Energy Package of Directives. In particular the [Directive, 2009] describe different unbundling organisation models for distribution companies as follows: legal and functional unbundling is the minimum requirement for distribution, as defined by Article 26. For the unbundling of distribution systems, is defined a threshold of exceptions for companies with a limited number of clients (100.000 customers or less) or small isolated systems, as stated in Article 26, and for companies operating closed distribution systems, as stated in Article 28. Although quite common, the separation between transmission and distribution is not mandatory; the

rules set in Article 29 concerning the combined operator have to be respected. An adequate transparency in the regulated activities also requires at least accounting separation among the corresponding business units. Concerning unbundling of accounts, Article 31 establishes the rules to ensure that the accounts of electricity undertakings keep separate from network activities to other electricity activities.

Although the Energy Package Directives do not require Ownership Unbundling, 16 European countries [Table 1] have applied this extreme model to their TSOs. However, regards DSO unbundling, the large majority of countries have fully implemented Directives provisions. In some countries, beyond these requirements, DSOs have decided to function as single ownership unbundled system operator [Künneke, 2006]. The most common models continue to be legal unbundling and unbundling of accounts. In contrast the separation of transmission system operators has generally been stricter than for distribution system operators, and more countries have applied ownership regime.

Unbundling Regime	Number of European Member States
TSO Ownership Unbundled	**16** (BE;CZ;DK;EE;FI;DE;IT;PL;PT;RO;SK;SI;ES;SE;NL;UK)
DSO Ownership Unbundled	**6** (BE;BG;IT;RO;NL;UK)
DSO Legally Unbundled	**22** (AT;BE;BG;CZ;DK;EE;FI;FR;DE;HU;IT;LT;LU;PL;PT;RO;SK;SI;ES;SE;NL;UK)

Table 1 : Unbundling model of electricity TSO and DSO in selected Member States
Source: Own depiction, data from EC (2012c)

Regarding international experiences where unbundling is required by law, until now, only New Zealand has implemented such mandatory requirement. In New Zealand Ownership Unbundling did not have the desired result regarding particular features of electricity market, however, also leads to economic and functioning improvements [Nillesen, 2010].

In Europe, the current level of unbundling is still insufficient ([CEER, 2013] and [Pérez-Arriaga, 2013]) to ensure a competitive market, so Ownership Unbundling in electricity distribution is an idea for the coming future and should it be necessary for an open-competition electricity system.

Chapter 3
State of the Art

3. State of the art

3.1 Unbundling: main literature

Concerning unbundling, the Energy Package of Directives regulates the whole process of unbundling in the EU. Several possibilities do exist in order to achieve the desired level of unbundling. This section deals with those publications, which are related to research papers focused on this topic and particularly on unbundling process apply by distribution companies and electrical companies.

There is some literature available on unbundling. However, the majority deals with transmission networks unbundling, or with vertical integration between generation and retail. Present section is mainly focused on research papers based on unbundling process required and carried out by distribution companies.

In 2004, [Oliveira, 2004] discussed how deregulation of the power industry followed different paths worldwide and also how specific aspects related to politics, economic and regulatory rules of each country has had influence on the performance of competitive models applied to electrical sector. For doing that it is established a comparison between developed and developing countries. Developed countries were more successful in applying market in electricity sector, but, in contrast, developing countries have a low consume per capita and a high charge growth of energy demand due to industrialization, but in relation to the electricity market competition faced some difficulties. Finally is recommended that only with a strong governmental presence and an effective regulatory body could be possible to ensure successful deregulation process and create good market mechanisms.

Later in 2009, in line with deregulation process, [Vasilyev, 2009] described structural changes in deregulated power systems which should take place if current trends and conditions remain in order to avoid disadvantages of network business as natural monopolies like higher prices and lower capacities. Monopolistic guarantees for network, non-discriminatory network access, distributed generation and renewables promotion are the main structural changes identified. Conclude suggesting that regulation of network business should be modified to postpone and soften the structural changes and to prevent corresponding inefficiencies.

However, the unbundling regime does not depend only on economic and political country framework but also depends on the degree of separation between network and competitive stages of the electricity value chain. [Lindemann, 2011] identified the optimal unbundling regime, between legal and ownership unbundling regime, from regulators point of view. This might lead to assume that the final decision on the unbundling regime is made at management level in every country, so Niskanen’s theory of bureaucracy

(budget-maximizing model) as well as the concept of Public Service Motivation (PSM) show that authorities with a higher PSM tend to opt for Legal Unbunding as the regulatory regime, whereas regulators with more selfish goals implement either Legal or Ownership Unbundling.

Focusing on Europe, unbundling provisions are considered as one of the main changes which took an active part in deregulation process, [Koten, 2008] assigned categorical values to different forms of unbundling and analyses how this variable responds to changes in the measure of integrity of legislative and regulatory processes through the Corruption Perception Index (CPI) as an assessment instrument. It is shown that the degree of unbundling is reduced with increasing corruption in European countries, so countries that are more corrupt are more likely to have chosen weaker unbundling regimes, which facilitates the continuing existence of large utilities that are effectively still integrated. However, the paper suspects that in order to fulfil the accession criteria to the European Union it was much easier especially for very corrupt candidate countries to pretend a high degree of unbundling rather than really implement it.

Following Europe case, as explicitly stated Directive 2009/72/EC [Directive, 2009], ownership unbundling is not required for Distribution undertakings. However, Dutch government have opted for ownership unbundling because consider that legal unbundling incurs too many competition problems. In this way, [Künneke, 2006] addressed the merits of ownership unbundling of electricity distribution networks and how the liberalisation of the electricity sector can become as an important instrument to preserve the public utility orientation of distribution networks. [Baarsma, 2006] conclude establishing that without an explicit cost–benefit analysis, any unbundling beyond what is required under European law would not be fully advisable. Later [Nooij, 2009], across a welfare analysis of ownership unbundling, revealed that the Dutch Act dealing with unbundling is more likely to decrease welfare than to increase welfare, also established that ownership unbundling might increase the vertical integration of generation and supply, which would cause competition to decrease. Conclude suggesting that previous statements make unbundling an unattractive measure, and raises the question why unbundling is nevertheless being pursued. Also mentioned that could be a risk that the regulator protects the interests of the regulated parties, instead of the public interest.

Although legal and functional unbundling were accepted in their positive impact, the European Commission concluded that these regulatory reforms are not sufficient to contribute to certain energy political goals. Further steps of unbundling such as ownership unbundling in case of distribution companies or an Independent System Operator (ISO) or an Independent Transmission Operator (ITO) in case of transmission system operator, are seen appropriate to stimulate competition, promote investments, and accelerate the evolution towards an integrated European energy market.

In many instances, the liberalisation goals have been achieved, but due to some market failures the whole restructuring effort was questionable and some authors like [Chao, 2006] concludes that a significant cause of failure has been the rule to unbundle vertically integrated utilities without sufficient consideration of alternative ways to manage the risk of

electricity market restructuring. Therefore is proposed a customized solution between vertical integration and unbundling.

For that reason, among others, some authors analysed the impact of ownership unbundling. Particularly, [Gugler, 2012] tried to identify the effect of ownership unbundling on investments and final consumer prices. This paper shows that before testing the relation between investments, prices and regulation in a regulated industry, unbundling reduces the investment rate in the sector. They also highlight that the way of competition introduced has important consequences, such introducing competition via market based measures increases aggregate investment spending. In contrast via cost based access charges or ownership unbundling creates a negative effect on investments.

In the same line, other authors compare the impact of legal unbundling and ownership unbundling. [Bolle, 2006] show that ownership unbundling leads to a more effective regulation, although causes the problem of double marginalization, which implies price increases in the long run. Overall, they find that the negative effects of double marginalization outweigh the positive effects in such a way that legal unbundling becomes preferred to ownership unbundling. [Cremer, 2006] point out that ownership unbundling is more detrimental to social welfare than legal unbundling due to the higher incentives for investments under legal unbundling. When legal regime applies, other parts of the company can still benefit from investments made by the formerly vertically integrated company, which is not the case under ownership unbundling. In a similar approach, [Höffler, 2011] confirm the previous findings and show that the desirable properties of legal unbundling with special regard to social welfare and investment incentives can only be achieved if there is a strong, effective and independent regulation.

Up to now no evidence of positive effects of ownership unbundling on prices or market concentration exists, nor is there any econometric evidence on its effects on investment incentives in energy markets. Nevertheless, several studies cover the impact of regulation and liberalization. [Steiner, 2001] deals with the effects of liberalization on consumer prices, finding that unbundling, without any distinction between legal and ownership unbundling, leads to increasing efficiency for the overall sector, however, the possible benefits are not necessarily passed on to private consumers via lower prices. Contrary this research line, [Hattori, 2004], who examined the economic impact of the regulatory reforms in the electricity supply industry; find that unbundling appears to increase electricity prices.

One recent report [Pérez-Arriaga, 2013], which has developed through THINK project, given a review of present state of electricity distribution in Europe, sets that one of most serious obstacles to retail competition in many distribution markets is an insufficient level of unbundling. The report claims that the lack of retail competition in this context is mainly due to insufficient degree of unbundling in DSOs. Therefore recommends the implementation of an unbundling regime, called as “Chinese walls”, between distribution and supply activities, since many such organizations belong to the same utility. In line with that suggestion, some Member States, such as The Netherlands ([Künneke, 2006] and [Baarsma, 2006]) and at international level New Zealand [Nillesen, 2010], have

already obliged to distribution companies to adopt the Ownership Unbundling regime, leading in some cases not to achieving the desired levels at structural organisation and market functioning side.

The Council of European Energy Regulators (CEER) monitors the status and implementation of the DSO unbundling requirements. Recently, [CEER, 2013] shows that unbundling at DSO level remains insufficient, even though a vast majority of European countries have already transposed the Third Energy Package of Directives into their national law. In many countries, the rebranding of DSOs is the main outstanding issue, which leaves scope for improvement and which have to be addressed further.

According to the Agency for the cooperation of Energy Regulators (ACER) Annual Report [ACER, 2013] the lack of adequate unbundling is one of the main barriers to entering retail markets. If unbundling is not applied correctly or fully implemented, this might result in the unequal treatment of market participants, including easier access to infrastructure or the better treatment of consumers of an affiliated company, and creating barriers to entry for new suppliers in the retail market.

3.2 Unbundling: beyond the state of the art

Because competition is believed to be welfare-reducing, European Directives requires Distribution System Operators (DSOs) to facilitate competition, which is effectively a vehicle for opening up distribution networks and for providing and equitable access to the energy market.

Recent studies indicated that the main motivation to vertically separate an integrated firm is to mitigate market power and discriminatory behaviours, so the network operation and control needs to be completely independent from the production and commercial activities. However, some studied reports and publications by scientists identified that unbundling has a number of advantages (increases competition, prevents cross-subsidies, etc), as well as a number of disadvantages (costs), insisting on making clear the ratio between the economic impact and market benefits. All conclusions presented by articles reviewed are relevant if the European debate on the ownership unbundling of distribution grids really takes off.

Therefore, further research regarding the economic and technical efficiency of Distribution System Operators unbundling will be critical and useful, not only to the success of the European Internal Electricity Market but also for the given European tendency to further strengthen the independence of the networks.

In order to cover the research gaps identified, this paper contributes to literature assessing how the unbundling impacts in the market functioning and also in the network operation. So, this paper, for evaluating that correlation, defines a set of Key Performance Indicators and compute a linear programming based on Data Envelopment Analysis (DEA) to benchmark the best practises from DSO under unbundling regime.

Chapter 4
Present State of Electricty Distribution

4. Present State of Electricity Distribution

4.1 Regulatory and legislative framework in Europe

Since early 1990s, the regulatory context of the electricity industry has begun to change. Structural, regulatory and market reforms have been applied in many countries around the world. Common features involved were the breaking up of monopolies, the introduction of competition in generation and supply, the privatisation of state owned utilities, the creation of wholesale electricity markets, the unbundling of network functions, the freedom of choice for consumers of electricity and the incentive regulation of networks.

Also European Member States have faced the restructuring process through the implementation of the European Commission Directives mainly focused on establishing a single internal electricity market which involves an open, competitive, well-connected and regulated electricity market that would be more likely to attract investment and enable consumers to better control their energy use and cost.

This restructuring process is commonly known as Electricity Market Liberalisation. Liberalisation requires a suitable market structure where effective competition can be fostered. Generally, this involves restructuring the sector by unbundling vertically integrated activities and the withdrawal of the state from involvement in infrastructure industries. The reason lies in the fact that competition leads to promote innovation, flexibility and efficiency in the production as well as competitive electricity prices and consumer protection.

According [Jamasb, 2005], the European Electricity Market Liberalisation is considered as one of the most extensive reform of the electricity sector involving the integration of distinct national electricity markets. However, efforts to create well-functioning and integrated competitive markets have revealed many significant challenges. By way, restructuring and competition reforms still remain a work in progress in most of European countries.

The following regulatory and legislative review is mainly focus on DSOs and the corresponding requirements on unbundling. It is not the intention to make any deeply statements on the unbundling of TSOs, neither regarding to wholesale and retail markets.

4.1.1 Motivation for change

Before liberalisation, electricity industry in most European Member States was traditionally dominated by monopolies and characterised by vertical integrated companies performing the different stages of supply chain: generation, transmission, distribution and retailing. However, in some countries centralised state-owned monopolies prevailed while in others the industry was dominated by private decentralised companies. But commonly, the

sector at this time behaved so concentrated because firms do not compete since each firm act as a monopolist in its own market.

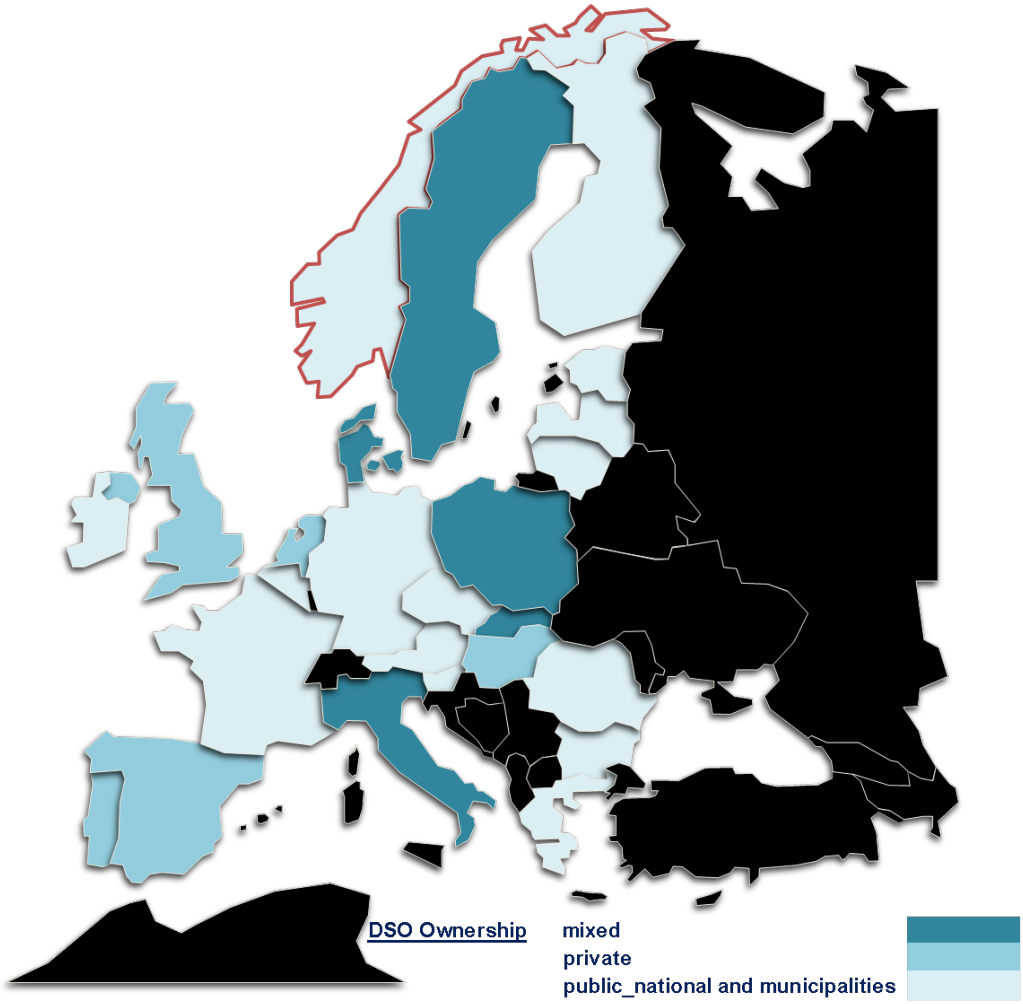

Figure 0-4 : DSO ownership before electricity liberalisation
Sources: Own depiction. Data from: (1) Power Distribution in Europe. Fact and figures [Eurelectric, 2013]
(2) Study on Unbundling of Electricity and Gas Transmission and Distribution System Operators
Annexes - Country Overview [Gomez-Acebo & Pombo, 2005]

As previous graph showed [Figure 4], some countries decided to nationalised fully (FR) or partially (DE, ES, IT, SE) their electricity companies under the assumption that a state owned enterprise do not maximise profits, but should lead to greater consumer welfare. Contrary, those countries who aimed to maximise it profits focusing on pricing, functioned as private but regulated monopolies and took advantage of regulation to reduce impacts on consumer welfare (UK). But, regardless of whether electric utilities are public or private, vertical unbundling becames a requirement at European level in 1996 [Directive, 1996].

Due to a consistent pattern of problems among European countries, most of them connected to the lack of competition, including strong barriers to entry in the market,

higher than necessary prices, inefficient production at higher average cost and lack of investment, market concentration and monopoly structure of the network industries, began to be questioned. In the early 1990s, European Commission started to work to change the traditionally monopolistic energy markets into a market integration programme. In the middle of 1990s, the fundamental assumption was that competition should be widely introduced and most of Member States began the process of deregulation and privatisation. From regulated distribution companies, privatization, unbundling and incentive based regulation mechanism were considered the most relevant changes carried out.

4.1.2 Regulatory reform

Following the beginning of the liberalisation of the energy markets, the European Commission insisted on the need of an adequate electricity market regulation. The market opening in a competitive way required the reduction of national monopolies, keeping it only to those activities that are monopolies by nature. Clear, strong and proper regulation contributed to offer customers protection and better prices and to allow new entrants into the liberalised competitive markets.

The regulatory reform was constituted by the enforcement of European Directives together with other supporting Regulations, whose requirements will be detailed in following sections. The three Energy Packages are all about creating a single and uniformed electricity market, increasing competition and efficiency as well as ensuring secure electricity supply.

Generally, regulatory reform is firstly focused on functional and accounting separation of regulated network functions from competitive business, introduction of competition in generation, and expansion of network access. More advantages stages of reform tend to include the formation of electricity spot markets for electricity price determination and trade, legal unbundling provisions for network business and unconstrained choice of supplier. The final stages of reform aimed to take the ongoing process even further to improve the functioning of the internal electricity market, empowering independent national regulatory authorities and by establishing the Agency for the Cooperation of Energy Regulators (ACER) to ensure effective cooperation between national regulatory authorities and to take decisions on cross-border issues.

The time and scope of regulatory reforms varies considerably across European countries. However, the regulatory reform generally requires common interrelated issues to stimulate competition in the same way.

In most cases **network access** takes the form of regulated Third Party Access (TPA), thus the legal obligation to provide network access under non-discriminatory conditions. Before liberalisation, network access was limited due to the power exercise by monopolies.

Another regulatory effort is the introduction of **consumer choice of supplier**. Some countries have introduced consumer choice for large consumers (UK) gradually, while others introduce full consumer choice immediately after the adoption of electricity sector reform (SE).

To allow price determination by the equivalence of supply and demand, **electricity markets** were introduced. The first electricity market in Europe was established in UK in 1990 as a mandatory requirement. Some years later, in 1996 Nordic countries established an optional requirement to create electricity markets, and in particular, Sweden, Norway, Finland and Denmark participate in the first international electricity markets, The Nord Pool.

The **degree of vertical integration** also plays an important role in the introduction of competition, as one of main objectives of liberalisation process in electricity supply industry. Regulatory reforms claimed for vertical separation, mainly based on legal, functional and accounting unbundling from network activities to production and supply. The separation is crucial to encourage competition in order to avoid discriminatory prices, access to the network and information for competitor use of the grid and therefore higher costs.

Independent regulatory intervention, mainly designed to avoid market failure caused for these remaining monopolies structures, appeared to guarantee that all competitors have access to these markets as well as to control how economical resources are allocated in the monopolistic part of the sector. Each European Member States is supervised by its **National Regulatory Authorities (NRAs)**. Furthermore, at European level, platforms for regulatory cooperation were developed, such the Agency for the Cooperation of Energy Regulators (ACER) created by the Third Energy Package to further progress on completion and market integration enhancing the harmonisation of regulatory frameworks. ACER is supported by the Council of European Energy Regulators (CEER) where national regulators cooperate and exchange best practice for the creation of a single, competitive, efficient and sustainable European internal energy market.

4.1.3 Legislative framework in Europe

The liberalisation process of energy markets in Europe started with the adoption of Directive 96/92/EC [Directive, 1996] concerning common rules of the internal market in electricity, which is part of the First Package of electricity and gas Directives, born to create a common, competitive and integrated market framework improving the functioning and the efficiency of both sectors.

In order to accelerate market opening even further and to correct the imperfections of the first Directive, the First Package of Directives was repealed after the adoption of the Second Energy Package [Directive, 2003]. The reason lies in the fact that unbundling requirements did not guarantee independence of network access whereas the negotiated third party access option offered the incumbent companies a way of keeping out the

competitors. Furthermore, there were no provisions and possibilities for competitive producers to find a market for their electricity, especially in a country with a dominant production and retailing positions, because Directives did not require a wholesale market to be set up.

As stated before, despite reform provisions, barriers to free competition and limited possibilities to exercise customer choice still remained. These obstacles led the European Commission, in their power of monitoring the success and level of competition implemented, to launch an inquiry in 2005 into the functioning of the European single market for electricity and gas. In its final report, in 2007, EC highlighted a number of structural problems in energy markets that remain from the pre-liberalization, which tried to be solved by introducing new legislation. Particularly in respect of unbundling, EC identified that the current provisions were inadequate because of the existence of an inherent conflict of interest system in the vertical integration of supply and network activities.

Based on this sector inquiry, EC proposed the Third Energy Package, which includes the Directive 2009/72/EC [Directive, 2009] for electricity markets, finally adopted on June 2009. The significant reforms introduced, in this case, were the implementation of stricter **unbundling rules** designed to ensure effective independence of the network business from the rest of the vertically integrated energy utilities and the establishment of the European Regulatory Authority as a new body to coordinate the actions of the NRAs enhancing regulatory transparency.

This present section illustrates those provisions set out by European Directives for electricity markets, paying special attention to unbundling provisions imposed for distributions companies. Therefore, considering for the purpose of this study, the relevant measures that affect directly or indirectly DSO liberalisation, are only the ones that will be examined hereinafter.

As mentioned before, the first legal step towards liberalisation was the adoption of the **First Electricity Directive** [Directive, 1996] which entered into force on February 1997. The implementation of the First Electricity Directive made important progress in connection with the development of the electricity market and market opening.

Regarding distribution systems, the Directive established that Member States have designate a system operator to be responsible for operating, ensuring the maintenance and developing the distribution system in a given area avoiding discrimination between system users particularly in favour of its subsidiaries or shareholders. It is a reference for the operator known nowadays as **Distribution System Operator (DSO)**.

From unbundling side, the First Electricity Directive required **accounting and management unbundling** to avoid cross-subsidisation, distortion of competition and at the same time enhance transparency in the market. Against the risk that integrated companies use their ownership of the network to unfairly give advantage to their generation and retail businesses, the mentioned measures require some corporate

separation from competitive to non-competitive activities. Since DSOs had to be designated to determine access to the networks and could be part of companies with other interests in the electricity sector, network companies had to prepare separate accounts for their network activities to demonstrate that any generation or retail activities were not being unfairly subsidised by their network activities. Furthermore, to comply with these requirements, DSO must ensure an audit and publish their annual accounts in accordance with the rules of national law. But the parent company, when applies, remains with supervisory rights to approve the financial annual plan and set limits to its level of indebtness.

Regarding network operator and particularly with the extension of the **access to the network**, the Directive 96/92/EC proposed measures to ensure all competitors would be able to get non-discriminatory access to the network. There were different access options, from a Negotiated TPA where the access and price are subject of negotiation, to a Regulated TPA where access to the network has to be granted at published tariffs and also the form of Single Buyer which require a central agency to be responsible for the purchasing of the country's electricity using some form of competitive process. However, the First Electricity Directive regulated only general principles, so member states had the opportunity to considering an ample scope to determine national legal framework. The different options of negotiating network access provide companies too many ways to ensure non-discriminatory access to the networks without guarantee of ensuring the opening of their networks. Although the Directive not directly addresses the issue of ownership, through the unbundling regime, indirectly require that dominant national ownership would inevitably have to move to privatisation but integrated companies needed to do no more than make an accounting separation between their networks to enhance the breaking up of dominant companies.

There was **no requirement for a sector regulator**, so it seemed unlikely that market abuses of competing companies would be monitored sufficiently to allow competition. All these approaches created inconsistent implementation of the Directive among the member states, and consequently competition were distorted.

As a consequence of the weaknesses identified from First Package of Directives, the **Second Electricity Directive** [Directive, 2003] passed reflecting the experience gained from the implementation of First Directive. This Directive was mainly focused on ensuring a full access to the networks, and accelerating the competition and market opening. Unbundling vertically integrated electricity activities, competition in wholesale and retail market, monitoring transmission and distribution networks, compulsory regulated third-party access to the energy infrastructure and regulated access tariffs, were part of the requirements to further liberalising the energy sector.

In respect of **unbundling** required, as a minimum standard, not only the accounting separation imposed by previous Directive, but also a **legal** separation of DSOs from the rest of the industry, suggesting that both positively contributed to the emergence of liberalised energy markets. This means that DSO activities had to be carried out by legally separate companies and shall be independent in terms of its organisation and decision

making from the other activities not related to distribution. Although distribution companies could be under the same corporate ownership as a company active in competitive functions, they have to be legally distinct companies without the obligation to separate the ownership of its assets. To comply with this requirements DSO managers must be capable of acting and making decisions independently, ensuring the absence of orders regarding day-to-day operation from the integrated electricity undertaking. To follow up that all this requirements are committed, DSO shall develop a **compliance programme** to set measures able to monitor the non-discriminatory behaviour and to establish the responsibilities of employees to meet this conduct. An annual report should be published and submit to regulatory authority responsible for monitoring this report. Besides, to ensure that the unbundling obligations are fulfilled, the Directives required the creation of **information barriers** between supply and network activities, mainly for avoiding the discriminatory usage of the commercially sensitive information obtained in the course of carrying out its business.

The independence in terms of legal, organisation and decision making that must follow DSO, not apply for integrated electricity undertakings serving less than 100.000 connected customers, or serving small isolated systems.

Also, this Directive promoted market competition by stronger network access, removing the **network access** options in favour of an access regime based on prior publication of access tariffs and also by established an **independent national regulatory body (NRA)**. Member States were required to designate a sector regulator with a minimum set of competences, fixing tariffs for ensuring non-discrimination and fair market prices, effective competition and well-functioning of the market.

The Directive 2003/54/EC was passed in order to eliminate deficiencies of the previous Electricity Directive, but still was not explicit on market power mitigation and wholesale electricity markets. In respect of distribution companies unbundling, as it was previously mentioned, the operation of the network must be carried out by a legally distinct company. However, the problem lies in a fact that this company can still be owned by an entity involved in electricity generation and/or electricity retail, thus the removal of conflict of interest was not fully guarantee.

As a consequence of the results obtained by the Sector Inquiry outlined before, it was recognised that the measures introduced in the Second Directive were insufficient to address the deficiencies of the internal energy market. For that reason, in September 2007, the EC proposed the **Third Energy Package** for the electricity [Directive, 2009] and gas markets which was adopted in June 2009 and it is the one that applies until now. This package consists of two directives and three regulations:

(i)Directive 2009/72 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC,
(ii)Directive 2009/73 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC,

(iii)Regulation 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation1228/2003,
(iv)Regulation 715/2009 on conditions for access to the natural gas transmission networks and repealing Regulation 1775/2005 and,
(v)Regulation 713/2009 establishing an Agency for the Cooperation of Energy Regulators (Regulation 713/2009)

This legislative package born with the aim to further liberalise the electricity and gas markets in Europe increasing the interconnection between national energy markets in order to improve the functioning and integration of the energy markets. The proposed package also seeks to address the insufficient level of network operations unbundling, the strengthening of the independence of regulatory powers, the decision making by NRAs on cross-border issues and the transparency of energy market operations and consumer protection.

Although in case of **unbundling** measures from DSO does not fully vary respect to Second Directive, the Third Directive insist on ensuring that their activities should be monitored by regulatory authorities so they cannot take advantage of its vertical integration to distort competition. For first time, the Directive refers to **communication and branding,** establishing that vertically integrated distribution system operators shall not create confusion in respect of the separate identity of the supply branch of the vertically integrated undertaking.

Despite of this report is not focus on TSO unbundling, but as this legislative proposal pay special attention on effective unbundling at the transmission level, the TSO unbundling is treated in an exceptional way. The Directive 2009/72/EC required the separation of transmission network, this means that no supply or production company active anywhere in Europe can own or operate a transmission system in any Member State, but the shareholding is allowed and limited, whose sole duty would be the collection of dividends; however they can neither vote nor appoint directors. The Directive proposed to Transmission System Operators different separation models: Ownership Unbundling (OU) and for those companies vertically integrated the Independent System Operator model (ISO) and the Independent Transmission Operator model (ITO). The OU model refers to the situation where transmission system operator and network owner must be completely separated from the vertically integrated company. This is fully unbundled from the rest of the system and owns and operates transmission assets. Under the ISO approach, network assets remain the property of the integrated company, but the operation is separated and not subjected to the control of vertically integrated company and the network owner. Finally, the ITO model is designed as a system where the transmission system operator remains within the vertically integrated company but with the related asset in its own possession. Under this regime the transmission system operator must not have shared services with the parent company nor should it transfer confidential and sensitive information to the generation and supply branches of the integrated company. The Directive ensures that Ownership Unbundling at transmission level could be the most effective tool to promote investments in infrastructure in a non-discriminatory way, fair access to the network for new entrants and transparency in the market.

Regarding the submission of a compliance programme by DSO, the Third Directive named the **compliance officer** of the distribution system operator as the responsible for assessing the behaviour and well-functioning of the DSO. The compliance officer shall be fully independent and shall have access to all the necessary information of the distribution system operator.

Moreover, it is introduced the concept of **closed distribution system**, such as a subcategory within the category of a distribution systems are related to the industrial level. These new structures integrate the networks on industrial sites.

While regulatory authorities were required to be wholly independent from the interests of the electricity industry, and thus from having any relationship with energy industry interests, political independence was not mandatory. Consequently, under the Third Electricity Directive, **national authorities have to be legally distinct and functionally autonomous from any other public or private entity**. In addition, their staff and any member of their decision-making body must act independently from any market interest, and must not seek nor take instructions from any governmental or private body. Besides, the European Agency for the Cooperation of Energy Regulators (ACER) is being established to complement the regulatory task of the national level and which is completely independent from the European Commission, national governments and energy companies.

So far and after a transposition period of two years, the provisions of the new Third Electricity Directive mark the latest regulatory stage to improve the operation of the internal energy market through the improvement and integration of competition in the electricity sector. Although the Third Package has not introduced ownership unbundling on the distribution level, however, several arguments for further unbundling of DSOs are evident, so a Fourth Package might have to address this issue.

Following figure [Figure 5] shows the timeline of Directives that cover Unbundling provisions and other regulatory reforms in which DSO are involved.

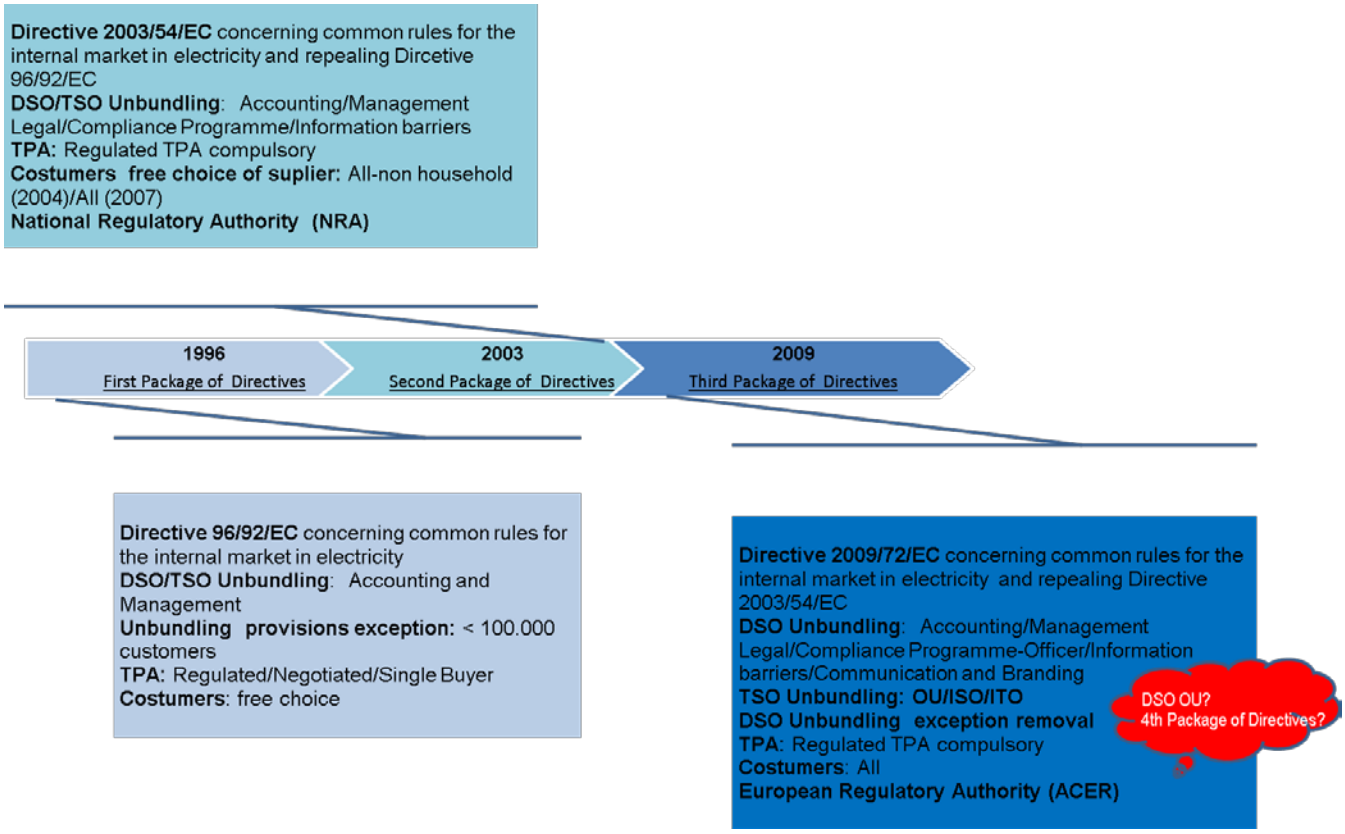

Figure 0-5 : European Directives Timeline and Key Aspects
Sources: Own depiction

4.1.4 Current situation: unbundling and network business

To show the current state of European DSOs, a number of Member States, accounting for more than 85% (2.415 TWh) of total distributed power in Europe, were selected (EU-15).

Considering the regulation of electricity distribution activities and the current organization of distribution sectors throughout Europe, around 2.400 [Eurelectric, 2013] (around 2.000 from the selection EU-15) electricity distribution companies operate and provide services for the European distribution network to connect transmission facilities with end users. The unbundling provision applies, at least, to those companies with more than 100.000 customers. Thus, approximately, 190 [Eurelectric, 2013] (165 from the selection EU-15) DSO in Europe shall be independent in terms of its organization and decision-making from other activities not related to distribution.

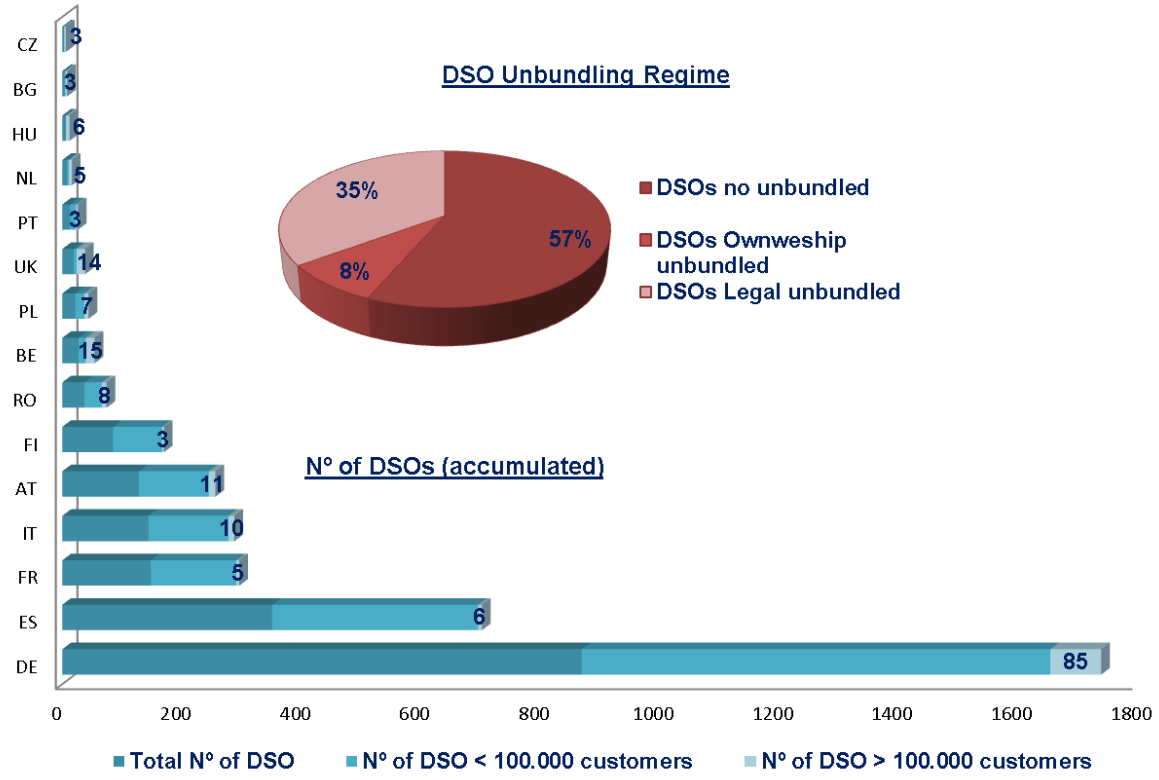

Figure 0-6 : Number of accumulated DSOs and unbundling regime in selected Member States
Sources: Own depiction. Data from (1) Think report [Pérez-Arriaga, 2013] and from [EC (2012c)]

An existing common structure is a consequence of the natural monopoly of the activity and obligations placed on DSOs across Europe by the European Commission. However, as [Figure 6] show, there is a huge variety of DSO across Member States in principle in terms of size, number and regulatory schemes. Over 35% of Europe DSOs, from EU-15 selected countries, following European Directives have already implemented unbundling provisions required and around 8% have decided to implement a stricter level of unbundling (NL, UK, BE, BG, IT and RO). Thus, in fact, in most European countries national monopolies were replaced by new private companies, but full ownership separation has been almost left and therefore most distribution networks are remained own by the vertically integrated utilities under legal, accounting and functional separation. The remaining 57% of companies are those that have not jet transposed the European Directives or, in case they have done it, still remain with a lighter level of unbundling than legal separation (such as accounting and/or management level) or under the decision to be excluded of unbundling provisions. With the exception of HU and CZ, from selection EU-15, there are DSOs providing electricity for less than 100.000 customers. These companies (<100.000 customers) account only for 8% of electricity distributed and 7% of total electricity consumption across selected countries [Figure 7].

From DSO unbundled side, only 5 countries (ES, NL, DK, FR, IT), out of selection of EU-15, which only accounted 8% of total number of DSO unbundled of this selection, cover more than 40% of distributed power across selected countries (EU-15) and serve more than 46% of total connected customers (EU-15). By these figures, the intention is to

highlight that regardless the number of DSO, the power distributed and also the number of connected customers provides the real information about the system. Although the number of DSOS out of unbundling provisions appears to be a cause of concerning, it might be, if only considering the number of DSO but, in fact, that approach does not lead to represent a relevant amount of distributed power neither connected customers, at least in Europe case. As graph below show [Figure 7], **only 4% of total DSOs serving more than 100.00 customers, cover more than 90% of electricity distributed and more than 90% of total electricity connected customers**. This suggests that unbundling rules and particularly DSO unbundled in Europe becomes a key issue, dealing with a relevant network market share, particularly in terms of physical operation, such as distributed power and electricity connected customers.

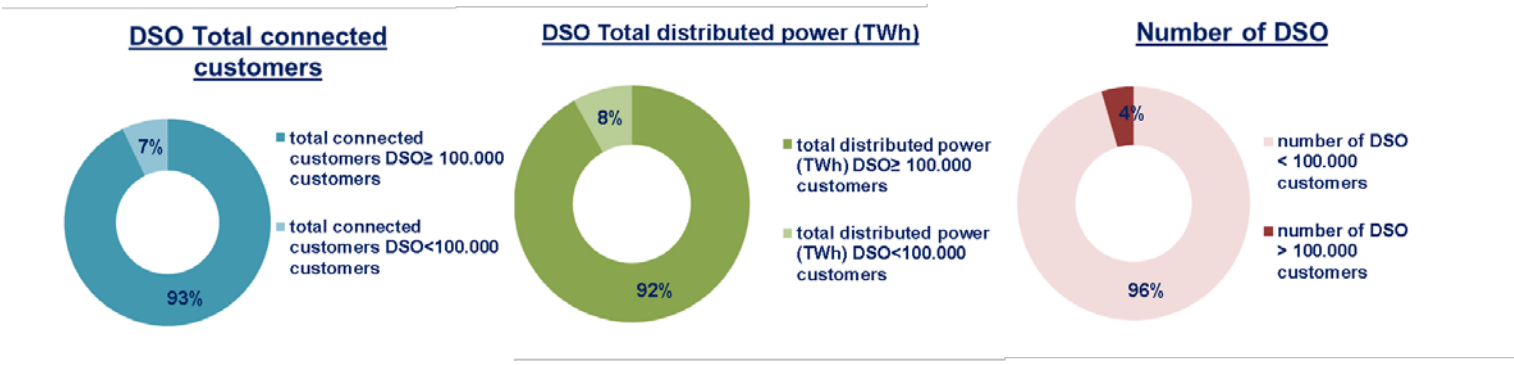

Figure 0-7 : DSO total connected customers, distributed power and number of DSO in selected Member States
Source: Own depiction. Data from [Eurelectric, 2013]

Although Directives have determined the course to develop a single vision of electricity market in Europe, regulatory and legislative mandates, so far, still not get the expected outcomes and benefits initially set. The majority of shortcomings identified, from the existing regulation, are those related to retail markets, regulated prices and network unbundling.

Regards retail market prices, great disparities still exist in electricity price levels among member states, for both households and industrial consumers, and around 60% of Member States [ACER, 2013] still applying regulated electricity prices, in most cases below market prices, hampering competition and encouraging cross-subsidisation among consumer groups, towards entry barriers for new suppliers and disincentives to switch supplier. Although the link between retail electricity prices and distribution grids seems not to be particularly strong, the share of distribution costs represents less than half, approximately an average of 30% [Figure 8], of the customer's electricity bill, suggesting that the regulatory framework of DSOs has an impact on electricity prices in Europe. But, only in six countries does it account for more than half of the consumer bill. Variations in retail prices between Member States can be explained, among others, by differences in network costs and taxation. However, it seems that even if consumers are willing to switch, the part of the final bill that they can potentially influence (energy component) by switching supplier is often not the one with the highest impact on the total bill.

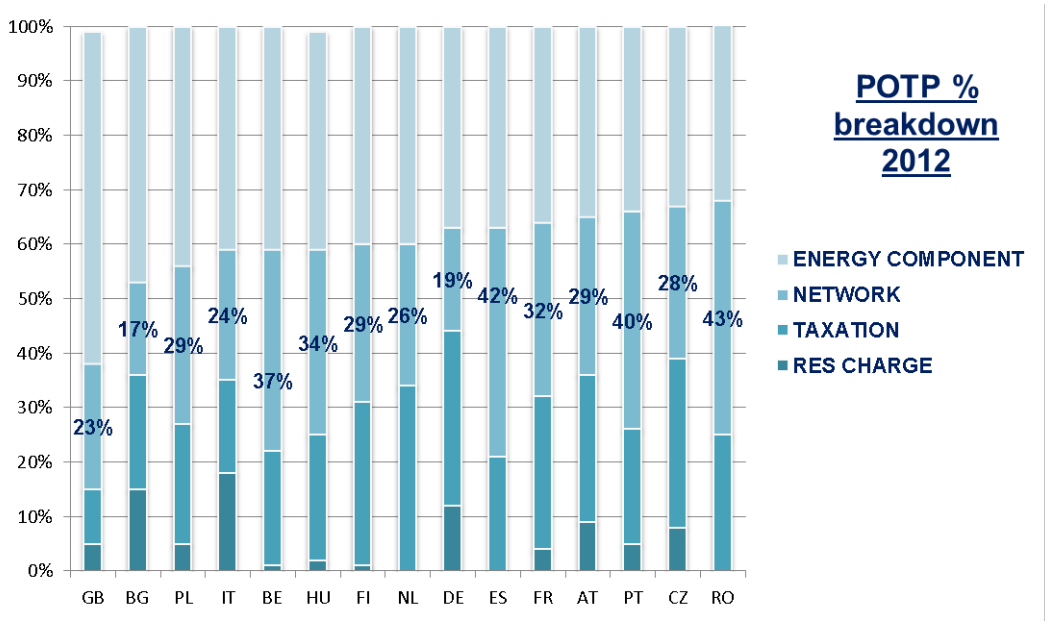

Figure 0-8 : Post-Tax Total Price (POTP): breakdown of components in % in selected Member States
Sources: Own depiction. Data from (1) [ACER, 2013]

In addition, the consumer switching behaviour provides also useful information on the level of competition in the market. In this line, switching rates in Europe vary widely, as show [Figure 9], and most of European countries still present a quite low range, hampering in some cases the market opening in search of competitive framework. The average switching rate for household consumers of selected countries (EU-15) was, between 2011 and 2012, equal to 5.7%. Some of these countries (BG and RO) had no switching at all. Low switching rates for consumers or switch very minimally or not at all can be partly explained by the application of regulated prices for household consumers. On the other hand, just those countries (UK and NL) that have applied stricter level of unbundling appear, at the same time, to have the highest level of competitive activity regarding switching behaviour.

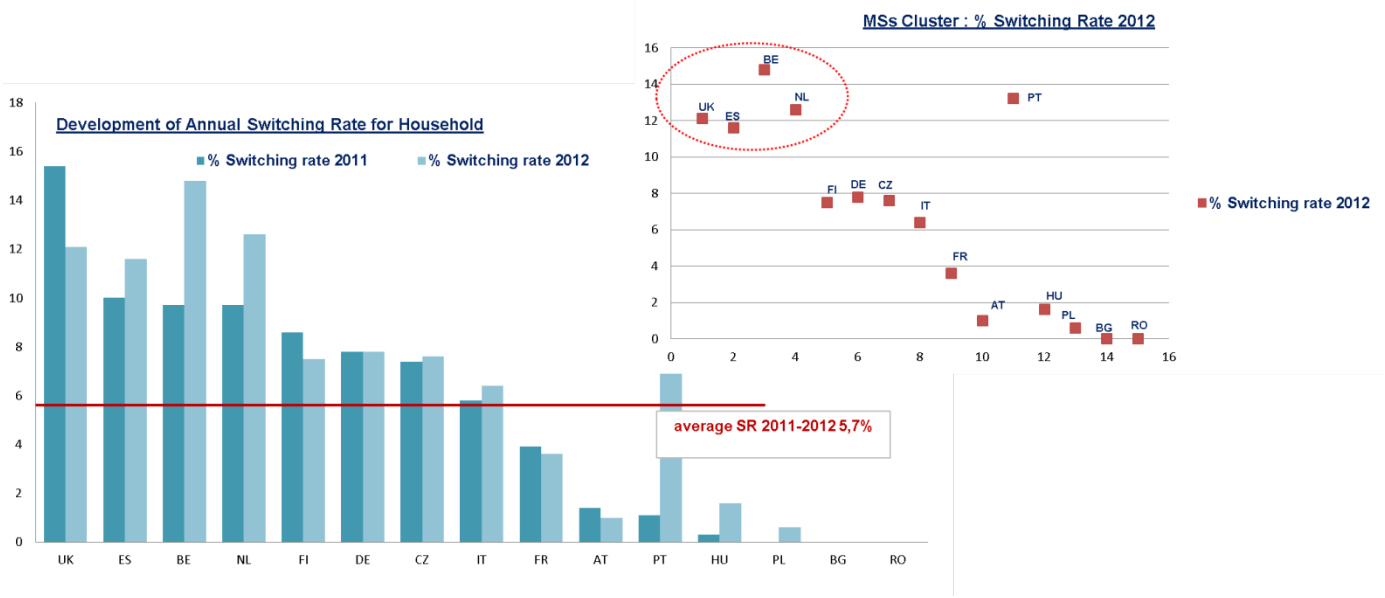

Figure 0-9 : Development and Cluster of Annual Switching Rate for Household 2011-2012 in selected Member States
Sources: Own depiction. Data from (1) [ACER, 2013] based on CEER national indicators database (12/9/2013)

As [Figure 10] show, high level of concentration can be evidenced by the fact that only around 20% of Member States (DE, BE, DK, AT, SE, FI), show low concentration values in terms of distributed power, given by the three largest DSO accounting less than half of total distributed power supplied. By contrary, a high level of concentration on DSOs is confirmed by the fact that there was a moderately concentrated market in most of Member States, where a small number of DSO, even a unique DSO, serve the majority of the total power distributed, between 60-80%, in this country.

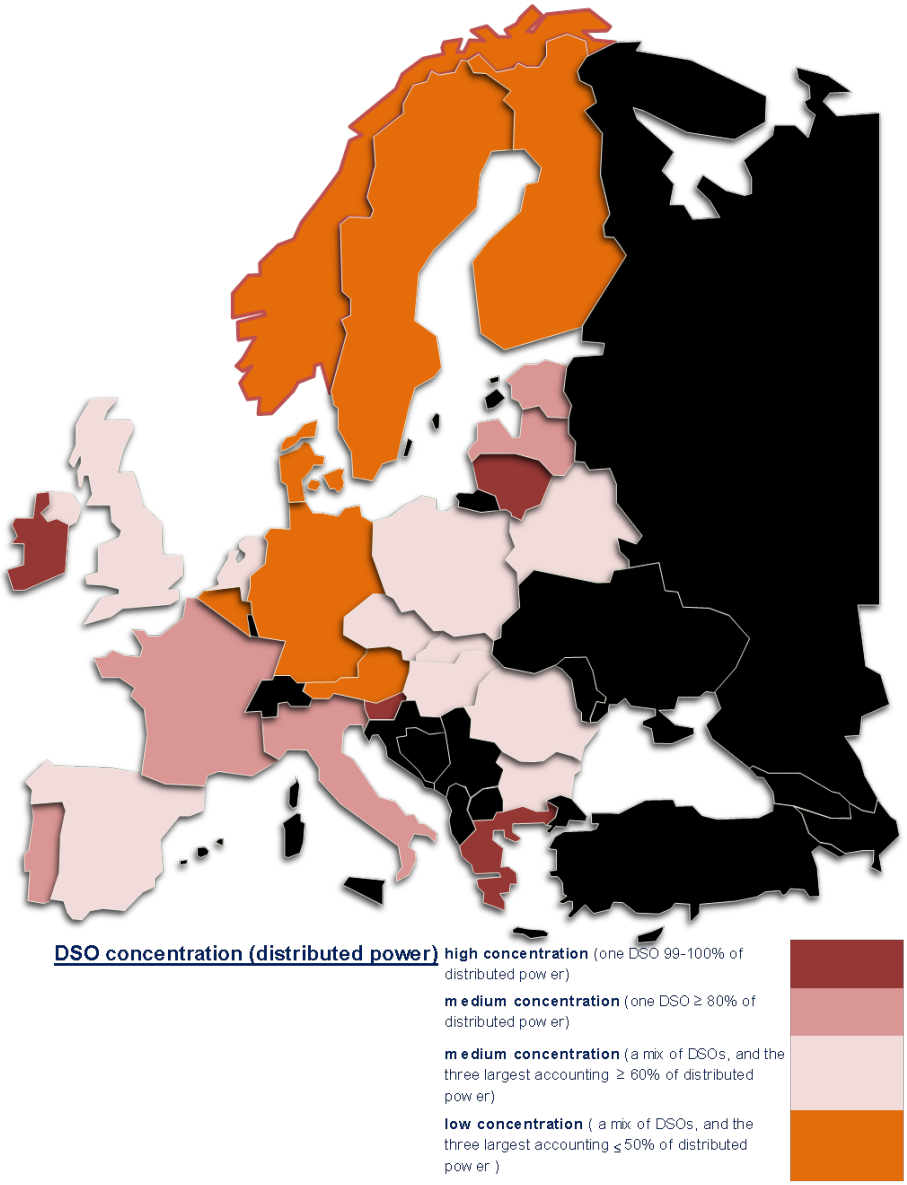

Figure 0-10: DSO market concentration based on distributed power supplied in selected Member States
Sources: Own depiction. Data from: (1) Power Distribution in Europe. Fact and figures [Eurelectric 2013]

As evidence abovementioned data, if unbundling is not applied correctly or fully implemented across Member States, this might result in the unequal treatment of market participants, including easier access to infrastructure or the better treatment of consumers of an affiliated company, and creating barriers to entry for new suppliers in the retail market, leading to higher retail market prices and lower switching rates. But actually, unbundling of the electricity activities should benefit end users by lowering the retail prices through higher competition among suppliers and more efficient monitoring of network costs. According to [CEER, 2013] *DSO "shall act as "entry gates" to retail markets in most countries, making them an important influence on the level of competition as well"*. Therefore, effective DSO unbundling is a prerequisite for promoting further retail market competition, by ensuring that companies belonging to a group do not benefit from the group's infrastructure business despite the potential incentive to do so.

4.2 Regulatory and legislative framework in Spain

4.2.1 Motivation for change

The evolution of the Spanish energy market needs to be understood in the context of European legislation. For that reason key aspects of European energy context are mentioned previously.

Before liberalisation, both types of utilities, privately and publicly ownership coexisted, but the market was highly dominated by one state-owned company. Utilities were vertically integrated, but the transmission function was separated from them and managed by one company under public shares. The creation of a company only for managing transmission network in 1985 was an early step of operationally separate national transmission system and system operator, the first country in the Organisation for Economic Co-operation and Development (OECD) to do so. Distribution companies operated in a franchise area, with power to abuse their position and raise charges prices.

In 1988, the government partially sold its shares in the country's largest utility and also reduced its shareholding in the national transmission company.

The Ministry of Industry and Energy, as the energy regulator at that time, carried out both energy policy making and the main regulatory activities of setting tariffs and negotiating with the utilities on energy matters. The National Energy Commission (Comisión Nacional de la Energía-CNE) as independent electricity advisory body from the Ministry contributed to the reform process but have few regulatory powers.

As stated before, the main deficiencies of Spanish electricity sector were the high level of concentration and the absence of an independent regulator, which constituted an obstacle for an efficient and transparent market design. The market power could be mitigated either by competition from imports, by new entrants into the Spanish market, or by structural reforms of the dominant firms. For that reason, and also with the aim to comply with European Directives, the Spanish government decided to start working on liberalisation.

4.2.2 Regulatory reform

In the network side, the access to the transmission and distribution networks is based on regulated third party access to ensure non-discriminatory access. Two different roles were created, on the one hand the market operator in charge of economic operation of the system and the determination of the dispatch merit order in collaboration with the system operator responsible for the technical operation of the grid. Both operators might act independently. Legal, accountant and functional separation of regulated network businesses (transmission and distribution) into distinct operationally separate companies from competitive businesses of generation and retail supply was also required.

In electricity distribution, cost-of-service regulation was replaced for incentive based regulation, allowing companies be remunerated according to their operational performance promoting the reduction of energy losses and the improvement of quality of supply.

During the transitional period, production companies in the sector received a compensation or "costs of the transition to competition" (CTC) in order to cover for profit losses due to the introduction of competition.

Regarding retail market opening, Spain followed a gradually development towards full competition, and since 2003 all customers are eligible and therefore can choose their supplier freely.

Regards electricity market, a common electricity wholesale market for Spain and Portugal was proposed by regulators to the Governments of Spain and Portugal. As a result of the process of cooperation, the Iberian Electricity Market (MIBEL) was developed and started to operate since 1st July 2007, in order to promote the integration of electrical systems of both countries. This constitutes an important contribution not only to the achievement of the electricity market in the Iberian Peninsula, but also at European level, as an important step towards completing the internal energy market. Currently now the work is focus, under the initiative known Price Coupling of Regions (PCR), on synchronizing the market participants and system operators of different European regions.

From Regulatory Authority point of view, the National Energy Commission (CNE) is designated as the single regulatory authority at national level to deal with energy issues and responsible for sector regulation, to ensure the effective and transparent competition in the operation and performance of energy systems. Since 2013, by recent changes, the national regulator belongs to the National Commission of Markets and Competition (CNMC) as public body, independent from the Spanish Government. Among its duties, the national regulatory authority has been monitoring unbundling measures since 2008. In 2012, it is published a report to monitor the implementation of the code of conduct for unbundling activities and the compliance with functional unbundling obligations. As a result the report concludes that distribution system operators have already established their compliance programme. Also in execution of it powers and with the aim to analyse the degree to which competition has developed in wholesale and retail electricity markets, the CNE published a report to cover the state of competition achieved in the period of 2008-2010. One of the key indicators to measure the level of competition in retail markets is the separation required between distribution and supply functions, although both activities, in most of cases are conducted within the same holding. The report refers also to several cases where CNE had to impose fines on electrical companies due to its involvement on abusive competitive practices consisting on denying access to switch a supplier and sharing commercial information with companies in their own groups.

4.2.3 Legislative framework in Spain

By different mandates, as is outlined in [Figure 11], the government recognised the need for liberalisation and greater transparency to further improve efficiency and reduce the cost of electricity. Firstly by 1987, the MLE Law (Marco Legal Estable) set out the scheme for regulating the electricity sector based on standard costs that would provide companies incentives to improve their efficiency. The MLE was an incentive-based regulatory framework mainly base on price-cap regulation. Then, in 1994 by LOSEN Law (Ley de Ordenación del Sistema Eléctrico Nacional) was created an independent system, as a parallel system of electric supply that would have operated along with the integrated utility.

However, these events did not result on a well-functioning competitive electricity market and is the **Law 54/1997** of Spanish Electricity System which establishes the legal base to develop a new electricity system whose main regulatory features were the creation of a wholesale electricity market where the price is settled to determine the remuneration of the electricity enterprise. This was the origin of the liberalisation process which dealt with following main measures: **privatisation** to lower the state participation and market concentration and **structural changes** by creating an independent regulatory body and an independent system operator and by unbundling regulated business from competitive ones.

This legislative framework was adopted for implementing the European Directive 96/92/EC [Directive, 1996] applicable at that time and which called for an accounting separation from regulated business to competitive ones. For distribution networks a softer legal and accounting separation was initially implemented to finally introduce stronger functional separation in July 2007.

Following unbundling requirements, the Spanish Electric Power Act [Law 54, 1997], in article 14, set for first time the provisions of **legal and accounting unbundling** of regulated activities, such as the technical management of the system, transmission and distribution, had to be legally separated from the rest of the activities and also keep separate accountancy. Therefore, as most of Spanish electrical companies were vertically integrated, companies had to adapt their structures and made some reorganisations following this legal framework to implement the unbundling provisions required. By way, regulated activities could be part of holdings which carry out non-regulated activities. It also established a range of sanctions for applying in case of breach either unbundling requirements.

In order to transpose several aspects still pending of European Directive 2003/54/EC [Directive, 1996] the **Law 17/2007** [Law 17, 2007] introduced modifications on the Spanish Electric Power Act [Law 54, 1997]. In particular, regards unbundling, was added in such article 14 the functional and informational unbundling to ensure the independence of organisation and decision making of DSOs which are part of vertically integrated undertakings.

Nevertheless, a regulated company might belong to a company or group of companies that undertake incompatible activities while ensuring that people in charge of regulated companies may not participate, neither in the management for the day-to-day operation nor sharing capital of the generation and commercialisation activities. Besides appropriate measures must be taken to ensure that the professional interests of those people responsible for the management of companies engaged in regulated activities are taken into account in a manner that ensures that they are capable of acting independently. This means that companies carrying out regulated activities shall have effective decision-making rights, independent from the integrated undertaking, with respect to assets necessary to operate, maintain or develop the electricity transmission and distribution network. This should not prevent the existence of appropriate coordination mechanisms to ensure that the economic and management supervision rights of the undertaking in respect of a subsidiary are protected. In particular, this shall enable the undertaking to approve the annual financial plan, or any equivalent instrument of the subsidiary and to set global limits on its levels of indebtedness.

Regards informational unbundling, companies that engage in regulated activities, as well as their employees, may not share business sensitive information with those other subsidiaries of the integrated undertaking that carry out liberalized activities.

Regulated Companies shall establish an **internal code of conduct**, which sets out measures taken to ensure the fulfilment of unbundling requirements set out by Law and also the specific obligations of employees to meet them. Besides, companies may submit annually a report to the Ministry and to NRA which shall be published and contained the measures adopted to comply with the unbundling provisions.

In respecto to unbundling and transparency of accounts, established that, in following cases, it is compulsory to keep separate accounts from all other activities in their internal accounting in order to prevent discrimination, subsidies between different activities and distortion to competition:

- For companies whose corporate aim is to perform regulated activities
- For retailing companies performed as last resort suppliers
- For companies engaged in unregulated electricity activities for activities performed within the national territory and all those other activities performed abroad.
- For generators operating under the special regime

Thus, utilities in the electricity sector performing regulated activities must publish their annual accounts differentiating between the revenues and costs that strictly comes from the transmission activity, the distribution activity and, when applicable, those corresponding to trading activities. Companies must submit again to the to the Ministry and to NRA, the accounting and economic-financial information, which is required by regulator, concerning the accounts of companies involved in regulated activities, to supervise that subsidies do not take place and analyse the economic behaviour of this type of companies. In line with those requirements, the NRA designed a regulatory model based on the retributive methodology and management accounting for the electricity

distribution activity and every year publish a legal procedure where claims to distribution companies the type of accounting information they may provide, how they should submit it and when [CNE, Circular]. They should provide not only purely financial information but also data related to forecast demand, existing and standardize facilities, distributed generation connected to distribution network, among others.

In 2010, [RD 6, 2010] came into force modifying the unbundling requirements contained in article 14 of the Electric Power Act and applying the legal and functional unbundling measures to energy recharge services, becoming incompatible services for regulated business. So, the legal company that performs regulated activities such as system operation, transmission and distribution cannot participate in production, supply or recharge of electricity, nor can it own any kind of share capital in companies performing such activities.

Since 2009, vertically-integrated companies have implemented their **compliance programmes** (code of conduct for unbundling activities) and submitted required reports on the unbundling measures they have adopted to national regulatory authority and to the Ministry under competence.

The **Royal Decree-Law 13/2012** [RD 13, 2012] has granted new powers and reinforced duties to the NRA on unbundling, consumers protection, the approval of methodologies concerning transmission and distribution access, tariffs, balancing services, access to interconnection infrastructures, capacity allocation and congestion management procedures.

Particularly to comply with the unbundling rules set by Directive 2009/72 [Directive, 2009], the [RD 13, 2012] set out the requirements for regulated business to separate its identity to vertically integrated undertaking identity, with a view to avoid confusion in their communication and branding. To monitor this new requirement, national regulator became in charge of full competence to supervise and monitoring unbundling provisions. According to [CEER, 2013], to date, DSO still use the name of the holding, so no DSO has rebranded in Spain as they all have had separate names to the suppliers of the corresponding group.

Furthermore and related to functional unbundling, [RD 13, 2012] obliged to regulated business to submit their compliance programmes (code of conduct for unbundling activities) every year before 31st of March about measures taken previous year.

The transposition process of European Directives still continues developing legislation at national level. Recently, **Law 24/2013** [Law 24, 2013] has removed, in terms of unbundling, the exception regarding distribution companies with less than 100.000 customers. Companies, in this situation, have to comply with the unbundling provisions, in a period of three years from the entry into force of this Act.

The timeline of national legislation transposed for complying with European Directives is described below [Figure 11].

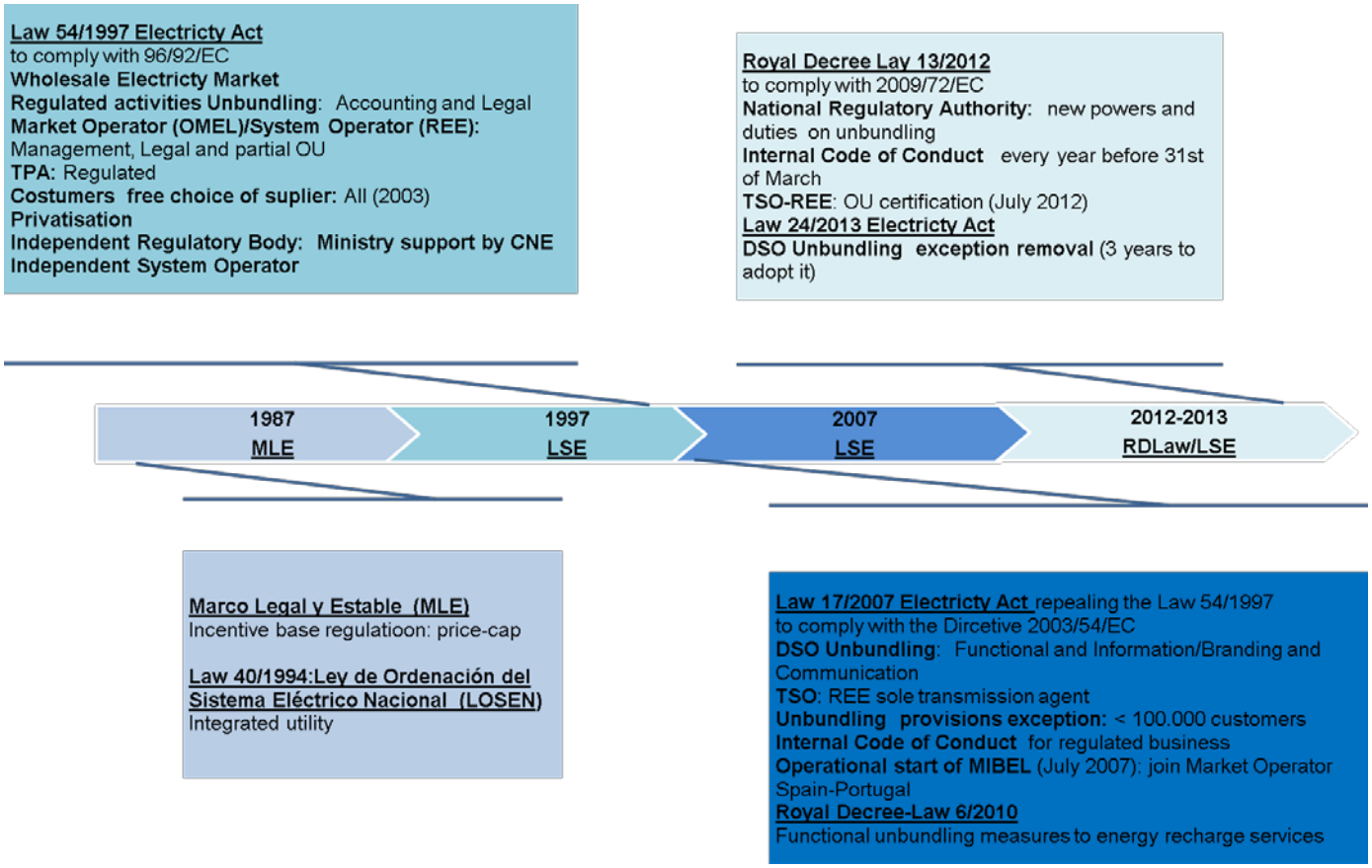

Figure 0-11: Spain Legislation Timeline and Key Aspects
Sources: Own depiction

4.2.4 Current situation: unbundling and network business

As for DSOs, there are over 350 distributors registered. These distributors are the owners of the networks they operate and those with greater market share are usually part of vertical undertakings that carry out various activities. Five of them are the main larger distribution companies. The rest of the companies are small distributors (less than 100.000 customers) which operate mainly in small-medium-sized towns. As stated before, and following [Law 24, 2013], those distributors who are exempted shall also comply with unbundling requirements.

Despite the mix of DSOs that currently exist in Spain, the five largest companies, which supply more than 100.000 customers, account for 270 TWh/year of distributed power and delivered to more than 27 million customers and their networks cover 666.894 km, more than 95% of overall circuit length of distribution networks in Spain [Figure 13]. As graph below show [Figure 12], **only 1% of total DSOs in Spain cover more than 90% of electricity distributed in Spain and more than 90% of total electricity connected**

customers. Curiously, those companies are the ones that shall apply unbundling requirements; thus in fact, this suggests that at least in Spain, the unbundling regime by DSOs result a Key measure to bear on market competition and network performance and being overcome from regulatory point of view.

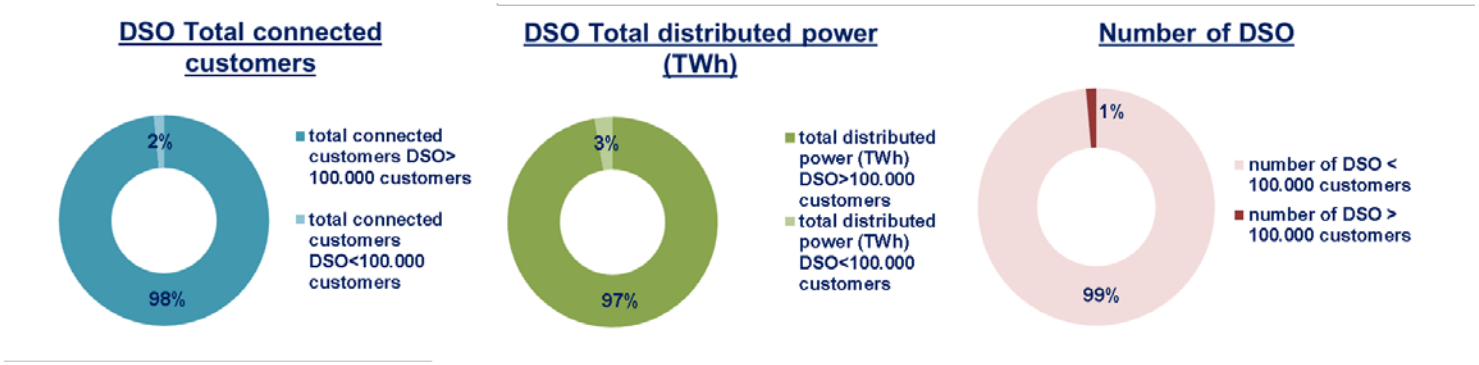

Figure 0-12 : DSO total connected customers, distributed power and number of DSOs in Spain
Sources: Own depiction. Data from: (1) Annual Report 2010 of DSO>100.000 customers. (2) Power Distribution in Europe. Fact and figures [Eurelectric, 2013]

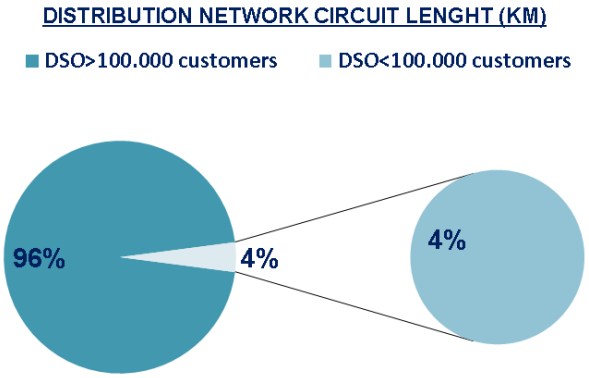

Figure 0-13 : DSO overall network circuit length in Spain
Sources: Own depiction. Data from: UNESA

As stated before, in most cases, distribution companies being part of vertically integrated companies and they commonly have the same registered office as the parent company and other subsidiaries. The Spanish regulation does not impose for the moment any obligation to keep separate registered offices. Therefore vertical undertakings take advantage of centralised holding services, despite its accounting, functional and legal separation.

As for TSO, REE, the Spanish Transmission System Operator, is the sole transporter and the authority responsible for the system's technical management and to guarantee the electricity supply's continuity and security and the production and transport system's correct co-ordination. According to European Directives, REE is organised by TSO ownership model since July 2012.

Spanish distribution companies have adopted most of unbundling requirements and try to be independent at least in terms of its legal form, organization and decision making from other activities not relating to distribution. However, still belong to a holding of undertakings performing incompatible functions, because the law allows this type of organisation. Furthermore the legal framework in force is quite open when implementing certain unbundling provisions, for instance regarding the management of regulated business it is not determine in detail which members could be part of the board and which not. This lead to different interpretations by affected companies.

Despite the legal and regulatory changes, there is no effective competition in Spain. Not only the former integrated monopolies still control the demand and supply of power generation, but also the barriers to introduce competition still appear in many cases due to partly by regulatory uncertainty. So it results difficult to guarantee the fully legal and functional separation between liberalized and regulated activities under current mandates.

As national reports by CNE [CNE, 2006-2013] and European ones by CEER [CEER, 2013] reflect, the particular Spanish unbundling process is still on-going, but at least for now, the breaches have to do more with the non-commitment by electrical companies than the lack development of national legislation.

4.3 Overview of practical experiences

The transition electricity markets from a fully regulated framework to liberalized schemes started in the 1980's in Chile and UK for introducing competition in a context commonly characterized by vertically integrated companies that also owned the networks. As energy demand increased continuously and new technologies were introduced, competition became a necessity and market deregulation became a reality. According [Nuñez, 2013], although the electricity sector reforms were implemented throughout the world only few countries got successfully market-functioning results.

At European level, the real implementation of these regulatory reforms, and in particular those refers to DSO unbundling requirements, varies widely from country to country and even across firms in the same country, as detailed previous section. These real experiences are extremely helpful to assess, since them provide an opportunity to better understand how different approaches affect sector performance.

European Member States have developed different types of unbundling, from minimum directives requirements to levels did not require by law, and different ways of request, from compulsory provisions to voluntary ones, creating distribution companies from stricter ownership unbundling (UK and NL) to weakly, almost absence, of unbundling implementation (EL).

In this section it is discussed how DSO structures and regulatory mechanisms impact their financial and operational performance, collecting, in the International context and also in the European one, practical unbundling experiences.

4.3.1 New Zealand (Compulsory Ownership Unbundling)

Far from European border, New Zealand is the first case where ownership separation was implemented at distribution level and therefore results worthy to analyse the economic and regulatory impact this movement caused.

Since New Zealand government decided to review the structure and regulatory environment of the electricity supply industry, successive rules related to distribution organisation and ownership were imposed.

In the 1980´s, distribution and retailing services were organised by public local monopolies, within defined geographical franchise areas, taking advantage of vertically integrated position for using their market power in distribution to restrict competition in retail. Between 1992 and 1998 several obstacles were identified by New Zealand Government, concerned for a situation that did not result in competitive energy trading, so definitely the privatisation of distribution companies becomes a reality and ownership of distribution assets were transferred to electricity consumer trusts. Moreover several important changes were introduced to the electricity sector, in particular regarding network business, a full ownership separation from distribution companies to retail business was required. The main reasons for the separation were to prevent network business incentives for restricting competitor access through their networks, or using monopoly gains to cross-subsidise retail customers or discriminatory investments. As a consequence of these requirements some companies sold their electricity networks, and continued to operate as an electricity supply business, others remained as electricity networks companies and sell their retail businesses.

As New Zealand represents a special case regarding ownership unbundling on distribution business from the rest of the market, extensive and several reports were developed.

Despite Ownership Unbundling in electricity distribution was implemented in order to encourage competition, competition has not benefitted from ownership unbundling as was predicted. [Nillesen, 2008], identified as a consequence of breaking up vertically integrated companies, a merger effect between generation and retailing business. Other negative effects they have found were an increase in the price cost margin and as a result of a structural separation, one-off restructuring costs. Contrary, in the positive side, ownership unbundling takes advantages from operational cost reductions and increases in quality of service. Operational cost reductions come from the consolidation of small distribution companies and also from the incentive scheme, but not necessarily lead to tariff reductions. Regarding quality of service from network business, network outages decrease based on SAIDI and SAIFI indexes.

Since Ownership Unbundling was implemented in New Zealand, not only regulatory studies are available but also economic ones [PWC, 2006]. Although from an economic

point of view, this report also concludes, in line with previous one, that distribution ownership unbundling in New Zealand did not result as was expected due to financial cost exceed financial benefits.

4.3.2 UK (Voluntary Ownership Unbundling)

It is known that UK has far more experience with a liberalised electricity industry structure than any other European country. Therefore, ownership separation between distribution and retail functions were carried out long before Directives were introduced.

The Electricity Act 1989 called for a reform of the electricity supply industry and the state owned monopoly structure was replaced by decentralised and private companies. The Regional Electricity Companies (RECs) owns and operates the electricity distribution network in its authorised area and also were responsible for retailing functions. At this time, distribution and supply were coupled and regional companies can supply electricity outside its franchise area on the payment of a charge for distribution over another REC's network. RECs were then privatized as Public Electricity Suppliers (PES). The Distribution Network Operators (DNOs) are the successors of the distribution PESs as a result of the Utilities Act 2000, which required separate licences for their supply and distribution businesses to be held by different legal entities, thus effecting legal unbundling.

Despite these initial integrated positions, some regional electricity companies have undergone voluntary Ownership Unbundling, once separate licenses for the distribution and retail functions were introduced. Regulation obliged owners of distribution and retail businesses make a full split among both in all aspects except ownership.

The electricity supply industry was radically restructured in 1990, and currently now regional distribution networks are owned and operated by Distributors Network Operators (DNOs) responsible for the design, financing, construction, operation and maintenance of the regional distribution services area. The DNOs are owned by six different groups. In addition there are also a number of smaller networks owned and operated by Independent Network Operators (IDNOs) that are located within the areas covered by the DNOs, and instead of having distribution areas, tend to own and operate network extensions, connected to the existing distribution network. The electricity selling is done in a separate way by the electricity suppliers.

UK electricity restructuring, as whole but particularly regarding unbundling of distribution companies, is a reference for being the ones that anticipate the liberalisation at European level, and a huge variety of reports were developed.

According to [Davies, 2007] it is a clear evidence of anti-competitive and market share advantages where there is common ownership between electricity suppliers and the distribution networks. In this line, these authors examined whether co-ownership of a network and commercial activities in the UK confers advantages on the company by investigating whether local market shares are significantly higher. Using a panel model of

market shares they found a direct relationship between market share and integrated companies, the more separated the company is, the lower the market shares percentage.

From consumer's point of view, the White Paper (Secretary of State for Energy, 1988) stated clearly that the main beneficiaries would be the consumers. Nevertheless, [Newbery, 1997] showed that the privatization of electricity networks has unambiguous effects on consumers. They performed a cost-benefit analysis, concluding that although overall restructuring led to a permanent cost reduction, does not affect equally to all agents: while consumers and the government lost out, producers gain more. [Domah, 2001] reinforce and support the same conclusions established by [Newbery, 1997], recognizing that the application of hard regulatory mechanisms have led to improvements in labour productivity and service quality in electric distribution systems in England and Wales as well.

After separation of generation and retail from network business, growing vertical integration can also be observed in the UK electricity sector among generation and retail. The UK energy industry has also been experiencing horizontal integration between gas and electricity supply undertakings [Ehlers, 2010].

4.3.3 The Netherlands (Compulsory Ownership Unbundling)

Although the European Directives does not required Ownership Unbundling at network distribution level, the Dutch government decided to impose compulsory Ownership Unbundling at this network level. As part of liberalisation process, on November 2006 was passed the Unbundling Act, such companies carrying out network activities in the Netherlands are not allowed to be part of the same group as companies carrying out other electricity activities not related to distribution business.

The decision for taking unbundling a step further than required by European regulation was supported by the difficulties in guaranteeing full independence of network management from other parts of the holding, such discriminatory access to the network by new entrants and adequate investment in the grid over existing legally unbundled distribution companies.

Distribution system is managed by regional distribution companies owned by local authorities and organised by vertically integrated firms. At the time of the proposal, Dutch network companies were already legally unbundled from commercial businesses, but do not have economic ownership of their assets. The fully unbundling regime would enable regional public authorities to sell their shares in production and supply, giving them an option from getting rid of risky commercial activities.

Despite the government proposal, some studies ([Mulder, 2007] and [Nooij, 2009]) showed that Ownership Unbundling in distribution companies directly affects the financial strength of energy companies because network separation negatively affects generation investments, also includes a cost due to the restructuring and cross-border contracts

renegotiation in case of selling assets and also implies a reduction of management and operational synergies in comparison with previous integrated corporate organisation. Moreover conclude saying that ownership unbundling could be a future step to develop when distributed generation and also separation of the transmission grid becomes a reality.

As the current form of legal unbundling and the Ownership Unbundling option seemed not to cover the welfare expectations for the Dutch electricity system, [Mulder, 2006] analyse the effects of several options for vertical separation between distribution network and commercial activities. Considering different unbundling ranges, from soft legal unbundling, intermediate options which strengthen legal unbundling requirements to a purely ownership unbundling form. By conclusion is suggested that the improvement of the current legal unbundling and the corporate governance structure were at this time sufficient measures.

According to literature base on Dutch case and government proposal there is a large degree of uncertainty concerning the benefits of Ownership Unbundling. On the one hand, government arguments in favour of Ownership Unbundling were the opportunity of strength effective separation between network and commercial activities improving the management and financial independence performance of the network. Against, some authors established that a welfare and social benefit is not clearly related with Ownership Unbundling and moreover it requires reorganization and may involve costs associated with cross-border leases. Besides, some Dutch energy companies argued that the Dutch Unbundling Act, requiring energy companies to unbundle their energy network companies, violates European law as it infringes the EU provisions on the free movement of capital and this was supported by Court in The Hague. As a consequence some integrated companies that were not yet unbundled have decided to postpone their commitment to Unbundling. The Dutch State has appealed that decision and the case is currently pending at the Supreme Court. Recently, in November 2013, the EU Court of Justice interceded and defined its position through following statement: *"The Dutch unbundling act is a distortion of the free circulation of capital but reasons of public interest may interfere with this free circulation if only the measure (unbundling) is not disproportional*".

4.3.4 Greece (Legal Unbundling)

Greece electricity market, due to its geographically isolated position becomes relatively unattractive to new entrants. Nevertheless, as a Member State, Greece has to comply with European Directives and complete the regulatory framework.

Before liberalisation, the electricity sector in Greece is organised by a vertically integrated and fully-state-owned company. When liberalisation market started in 2001 to comply fully with the provisions of European Directives, the public company was partially privatised and began to sell shares, but still holds a highly dominant position in both the electricity generation and power supply markets. In this case privatisation has nothing to do with

vertical separation and the current structure still includes production, trading and network business divisions.

According to Law initial provisions, legal unbundling was introduced only for the operation of the Transmission System, and then legal unbundling for the Distribution Network Operator was required. In order to overcome eventual incompatibilities with the European Directive, in respect of unbundling issue, there were also included specific rules for the implementation of functional and accounting unbundling between the divisions that are responsible for the networks and the divisions active in the competitive parts of the sector. Although unbundling rules were transposed to national Law, [CEER, 2013] found that distribution networks have not yet fully unbundled neither rebranding so far.

Referring to the distribution activity, distribution and transmission networks were assigned to the Transmission System Operator, a majority state owned company, with half of its shares belonging to the public energy company. But, as an attempt to comply with the obligation of legal unbundling of the distribution from the incumbent, when legal and operational unbundling took place in May 2012, the entire distribution business unit was transfer to a new subsidiary company to own and manage the distribution network, 100% subsidiary of the public energy company which is still the owner of network assets.

As evidenced before, the Greek electricity market presents critical points for the success of a liberalized electricity market. Several characteristics of the incumbent contribute to the distortion of Greek markets, leading to market power positions due to its dominant size, discriminatory behaviours because of the joint ownership and participation of the electricity networks and also the retention of the vast majority of customers.

According to [Iliadou, 2007] to promote competition and an opening electricity market, a clear and coherent unbundling model, based mainly on efficiency considerations, should be a key step to fully develop the network electricity performance in Greece.

4.3.5 Conclusions of practical experiences

Although most of European countries transposed European Directives, DSO unbundling provisions are implemented in a formal way rather than in a practical way. The majority of Member States have been adopted the minimum unbundling level required and still belong to the same group of companies as electricity retailers and generators, sharing part of the strategic, managerial and financial responsibilities.

However, in some cases interest exists in developing a structure that goes beyond the legal and functional obligation, such as the UK and Dutch case. One of the main arguments for ownership unbundling of distribution networks is that common network ownership and activity in competitive sectors of the industry leads to a non-competitive playing field.

In fact, both levels of unbundling, the one is required by European Directives (legal, accounting and functional) and the most restrictive one (ownership unbundling) not required at distribution level but implemented in some cases, drive to some regulatory and structural deficiencies. The economic and regulatory issues that directly affect network business and despite unbundling provisions remain an obstacle for effective market integration could be summarized in following items:

- Common ownership between regulated and competitive business inhibits competition hindering new entrants.
- Market concentration leads to high level of market power and the opportunity of price manipulations
- The double mark-up reduces the investment incentives of a separated network operator, as it reduces its profits from additional investment.
- Cross subsidies between businesses that belong to the same holding cause distortion of competition as well as an exercise of market power on retail markets.
- Insufficient practical separation leads to privileged information to parent company.
- The lack of an active communication strategy of the DSOs towards suppliers and consumers has a negative impact on the switching rate.
- Discriminatory network access due to the vertical integration and the lack of fair separation of information flows prevent equal terms and opportunities to all participants.
- Loss of economies of scope due to the lack of operational and financial synergies when vertical separation occurs

Most of these obstacles were identified by [PWC, 2007] trying to find how energy companies are facing major changes and how they do business in order to manage energy effectively [Figure 14].

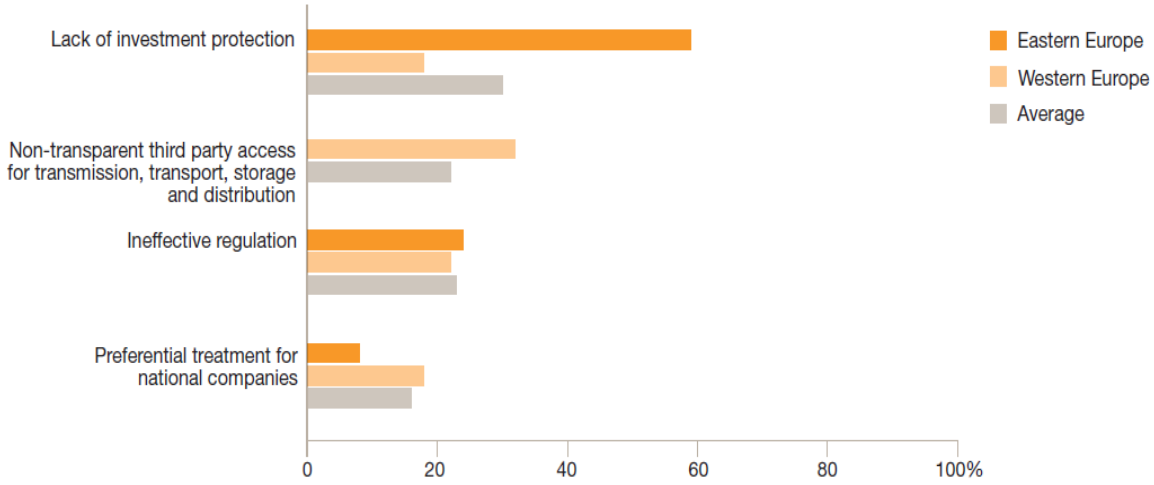

Figure 0-14 : Largest barriers for competition
Sources: PricewaterhouseCoopers, Utilities global survey 2007 [PWC, 2007]

In addition, regardless the level of unbundling, most of countries following regulatory and legislative mandates have decided to implement unbundling provisions in a merely formal way to ensure required unbundling provisions, throughout compliance programmes, active communication strategy and branding differentiation, etc. These tools, as practical experiences show, are necessary but not sufficient to guarantee a real independent and efficient DSO performance that must contribute actively to the single European competitive market.

All these mentioned effects could be supported by figures and common indexes, reinforcing previous results and arguments and allowing us, from a quantitative point of view, to assess the success and grade of implementation of liberalisation and unbundling reforms, as is shown next table [Table 2].

key indicators	The Netherlands	UK-Great Britain	GREECE	SPAIN
Total Number of main distribution companies (0)	8	21	1	342
Number of main distribution companies(1)	5	17	1	6
Ownership/Structure main distribution companies (2)	public DNO/no VI	private local DNO/no VI	mix public-private DNO/ VI	private DNO/ VI
Level of unbundling (3)	OU	OU	LFA	LFA
Number of main electricty retailers (4)	3	6	1	4
Switching rates (entire electricty retail market) (5)	8,90%	15,00%	4,19%	10,60%
HHI in power-generation market (6)	1.811	947	6.844	1.361
HHI in electricty retail market (6)	2.264	1.768	8.616	2.543
Electricty prices (inclusive of taxes) households (7)	11.37	16.06	17.82	21.40

(0) data from CEER report April 2013

(1) data from CEER report April 2013_Companies are considered as "main" if the have more than 100.000 customers

(2, 3) data from NRA and ACER. VI (vertical integration);OU (ownership unbundling); L(legal); F(functional); A (accounting)

(4,5) data from EC report (Energy Markets in the European Union in 2011) and Eurostats. Retailers are considered as "main" if they sell at leas 5% of the total national consumption

(6) data from EC report (Energy Markets in the European Union in 2011). The HHI (Herfindahl-Hirschman Index) is commonly acceptable metric which measures the concentration level of a market and is based on the relative size of the firms participating in the market (the higher the index, the more concentrated the market).
Moderate concentration: 750-1 800; high concentration: 1 800-5 000; very high concentration: above 5 000.

(7) EC_Quarterly report on European Electricty Markets, DG Energy. Second quarter 2013. Prices per kWh (c€). Consumption Band Dc with annual consumption < 20 MWh. Bands of consumption: Spain (≥ 21MWh); UK (13.01-17 MWh); Greece (17.02-21MWh); The Netherlands (< 13.01MWh)

Table 2 : Key indicators of electricity market in selected Member States
Sources: [ACER, 2013]; [EC, 2013]; [EC, 2011]

All these indexes reveal that those countries with a deeper unbundling regulation show better electricity market performance. The ratio of end-user electricity prices is reduced by the unbundling of distribution network and retailing functions, expansion of Third Party Access (TPA), and introduction of electricity markets. So, the stricter unbundling level is required, the lower electricity prices and values of market concentration are found. However, it is clear that if unbundling is not applied properly or fully implemented, this might also in turn of hampering effective market integration. Taken together, these findings, could be suggest that regulatory reforms involving vertical separation of the industry impacted favourably on distribution network performance efficiency.

4.4 Conclusions and next steps

It is generally accepted that the market design of a liberalized electricity market includes a certain degree of unbundling from network operators to competitive activities to prevent discriminatory behaviour against alternative market participants in search of equal treatment and to secure a competitive performance.

There is a legal uncertainty around Distribution System Operators unbundling, supported by some countries which have decided on going further than the Directives, implementing a stricter level of unbundling in distribution business. In this line there is a discussion about the efficient performance of DSO full Ownership Unbundling. In both situations, legal and Ownership unbundling, although the effects on competition were not suffered at same level, the real effects were not been fulfilled as initially hoped. So, the discussion remains about what level of unbundling could be sufficient to maximise the financial and operational performance of DSO that could lead to an efficient, competitive and integrated European energy market.

What should also be borne in mind is that while effective separation, between competitive segments of the value chain and monopolistic segments, was thought for breaking up vertically integrated monopolies and privatises state owned utilities, unfortunately in some cases the results did not follow this way. The expected results regarding getting full network independence at management and financial level, removing undesirable cross subsidies, enhancing non-discriminatory access to the network and developing a transparent and appropriate access tariff, not in all cases were achieved.

Besides, although unbundling was supposed to be a key issue for the formation of the European energy market, in fact requires a corporate restructuring process that incurs in transaction costs and complicates the coordination issues, losing the economies of scope before strengthen by vertical integration structures.

Since competition alone is unable to solve many structural problems, as practical experiences in the European and International context showed. Relying on a balanced mixture of regulation and economic issues around competition, allows addressing how DSOs could contribute to an effective level of market competition. Especially, since DSOs act not only as system operator but also as market facilitators, providing non-discriminatory access to their networks for other system users beyond their traditional role of passive grid agent towards active grid management agent.

So in light of all these effects, what is obvious is a still clear insufficient level of DSO unbundling and as a consequence a seriously limit on effectiveness. So, the route ahead will be based on defining the most effective tools from a regulatory point of view to determine the best utility industry structures that maximize the necessary level of unbundling. These tools should allow the provision of regulatory suggestions and guidelines for DSO for an active network performance role in a competitive electricity market context.

Chapter 5
Methodology & Analysis

5. Methodology and Analysis

The unbundling progress has been shown to be a critical factor in assessing the advancement of a liberalized market. Monitoring how companies are organised is an essential tool in the overall electricity market functioning, and regulators are in charge to strike a balance between discriminatory structures, that could lead to possible cross subsidy, cost efficiency performance and network quality of supply, using a diversity of regulatory instruments.

In order to assess how regulators could determine the efficient level of unbundling that enables DSOs to accurately deal with the provision of network services to final consumers and the objective of decisive move towards healthy competition in the electricity market, a systematic methodology is proposed based on performance indicators, benchmarking techniques and a practical case to proof the viability of the approach defined.

Although, methodological framework proposed is DSO-oriented, has been developed with the aim that the general scheme could be adapted, at the simplest level, for all activities along the electricity supply chain.

The first stage proposed starts with an acknowledgement of the performance of distribution network operators. Pre-defined key indicators are identified to assess the present state of the business allowing the identification of either deficiencies or potential improvements of how best fix operational and structural inefficiencies of a distribution undertaking performance. The second phase generally includes a debate on what could be the decisions that the regulator should make in terms of unbundling regime to achieve the technical and financial targets desired based on econometric techniques for efficiency comparison. The third phase involves the analysis of the robustness of predefined targets and strategies in a temporal scale and considering different scenarios.

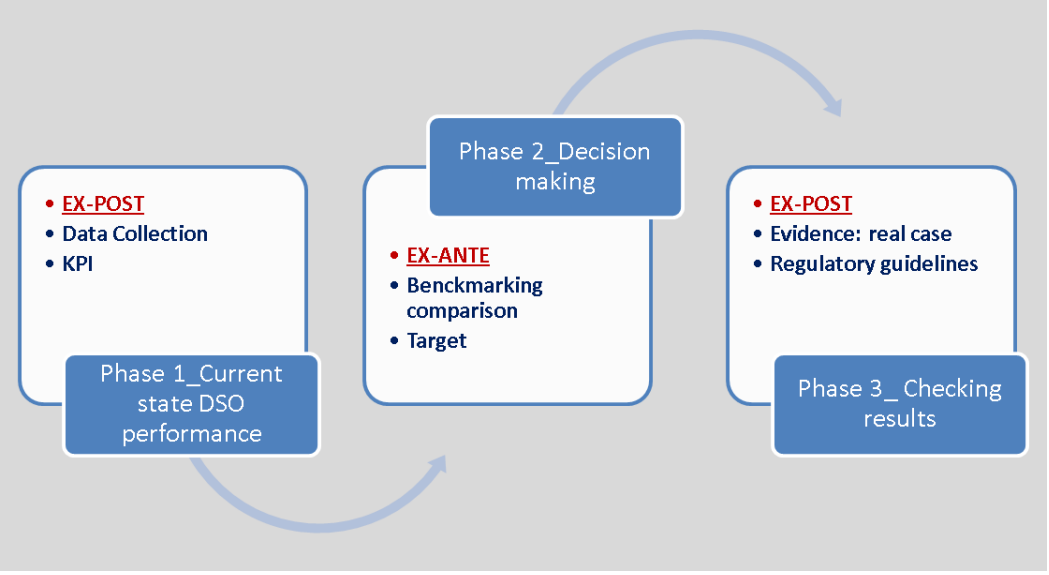

Figure 0-15 : Key Steps: Methodology scheme
Source: Own depiction.

5.1 Analysis of the DSO Unbundling Performance

The present chapter provides a methodological framework based on distribution performance of the electricity industry. Indicators developed seek to identify the principal drivers for effective competition, in terms of existing market structure and framework conditions necessary for the emergence of competitors. Moreover, particular attention is made to indicators measuring the technical and financial operation of DSOs, for instance, in terms of fair access to the network, network costs and grid operation in a reliability basis.

A methodological approach is proposed motivated by the fact that distribution companies and regulatory authorities will be able to identify the powerful level of unbundling better fits for a particular case, in terms of distribution network performance and electricity market interaction. According to [Figure 15], this empirical approach is based on an EX-POST assessment of DSO network operation and financial management in order to identify EX-ANTE a fair and suitable unbundling regime, supported by a set of KPIs and benchmarking technique.

5.1.1 Methodology scheme

5.1.1.1 Phase 1. Current state DSO performance

Data Collection

The data requirements depend on what the regulator is seeking to be targeted and the level of information disaggregation required. In addition, the data collected must be measured on a consistent basis in order to avoid, as far as possible, erroneous figures and providing reliable final results from which the regulator could make appropriate decisions. To do that, regulator should come to the aid of an official database or, especially if the scope of the study is wider enough, sending out specific questionnaires to collect additional data required for the empirical evaluation of the indicators.

Other notable feature, regarding data is the scope of the analysis, the wider the scope the more reliable/useful would be the results. The greater the sample of companies (in terms of not only number of companies but also in terms of power distributed, customers connected, etc.) and particularly the wider and variety of unbundling approaches, the fairly the regulatory decisions.

For the purpose of this methodology, and as will be discussed further below, information about network financial and technical operations should be compiled, including market scale, utility characteristics and network cost, quality, and access. All these pieces of information are more fully described and detailed in next section. Furthermore, to determine benchmarking efficiency scores, the sample size, in terms of temporal scale, number of companies and input-output variables, has an important role to obtain a

feasible and reliable solution, allowing the regulator making the decisions as close as possible of a real scenario.

Additional information used for the evaluation of the indicators includes data provided by Europe-wide industry associations and data collected directly from companies and market places. In addition to the data submitted from the DSOs and suppliers, data from regulators surveys and as well as other sources may be also be used as part of the analysis.

Network Key Performance Indicators (KPIs)

To identify how an existing electricity network business is functioning, we proposed to measure a package of performance indicators in order to lend a wider perspective over the effect of network structural separation in the electricity market and, particularly, in the company performance. According to [Figure 16], to better understandable the relationship between network unbundling and market measurements, the selected indexes are compiled under four main categories: (i) Market structure; (ii) Network Quality; (iii) Network Access and (iv) Network Costs, allowing making a diagnosis of whether competition and an efficient performance is taking place, from distributor's perspective to market context.

A set of standardised indicators will be then developed in each category to cover detailed aspects of how unbundling provisions influence market competition and operational framework conditions focus also on four key areas. These areas basically refer to market competition, network charges and connection process, network operation and investment cost and quality of service. Each set of indicators, principal areas and categories are described below in detailed.

For the empirical analysis in this paper, the following performance indicators are recognised as the most appropriate for determining the current state of DSOs from a structural and operational point of view. Regarding the scope of the analysis the regulator might use all indicators detailed in present study or might select only those ones that better fit with the aim of a particular monitoring. Regardless the KPIs chosen, it is recommended that at least, the performance measurements be updated regularly in order to work with the current situation and avoid making decisions that have already considered or might distort the reality.

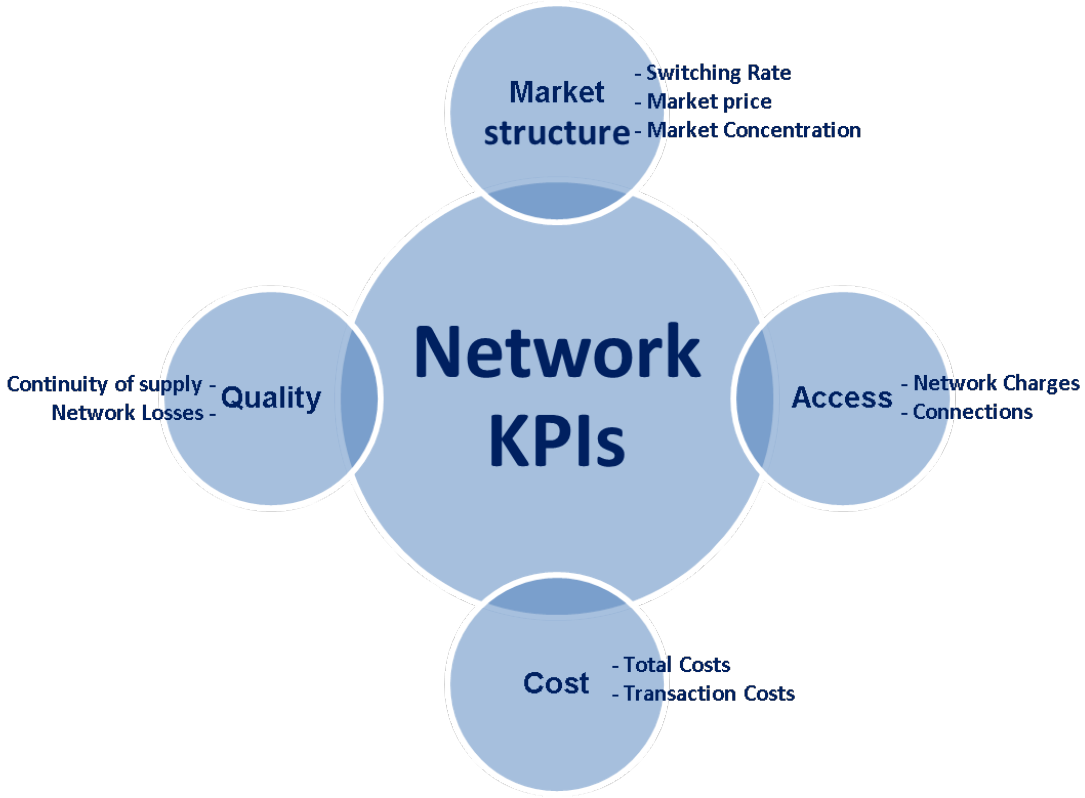

Figure 0-16 : Categories and Areas of Key Performance Indicators (KPIs)
Source: Own depiction.

(i) Market Structure

As one of the main objectives is the creation of an European integrated energy market, network unbundling provisions appear to be having an effect on the level of competitive activity, especially in retail competition, and ultimately in price levels.

Therefore, splitting network and commercial activities will remove the incentive for the network operator to discriminate, denying or restricting access to the network to competing retailers, taking advantage of their monopoly position. Since commercial activities constitute a riskier business, there is a financial tend of benefiting from the stable and predictable cash flows of network business, particularly when being part of an integrated company, leading to structural access restrictions on the retail market thus hindering the free competition of the market.

a. Consumer response: Switching Rate (SR)

Since the electricity reform regime allows free choice of supplier, the customers movement among suppliers looking for a range of products, seems to be one of the drivers to competition. So, full eligibility for customers is mandatory and DSOs are supposed to carry out the switch of supplier without any delay or discrimination and it should be guaranteed that the incumbent supplier does not have any advantage.

Switching rate is a natural indicator of consumer engagement and effectiveness of competition in the market. Many factors as dominant positions and insufficient unbundling contribute lowering the switching supplier. Particularly, by separating the commercial and network activities the contestability of customers will increase and is likely to benefit competition.

So this indicator, pursuant to the level of unbundling implemented, could send signals about whether retailing and network functions apply an effective unbundling in terms of free movement of customers. Contrary if changing suppliers is still often perceived as risky due to cross subsidy among both business, results on preventing new entrants and thus hindering competition and the named free customer's movement.

From network unbundling side, by low switching rates or few customers changing current supplier, it is supposed that there is a need of further strength the separation between retailing and distribution functions to improve market well-functioning. By contrary, an increase in switching rates seems to be linked a robustness unbundling by enhancement customers freedoms and security when changing energy provider.

Individual indicators for the market area refer to:

- Switching Rate (SR) : Nº of eligible customers switched/Total Nº of customers
- Market shares retail supply: Nº of suppliers independent of DSO

b. Market Price

While unbundling might improve retail competition, although not directly, it seems that also cause effects on wholesale competition and price. In particular, these effects from distribution network become more relevant, when distributed generation appears and networks acquire an active role as market facilitators.

More effective competition from well advanced market opening process, especially in this case where competition come from an effective unbundling regime, leads to lowest end users prices. By contrast, higher prices are still found in those countries with minimal market opening or ineffective regulation of third party access.

One of the regulatory reasons of unbundling between regulated distributor and retailer applies to avoid any advantage ensuring that a distributor with monopoly power levies a price which allows entry discrimination. Nevertheless, while common ownership persists, it is likely that both the incentive and the ability to distort prices by the allocation of costs disproportionately to the regulated function to raise the charges might remain.

So the price trend from a market where network functions are unbundled from competitive ones should provide information to detect or correct such competitive distortions and to identify if the unbundling level put in force contributes to empower or not market competition.

Individual indicators for the market area refer to:

- Price trend: electricity prices from industrial and household customers in a predefined temporal scale
- Household price: end-user price for typical household customer

c. Market Concentration

The existence of market agents with dominant market share is likely to hampering the entry of other market agents with less market share rather than be a competition driver. Thus, in order to deliver more effective competition towards balance market concentration, an effective separation between distribution and retailers contribute promoting a degree of concentration which may seem cost reflective to network operators avoiding conflict of interest with retailers business as already noted previously.

The underlying problem from network point of view is the degree of DSOs concentration, not only in terms of the number of players, but also referring to the amount of distributed power and number of customers supplied. These ratios provide information about how the distribution business is organised. It seems no to be the same that few, or even one, companies cover higher market share in terms of distributed power and supply points than be done by several.

Thus, in fact, although network structure and dominance apparently not affect directly market competition, when market concentration rate shows high values, the dominant position needs particular attention and the adoption of stricter market mechanisms in order to balance the degree of concentration and the effects on efficiency, quality, and especially prices.

There is no precise threshold above which dominance is presumed and the level varies form market to market, depending on its particular characteristics, but as a general rule a company is unlike to be dominant if it has a market share less than 40%.

Individual indicators for the market area refer to:

- DSO concentration: Market share of three biggest DSO/each DSO in terms of distributed power
- Retail concentration: HHI (Herfindahl–Hirschman Index) in electricity retail market
- Vertical integration ratio Retail-Distribution: SR/Distributed power MWh
- Vertical integration ratio Generation-Distribution: Generated power MWh/Distributed power MWh

(ii) Network : Quality of service

Where markets are open to competition, the ability to meet given minimum standards is a precondition for operation in the market. Certain minimum customer service standards may, in fact promote competition since they provide customers with assurance that new

entrants will meet the same standards as incumbents. On the other hand, as a consequence of network unbundling from retailing side, by removing the cross-subsidisation and cross financing, more financial room is available for the network owner to invest. This separation is likely to have positive effects on the investment levels and subsequent quality of the network.

A network company should have a strong incentive to maintain the quality of the network in order to minimise possible negative effects on network performance and particularly on customers, who pay not only for the physical product which they consume, but also for the security of uninterrupted power supply which they expect to receive.

This is of special interest in the electricity industry, where a low level in quality and security of supply may cause significant costs and losses to electricity users. For this reason, a central goal of regulation is guaranteeing the supply of power in the best price and quality conditions.

a. Continuity of supply: Zonal KPI

To measure system performance, the electric utility industry has developed a variety of network reliability indexes, involving measures of outage duration, frequency outages, system availability, and response time.

Regulation imposed minimum obligations on service standards with sanctions in the event of a failure to meet the required level. These standards are particularly important, in case of distribution monopolist part, in terms of the interruptions frequency and duration. The most common quality indexes for electricity networks are outages, which could be measure towards SAIFI (System Average Interruption Frequency Index) and SAIDI (System Average Interruption Duration Index).

SAIFI measures the average number of interruptions that a customer would experience considering the failure rate, the location of number of customers and the total number of customers served. On the other hand, SAIDI index measures the total duration of an interruption for the average customer during a given time period. Whereas SAIDI measures the minutes of power lost power, SAIFI measures the number of times without power.

Although is difficult to establish a direct causal relationship between network unbundling and the improvement of the quality service and network performance, as stated before, we can state that as a result of separation, as the opportunity of investment seems to be higher, the quality of the network would be improved.

Individual indicators for the quality of supply area refer to:

- SAIDI: time of interruptions
- SAIFI: number of interruptions

b. Distribution Network Losses

In the same line as abovementioned quality indexes, the losses ratio is an indicator of the technical and administrative network losses. Distribution losses refer to ones occurring during the process of delivering electrical energy from feeders to the specific customer's locations. Any reduction in energy wasted will have positive economic benefits, mainly when companies receive an incentive to reduce losses. By discovering and solving the problem, the distributor is able to increase allowed revenues.

There are two types of distribution losses: administrative or non-technical losses and technical losses. The non-technical losses may occur as a result of the misallocation of electricity flows between different agents using the network by theft, defective meters, and errors in meter reading and in estimating supply of energy. All the electrical flows across the network need to be allocated to the retailers using the network. If customers common switch, this allocation becomes more complex, so as switching increase, and improving market competition from one side, at same time may lead to an increase of non-technical losses due to the administrative burden.

On the other side, technical losses arise for physical reasons (the Joule effect, for example) and directly depend on the network characteristics, nature of lines and transformers, and the mode of operation. Some remedial measures to control technical losses are based on reinforcing existing facilities, providing additional equipment or investment in new technology. Therefore, as unbundling could derive in strengthen the financial capital of network business once leave commercial risk, a reduction of technical losses could be expected.

Individual indicators for the quality of supply area refer to:

- Total Distribution Losses: the electricity leaving a system for consumption or further distribution - the total amount of electricity entering a system
- Technical Losses ratio: load losses at peak demand
- Non-Technical Losses ratio: total losses-technical losses

(iii) Network Access

Another key issue in the regulation of network business, and particularly connected to electricity distribution where retail liberalization has happened, is to guarantee Third Party Access (TPA) or open access for power sales and purchases.

a. Network charges: distribution charges (cost of access)

Third Party Access to existing electricity networks, on a non-discriminatory and cost reflective basis, is essential for the operation of a competitive market. In practice this means that network owners should be prevented from earning excessive profits from monopoly activities; and, where DSOs are part of a vertically integrated company, all

network users, including those affiliated to the network operator, should be offered the same terms.

Commonly, household energy prices are greatly influenced by taxation and network charges, which usually make up more than half the total energy bill. When retail competition is weakened, for instance as a consequence of taking advantage for being part of vertically integrated undertaking, the contestability of end-user prices could be altered. In addition, where the incidence of regulated distribution network charges and taxation is high, the ability for new entrants to differentiate final prices will be limited in terms of pricing.

Therefore, one of the keys to achieving fair access to networks is the degree of unbundling of the network businesses from the competitive parts of the industry. As an access regime implies a cost reflective but simple tariff structure with non-discriminatory access to network, lighter separation between distribution and retail vertically integrated, even considering functional separation, allow the distortion of the competitive part of the market hampering network charges and leading to too high values as a consequence of clear risk of profits earned by monopoly.

Clear unbundling of networks from their associated generation and supply businesses would help to ensure a better understanding of the underlying costs of the different business and guarantee that costs, profits and taxes are being allocated correctly. By seeking network charges, it is possible to find if grid costs efficiently pass through network charges to consumers and how contribute to impact electricity prices.

Individual indicators for network access area refer to:

- Network cost ratio: energy cost/grid cost
- Type of charge: Deep, Shallow , Shallower
- Distribution charge: network charges for different voltage levels

b. Connections

This indicator is important as it provides information on how effectively the market is delivering good service to customers. That information on connection times is collected from DSOs as they are in charge of developing quality of service obligations for connections.

Individual indicators for network access area refer to:

- Nº of connections/ Nº of required connections
- Time required for connection process
- Net cumulative connections

(iv) Network Costs

Generally speaking, distributors are normally authorized to charge rates that cover the full costs incurred. This recovery is made by regulated remuneration to ensure economic viability on the one hand and low rates for service users on the other. Mainly distributor's costs may be classified under the following items: investment to strengthen the existing grid and build new facilities and grid facility operation and maintenance costs. Thus, in this line, there are two different distribution cost categories, one of them to cover investments, depreciation and return on assets known as capital expenditure (CAPEX) and the other one based on personnel costs and operation and maintenance expenditures or operational costs (OPEX).

DSOs by the removal of cross-subsidies and cross-financing, as a consequence of unbundling regime, experience a structural influence on costs. From one side, the financing cost would be diminishing due to less risk without the commercial activities. From a regulatory perspective, the separation will increase transparency and therefore increase and facilitate governance or regulatory oversight functions. Thus is likely to have a positive impact on costs if regulators are able to impose higher cost-effective provisions for network operation and remuneration. But, contrary, the separation also implies transaction costs in terms of structural organisations, that should be take into account to examine the costs of the network companies over time.

a. Total Controllable Cost (CAPEX and OPEX)

CapEx is required to designing, building, and maintaining the network for the expected level of quality. Equally, regulators may provide for sufficient OpEx to allow for adequate response times.

Regarding CapEx expenditures, it is clear that network investment decisions can be distorted as a result of the potential impact of network unbundling on integrated generation or retail businesses. In case of ownership of network operators is completely unbundled, separation could lead a lower overall capital base, and thus reducing the ability of invest. But also when network companies, as a consequence of unbundling process leave the risk of commercial side, the opportunity of invest could increase. In addition, some other reasons such as the quality of supply targets, generation capacity connected to the distribution network, and regulation, can also influence the level of a DSO's investment.

In terms of OpEx costs, it seems that some extra operational costs are needed before unbundling as the unit cost could be higher than the previous stage due to, for instance, the loss of economies of scope. However, average operational unit costs could also have been reduced as a result of economies of scale.

Therefore, trend analysis of network costs allow determining how financial (expenses/revenues) performance of distributors could be affected once unbundling

provisions are implemented. The trend analysis was performed by comparing differences in actual TOtex (CapEx + OpEx) with before unbundling TOtex over time.

Individual indicators for network costs area refer to:

- Total controllable costs (TOTEX= OPEX+CAPEX)

b. Other Costs: Transaction Costs

As a result of unbundling, it is also expected negative effects on costs. There are likely to be one-off transaction costs involved with the unbundling process, such as structural support costs, finance and audit costs, legal costs, information systems costs and contract renegotiations, due to the break-up. As a consequence of those restructuring costs, network business loss on disposal of generation assets, loss on sale of electricity contracts mainly those associated with retail business, and also remove potential synergies and economies of scope, particularly by internalizing and sharing functions with business integrated in same holding.

The main costs are the permanent reorganization cost of the unbundled organizations. But, most of these transactional expenditures can be seen as transfers rather than real costs, and temporal, even punctual, when the restructuring process takes place.

Knowing the industry cost function is fundamental for evaluating and discussing the cost - efficiency of unbundling process and assuming that unbundling structurally could influence the level of average costs at the time of unbundling, results interesting to verify this kind of costs dealing with network company's annual accounts over time to identify how this costs affects the financial viability of network business performance.

Individual indicators for network costs area refer to:

- one-off transactions costs
- average costs at the time of unbundling vs. average costs before unbundling

The main reason of selected indicators is making easier for the regulator the monitoring of key defined areas. The four different categories to measure, as [Table 3] mapped, involve not only the traditional DSO role as network operator but also the key role of enabling open competition retail markets among others by facilitating transparent and non-discriminatory access to network.

Category	Area	Indicator	Formula	Units
Market structure	Switching Rate	Switching Rate (SR)	nº of eligible customers switched/total nº of customers	%
		Market shares retail	nº of suppliers independent of DSO	Nº
	Market Price	Price trend	electricity prices from industrial and household customers	% increase
		Household price	end user price for household customer	annual avergae
	Market Concentration	DSO concentration	market share of three biggest DSO/each DSO in terms of distributed power MWh	%
		Retail concentration	HHI (Herfindahl–Hirschman Index) in electricity retail market	0-10.000
		Vertical integration ratio S-D	SR/distributed power MWh	%
		Vertical integration ratio G-D	generated MWh/distributed power MWh	%
Network: Quality of service	Continuity of supply: Zonal KPI	Time of interruptions	SAIDI = Σ(ri * Ni) / NT	minutes
		Number of interruptions	SAIFI = Σ(Ni) / NT	Nº
	Distribution Network Losses	Total distribution losses	network injection-network consumption	MWh
		Technical Losses ratio	load losses at peak demand	%
		Non-Technical Losses ratio	total losses-technical losses	%
Network Access	Network Charges	Network cost ratio	energy cost/grid cost	%
	Connection	Type	shallow, deep, shalowish	type
		Distribution charge	medium voltage/low voltage average charge	€/MWh
		Connections	nº of connections/ nº of required connections	%
			time required for connection process	minutes
			net cumulative connections	Nº
Network Cost	Total Costs	Total controllable costs	TOTEX=CAPEX+OPEX	m€
	Other Costs	Transaction costs	one-off transaction costs	m€
			average cost at the time of unbundling/average cost before unbundling	m€

Table 3 : Summary of selected Key Performance Indicators (KPIs)
Source: Own depiction

5.1.1.2 Phase 2. Decisions making (EX-ANTE)

Performance Benchmarking

Once data is collected and KIPs formulated, a **comparative benchmarking technique** [Annex 1] would be put in practise by regulators to obtain a global view of the business performance and how far being a distribution company for the efficient performance. It is useful to evaluate the situation of the electricity companies compared to other to identify performance gaps.

Benchmarking techniques are increasingly used as an aid to regulating network utilities. Particularly in the electricity sector, those tools are often being used by regulators for determining costs ratios as part of the remuneration mechanism for distribution companies. In this case the same idea is captured but to other extent.

Although there is a wide diversity of benchmarking techniques that could be properly fit with the methodology proposed, a Data Envelopment Analysis, commonly known as DEA, is the technique proposed to estimate DSOs productivity performance in a basis of unbundling regime, or even in absence of such kind of organisation. DEA allows comparing efficiency among different companies by observing distances to the efficient frontier, which is formed on the basis of the best performing firms from the observed productivity of distributors. Each company presents several inputs and outputs, but there is no need for a functional relationship among them. That's one of the reasons for using DEA instead of another benchmarking or econometric technique.

Variables required to run DEA model are represented by Key Performance Indicators predefined and calculated in a previous stage. According to the scope of the assessment, the regulator should identify in a rigorous way, not only which could be the most accurate KPIs, but also which of them enter in the model as proper **inputs or output variables** to get reliable results on the grounds that the efficiency analysis depends on input–output selection. It should be noted that it seems unavoidable that the prioritisation of the indicators and variables is subject to changes as new information becomes available or new organisation models appears, so changes to the classification are possible at any point.

Distributors use a wide range of inputs to provide services to customers and operate the network resulting in a range of outputs. Distributors that form the efficient frontier use the minimum quantity of inputs to produce the same quantity of outputs as other similar organisations. This means that distributors that use different combinations of inputs to produce different combinations of outputs can be frontier efficient. While all distributors use broadly the same inputs, some distributors may use proportionately more of some inputs and less of others, in this case dependent on the level of unbundling regime implemented. The nature of network operation and services provided by distributors varies

according the nature of customer demands, level of market competition, and regulatory framework.

Apart from variables, it is important to identify the organizations to be included in the benchmarking study. In this line, it may be crucial and will condition the final results. In order to identify potential benchmarking partners, it will be necessary to define the best for the performance to be benchmarked and different unbundling approaches in the key performance measures selected. The idea, therefore, is to identify benchmarking companies as a reference in a particular operational or functional area.

In this section, the impact of number of variables, the selection of variables, and the effect of unbundling factors on efficiency will condition the efficiency scores resulted by DEA tool. According to this study, the variables that may affect the unbundling process at distribution network scale have already been defined as KPIs, leaving the decision of inputs-output selection in hands of regulator to be used in the efficiency analysis of selected distribution companies.

The results obtained from benchmarking analysis are used to determine the most proper model, to detect the relevant performance gaps, and to find the common characteristics of the most inefficient firms.

Decision making

Since regulators are in charge of monitoring network unbundling progress, measuring the relative efficiency of a particular electricity firm compared with other competitors helps regulators adjust different operational and market factors. In fact, once the efficiency scores of each company are obtained is when the regulator should define the most adequate unbundling regime as the target that distribution companies shall implement. This needs to be done in the spirit of the European Directives to create a functioning internal energy market in the interest of European citizens as electricity consumers.

Therefore, one of the purposes of regulators as **decision-makers** is to **identify the weaknesses and shortcomings** of the current situation and the areas in which further action is needed. So, regulators should suggest structural remedies to solve not only market malfunctioning but also inefficient network operation. They must detect certain practices which appear unlikely to lead to effective network operation and may in practice lead to discrimination and foreclosure of competition. Based on technical and financial current performance and market context, regulator shall decide the necessity of **imposing further structural remedies** regarding the unbundling of network activities; among setting a softer level of unbundling, for instance an accounting structural separation, or reinforcing the current unbundling measures, if exists, or imposing a stricter ownership unbundling organisation.

In evaluating the performance gaps, which may require strategic actions to be closed, regulator should drive the distribution performance to a more effective behaviour, deciding if unbundling should be strengthened and in which way and providing the guidelines for

good practice to some improvement on the issues abovementioned. Regulator should also examine whether the introduction of unbundling leads to real improvements, not only in the on-going process of internal energy market but also in the efficiency of network business at operational and financial level. A new level of unbundling regime would be considered as the **regulatory target**. In order to comply with this target, DSOs must enforce and implement following regulatory decisions in order to establish a more efficient framework. The target must pursue effective unbundled distribution system operators, full independent, and also allowing them playing as market facilitators.

For setting the target, the regulator must mapped all the adjustments and results from indicators on an aggregate predefined categories to illustrate in more detail how each factor explains the efficiency differences between DSOs and to assess consolidations among them. Thereby, regulator should assess the performance in terms of market competition structure and network quality, access and costs and will be able to rank each company or country according to its efficiency and estimate if there is an opportunity for improvement in its performance.

5.1.1.3 Phase 3. Checking results (EX-POST)

Target compliance

Once the need for any residual regulation by a regulatory target is set, according to the benchmarking comparison between different distributions companies, it is time to **prove the viability and the degree of effectiveness** respect to unbundling provisions that have already been decided by regulatory authorities.

After an appropriate period of time for leaving the companies to adopt the new regulations and the effects on system operation and market behaviour being revealed; the regulator should start by collecting the data to update the KPIs initially selected and test **whether the target positive impact or not in an actual case.** As a consequence of regulatory practise, the new KPIs and new benchmarking results give regulators the impression about right or wrong direction of defined mandates and the chance to review again provisions. An in case it would be necessary, regulators should turn to the decision making phase.

Analysis of new data indexes allow to examine trends in the different network issues and market segments on an aggregate level. Besides, updated KPIs offer greater insights into the impact of unbundling in network performance and market development.

To assess the results and to determine fairness of the regulatory target about company performance and market competition, the regulator should **evaluate the results in different scenarios and under different hypothesis**, to full verify the value added and adequacy of proposed goals, to see the effect of unbundling approach of the firms on efficiency and to weight up progress towards goals.

Guidelines: findings and recommendations

This final phase is where leadership abilities are most crucial. The regulator team must be able to justify its recommended approach for improvement to DSO managers, national governments and sectorial associations. As well, process improvement teams must be able to manage change implementation and track their progress.

After the implementation phase, from real data and hypothetical scenarios, it is important from a regulatory point of view the proposal, accordingly with each situation, of the **best regulatory guidelines and practices**, take corrective actions if necessary and ensuring continual involvement and commitment.

As the firms are compared in terms of unbundling, network operation and market behaviour, the regulatory findings and recommendations based on the econometric model will be set under the same criteria, and following the analysis line initially set. Also should be proposed in order to fulfil the performance gaps, trying to improve not only the current level of performance, but also understanding the trend in that performance.

For each performance gap, identified by the regulator, as a point far from the target, should be define a **Finding**, for which the agent mainly affected, should react and correct, following the **Recommendations** also defined by the regulatory body. At least one recommendation for each finding would be necessary to understand what level of performance will be required and how could attain that level.

5.2 Analysis of Spanish DSO unbundling: a case study

The present section provides a real application of the methodology defined in previous section in order to demonstrate its robustness and suitability.

5.2.1 Case study

Since European electricity market is still in the process of restructuring to improve the operational efficiency and market competition, it is relevant to investigate how the reorganization of distribution companies affect the market function and their inherent network operation.

This practical survey aims to contribute to the discussion on current model of unbundling in Spanish electricity distributors, in comparison with other European distributors with both similar and different unbundling regimes, following the methodology defined in the previous section. In particular the impact that alternative forms of unbundling would have on the market structure and network performance is calculated by using a benchmarking technique called Data Envelopment Analysis (DEA) [Annex 1], under the DEAP computer program (DEAP version 2.1). The aim is to provide firms regulatory recommendations and

reorganization alternatives, when needed, to close their efficiency gap with the efficient frontier firms.

The key methodology steps followed in this case study are mapped in following graph [Figure 17].

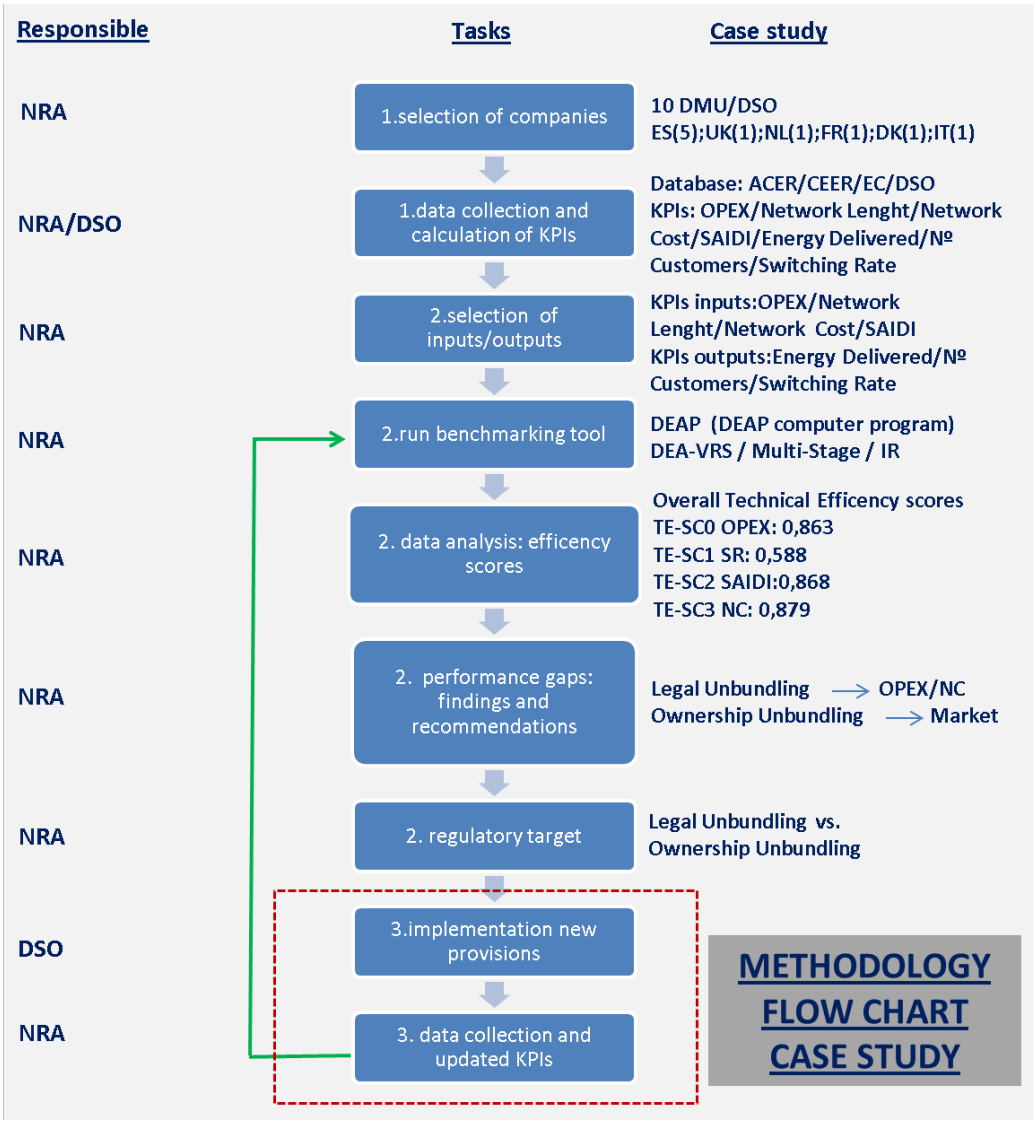

Figure 0-17 : Key steps: Case Study Flow Chart
Source: Own depiction.

5.2.1.1 Phase 1. Current state DSO performance (Analytical framework)

Data Collection

The benchmarking study reported here is based on data from 10 Distribution System Operators (DSO) in 6 different countries of European Union (ES, UK, NL, FR, DK, IT). All of them served more than 100.000 customers, thereby unbundling regime applied, but whereas two companies operate under ownership unbundling, the remaining are organised under legal unbundling. All DSOs total accounting for more than 337.000 GWh of distributed power (13% of total electricity consumption across EU-25) and more than 36 million customers (14% of total EU-25 electricity connected customers).

The data used in the present survey is collected for the annual accounts reports of selected companies, National and European regulatory authorities (ACER, CEER), EC and other European institutions (Eurelectric) reports for the purpose of this benchmarking exercise. The focus of our analysis is on both physical and costs data. This is particularly advantageous from a regulatory point of view, as monetary values could be used to measure the relative cost efficiency of utilities. Table 4 [Annex 2] shows the number of DMUs (Decision Making Units) or firms included in the study from each country and how they are organised regarding unbundling regime. As it is shown in the table, the number of utilities varies across the countries, being Spain the country with high DSO concentration for this practical case study.

The data collection applied for this particular report is summarised in Table 6 [Annex 2] based on statistics of data used.

Network Key Performance Indicators (KPIs)

In order to follow the methodology defined in the previous chapter and to evaluate the four relevant categories and areas, the key indicators, set in an annual basis and selected to model the practical case, are described below and in Table 5 [Annex 2]. These variables are among the most important distribution cost and operation drivers and are frequently used in benchmarking efficiency studies for electricity distribution.

i. Market Structure:

The Switching Rate (SR) ratio is selected as an output to provide the number of customers who have changed supplier, allowing assessing the consumer engagement and competition in the market. The ratio is annual considered at country level, due to the limitation of such information for particulars companies. Since DEA considers, the higher the outputs, the better the performance of the company, it could be used the inverse of the Switching Rate as the market index.

ii. Network quality of service:

The System Average Interruption Duration Index (SAIDI) is included in this study as an important controllable quality input measure to assess how reliable is the operation of the network.

iii. Network access:

The ratio of Network Costs, as a component of the household electricity prices of each selected country, exempted taxes and energy cost, is considered as an input. To evaluate if grid costs efficiently pass through network charges to consumers, network costs are assumed as an approximation of whole access tariff.

iv. Network costs:

The Operating Expenses (OPEX) is one of the most significant inputs for maintaining the distributors under specific financial constraints. It includes employee costs and other operating expenses from the annual financial reports of distribution companies.

In addition, the total amount of Electricity Delivered to end users is taken as output parameter since it represents the primary activity performed by distribution utilities, and also the total Number of Customers that is associated to the number of nodes that must be supplied is considered as output. Contrary, Network Length is selected as an input, representing capital expenses in physical units estimated by the length of the grid in kilometer, controlling for different voltage levels as well as for aerial and cable lines.

The relative efficiency level of each firm compared to others is estimated and showed by Technical Efficiency (TE) scores under following approaches: Variable Returns to Scale (VRS), Input Oriented (IR) and DEA-Multistage [Annex 1]. If the efficiency score has a value of one (or 100%) then the DMU is one of the best performers and lies on the efficient frontier. To follow the most proper decisions in benefit of all market players, TE scores are used to calculate the percentage by which all inputs can be decreased without decreasing the outputs. These decreased input levels are referred to as targets, and define the projected performance point that would cause the DMU to fall on the efficient frontier. As distribution companies cannot determine their output level because the relevant legislation makes them accountable for providing distribution service to all customers, to increase the efficiency, distribution companies have to decrease the amount of inputs. Taking into account this fact, IR models are more suitable to analyze the performance of selected European distribution companies. As the selected model is based on an input-oriented approach, the efficiency scores relate to changes in the inputs, so no measure of percentage changes related to outputs is calculated. The VRS assumption fits better in case of, for instance, imperfect competition and financial constraints, against optimal scale behaviour.

The DEA model and the variables characterisation as inputs and outputs are identified for each particular scenario.

5.2.1.2 Phase 2. Decisions Making (Analytical scenarios)

Performance Benchmarking

This section gives an overview about the performance of unbundled distribution companies from real cases, considering different scenarios by running the DEAP program.

According to the goal of testing the unbundling regime behaviour, different hypothesis are tested to cover four main categories defined in the methodology section, each of one is an independent objective function, which employ different combinations of the variables, so it defines a particular concept of efficiency, as a key managerial concept for distribution business. Table 7 [Annex 2] lists the Technical Efficiency (TE) scores for each DMU under the different scenarios and DEA approaches.

SCENARIO 0_NETWORK OPERATION COSTS

KPIs: As input variables OPEX and Network Length are selected and Energy Delivered and Number of Customers as output variables.
DEA Model: DEA-VRS Multi-Stage IR
Efficient Frontier Diagram:

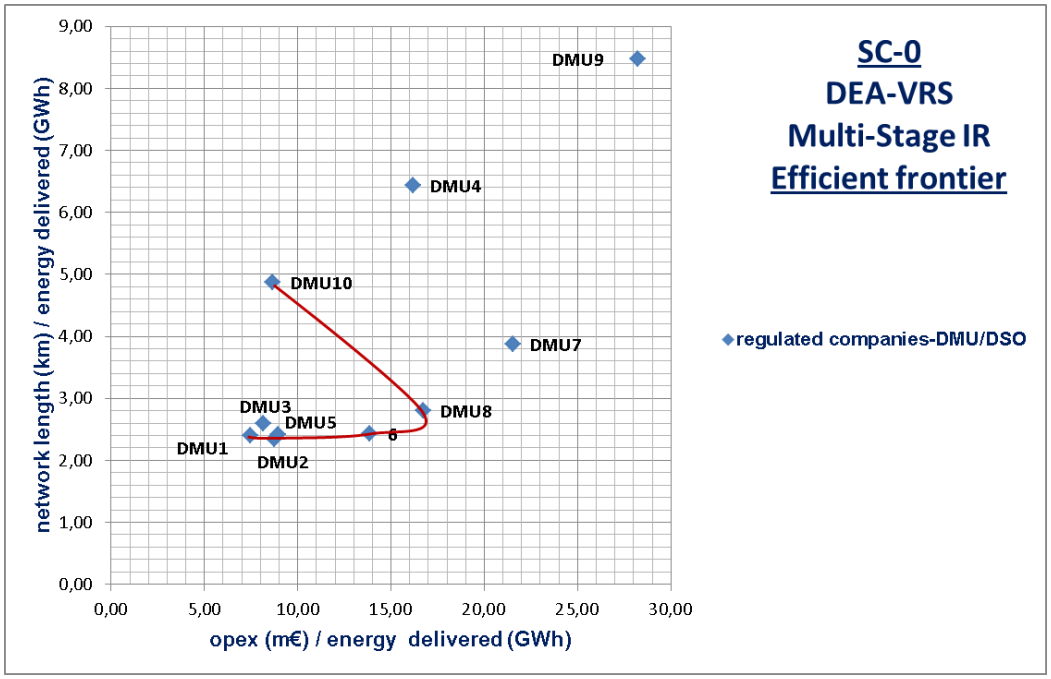

Figure 0-18 : DEA results: SC-0 DEA VRS Efficient Frontier
Sources: Own depiction.

Findings:
Under these criteria the DMUs rated as efficient are DMU1, DMU2, DMU5, DM6, DM8 and DMU10. As shown the diagram, these four utilities have Technical Efficiency (TE)

scores of 100% and dominate the frontier. Regarding unbundling regime DMU6 is under ownership regime and results full efficient in terms of OPEX, whereas company DMU7 also with stricter unbundling structure results in a lower efficiency score. This could be due to some extra operational costs need to compensate, for instance, the loss of economies of scope. In addition three distributors (DMU3, DMU4 and DM9) under legal degree of unbundling obtained inefficient scores, ranging from a minimum of 0.534 (DMU 9) to 0.941 (DMU 3).The mean of the efficiency score for all the firms in the sample is around 86%.

Recommendations:
Regarding opex objectives, those companies rated as efficient already have reached their target values, this means that their projected values, for both inputs and output variables, are equivalent to original values, so do not have to take decisions about their expenses. Whereas those companies with inefficient values (technical efficiency below one) should reduce their operational expenditure in order to achieve the efficient frontier and should effectively promote resources by better handling their inputs. These companies should reduce their operating expenses among 50% (DMU4, DMU7 and DMU9) and 10% (DMU3) for being aligned with the observable best practices.

SCENARIO 1_MARKET STRUCTURE

KPIs: As input variables OPEX variable is selected and as outputs Energy Delivered, Number of Customers and the Switching Rate ratio.
DEA Model: DEA-VRS Multi-Stage IR
Efficient Frontier Diagram:

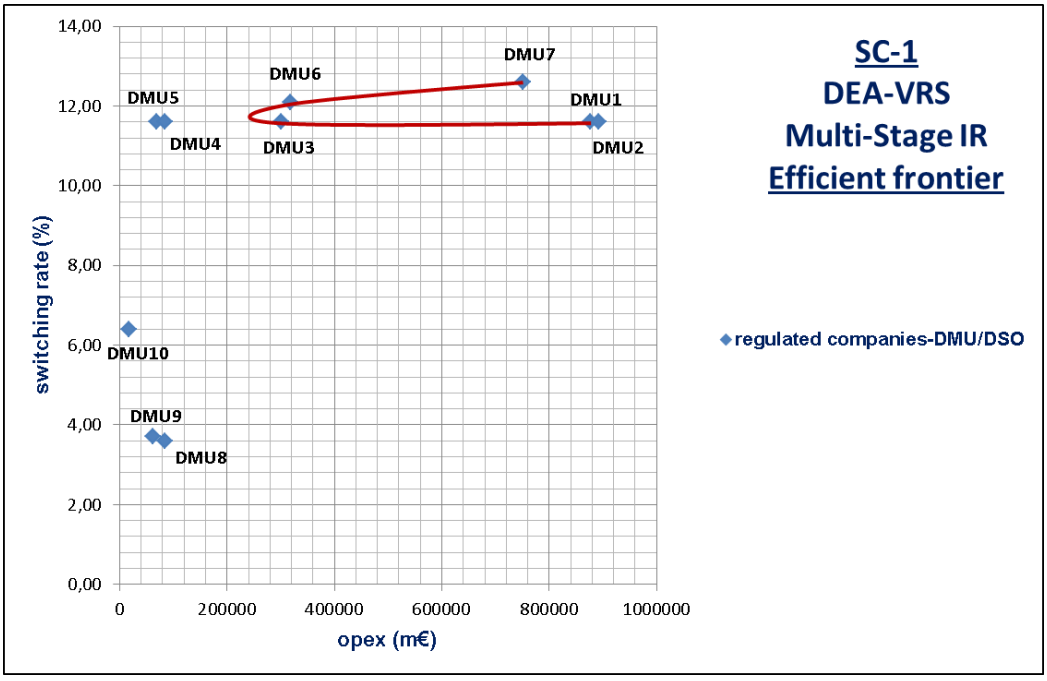

Figure 0-19 : DEA results: SC-1 DEA VRS Efficient Frontier
Sources: Own depiction.

Findings:
In this particular case, only 4 DMU (DMU1, DMU3, DMU6, DMU7), are rated as efficient, while the rest, are no longer efficient respect to this criteria. As being observed, in terms of Technical Efficiency (TE) these four companies with efficiency ratings equal to one set the efficient production frontier. Other companies obtained efficiency ratings below one, ranging from a minimum of 0.143 (DMU 9) to 0.983 (DMU 2), making them technically inefficient. Regarding unbundling regime, both companies under ownership unbundling result as efficient companies. Thus those countries, UK and NL, which have decided to implement a full degree of unbundling respect to other function in the electricity supply industry, show an efficient performance when the Switching Rate variable is added. The mean overall technical efficiency score of distribution units is around 59%.

Recommendations:
Regulator should be concerned about the consumer free movement, because the mean of efficiency scores results too low. Therefore, 60% of distribution companies tested should reconsider more than half of their operation resources to get best practices regarding free movement of customers.

In particular, for those countries (FR, DK, and IT), which DSO efficiency results far away from the best practises, regulatory authority should be further concern of ensuring the absence of incentives between retailers and distributors hindering the effective competition and the free movement of consumers. To ensure the contestability of customers increasing their security when changing the supplier and prevent anti-competitive behaviours, regulators should monitor the behaviour of inefficient performance, in line with few customers changing current supplier, further strengthen the separation between retailing and distribution functions as a regulatory solution. From practical case, just both countries (UK and NL) with stricter regime of unbundling form part of the efficient frontier, being this evidence of the contribution of effectiveness of full unbundling from this particular scenario.

SCENARIO 2_ NETWORK: QUALITY OF SERVICE

KPIs: Energy Delivered, Number of Customers are selected as output variables, while as input variables OPEX values and SAIDI ratio.
DEA Model: DEA-VRS Multi-Stage IR.
Efficient Frontier Diagram:

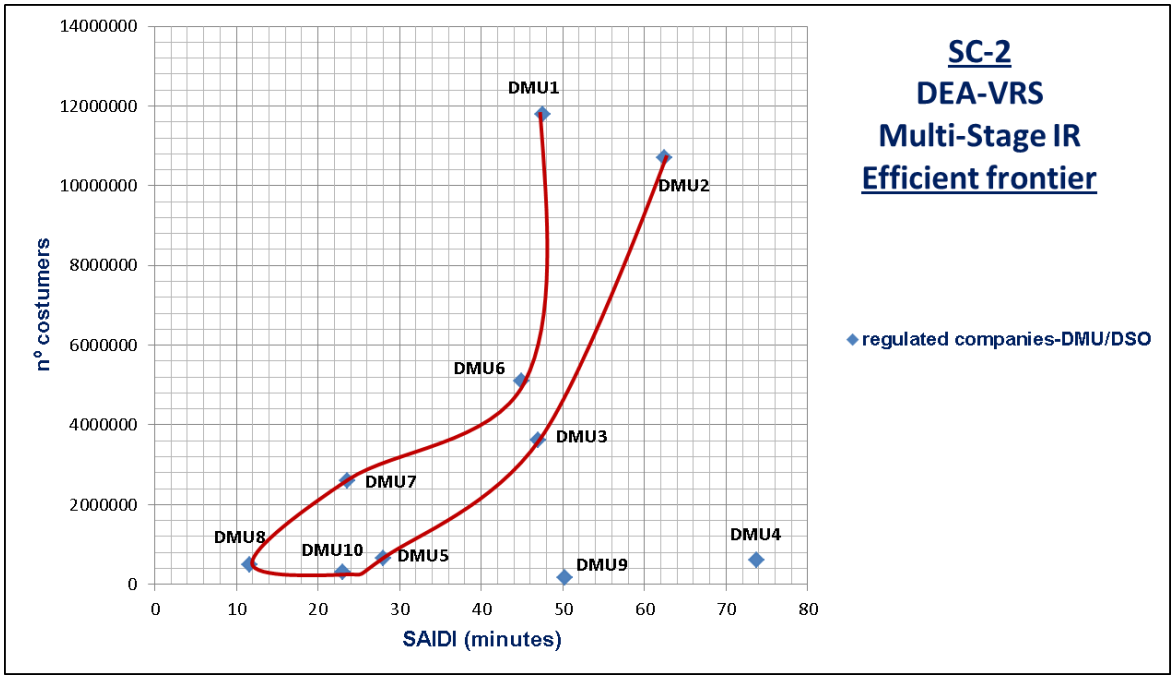

Figure 0-20 : DEA results: SC-2 DEA VRS Efficient Frontier
Sources: Own depiction.

Findings:
Based on the result of VRS model analysis and regards the quality of service, 80% of distribution companies' result under technically efficient operation (DMU1, DMU2, DMU3, DMU5, DMU6, DMU7 and DMU8). The two remaining companies are classified as technically inefficient. In terms of reliability, both distribution firms under ownership unbundling organisation are rated as efficient. The results show a considerable variation in efficiency scores ranging from 27% to 100%.The mean of the efficiency score for all the firms in the sample is around 87%.

Recommendations:
Regulator should pay attention in those companies rated as technical inefficient. Particularly in terms of continuity of supply, the promotion of rewarded incentives to improve yearly the reliability indexes could be a solution for this problem.
In order to pursue the obligations on service quality standards, regulators commonly set sanctions in case of not fulfil them. Apart from penalties policy, as a result of real separation, the opportunity of investment seems to be higher, once the removal of cross-subsidies and financing between distributors and retailers becomes factual, so the higher the opportunity to invest, the higher the opportunity to improve the quality of the network.

SCENARIO 3_NETWORK ACCESS

KPIs: Energy Delivered and Number of Customers are selected as output variables, while as input variables OPEX values and Network Cost ratio are set.
DEA Model: DEA-VRS Multi-Stage IR.
Efficient Frontier Diagram:

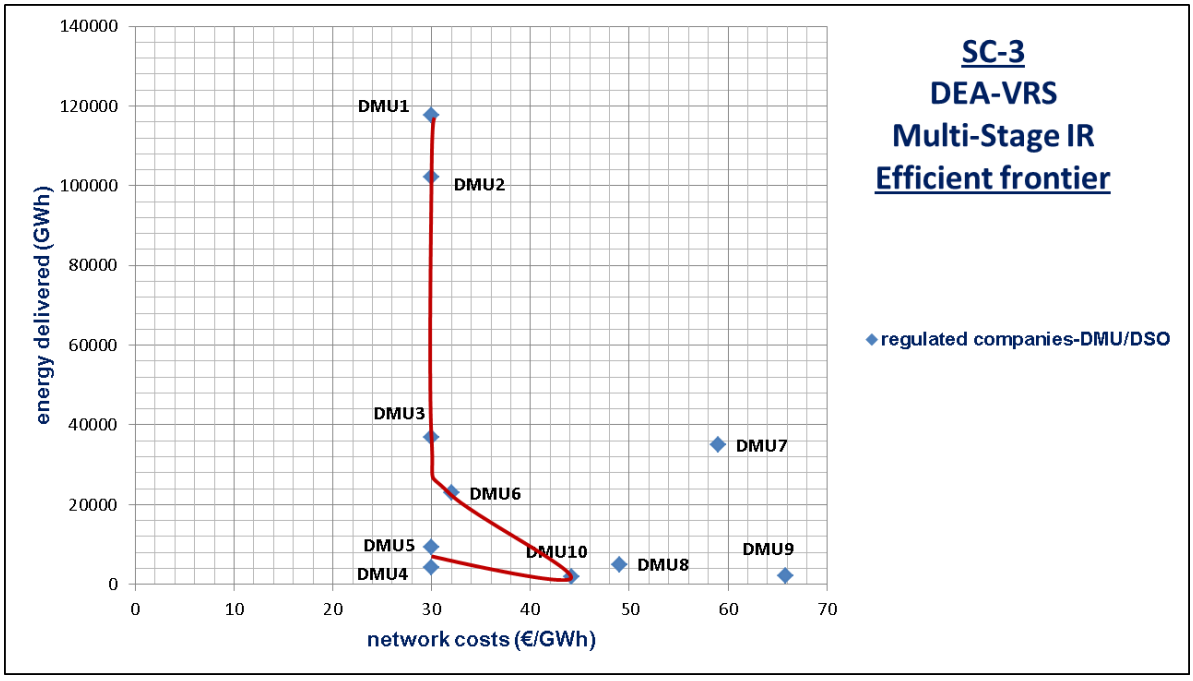

Figure 0-21 : DEA results: SC-3 DEA VRS Efficient Frontier
Sources: Own depiction.

Findings:
The results of all DEA model specifications show again variability in the technical efficient levels. The majority of companies (DMU1, DMU2, DMU3, DMU4, DMU5, DMU6 and DMU 10) are rated as efficient. The rest of the companies obtained efficiency ratings below one, ranging from a minimum of 0.508 (DMU 7) to 0.696 (DMU 8), making them technically inefficient. The lower the network cost, as a component of the electricity tariff pass through consumers, the greater the performance efficiency of the company, so those companies with a ratio below one should reduce network costs with the aim to be close to the efficiency. As the diagram show, again the same DSO (DMU6) under Ownership Unbundling is rated as efficient. The mean overall technical efficiency score of distribution units is around 88%.

Recommendations:
Although the overall technical efficiency in case of network costs seems to be close to the full efficiency, Regulatory Authorities should make some decisions in order to avoid disproportionate network costs, especially in those countries that are rated far from the efficient frontier, that pass through consumers by electricity tariffs, jeopardizing fair access to the network. Third Party Access is established as a measure to ensure a non-

discriminatory access to the network, but in case those network companies belong to same holding of retailing business may keep the risk of altering the opportunity for new entrants and hence the full open market competition.

Decision making

Now it's time to regulators to analyse the results from benchmarking and make the most accurate decisions that lead inefficient companies to best practises.

As results from analysis showed (see [Figure 22] and Table 7 [Annex 2]), the only DMU under OU rated as efficient under the four criteria is the company DMU6. These results corresponds to the DSO in UK, where OU was decided as a voluntary way to improve the market functioning and competition. Whereas the DSO from NL (DMU7), also functioning under OU, is only efficient in terms of SR and reliability of the network (SAIDI). This could mean that since divestiture between the distribution and retail function has been voluntary, the costs have been borne by the shareholders, however in case of a compulsory measure there is an inherent risk to pass through the cost on to consumers. This reflection coincides with the results of DMU7 in the Network Cost scenario, being the least efficient company.

From an overview, there are two main findings. First, the efficiency gap arises in the four main categories although in different overall efficiency scores. Being legal unbundling DSOs slightly more efficient in terms of costs, and OU DSOs remarkable more efficient in terms of SR. Second, the outcome reveals a relatively low overall efficiency scale from services issues that directly affect customers (SR), so addressing this area becomes a clear key step of improvement. These findings are graphically represented in the following scheme [Figure 22]. Each corner represents one DMU and either the areas of each scenario or the relative distance from the DMU corner to the centre, measures the efficiency level of each DMU or KPI. In the former case the greater the area, the higher the efficiency of the KPI. In the latter case the closer the distance to the corner, the greater the efficiency of the DMU. Therefore, the Radar Chart graph allows assessing the efficiency of both, KPIs and DMUs performance.

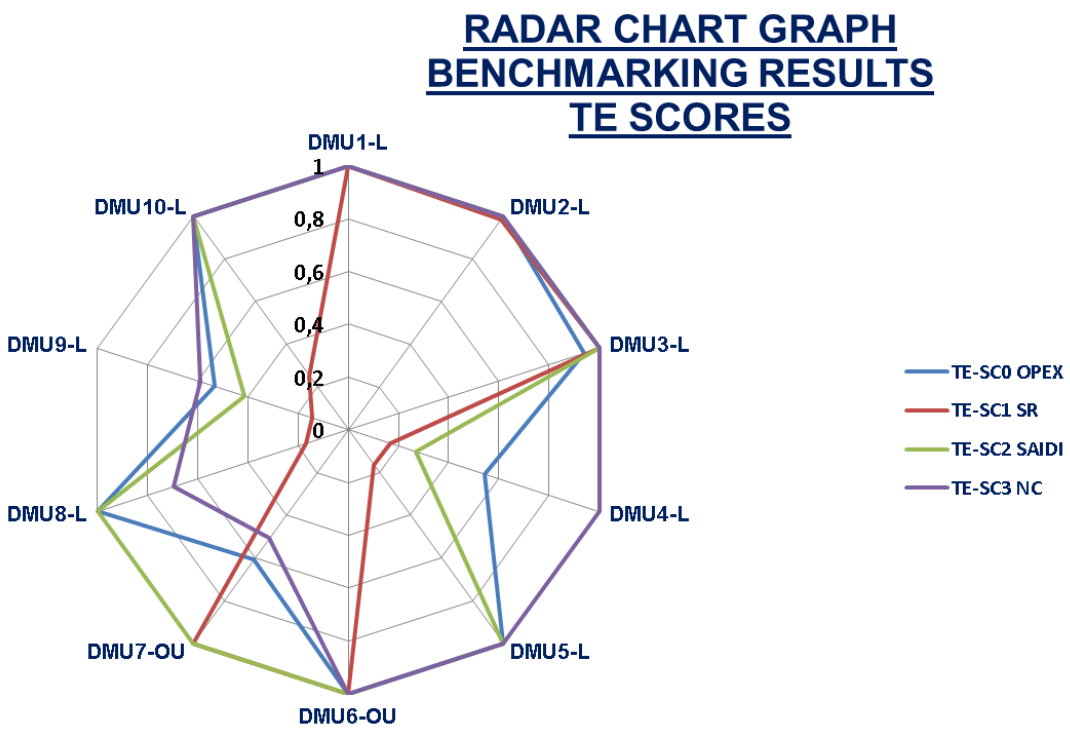

Figure 0-22 : DEA results: Radar Chart Overall Technical Efficiency (TE) scores (L=Legal unbundling; OU= Ownership Unbundling)
Sources: Own depiction.

Regarding Spanish distribution companies, even though belonging all of them to a vertically integrated company, the outcome shows greater marks from the majority of DSOs having an average efficiency score close to 100%, regarding cost, both operating expenses (overall efficiency score of 89,7%) and network costs fraction of household prices (overall efficiency score of 100%). In terms of unbundling, this seems to be a result from accounting unbundling imposes to DSOs by First Package of European Directives [Directive, 2009]. In a compliance of that provision, DSOs financial accounts must be kept separate to prevent cross subsidization and must be published separate for regulatory accounts. In terms of network reliability the overall efficiency level was also remarkable. However, turning to the results on Switching Rate it is observed the lowest overall efficient score (66, 34%). Thus, Regulatory Authorities should especially focus their mandates on corporate structures which ensure that consumers are benefitting from competition.

Once performance gaps are identified, Regulatory Authority should define the **target** that allows Spanish distribution companies to contribute to a perfect competitive electricity market and at the same time allows them to operate under cost-efficient conditions with the aim of increasing efficiency.

In order to reduce the efficiency gaps obtained for Spanish DSOs in all categories, regulators should focus their target on:

- Enhancing and supporting the **Switching Rate**. For doing that one way could be harder branding rules. It must be clear for customers that the network

operator is a neutral entity separated from any supply activities with the task of providing access to all energy suppliers in an equal manner. The customer must not believe that the integrated supplier is more reliable because of his closeness to the integrated grid, and therefore be reluctant to change suppliers. It is important to ensure that these processes continue to function in order to ensure that consumers have a positive switching experience.

- The OU DSOs results, in terms of consumers free movement, greater efficient than legal unbundling companies. This suggests that a **strict level of unbundling** could ensure a more reliable service to customers. By way, to reduce the performance gaps of legal unbundling in these areas, the regulator could impose a strict separation between distributors and retailers. Nevertheless, OU function worst in terms of cost, this could be related to the loss of economies of scope consequence of the full separation.
- However, legal unbundling DSOs are ranked only well against its peers in network costs measures. This means that **strengthen legal degree of unbundling** could be enough to ensure that DSOs pass through the cost on to consumers in a fair way and operate the network on a well-handling of resources. But, legal unbundling results worst in case of engagement of consumer because network companies belonging to the same holding of other business of the electricity supply chain tender to cross subsidies and conflict of interest hindering the opportunities for new entrants in the market and the free movement of consumers.

From regulatory point of view, the **structural target solutions** to create competitive electricity markets towards an efficient unbundling regime and aligned with benchmarking results are:

Target A. – Network Costs and Operating Expenses

In case of network costs, a financial robustness separation under legal unbundling regime seems to be enough. For strengthening legal unbundling between the network and commercial activities, Regulatory Authority should reinforce the financial audit process, allowing them a greater and transparent supervision not only of intragroup margin but also regarding financial cross-subsidies. In terms of intragroup margin, the financial robustness separation, allows distribution companies be more independent from holding to manage their benefits margin. In case of cross-subsidies supervision for ensuring that networks do not run into financial difficulties due to financial losses in other parts of holdings.

Target B. – Market Structure

In case of market-oriented (SR), to increase retail competition, Ownership Unbundling from network to commercial activities could be an efficient solution. However, due to the structural reforms that this degree of unbundling implies, both regulatory authorities and distribution companies should keep in mind that this kind of measures implies a cost. The transaction costs would appear because companies have to adapt their structures and make some reorganisations not only at personnel level, but also for legal and infrastructure issues. In favour, a full unbundling level does not require a deep regulatory

supervision and allow distributors to increase performance, efficiency and extra gains because of a better focus on networks.
In order to avoid the transaction costs, reinforcing the legal unbundling regime could be also a solution but with particular considerations. The promotion of higher "Chinese walls" between the DSO and its subsidiary retailers could be the best solution in the short run, since all Spanish distributors benchmarked belong to the same utility. "Chinese walls" refers to "information unbundling" through the creation of information barriers between supply and network activities. Network operators must act independently and must not be influenced by the vertically integrated group. This latter model implies a direct regulatory supervision, but creates a more transparent system.

Concluding, the net efficiency effect of Ownership Unbundling is ambiguous. Therefore, OU is not the only option to realise market competition and network operation efficiency. So, both strong Legal Unbundling and Ownership Unbundling formulate a more independent position of the network providing benefits for the network performance. However, it should be keep in mind that beyond the KPIs measured in this present report there are other variables that could affect them. For instance, SAIDI depends deeper on the remuneration scheme and the opportunity to invest rather than in the unbundling regime. On the other hand, the functioning of the free movement of customers (SR) is consequence not only of an efficient unbundling degree but also of the existence of regulated end-user tariffs. The regulatory schemes should be also another issue to take into account when monitoring unbundling regime and its influence in market competition.

Although seems to be clear that the current level of unbundling is not fully satisfactory to ensure fair competition, the ideal unbundling regime still seems to be an issue under ongoing discussion.

5.1.2.3 Phase 3. Checking results

Once the target is defined and within a period of time considered as sufficient to implement these new provisions, regulators must collect again the data of KPIs. With updated KPIs, they will be able to assess the fulfilment of new requirements in order to proof the robustness of regulatory measures and the degree of fulfilment by DSOs. For that reason and at least for time being, there is no chance to carry out tasks involve in this phase as part of the scope of this thesis.

Chapter 6
Conclusions

6. Conclusions

6.1 Conclusions

The main purpose of this Master Thesis is to define a detailed framework for monitoring distribution companies under unbundling regime. In the research way, many conclusions were found.

Firstly, by assessing the current state of distribution companies in Europe and Spain is realized that the supplied **distributed power** and the **served customers**, rather than the number of companies, provides the real information about the network system operation. This information, in both Europe and Spain, suggests that the unbundled Distributors System Operators become a key issue in the development of an open and competitive electricity market, dealing with more than 90% of energy delivered and having more than 90% of connected customers in the system.

By checking some practical countries experiences, in terms of unbundling regime, results evident that the **ineffectiveness of the current unbundling requirements** contributes significantly to the slow pace of the European electricity market integration.

So, as a consequence of these first findings, a systematic **methodology** is proposed to be followed by Regulatory Authorities in charge of unbundling monitoring. To test the robustness of the methodology designed, a real case study is analysed. The application of the methodology scheme shows that the key steps defined allow Regulatory Authorities to identify inefficient performance gaps and propose regulatory changes.

The benchmarking overall efficient scores **show that neither Ownership Unbundling nor Legal Unbundling lead to a full efficient performance of distribution companies**. To realise market competition and network operation efficiency, Ownership Unbundling performs better in terms of market structure and regards customer's services. While, Legal Unbundling regime is rated as more efficient in terms of network costs and operating expenses.

The case study results obtained are in particular aligned with New Zealand and The Netherlands case studies. Both countries imposed the Ownership Unbundling regime, and the results were not as successful as was expected in terms of network operation and market competition. Especially, the main equivalent finding with present survey is related to costs because Ownership Unbundling presents key drawbacks at this level, because implies an extra **transactions costs.**

Finally, highlight that the **unbundling regime** should be an **ongoing process** for finding the ideal organisation model for DSO. At least for time now, regardless the degree; it is evident that an effective unbundling regime provides a clear key solution essential to ensure independent network operation and non-discriminatory access to networks for all market participants.

6.2 Limitations

The main limitations found in this Master Thesis are related to the benchmarking analysis.

First of all, the small sample of distribution companies limits the number of variables or performance indicators that could be measure. So a larger sample will provide more reliable benchmarking results. The lack of harmonisation between existing data in different countries also was a barrier. Nevertheless, all information could be collected, and is presented in the case study part of this report.

Although, data for most distribution companies was available, some information was either missing or overly aggregated in a number of cases. For instance, in case of Switching Rate, the information must have been collected in a country level, instead of for each company.

For predefined methodology scheme, it is not possible to put in practise the last stage. To follow the criteria established it is necessary a period of time that allows distribution companies to apply the regulatory target proposed. And then will be able to measure the robustness of these set of guidelines and recommendations.

6.3 Further research

While the methodology initiative serves as a transparent regulatory way to acknowledge the performance of unbundled electricity distribution utilities, it calls upon further analytical work to identify other existing performance indicators that also affect network performance and market functioning.

In addition, the lack of definitive evidence on what would be the ideal unbundling regime clearly illustrates the need for further work. So, future analytical work is valuable because it may be used to draw successful best practises and regulatory changes that should be implemented for removing the current regulatory uncertainty.

Chapter 7
References & Glossary

7. References & Glossary

7.1 References

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7.2 Glossary

Term	Definition
ACER	Agency for the Cooperation of Energy Regulators
AE	Allocative Efficiency
CAPEX	Capital Expenses
CE	Cost Efficiency
CEER	Council of European Energy Regulators
CNE	National Energy Commission (Spain)
CNMC	National Markets and Competition Commission (Spain)
CRS	Constant Return to Scale
CTC	Costs of the Transition to Competition
DEA	Data Envelopment Analysis
DMU	Decision Making Units
DNO	Distribution Network Operators (UK)
DSO	Distribution System Operator
EC	European Commission
HI	Horizontal Integration
IR	Input Oriented
ISO	Independent System Operator
ITO	Independent Transmission Operator
KPI	Key Performance Indicator
LOSEN	Ley de Ordenación del Sistema Eléctrico Nacional (Spain)
MIBEL	Iberian Electricity Market
MLE	Marco Legal Estable (Spain)
MS	Member State
NPAM	Network Performance Assessment Model
NRA	National Regulatory Authority
NRM	Network Reference Model
OECD	Organisation for Economic Co-operation and Development
OPEX	Operational Expenses
OR	Output Oriented
OU	Ownership Unbundling
PCR	Price Coupling of Regions
PES	Public Electricity Suppliers (UK)
REC	Regional Electricity Company (UK)
SAIDI	System Average Duration Interruption Index
SAIFI	System Average Frequency Interruption Index
SR	Switching Rate
TE	Technical Efficiency
TPA	Third Party Access
TSO	Transmission System operator
VI	Vertical Integration
VRS	Variable Returns to Scale

Country abbreviation	Full country name
BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
HR	Croatia
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary
MT	Malta
NL	Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
UK	United Kingdom

Chapter 8
Annexes

ANNEX 1. BENCHMARKING TOOLS

Benchmarking involves evaluating the other company's business processes and adopting them to incorporate best practices to improve performance and gain a competitive advantage.

To estimate the efficiency scores of companies, parametric and non-parametric methods have been developed. In the parametric methods, a cost of production function is estimated, whereas in the non-parametric methods, it is not necessary to estimate the cost or production function. Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are the major parametric and non-parametric models respectively.

DSO Performance Benchmarking Technique: DEA Model

The DEA tool is the method selected to analyse the efficient performance of Distribution business in this report, being established as one of the most advanced benchmarking methodology and practicable approach for evaluating relative efficiency of homogenous Decision Making Units (DMUs).

DEA is a non-parametric method and uses piecewise linear programming to calculate the efficient or best-practice frontier of a sample. Those DMUs located at the efficiency frontier have their maximum outputs generated among all DMUs by taking the minimum level of inputs, which are efficient DMUs and own the best efficiency among all DMUs. The existing gap from any DMUs to the efficiency frontier shows how far the DMUs should be further improved to reach the optimal efficiency level. The efficiency of the firms is calculated in terms of scores on a scale of 0‑1, with the frontier firms receiving a score of 1.

DEA models can be Input (IR) and Output (OR) oriented. When the company is considered to have greater control over output quantities, then an output-oriented model with output-expansion focus should be used. Conversely, input-oriented models minimise input factors required for a given level of output, when the business is considered as having greater control over input quantities relative output quantities. An input-oriented specification is generally regarded as the appropriate form for electricity distribution utilities, as demand for distribution services is a derived demand that is beyond the control of utilities and has to be met, so the outputs are generally assumed as beyond the control. Regarding the choice of constant or variable returns-to-scale model may, in part, depend on the nature of returns-to-scale in the industry.

A central step in DEA is the choice of appropriate input and output variables. The variables should, as far as possible, reflect the main aspects of resource-use in the activity concerned. DEA can also account for factors beyond the control of the firms that can affect their performance (environmental variables). The variety of variables use shows that there is no firm consensus on how basic functions of utilities are to be modelled. In some cases a variable is an input and in others an output. From a

regulatory point of view it is often preferable to use monetary values of inputs in benchmarking.

This technique allows us to calculate Technical Efficiency (TE) scores, Allocative Efficiency (AE) scores and Cost Efficiency (CE) scores under the assumptions of both Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). Technical Efficiency measures the ability of a firm to minimise inputs to produce a given level of outputs, whereas Allocative Efficiency reflects the ability of the firm to optimise the use of inputs given the price of the inputs. When DMUs are operating at optimal scale, the CRS assumption would be more appropriate, whereas in case of imperfect competition or other constraints, VRS approach would be more suitable. Regarding the treatment of slacks a Multistage-DEA, in comparison with one-stage and two-stage models, is recommended because identifies efficient points which have input and output mixes which are as similar as possible to those of inefficient points.

An advantage of DEA is that inefficient firms are compared to actual firms rather than some statistical measure. In addition, DEA does not require specification of a cost or production function. However, the efficiency scores tend to be sensitive to the choice of input and output variables, and the method does not allow for stochastic factors and measurement errors. Further, as more variables are included in the models, the number of firms on the frontier increases, so it is important to examine the sensitivity of the efficiency scores and rank order of the firms to model specification.

There are number of articles and reports that employed DEA in the assessment of electricity distribution. In order to regulate the electric distribution utilities, most of the countries have adapted benchmark regulations, and particularly DEA benchmarking methods have been applied by a number of private, public and regulatory organisms ([EC, 2004], [CAPGEMINI, 2008], [CEER, 2011],[AER,2012].

Although the application of DEA in the electric power industry is widely extended, the results of regulatory benchmarking may have an inherent uncertainty [Eurelectric, 2002], and particularly this uncertainty could be reduced developing a regulatory benchmarking with particular view to international comparisons of efficiency. In this line [Jamasb, 2002] provided a useful survey of the use of frontier studies in regulation of electricity distribution and provide some regulatory recommendations for co-ordinating international benchmarking, paying careful attention in the sample size, in the collection of information, common templates, and submission deadlines for data standardisation.

There exists wide theoretical and applied literature on benchmarking of electricity distribution utilities driven by its importance for incentive regulation. Amongst others, [Hess, 2007] test the robustness of structural difference of technical efficiency scores between East German and West German electricity distribution companies. [Samuli, 2006] describes the different benchmarking methods used in benchmarking of electricity distribution companies in Finland, Sweden and Norway, based on DEA and other model, the Network Performance Assessment Model (NPAM). In Australia, New South Wales, during the first distribution price control review, [London Economics,

1999] benchmarking study concluded that New South Wales distributors were inefficient compared to the 200 other distributors.

Regarding the sample of companies that must be selected in order to achieve reliable results, a general rule is that the sample size should not be less than, the product of the number of inputs and number of outputs, or three times the sum of the number of inputs and outputs, whichever is larger [Cooper, 1999]. A relatively small sample size combined with a large number of outputs and input dimensions would artificially inflate the efficiency scores and most distributors will approach 100%. This is because most distributors will become ‘unique’ in some way and hence will only have themselves as a peer (and therefore an efficiency score of 100%).

In Spain, application of DEA for performance evaluation of electric utilities has been very limited. National Regulatory Authority applied a Network Reference Model (NRM) to evaluate the regulated businesses remuneration, based on implications of an engineering-based model. However, [Arocena, 2005] assessed the existence of economies of scope, diversification and scale in the Spanish electricity sector through a non-parametric model.

ANNEX 2. BENCHMARKING DATA

Table 4: Number of DMU in the sample, country and unbundling regime (L= Legal unbundling; OU= Ownership unbundling)

DMU	COUNTRY	UNBUNDLING REGIME
DMU1_Endesa Distribución Eléctrica	ES	L
DMU2_Iberdrola Distribución Electrica	ES	L
DMU3_Unión Fenosa Distribución	ES	L
DMU4_Eón Distribución	ES	L
DMU5_Hidrocantabrico Distribución Eléctrica	ES	L
DMU6_Electricity North West	UK	OU
DMU7_Enexis	NL	OU
DMU8_Electricité de Strasbourg réseaux	FR	L
DMU9_Energi Midt	DK	L
DMU10_Dolomiti Energia_SET Distribuzione S.p.A.	IT	L

Table 5: Key Performance Indicators (KPIs) and classification as input/output variables

Inputs	KPIs
x1	Operantig Expenses_OPEX (miles €
x2	Network Lenght (Km)
x3	Network Costs (€/GWh)
x4	SAIDI (minutes)
Ouputs	
y1	Energy delivered (GWh)
y2	Number of customers (nº)
y3	Switching Rate (%)

Table 6: Descriptive Statistics: Input and Output data for the 10 DMUs

Inputs	KPIs	mean	st.dev	min	max
x1	Operantig Expenses_OPEX (miles €)	345635,64	357663,02	17141,76	892284,00
x2	Network Lenght (Km)	90036,90	98954,67	9633,00	282251,00
x3	Network Costs (€/GWh)	0,04	0,01	0,03	0,07
x4	SAIDI (minutes)	41,22	19,36	11,60	73,79
Ouputs					
y1	Energy delivered (GWh)	33740,40	42354,60	1978,00	117760,00
y2	Number of customers (nº)	3601881,10	4355406,79	176000,00	11786168,00
y3	Switching Rate (%)	9,64	3,59	3,60	12,60

Table 7: Technical Efficiency (TE) scores for each scenario

	TE-SC0 OPEX	TE-SC1 SR	TE-SC2 SAIDI	TE-SC3 NC
DMU1-L	1	1	1	1
DMU2-L	1	0,983	1	1
DMU3-L	0,941	1	1	1
DMU4-L	0,544	0,167	0,271	1
DMU5-L	1	0,167	1	1
DMU6-OU	1	1	1	1
DMU7-OU	0,608	1	1	0,508
DMU8-L	1	0,167	1	0,696
DMU9-L	0,534	0,143	0,412	0,588
DMU10-L	1	0,25	1	1
overall efficency scores (mean)	**0,863**	**0,588**	**0,868**	**0,879**