Managing Electricity Sourcing in Europe's Energy Intensive Industry - A Methodology to Develop an Electricity Sourcing Strategy

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SUMMARY

Several regulatory changes in Europe's electricity sector have stimulated competition in the market. National power companies, with monopolistic structures, have evolved into competitive entities, creating increased choices for consumers.

Electricity prices have also been very much affected by these new regulations and have been particularly influenced by climate change policy that was introduced in 2005. Electricity prices are now affected by both the volatility of the fossil fuel market and the prices of CO_2. We recognize the effort to develop and introduce renewable electricity in Europe – 20% renewable energy by 2020. In order to achieve this, governments have promoted the creation of a more CO_2-friendly generation capacity.

All of these new conditions have introduced more competition into the market, while offering more choice in terms of sourcing electricity. Consumers have identified and assessed the market changes to better select the way of sourcing their electricity needs; consequently, we have developed a new electricity sourcing methodology.

The new sourcing methodology integrates a series of steps that will allow electricity users to better understand the current electricity sourcing options and then look to the future in order to identify market trends. Details about company organization and resources have to be considered in order to make a complete assessment of the feasibility of implementing a possible option.

The methodology has been tested in three countries (Croatia, Spain and the UK), each with different market conditions. Case studies focus on each of these markets and provide an overview of electricity consumers, as well as their electricity profile and market conditions, including details about electricity prices, electricity demand and electricity sourcing options in relation to the market structure.

A decision making tool has been developed to incorporate all of the steps described in the methodology in order to facilitate the creation of scenarios from both the supply and demand sides. This will help the organization to frequently monitor and assess the changes in the market, as well as identify new business opportunities.

Key words: Electricity, sourcing, decision making, Europe, supply, demand, industrial, methodology, strategy.

RÉSUMÉ

Plusieurs changements réglementaires dans le secteur électrique de l'Europe ont stimulé la concurrence sur le marché. Les entreprises nationales d'électricité, aux structures monopolistiques, ont évolué vers un marché plus dynamique, créant pour les consommateurs davantage de choix en la matière.

Les prix de l'électricité ont eux aussi été très fortement affectés par ces nouvelles réglementations et ont été particulièrement influencés par la politique sur le changement climatique introduite en 2005. Maintenant, les prix de l'électricité sont affectés à la fois par la volatilité du marché des combustibles fossiles et par les prix du CO_2. Nous reconnaissons les efforts visant à développer et l´introduction de l'électricité produite à partir de sources renouvelables en Europe – 20% d'énergie renouvelable d'ici à 2020. Pour y parvenir, les gouvernements doivent promouvoir la création de capacités de production d'électricité émettant moins de CO_2, en ouvrant la possibilité, pour toute entreprise, de produire de l'électricité et d'intensifier son intégration dans le secteur électrique.

Toutes ces nouvelles conditions ont introduit plus de concurrence dans le marché tout en offrant plus de choix en terme d'approvisionnement en électricité. Les consommateurs ont identifié et évalué les changements du marché afin de mieux choisir la manière de sous-traiter leurs besoins en électricité. Ce processus complexe peut s'organiser autour d'une nouvelle méthodologie d'approvisionnement en électricité.

Cette nouvelle méthodologie d'approvisionnement comprend une série d'étapes permettant aux utilisateurs d'électricité d'abord de mieux comprendre les options actuelles d'approvisionnement en électricité, puis de se tourner vers l'avenir afin d'identifier les tendances du marché. Les détails de l'organisation et des ressources de l'entreprise doivent être pris en compte pour établir une complète évaluation de la faisabilité de la mise en œuvre d'une option envisagée.

Cette méthode a été testée dans trois pays (Croatie, Espagne et Royaume-Uni), chacun présentant différentes conditions de marché. Elle comprend des études de cas focalisés sur chacun de ces marchés, qui fournissent un aperçu des consommateurs d'électricité, de leur profil de consommation d'électricité et des conditions du marché, y compris des détails sur les prix de l'électricité, la demande en électricité et les options d'approvisionnement en électricité en lien avec la structure du marché.

Dans le but de faciliter la création de scénarios à la fois de l'offre et de la demande, un outil d'aide à la décision a été développé pour couvrir toutes les étapes décrites par la méthodologie. Cet outil aidera l'organisation à surveiller et évaluer fréquemment les changements du marché, mais aussi a identifier de nouvelles opportunités.

Mots-clés: Electricité, approvisionnement / sous-traitance, prise de décision, Europe, offre, demande, industriel, méthodologie, stratégie.

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1.1 The context: The electricity market

Electricity plays an essential role in modern society and is an indispensable resource for industrial development. In the past, electricity production was dominated by vertically-integrated utilities which owned the majority of the generation capacity, as well as the transmission and distribution facilities. Today, however, the European Union's (EU) electricity sector is moving away from that model and is undergoing a fundamental transformation in the way that it delivers electricity to millions of residential, commercial and industrial customers.

Traditionally, the electricity sector was controlled by public monopolies, where a vertically-integrated company was responsible for the whole supply chain, from generation to electricity retail (IEA, 2007; Coppens and Vivet, 2006). However, with the advent of deregulation, the market rules have changed and the electricity sector has evolved into a system characterized by new players involved in production and wholesale and, ultimately, in the retailing of electricity. The network infrastructure is now under the control of the transmission system operators (TSO).

The recent increase in the number of market participants, and the emerging competitive markets, have fundamentally changed the way electricity is supplied and, with it, the supply chain's structure and dynamics (Hass and Auer, 2005; Boisseleau, and Hakvoort, 2002). While the energy supply used to be restricted to a limited set of products offered by single suppliers, deregulation has offered consumers – for the first time – considerable choice in supply alternatives. The static approach to energy procurement has been transformed into a new way of doing business and has brought with it more challenges and opportunities to secure energy needs within a competitive environment.

The EU has been promoting liberalization in the energy sector since the early 1990s. The European Commission (EC), through various EU Gas and Electricity Directives, lays out the conditions that have to be put into place with the main goal to create a "single energy market." This means that Member States (MS) must open up their national markets and allow competition. Nevertheless, liberalization of the electricity sector is not progressing at the same time or rhythm within all of the European countries; therefore, one can find different structures, ranging from monopolies to competitive markets.[1] As a result, large electricity consumers in many countries can improve their energy sourcing options – in a more competitive way – so that they are able to access a full range of opportunities and obtain the necessary flexibility to manage their supply costs.

Although the EU has made an effort to speed up the process of liberalization and encourage competition to reach a level where the market is transparent and liquid, providing incentives to actively participate in it, some EU countries have not yet reached this last stage of the liberalization process. However, the increasing number of market players and the existence of "free choice of supply" is now a reality in many European countries. Suppliers have developed a variety of services with the intention of creating a marketplace and gain an advantage over other market players. On the consumer side, development has been focused on improving the variety of the sourcing portfolio, providing better cost management and possible business diversification.

The new regulations and the market dynamics are the key elements promoting change in overall market conditions, adding a layer of complexity to the sourcing process; this forces large electricity consumers to leave behind the reactive attitude of the past and adopt a proactive attitude in order to respond to the new emerging conditions (IEA, 2007; Handfield, 2004).

Supporting this new proactive strategy and its application in power procurement is the basic motivation of this doctoral dissertation. Thus, this study aims to examine the process that needs to be followed in order for large electricity consumers to select the right energy sourcing strategy as well as to analyze the critical changes in the market design and dynamics in Europe as a lesson to other economies.

The proposed methodology is intended to support the manner in which large electricity consumers identify and select their electricity sourcing options, as well as provide them with a structured way to identify and assess all of the opportunities available in the

[1] We assume a competitive market, meaning that the customers can select among different electric power suppliers.

market. The methodology has been integrated into a decision making tool[2] that provides flexibility in the study of the electricity market's current and future conditions. This is a contribution of the present research study.

Over the past few years, market analysis has been considered the primary way to manage the development of power procurement. However, market analysis has focused mainly on only one dimension of the problem, missing some of the important conditions regarding time and environment, both crucial to an organization. Alternative techniques, used in other sourcing areas, have never been applied to the power domain. For example, studies to build on the extrapolation of current trends into the future – the so called "business-as-usual" or "baseline scenario" – can be used in conjunction with alternative sourcing options or scenario planning to include future trends (Brummell and MacGillivray; Soontornrangson, Evans, et al., 2003).

Power procurement strategy developers, however, are still applying short-term assessments that are not sufficient in developing robust sourcing strategies. Therefore, the overall contribution of this research is to introduce a new way of thinking with regard to power sourcing.

1.2 Problem statement

The liberalization of the electricity sector in Europe has created new markets with an important increase of market players that have, subsequently, provided more supply options to the customers. In parallel, new environmental regulation has influenced electricity prices since 2005, when the first phase of the European Emission Trading Scheme (EU ETS) began. The power sector has been passing the cost of CO_2 on to the end-user and this has increased the cost and volatility of electricity.

Because these new conditions have created more competition, and have provided more choices for consumers, management needs to better assess their electricity sourcing options and adopt a decision making process to aid in selecting the best electricity

[2] The tool is an Excel model that integrates all the steps related to the electricity sourcing methodology.

sourcing strategy. Therefore, electricity intensive users must respond quickly to these changes. The best way to do that is to analyze and understand both current and future trends in electricity sourcing.

Until now, the methodologies developed to analyze and understand electricity supply have focused mostly on cost analysis and profit maximization, without taking into consideration the external environmental conditions and the firms' capabilities and resources. The possibility of identifying and integrating the power sector trends – in their various dimensions – has thus far not been integrated into a methodology which is able to assess electricity sourcing portfolio options.

1.3 The objective of the study

To recapitulate, the evolution of the electricity market in Europe is driven by three essential factors (Bozon, et al., 2007; WBCSD, 2004, 2005):

1. The energy market, particularly electricity, is changing more rapidly than ever, due primarily to policy and economic changes.
2. Environmental issues are of increasing concern in the international energy market.
3. Technological improvements greatly affect market efficiency, including integrating green electricity options.

Although electricity deregulation has added layers of complexity for customers with regard to how they manage their electricity needs, it has also created opportunities for large electricity consumers to change the way they are managing the risks that lie behind their energy supply (Handfield, 2004; CEEPR, 2005).

Today's competitive and dynamic market requires large electricity consumers to be proactive and prepared to respond to future changes (Davenport et al., 2003). In the monopolistic market, electricity supply was identical for all players.

Because the price of electricity was fixed, the only way to manage the cost of supply was through increases in operational efficiency. As a result, instead of developing an approach for electricity procurement, large electricity consumers have, until now, been more oriented toward acquiring and developing the knowledge and skills they need to manage energy costs from an operational perspective.

The objective of this dissertation is to develop a methodology that will assist large electricity consumers to formulate their power sourcing strategies. The methodology provides a range of sourcing options and an assessment to select the best strategy. As a result, this research will answer the following question: The electricity sourcing complexity represents an important challenge for large electricity consumers. Could a new sourcing methodology provide important support for decision making?

The benefit of this study is three-fold. First, it presents a methodology in developing a sourcing strategic plan. Secondly, it provides a systematic tool that can be used to create scenarios and monitor the effect of changes in external and internal conditions. And thirdly, it provides a framework for assisting supply managers in learning about the electricity supply market and electricity sourcing.

1.4 Limitation and study framework

The dissertation framework covers supply and demand activity in the electricity sourcing strategy for energy intensive companies located in the European region. This region has different electricity supply structures that come from monopolistic to market based elements. The study is built around the electricity large consumers to support the development of its electricity sourcing strategy.

Chapter 2. The Electricity Market in Europe

2.1 Introduction

Over the past 15 years, the liberalization process has significantly shaped Europe's electricity sector. The EU countries have implemented measures to promote competition in the electricity market – actions that have already affected, and will continue to effect, the way energy intensive users satisfy their electricity needs.

The development of new regulations has also created incentives for the use of energy efficient technologies, as well as for a more rational way to consume electricity. These are all elements of strategic importance for the large electricity consuming sector.

The development of an energy sourcing strategy – one which considers these new market conditions – can provide an important competitive advantage for energy intensive industries, such as steel, cement, glass and others. More precisely, these new market conditions can indeed offer interesting opportunities for energy intensive users to self-supply electricity from different sources, such as fossil fuels or renewables. Moreover, they may even provide incentives to develop vertically-integrated firms.

Overall, this chapter provides an overview of the electricity market and various factors that have shaped the evolution of the electricity sector's liberalization, taking into account the deregulation process, the dynamics of the electricity prices and the support mechanisms that incentive the development of renewable energy technologies.

Climate change policy continues to affect the development of the electricity sector – a process that started in 2005 when CO_2 regulation[3] was put into place and the emission trading scheme began operating; there is no question that the trading of European Allowances (EUA)[4] has influenced the price of the electricity. The development of the generation mix is now driven by climate change and environmental regulation, in addition to fossil fuels and renewable technologies that will all have to be assessed to find the best solution to supplying electricity. Industry will have more options to source their electricity and, possibly, incentives to develop self-generation projects. This environment can bring about both benefits and risks that will be addressed here, as well as the need for a systematic approach to find and evaluate new electricity sourcing options.

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[3] Phase 1 period was 2005-2007, Phase 2 is 2008-2012 and Phase 3 will be 2012-2020.
[4] EUA – European Unit Allowance (CO_2 Allowances traded in secondary markets).

2.2 Electricity market overview

Throughout the 20th century, the electricity industry has been vertically integrated. Corresponding utilities have provided all services with their own generation, transmission to distribution networks. In addition, they have been responsible for supplying all end-users. From the consumer's perspective, the whole system was characterized by having a secure source of electricity from a single supplier, without any opportunity to diversify supply and manage the price structure.

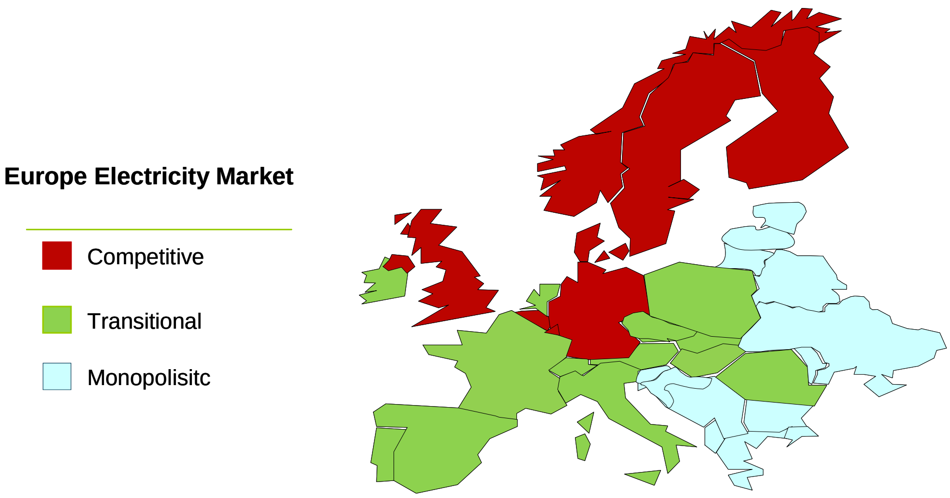
During the last decade, there has been a significant change in the way electricity is purchased and retailed (Handfield, 2004). The dominant model of vertically-integrated, state-owned national companies has evolved and the industry has begun to be restructured and privatized (Kessides, 2003; Joskow, 2006; Danwitz, 2006).

The process of liberalization has included introducing competition to both wholesale generation and retail supply, incentivizing regulations of transmission and distribution networks and establishing an independent regulator (EC Directives, 2003) – a process expected to result in more competitive wholesale and retail markets (Hogan, 2007). The purpose of introducing the unbundled service was to separate generation and supply activities from transmission and distribution. This change was required to foster competition in the wholesale and retail markets and give consumers a cost-effective choice in energy supply. Nonetheless, designing and implementing an effective scheme has led to some difficulties, especially in the process of opening up the market, cross-border trade and competition (EC, 2007).

Regulation has allowed incumbent suppliers to remain integrated with generators (Kumar, 2001). On the one hand, the main negative consequence of this is a situation where consumers lose the choice to switch suppliers, while the market continues to be largely captured by incumbents. But, on the other hand, the number of independent suppliers has been increasing and will eventually introduce competition into the supply sector. Even if it does not reach a fully open competitive environment, this new supply market structure will provide the end-users with a wide range of options to improve and optimize their competitiveness (Handfield, 2004).

In addition to vertical unbundling, another critical point is access to the network. In principle, deregulation brought "free access to the grid." Therefore, access to either transmission or distribution networks should be accessible to any generator under the same conditions (EC Directives, 2003; EC, 2007). This situation is promoting an increased number of players, making the wholesale markets more important. Moreover, vertical unbunding is also favorable for independent generators because it helps them to integrate into the marketplace, as part of their supply options. It also represents a challenge when assigning the right incentives to transmission system operators in order to provide independent producers with transmission capacities. **Figure 1** describes the configuration of the electricity sector related to the level of liberalization – monopolistic, transitional and competitive.

Figure 1 *Europe electricity market*



(Source: Modified from EU commission – 2005; and Jamasb, Tooraj; Pollitt, Michael - 2005)

Changes in the regulatory systems tend to turn European markets into more competitive environments by increasing supply options and reducing transaction costs (CEEPR, 2005). The liberalization process has changed the conditions in terms of how large electricity consumers source the electricity. Today, a large number of industrial consumers operate in a more competitive market and with a wide range of energy supply options from the monopolistic to the competitive market structure (Danwitz, 2006).

Since regulations have been changed and have opened up the electricity sector to competition, this new electricity market has been characterized by a higher number of independent players along the supply chain – from production to the wholesale and retail markets. This increasing number of market participants has fundamentally modified the electricity supply pattern, affecting not only the structure of the electricity supply chain but also the stability or volatility of the electricity prices (Cartal, 2006).

Likewise, since liberalization was introduced, electricity prices obey the market laws of supply and demand, making the cost of supply variable (IEA, 2007). Other important factors that affect those costs of supply are: electricity regulation, volatility of fuel prices and new CO_2 regulations (EC, 2007; EER, 2007). All of these factors force energy intensive users to take more responsibility in the price dynamics and think more strategically when making a decision about how to source power (Handfield, 2004).

New regulations may also bring additional business opportunities to the marketplace. It is expected that the new regulations will promote competitiveness and investments, as well as ensure quality of service (EPRI, 2007). Therefore, large electricity consumers should accept the challenge of improving the existing sourcing portfolio as a way to create a better cost structure and utilize the opportunity for business diversification.

Along with the above-mentioned benefits, emerging environmental conditions might involve some additional risks – risks related to the uncertainty of new market regulations and the organizational changes that each company might suffer when trying to implement a new power supply strategy.

New market conditions will force large electricity consumers to change their business strategies through the continuous monitoring of supply environments, improve their assessments of current positions and conduct frequent research into potential sourcing solutions. These important parameters can be incorporated into a systematic approach that will serve as a guideline for all large electricity consumers, whose managements are trying to change traditional procurement practice when sourcing power.

2.3 Liberalization of the electricity sector

The key objective of the liberalization process was to increase efficiency of the electricity sector by promoting competitive prices, as well as by improving the diversification of supply options (EC Directive, 2003).

Another aim of liberalization has been to strengthen the reliability of supply, with adequate infrastructure investment to ensure sufficient network capacity and efficient generation of electricity with a wide range of technologies. To put these objectives into action, a reorganization of the electricity sector was required. The liberalization process in Europe began by restructuring the electricity sector and was comprised mainly of privatizing state-owned electricity and introducing competition. The term “market liberalization” covers several related reforms in the electricity sector, which were not pursued at the same time (Sioshansi and Pfaffenberger, 2006) and are summarized as follows:

1. Corporatization – transfer of state-owned utilities into commercially structured and commercially oriented companies.
2. Privatization – transfer of assets of the electricity sector from state to privately-owned organizations.[5]
3. Deregulation – reducing direct state control or oversight of various aspects of industry operations.[6]
4. Competition – allowing two or more electricity suppliers to compete for customers in a given market.

The steps required for a complete liberalization of the electricity industry included reforms in the opening up of generation and supply sectors to competition, managing transmission and distribution networks through different incentive programs including, in some cases, an independent systems operator (ISO), creating an independent regulator and finally, privatization (Jamasb and Pollitt, 2005).

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[5] Power companies that provide power generation and electricity trading capabilities.
[6] Deregulation is considered as a move by government entities to introduce increasing market-driven measures.

Going further, the unbundled electricity supply was meant to eventually separate competitive generation and supply from regulated activities of transmission and distribution, while a horizontal separation had to create competition in generation and retailing where economies of scale would allow for competition (Estache and Martimort, 1999). The whole process has resulted in a combination of evolving the energy wholesale and retail markets, complemented by regulating transmission and distribution activities that differ from country to country.

According to Genoud and Finger (2002), three models of market and regulation design can be derived when comparing each individual country's liberalization and regulation goals. Today, these organizational models still apply in the electricity markets, ranging from fully integrated utilities to stand-alone generators and independent suppliers.

Public service-oriented model

In an early stage of liberalization, for example, vertically-integrated companies and contractual relationships between generators and suppliers were predominant. Some governments have accepted the *public service-oriented model* that emphasizes the importance of electricity as a strategic utility requiring specific protections and safeguards in a competitive market (Hogan, 2002). There are countries such as: Poland, Latvia and Croatia that are recognized as still using this model and they are primarily located in Eastern Europe (EURELECTRIC, 2007)., as shown in Figure #1. Public service definition minimizes the concept and potential to consider electricity a tradable good subject to competitive forces.

Market-oriented model

The *market-oriented model* makes an explicit reference to the creation of competition and efficiency as primary objectives of the reforms (ELTRA, 2003; Künneke and Fens, 2007). Some countries, such as England, Wales and Norway have introduced this model with the aim of protecting consumer interests and have also promoted competition by preventing market power abuse and predatory behavior. Consequently, business strategies used by market participants seem to be more diverse. In the UK, for example, there is a considerable number of independent generators with their own business strategies that co-exist with larger integrated firms (Lillis, 1997). The same situation can be found in Norway, Sweden, Finland and Denmark, where more importance is given to independent suppliers and generators (ELTRA, 2003; Hope, 2004). Regulation in this model is designed primarily to create and maintain competition in the sector, and consider power as both a public service and also a non-utility tradable and competitive good.

Mixed model

The *mixed model* lies between the two previous models. This is the most popular model in Europe, although there are some substantial differences between how it manifests in each country (Hogan, 2004; Newbery, 2005). What characterizes these countries is the explicit combination of liberal measures and public service objectives, such as the creation of an efficient market while creating a reliable supply sector. Regulatory reforms under this model seek to create efficient market conditions while taking into account the public interests that comprise a range of issues from ensuring supply reliability to the implementation of environmental measures (IEEE, 2007; EDP, 2009). Today, this model can be found in Spain, Portugal, France, Hungary, the Czech Republic and Slovakia.

It can be said that the goal of liberalization and regulatory reform are the main factors that determine the dominant players in both the wholesale and retail markets. Due to the change of regulatory models and market structures, consumers will be able to find different power supply options in various countries. Although the liberalization process has brought many new options – and represents an opportunity for supply portfolio diversification – there are still gaps in its overall improvement, mainly because the liberalization process has added a layer of complexity to energy supply practices. Therefore, the management of large electricity consumers has to change traditional sourcing habits to adapt to the new business environment.

2.3.1 The liberalization process

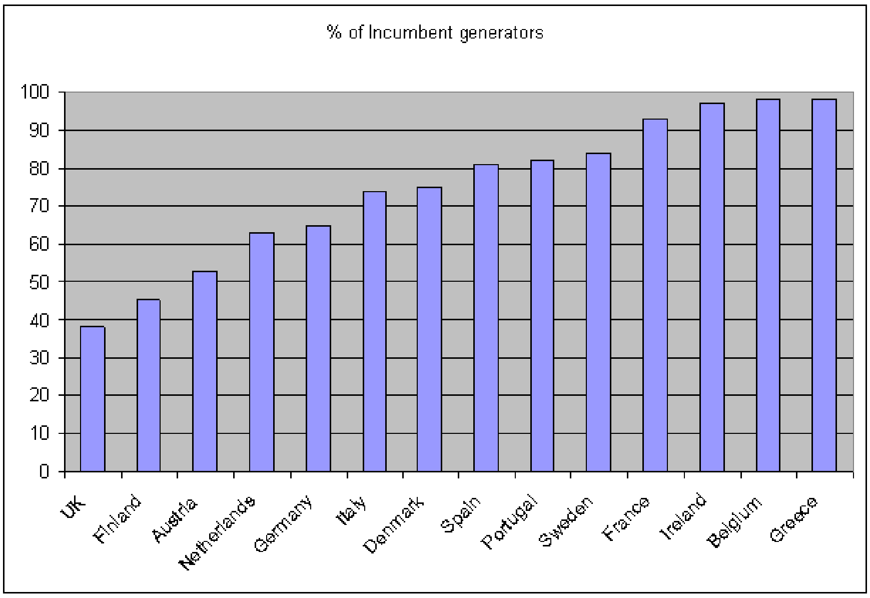
The liberalization of the electricity sector has been widely implemented across Europe and is expected to lead to clear efficiency gains and cost reductions, as well as to promote the creation of a single electricity market (EC Directive, 2003). The first critical step in achieving complete industry liberalization was to open the generation and supply sectors to competition. Managing the new transmission system independently was possible as a result of bringing about more competition since the transmission and distribution charges represent a significant percentage of the retail price (Coppens and Vivet, 2004).

In the past, a close relationship between generation and networks have created incentives for transmission operators to allocate transmission capacity on a priority basis, modifying rules and requirements to meet their needs or giving access to their available capacity (EFET, 2000). Access permits and node prices were used as transmission constraints, acting as entry deterrence mechanisms (Ibarra, 2005). Thus, the access to transmission and distribution networks was not a standardized procedure, providing advantages to some generators and leaving others unable to compete.

Currently, due to the deregulation process, the majority of network operators serve their clients in a non-discriminatory and transparent way by offering equal and fair service terms (EC, 2007). More competitive wholesale and retail markets, complemented by regulated free access to the grid, are promising elements of a move towards more competitive prices and lower supply costs, as well as the possibility of large electricity consumers becoming increasingly involved in the electricity supply chain.

With the introduction of competition in wholesale markets, the access to the network without discrimination was attained and the monopoly behavior by incumbent generators reduced. At the beginning of the liberalization process, many market participants complained about price distortions and price differentiation between countries, linked to the degree of concentration within the generation sector. However, while the majority of wholesale markets have remained under the influence of dominant generators, the reduced level of concentration in some countries limits generators in their capacity to extend market power. **Figure 2** shows how dominant players are still incumbent generators, with the possibility to reduce power of new entrants.

Figure 2 *Market power of incumbent generators in Europe (market shares)*



(Source: EC - Eurostat, 2007)

More competitive wholesale markets and free access to the grids are providing large electricity consumers with a new access to supply and the possibility of joining the electricity supply chain (Hogan, Rosellon and Vogelsang, 2007). In the past, transmission access was an obstacle to the development of self-generation; now, however, free access to the grids has created an implicit market for those large electricity consumers willing to secure the electricity supply through self-generation projects or for those ready to diversify their businesses (Belmans, et al., 2005). Other factors that motivate large electricity consumers to participate in the market are changing regulations and dynamics in the commodities markets. In fact, new legislations on environmental issues have created an opportunity for self-generators to market their electricity at a competitive price. The volatility of electricity prices motivates large electricity consumers to invest in self-generation as a way to control supply costs.

2.3.2 Electricity prices

Before liberalization began, organizations were supplied by state-owned utilities. Typically, supply contracts were arranged for by long term periods and prices were set by a regulated rate in a flat or a peak-off/peak structure. The bargaining power of incumbent suppliers offered almost no space for flexibility or negotiation. However, as markets opened up, some consumers garnered the opportunity to switch suppliers (Jamasb and Pollitt, 2005) and leave the tariff structure.

When the deregulation process began, large electricity consumers paid regulated prices, according to their level of consumption. The price was, in most cases, managed by a transfer scheme. However, as part of deregulation, many countries faced an alignment of prices to cost and then introduced a market-based energy price. Thus, large electricity consumers today have to choose between two options: 1) payments of an all-inclusive price based on real time pricing, or 2) choosing energy through an independent supplier or generator and integrating the delivery services via regulated transmission costs (EC, 2007). In both cases, prices would be market-based by linking them to the spot price of electricity or to the price of any other commodity, such as fuel oil, natural gas or coal.

The introduction of market-based energy prices has changed the pattern of supply costs. In addition, through the unbundled price structure, users are allowed to modify their price components according to their consumption pattern, profiting from the price situation in the best possible way. At the same time, however, they are being exposed to the risks of price fluctuations.

In some countries, the tendency to switch suppliers has been relatively low, due either to the co-existence of regulated tariffs that eliminate the incentive to save on price or strict administrative procedures, information exchange, protocols and payment conditions (EC, 2007). This behavior has a direct impact on the level of competition in the supply sector by reducing the number of alternatives and, indirectly, the price of electricity that, in turn, affects other costs. This emerging market structure comprises a greater number of players, different contractual relations and a new set of products that has added complexity to decision making processes.

New market conditions, increased concern about environmental issues, the combination of competitive and regulated regimes in generation and supply sectors, a variety of market players and a diversity of business models with contractual relations have all affected the price of electricity (CEEPR, 2007). Additional factors that affect the volatile behavior of electricity prices are the dynamics of CO_2 and fuel prices – these rising costs are referred to as risk sharing between suppliers and end-users (Handfield, 2004). Actually, those factors make power sourcing a complex process, compelling energy intensive users to redesign their supply strategy in order to keep supply costs under control (Platts, 2004).

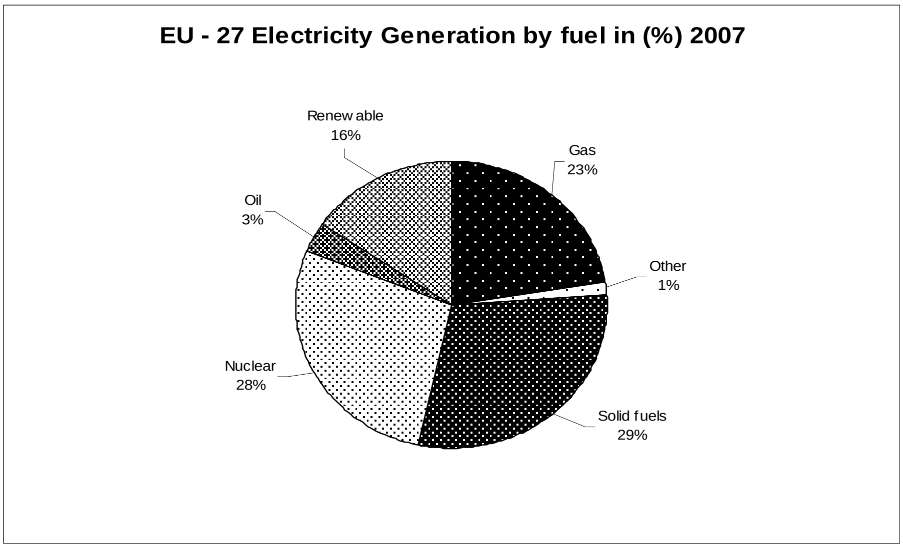
In the past, electricity prices were determined mainly by physical conditions, such as weather, hydrology, outages, etc. and by market factors, such as supply and demand and investment needs (EER, 2007). Today, there are some additional factors that also modify the behavior of electricity prices. The most relevant of these are fuel costs and environmental policies, such as emissions trading and support systems.

Fuel market

The cost of electricity reflects the price of fossil fuels (IEA, 2007; EER, 2007) if there is a cost pass-through. Coal, fuel oil and natural gas prices are important components of electricity prices because they are the dispatched technologies that participate in the day-ahead market (EFET, 2000; EUROSTAT, 2006; IEA, 2007).

For example, in countries where coal plays a major role in electricity generation, such as Germany, Poland and Estonia, the price of coal has a major impact on electricity prices (IEA, 2007**). Figure 3** shows the generation mix in the EU-25 to be mainly dominated by nuclear and coal generation.

Figure 3 *Electricity production mix, EU 25*



(Source: EU Europe´s energy position markets and supply- Report 2009)

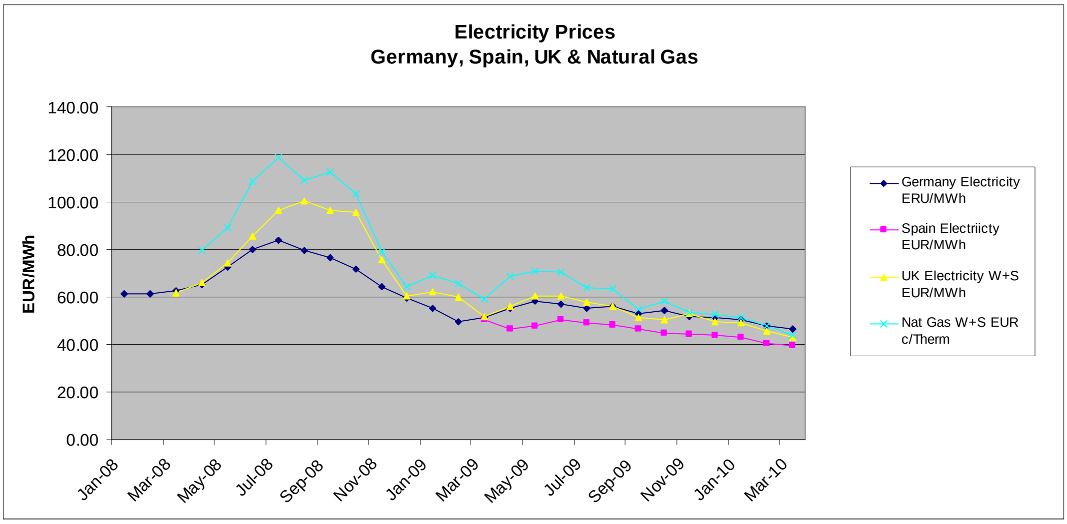
In recent years, the evolution of the technology and CO_2 regulation has provided additional incentives for Natural Gas Combined Cycle Units. But experience shows that changes in the gas markets directly initiate changes in the electricity market – both in terms of the price level and price volatility in countries, for example, such as the UK, the Netherlands, Italy and Spain where the off-peak price is set based on natural gas prices (EC, 2007). The calculation for the correlation of electricity prices and natural gas is 0.9394. This calculation shows that the highest level of dependency is on natural gas. The correlation of power generation with the following commodities is shown next[7]:

Natural Gas	*0.9394*
CO_2 */EUA*	*0.9136*
Coal	*0.8742*
Oil	*0.8545*

[7] Analysis and calculations based on EC, 2007 EU 27

The next **Figure 4** shows the high correlation level existing in several countries between forward natural gas and electricity prices. This situation can be explained by the fact that almost 40% of installed capacity in the UK is gas-fired.

Figure 4 *Electricity and natural gas prices*



(Source: 2010 - OMEL – Spain, EEX - Germany, NETA – UK, EU Eurostat)

Recently, fossil fuel prices – especially natural gas prices – have increased and are also unstable, making the electricity price more volatile than ever (IEA, 2007). There are several factors that explain the behavior of gas prices, including: the increased demand for natural gas, as opposed to oil or coal (due to environmental concerns), the lack of sufficient reserves in Europe to satisfy increased demand, the emergence of new advanced technologies and regional political issues.

At the moment, large electricity consumers face two concerns related to fuel prices and their impact on supply costs (Talluri, 2004). First, the development of fossil fuel prices is highly dependent on factors that have not been considered in the past and which are the result of more rigorous environmental regulations and policies (IEA, 2005). In fact, the number of factors that affect the supply cost, either directly or indirectly, is expected to rise significantly in the coming years. Second, the fuel mix varies between countries and the cost of technology strongly influences generation prices, making the price of electricity variable within the Member States of the EU (IEA, 2007).

This offers large electricity consumers the possibility of relocating their operations to countries with better cost structures by adopting a cost-effective way of sourcing. Consequently, large electricity consumers today face two challenges: 1) Addressing the question of whether their position allows them to change geographical location, according to the electricity price formation and depending on the energy market conditions and price, and 2) considering whether the company can adapt to the new energy cost structure, based on the changes in fuel and electricity prices, regulatory systems and different policies on environmental issues. It is also important to remember that the price of electricity in a particular country not only depends on costs derived from the generation mix but also on the administrative system of the country and support schemes that the authority provides for different green energy technologies.

2.3.3 Support mechanisms

The EU has proposed changes in energy regulations to make energy markets more secure, competitive and sustainable. In several countries, such as Portugal, France, Italy, Spain, Hungary and Poland, a liberalized supply market and freely negotiable energy prices co-exist in a system where customer tariffs are still being regulated (IEA, 2007). However, the governments of those countries have determined tariffs below the corresponding wholesale benchmark to ensure the lowest price for intensive users who have decided to stay under a controlled regime (EASAC, 2006). This concession represents a significant difference in electricity prices among consumer groups within the same country. This is because the differences in electricity prices offer large electricity consumers operational flexibility – the opportunity to relocate their energy consumption patterns to those places where electricity is less expensive. Within the threshold of higher and more volatile electricity prices, some governments have also provided large electricity consumers with green subsidies that favor some of the existing technologies or supply options, negatively impacting the viability of other sourcing alternatives and affecting the competitiveness of the whole market.

Support mechanisms provide incentives to generators that use specific generation technologies. The main advantages of subsidies in energy self-generation are basically threefold: 1) the initial cost of self-generation is lower than the typical cost of generation, 2) the cost of the energy supply is less variable because it is under the user's control of the company and is not subject to the market fluctuations. While a number of different support systems seem to exist and favor independent generators, one of the most advanced is the formation of a purchasing consortium for energy intensive users.

3) emission trading is a support scheme that favors non-fossil-based technologies through allocating the additional cost to the fossil-based technologies (Cédric and Reinaud, 2004). Therefore, the final supply cost will depend highly on the selected supply option, for example, on the technology used for electricity generation. Thus, self-generators today are more oriented to use green technologies that can help them to generate and market the power at a competitive price with the green tag.

Subsidies are considered to be a factor that affects price differences between countries and the variety of available supply options (EC, 2007). While those schemes represent a solution to solve specific problems and are good temporary options for supply at lower cost, they also distort a competitive price formation by favoring specific technologies or specific supply approaches.

Various support schemes face different levels of uncertainty and make the selection of a supply option more complex. First, there is regulatory risk, which includes uncertainty associated with the introduction of new measures to address climate change (such as the timing, extent and form of policy); there are also deferred decisions associated with policies that have already been implemented (for instance, future permit allocation under the European Emission Trading Scheme [EU ETS]); and there are intervention risks (like a change in policy direction). Second is the implementation risk, which is comprised of uncertainty associated with the efficiency of climate change policies that have been announced but have not yet been applied. The above uncertainties need to be internalized in strategic plans of sourcing portfolio options at the company level.

2.4 Climate change policy

Since the late 1990s, the EU has faced new challenges due to climate change concerns. The EU governments are committed to cut their greenhouse gas emissions by 8% from 1990 levels by the period 2008-2012.[8] Because the power sector is the largest greenhouse gas emitter in most Member States, the EU has decided to partially de-carbonize the electricity system by introducing and promoting a reduction of pollutants through the use of renewable energy sources (Directive 2009/28/EC). This objective, however, is not completely aligned with the basic energy regulatory goal of maintaining affordable prices for consumers. In practice, reducing greenhouse gas emissions has increased electricity prices since electricity generation from fossil technologies is still less expensive than from those based on renewals. Therefore, politicians face a challenge in finding a balance between climate change policy and energy liberalization.

2.4.1 Emission trading scheme

Climate change and global warming have become the main drivers of environmental trends. In an attempt to address these environmental issues, the EU has implemented some policies that have promoted the development of clean technologies; at the same time, this has led to extensive changes in the EU economy (Point Carbon 2010). The main change has been the emergence of a "Carbon Market" as a result of CO_2 emission permits (such as European Unit Allowance [EUA], Certificate of Emission Reduction [CER] or Emission Reduction Unit [ERU]) transactions (Reinaud, 2005). The Carbon Market is strongly correlated to the energy and electricity markets; in fact, CO_2 price variations depend greatly on overall energy and electricity generation.

EUA's are administered by the EU ETS and these allowances are given for free in Phase I and Phase II – 2005-2007 and 2008-2012, respectively. It is expected that the EUA allowances will be more restricted in the third phase and that large electricity consumers, as well as power companies, will need to buy them in the market or through the auctioning process organized by local governments (IEA, 2007).

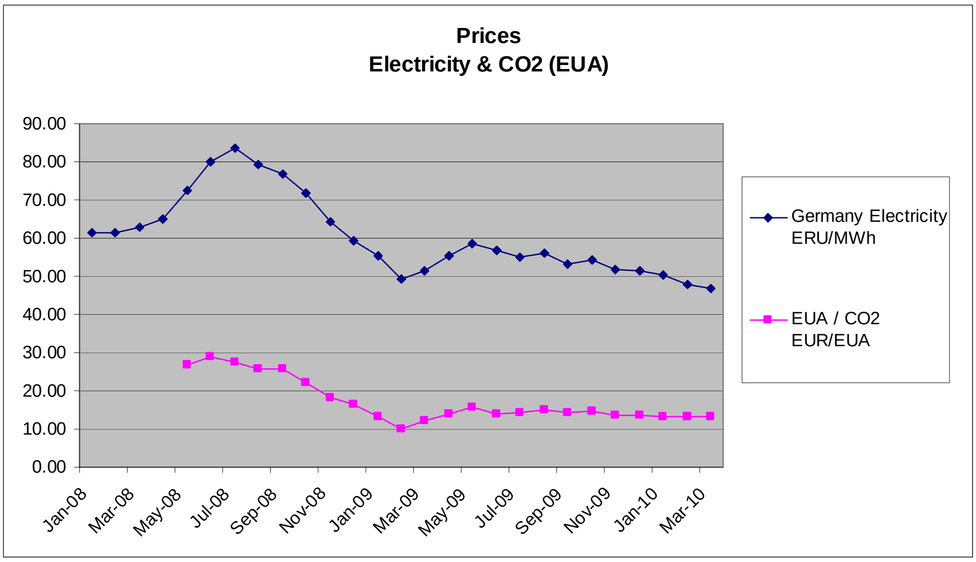
[8] The EU Climate and Energy Package, 2008

The clean development mechanism (CDM) and the join implementation (JI) have been developed by the United Nations (UN) framework convention on climate change. These mechanisms allow large electricity consumers to develop emission reduction projects that would be credited with certificates of emission reduction units (CER-CDM or ERU-JI). These credits can be exchanged in the EU ETS program, in order to comply with the regulation and emission targets.

2.4.2 Drivers of CO_2 prices

The changes in the market price of CO_2 may directly affect the cost of electricity to the end-users and, consequently, may influence their final decision about how to source power (Oko Institute and Ilex Consulting, 2006). Depending upon the way that power is generated and then supplied to end-users, different relationships between the final price of electricity and CO_2 prices can be identified. Those interactions are, indeed, largely responsible for making some sourcing strategies more favorable than others. **Figure 5** shows the evolution of the prices of CO_2/EUA and the prices of electricity in Germany. The prices of CO_2 are related to the second phase of the EU ETS.

Figure 5 *Prices of CO_2 and electricity*



(Source: 2010 - EEX - Germany, EU Eurostat)

Before explaining the relationship between electricity and CO_2 prices, an overview of CO_2 price formation is provided. This will help understand the complexity inherent to this process, its influence on electricity price changes and how those changes may affect the selection of specific sourcing strategies.

According to an IEA Information Paper (2007, p. 17), the price of CO_2 is typically influenced by the following factors:

The overall stringency of caps imposed on installations

This is a function of the initial allocation – how much lower it is from business-as-usual emission projections, as well as from the economic environment of the underlying activities. For example, a sustained steel demand would obviously increase emissions in the near future and drive up demand for allowances. Similarly, demand for electricity-intensive products would also put pressure on the power sector to reduce emissions.

External supply of project-based mechanisms

An abundant supply of project-based credits (for example, certified emission reductions [CERs] and emission reduction units [ERUs]) could have an ensuring effect on the price, since project-based reductions are generally expected to cost less than EUAs. This is borne out by current observations: Project-based units being priced mostly at EUR 13-15 per t CO_2 in August 2006 for delivery in 2007 and EUR 6-13 per t CO_2 for delivery in 2009-2012, against EUR 15-20 for spot EUAs. It is not clear, however, that Clean Development Mechanism (CER´s) and Join Implementation (ERU´s) can deliver enough credit volumes to meet a significant portion of Kyoto Parties' demand. On the other hand, a limited demand for EUAs could increase the relative importance of project-based units.

Relative fuel prices

For some industries, especially power generation, the price of gas and its relationship with the price of coal affects operating choices. A relatively high price of gas encourages more use of coal, which should drive up demand for CO_2 allowances, while keeping all other things equal because coal emits twice the CO_2 emissions than natural gas. If such a phenomenon is sustained, and EUA supply becomes tighter, CO_2 prices may reach a level that allows gas to be more competitive again.

Weather (temperature, rainfall, cloudiness)

Power generation represents the majority of the total EUA allocation. Hence, factors that affect power generation are bound to affect the supply and demand of EUAs. A dry year in Scandinavia is likely to trigger more demand from fossil-based generators and increase emissions.

Regulatory features

Several national allocation plans (NAPs) specify, in the majority of cases, EUAs that have already been allocated are not transferable upon the closure of a plant. Therefore, the possibility of selling unused allowances is minimal. Consequently, installations are less likely to resort to such measures as a way to reduce emissions. This should, in a tight market, put upward pressure on prices.

Policy uncertainty

Climate change is inherently a long-term, uncertainty-ridden challenge in a number of aspects, including scientific, technologic and economic. Given that political systems are skewed toward addressing more immediate concerns, few governments are well prepared to consider and adopt long-term action against long-term risks. Uncertainty may lead to a delay in investment, therefore, having an impact on the overall level of CO_2 allowance prices (Blyth and Yang, 2007). Still pending are the rules that will apply in the EUETS Phase III (2013-2020).

Abatement options

While marginal CO_2 abatement cost might, in the long run, trigger direct investments toward abatement projects, fuel switching from coal to gas or from lignite to coal in power and heat production – probably the most important short-term measure.

According to the above-mentioned reasons, it is evident that the price of CO_2 is no longer the outcome of a simple calculation based on fuel used. The considerable volatility of the observed price of carbon emissions has also raised some concern about the regulatory framework for climate change and the technologies that could be used to offset CO_2 emissions, making it more difficult for energy intensive users to select a strategy that would respond to those changes.

2.4.3 CO_2 influence on electricity prices

In general, the cost of supply is affected by the CO_2 cost component – either directly or indirectly – through the cost of generation when using those technologies that rely on fossil-based fuels. The power generators that are subject to emission caps now face an additional cost component, as a result of their CO_2 emissions and with the possibility of having to incorporate it into the price of the electricity. However, because not all generators are willing to explore this opportunity, nor do they all use fossil-based technologies; this additional cost component is defined by two factors: 1) The generator's strategy on which the business is based, and 2) the technology used. Thus, today we can find many large electricity consumers paying different prices for electricity, as a result of the emissions costs.

The first correlation between CO_2 cost and electricity prices was obvious only a few months after the scheme began and clearly demonstrates its correlation. This relationship is generated by a series of interactions triggered by CO_2 prices that vary, depending upon other environmental and political factors. Variations in CO_2 prices directly impact the behavior of electricity prices, and vice versa, building a dynamic cycle that is also exposed to market changes. The low correlation between CO_2 prices and power prices does not imply that there is no relationship between CO_2 and electricity prices; rather, it means that specific variations are due mainly to additional factors.

Climate variability may also influence the relationship between electricity and carbon prices. More precisely, rainfall impacts a country's electricity production with regard to its energy mix and this, in turn, influences CO_2 emissions. For example, the Spanish electricity market suffered from a low level of rain in the winter of 2005 and had to replace the shortage in hydro-electric power by thermal and fuel energy.

No matter which factors affect the price behavior, large electricity consumers need to manage the price volatility because their competitiveness highly depends on it. There are different sourcing strategies that large electricity consumers can follow to control the cost and reduce potentially negative effects on the final price of their products.

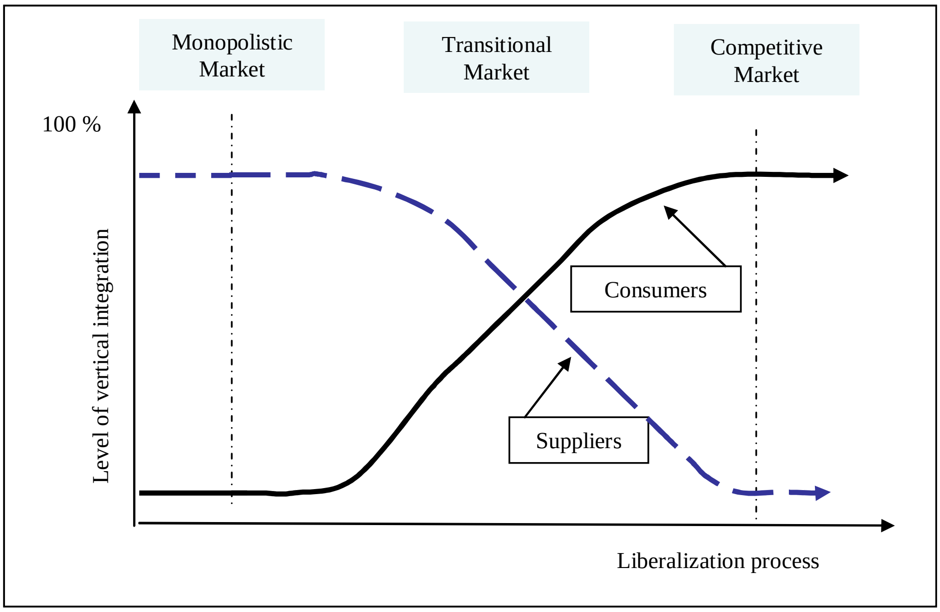
2.5 Industrial vertical integration

Before the liberalization process started, organizations were supplied through long-term contracts, where the price of electricity was set at a tariff rate. With the high bargaining power of suppliers – and with almost no space for negotiation – on-site power generation was the single possible measure to provide continuous supply at a competitive cost. According to Bain (1956, 1959) and Tirole (1988), companies make the decision to vertically integrate as a response to market power that exists in upstream and/or downstream markets and/or reflects efforts to create or exploit market power.

With the presence of weak incumbent generators, new players were able to participate in organizing the wholesale market. The companies that now invest in generation units are independent power producers and large electricity consumers that must cover their energy needs. With market changes, energy intensive consumers have gained the right to sell electricity, taking a more active role in the market, as well as in the electricity supply chain (EC Directive 2009). Thus, self-generation is not only a way to ensure a back-up, or get a reliable supply; it is also an opportunity for price hedging and business diversification (Joskow, 2006). In addition, new market regulations may motivate on-site generators to participate in large projects. It is expected that some small, on-site generation units will be replaced by larger scale units that have the ability to provide a steady supply to the grid and allow generators to sell generated power to the market. Moreover, new regulations on environmental issues and a market reformation process are encouraging the development of a marketplace for environmentally friendly technologies by allowing intensive consumers to market their electricity at a very competitive price (Madlener and Stagl, 2004).

The fundamental reason behind new environmental regulation is to integrate other technologies to replace coal-fired generation, which would lead to lower CO_2 emissions and reduce environmental impact (NREL, 2002). Some incentives have become available to promote green power, where the green electricity is an important premium against standard electricity prices. From the perspective of both generators and customers, these environmental incentives, in addition to the process of market reform, have significantly changed the status of electricity self-generation. This can be considered a supply option or a solution for business diversification. **Figure 6** presents a timeline of the liberalization process and the level of vertical integration in which a consumer can become involved.

Figure 6 *Vertical integration in the evolution of the electricity market*



(Source: Treviño, 2010)

Power sourcing has become more integrated for consumers as a result of an opening market and ongoing market changes. Technology standardization, the increasing liberalization of electricity markets across Europe and government subsidies are three of the many reasons that have made self-generation projects widely acceptable.

2.5.1 Evolution of vertical integration

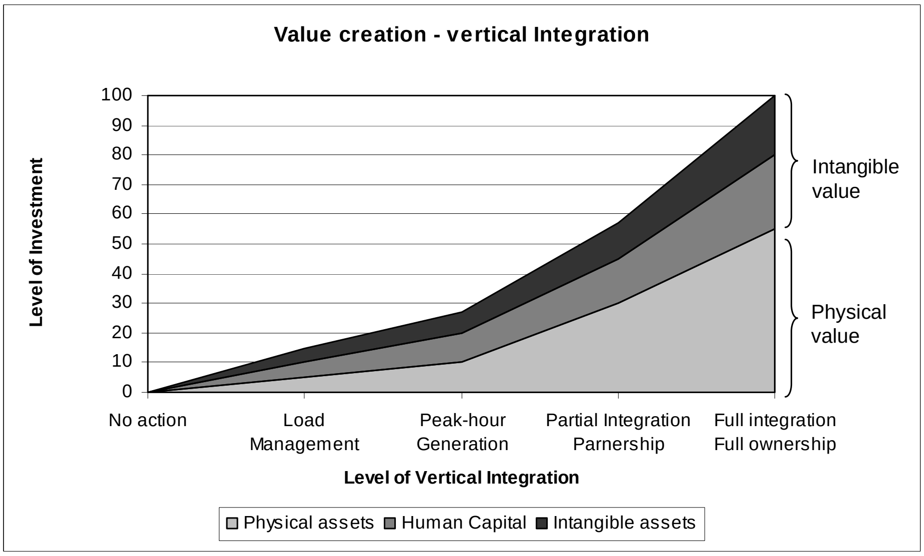
The opening up of the electricity market has promoted new favorable market conditions where advanced technologies might encourage large electricity consumers to invest more in self-generation projects (CSEM, 2007).

The reliability of supply and the incentives to reduce demand from the grid have promoted the development of self-generation units to provide back-up flexibility during some of the hours when the system is overloaded. Therefore, self-generation with access to the cost-effective technologies and marketplace is seen as an opportunity of accessing a reliable supply and controlling the variability of supply costs (D'Aveni and Ravenscraft, 1994; De Boer, et al., 2003).

The evolution of different actions and investments in the company to increase the level of participation in the control of the electricity supply can be categorized as the level of vertical integration. **Figure 7** exhibits, graphically, the evolution of vertical integration as a function of investment levels, starting with the assumption that a firm increases value when it gets involved in vertical integration activities.

As a company implements an action to manage the energy supply, the capital required to integrate initiatives will also need to include additional human capital. Also, the intangible value of the company increases as the full integration takes place.

Figure 7 *Value creation integrated in the development of vertical integration*



(Source: Treviño, 2010)

Load management practices, such as production shifting and peak hour generation are typical of low-scale projects with a small investment during the regulated and transitional period of market restructuring (Bonneville, 2006). Additionally, the level of integration is relatively low, since only a fraction of the needs are covered by these activities (Ellram and Carr, 1994). However, even those projects are usually created by on-site investments for implementing “production shifting” that include the cost of labor and the cost of operations (Williamson, 1996).

Similar to production shifting, peak-hour generation is often covered by small fossil fuel-based generation sets. Those sets do not represent a significant investment and they do not require skilled labor. Although a firm may be producing its own electricity during peak-hours, the rest of the energy needs are met through some means other than self-generation. Therefore, in this case, the level of integration is low.

In general, load management activities, such as production shifting and peak hour generation, are low-investment options. This option offers interruptible contracts, bringing additional value to the scenario (Baldick, et al., 2006); it complements regular supply contracts for load management and back-up units that can provide the operators with increased flexibility.

With market deregulation and sector unbundling, large electricity consumers have gained the right to use different economic mechanisms to improve their positions and establish their market presence. Today, for example, large electricity consumers might aggregate their load to take advantage of a joint investment in a generating facility. Partners would share the value of the assets. A company with a 1% contribution could be provided by 20% of the total power generated. Companies entering these types of agreements would not be obliged to share the human capital that has been built to operate and maintain the plant. The risk and exit barriers would be significantly lower than if a firm had invested in a facility of its own. Large electricity consumers sharing a power plant can be partially integrated, still buying some of its power from the market or from a retail supplier.

On the contrary, full ownership requires the highest investment and involves a larger risk (Ellram, 1993). Besides the investment needed to build or acquire the facility, the human capital will also provide the required talent to manage and operate the new facility.

In the end, utilizing self-generation and reaping its ensuing benefits depends mainly on market conditions. If a firm is willing to face both the investment and challenges that self-generation involves, potential value can be generated by integrating the generation activity with the core operations; this, however, must be planned very carefully to achieve the optimal level of the firm’s general strategy.

Additionally, the size of the company and its resource capacity should also be considered decision making factors. For example, it is normal that small companies decide to buy electricity instead of to self-generate. The main reason is that they do not have the required capabilities (such as financial, human and intellectual capital, etc.) to carry out all of the required activities. But, as the business of the company grows, the operation changes its consumption pattern. Demand increases and power costs represent an important fraction of the total cost. In this case, power supply becomes a strategic issue for the company. There are two main factors – the internal company's capabilities and the importance level of the supply cost – which should be considered while integrating the new business.

2.5.2 Motivations for power generation

Power generation can also be used for price hedging because it might help large electricity consumers monetize the value (Williamson, 1985). For example, grid connection allows power generators to sell the surplus of the generated electricity to the grid when market conditions are favorable and to take electricity from the grid when the cost of generation is higher or when the generation unit is out of service. This situation is typical in more competitive environments, where industrial users are equal participants in the market.

Apart from managing and benefiting from changes in market conditions, another motivation of self-generation is to lower the level of dependency on third party suppliers (Bain, 1956; 1959). Large electricity consumers can make use of economic advantages to supply their power needs directly and avoid double price distortion that occurs when firms add their marginal costs at each stage of the chain value (Tirolle, 1988; Grega, 2003). In this way, generation can make the supply cost equal to the generation cost.

There are two factors that have promoted the practice of self-generation: 1) energy efficiency development with new regulation, and 2) environmental concerns and the promotion of green friendly technologies (IEA, 2007). In fact, while sector restructuring has helped independent power producers access the marketplace, technology development has also allowed them to generate electricity at a very competitive cost.

A generation unit can be used for different purposes, from load shifting where only 5% of the need is covered through to self-generation and full integration where 100% of the need is met. Depending upon the case, the technology used for electricity generation will have an important effect on the production cost.

2.5.3 Technologies related to power generation

The power generation technologies can be categorized by different criteria but the most frequent is the type of fuel (Oko Institute and Ilex consulting, 2006). According to the fuel used, available technologies for electricity generation can be divided in two main groups: 1) fossil-based technologies and 2) technologies based on renewable energy (RES) sources, the so-called environmentally friendly technologies.

Fossil fired technologies are a low investment option (EUR/KW), although the variable cost linked to the fuel and CO_2 costs might increase the overall expense. The operational reliability is quite high, making the technologies very suitable for load management, particularly in the case of production shifting and peak-hour generation.

Technologies based on renewals are relatively new and some of them are still in the development phase. They are environmental friendly, free of emission costs and are commonly supported by governments through different financial mechanisms. The operational reliability is lower than fossil-based technologies due to the availability of natural resources, such as wind, geothermal, etc.

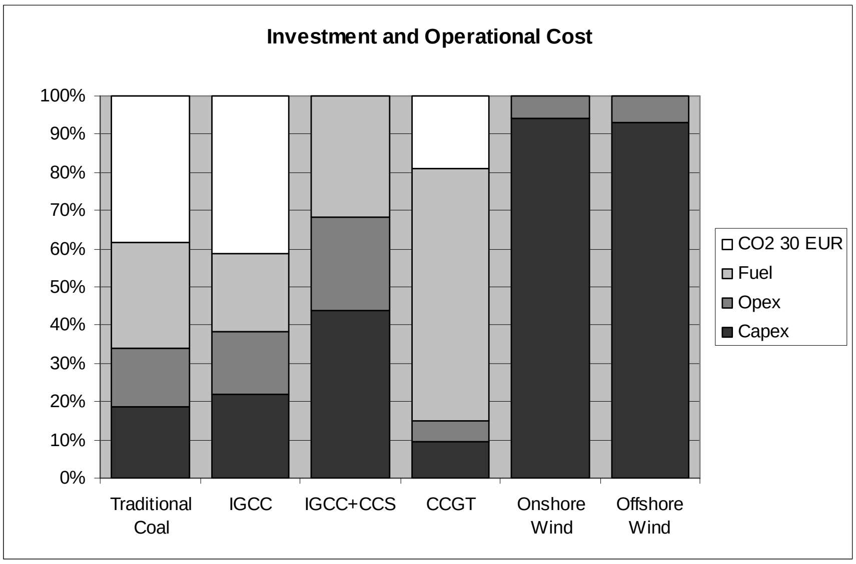
In general, the majority of renewable (RE)[9] technologies have become more cost-effective, as a result of research and development (R&D) activity (Egenhofer, 2006). Therefore, the variable and higher costs of fossil fuels – with an adequate technological development – have reduced the gap of generation costs between fossil and RE-based technologies, making RE more feasible (EER, 2007).

In an effort to provide future cost reductions, the development of more highly efficient technologies is still underway (Egenhofer, 2006). Previous financial barriers that represented significant impediments for RE deployment have now been overcome. In

[9] RE: Renewable Energy

some cases, small on-shore wind projects might be less expensive than conventional technologies with the cost range of 900- 1,100 EUR/kW, compared to a pulverized coal combustion plant at 1,100 EUR/kW and a CCGT[10] at 550 EUR/kW (EER, 2007). The relationship between investment and operational coal in different technologies is illustrated in **Figure 8**.

Figure 8 *Investment and operational cost*



(Source: Emerging Energy Research – Vestas 2006 pag. 6)

Apart from support schemes and market restructuring, other factors continue to act as important incentives to encourage the use of environmentally friendly technologies. First, the prices of fossil fuels will promote RE projects. This is due to volatile and unpredictable fuel prices, the lack of reserves, changing weather conditions and increasing environmental concerns affecting the variability of the generation cost of fossil-fired technologies (Wiser and Bolinger, 2004). Second, there are new cost components, such as expenses related to emissions, air pollution, water and soil disposal, etc, which will support a move toward the environmental protection effort. And third,

[10] CCGT: Combine Cycle Gas Turbine.
IGCC: Integrated Gasification Combine Cycle.
CCS: CO_2 Capture and Storage.

technology development and higher energy efficiency have changed the production output, bringing the cost of RE generation down (Gross, et al., 2002).

Finally, financial and R&D support, new regulatory and legal frameworks and re-established administrative procedures and policies, have all been created to help large electricity consumers with technology development and market penetration. Both well-organized incentives and a regulatory system are crucial motivational elements to encourage large electricity consumers to invest in self-generation.

2.6 Conclusion

The electricity market in Europe has been driven by the liberalization of the electricity sector and new reforms to create more competition develop a single electricity market and free access the network.

New incentives were put in place to promote the development of renewable electricity and support mechanisms were crated to introduce new green technology to generate CO_2 free electricity. This has created a more complex process to identify, analyze and select the best electricity sourcing option.

Additional regulatory risk has been introduced, which includes climate change regulation that has been implemented in different phases since 2005 when the EU-ETS started. CO_2 regulation will have a direct effect in the way electricity is being supplied and consumed.

Fossil fuel technologies will continue to dominate the generation mix, especially after the disaster (2011) in Fukoshima, Japan. Nuclear technology will remain to be questioned as a reliable source of electricity. Any way, vertical integration for the demand side will not be affected by this event, since is unlikely that electricity consumers could invest in nuclear generation for economical reasons.

Chapter 3. Theory Related to Electricity Sourcing Strategy

In this chapter, important concepts for this research on strategy foundation are revised in order to describe the relationship between strategy and methodology formulation. Additionally, different economic theories and supply chain literature will be examined to illustrate the relationships between electricity sourcing options and specific market conditions.

3.1 Sourcing strategy

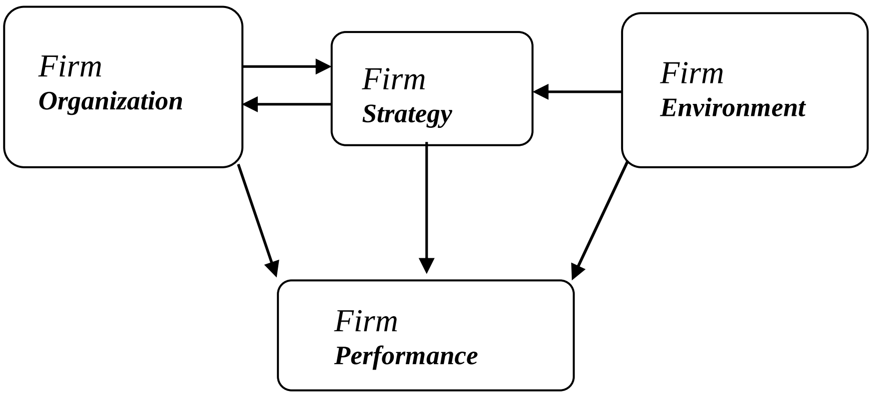
Strategy has been seen as an alignment between mutually supporting systems – the firm and its environment. Strategy research has two main concerns: 1) To explain *what determines firm performance*, and 2) to identify *what affects firm strategy*. There have been three main paradigms that are utilized to answer these two questions:

1. The Structure-Conduct-Performance (SCP) paradigm (Bain, 1956) and its derivative, industry structure model (Porter, 1980) view the external environment as a key determinant of strategy (i.e., conduct) and performance. According to SCP, the main flow is going from industry structural variables to firm strategy and then to firm and industry performance. Porter's model retained the basic flow of the SCP but, rather than focusing on industry, used the model to discuss strategies open to the firm to improve its performance (e.g., positioning strategies).
2. The Strategy-Structure-Performance (SSP) paradigm highlights factors complementary to strategy, such as organizational structure and firm performance. Originating in Chandler's (1962) classic study, the model proposes that different growth strategies are driven by internal structural arrangements, implying that the match between strategy and structure results in better performance. This model has been integrated into contingency research in organizational theory.
3. A related and more recently embraced model is the Resource Based View (RBV), highlighting the importance of resources on the firm's growth. The RBV sees certain resource attributes, such as inimitability, uniqueness and flexibility as

enabling certain strategies (e.g., cost leadership) and contributing to sustained competitive advantage (Barney, 1991; Teece et al., 1997).

Together, these three different paradigms see firm performance as affected by the environment, firm strategy and other internal attributes, such as resources and organizational structure. A visual characterization can be shown in **Figure 9**.

Figure 9 *General Strategy Model*



(Source: Farjoun, 2002 pp. 561)

The presented theories have considered strategy as position and implied that strategic choice is mostly a selection among static configurations. Furthermore, viewing strategy as the main determined factor, which promotes firm success, is occurring in a changing environment.

However, while recognizing the dynamic nature of the environment, the concept of strategy has to be questioned. Its simple assumptions may be better suited to a relatively stable and predictable world and seem to be at odds with more complex and constantly changing behavior of individuals, firms, and markets.

The previous model on strategy existence does not necessarily have to be rejected because it explains the idea of steady states and strategic positions. Rather, we would like to explain firm success and failure by looking at historical development and observing the path of change (i.e., assuming the future changes). We see capabilities, environment and performance as both affecting and being affected by strategy.

Therefore, extending earlier definitions, a firm's strategy could be defined as the planned or actual coordination of the firm's major goals and actions, in a time and space that continuously co-align with the firm its environment. The firm's strategy co-aligns it with the environment by building on and modifying the firm's internal attributes and forces it to respond to, and influence, environmental conditions and developments.

Firm organization

Firm organization includes the actual and potential (i.e., future) internal mechanisms, institutions, developments and forces that induce, enable, modify and carry out the firm's strategy. This particularly includes the states and paths (i.e., history) of a) resources and technology and b) administrative and social structure. These two categories are viewed as mutually supportive and distinct from strategy, whose main role is to mediate and guide firm-environment interactions. Each of the categories are viewed as an open subsystem that interacts with related elements in the environment through resource exchange, communication and other relationships and boundary activities (Chandler, 1962 pp91-104).

Firm environment

Firm environment can be an important consideration: it is indeed useful to view the environment as consisting primarily of other actual and potential actors, as well as their actions (Bain, 1956; Porter, 1980). They can include individuals, groups, organizations, an entire industry (Porter, 1980), a distribution channel, a network (Thorelli, 1986), etc. The environment includes political, economic, social, institutional, informational, technological and demographic aspects, as well as conditions and developments. The firm's environment includes, in particular, actors' resources, technologies, strategies, relationships and interactions, performances and external developments, forces, events, and discontinuities that may affect them and the focal firm. Finally, the environment includes past and current environments and future environments in which the firm may potentially operate, either as a result of its own initiatives or as the result of the initiatives of other actors.

Firm performance

Firm performance denotes the quality of the firm's continuous co-alignment with the environment (Chakravarthy, 1986 pp 437-458). This parameter can be represented by growth, profitability, survival and other standard indicators but not by financial indicators. Depending upon the context, firm performance may include indicators in multiple levels of analysis (e.g., business unit).

Apart from the strategy position, it is useful to know what the procedure is that we should use in order to build a strategy. The practices utilized in creating a strategy are referred to as a strategy formulation process. The main goal of this study is to actually understand and present a systematic approach that can be used to develop a methodology to formulate strategy in the electricity sourcing domain.

Strategy formulation process

According to Farjoun (2002), strategic management is defined as the super-ordinate and continuous organizational process for maintaining and improving the firm’s performance by managing or rather, enabling, formulating and realizing its strategies. Within this definition, strategic management is viewed as a process and a progression, which includes the sequence of events and activities over the time.

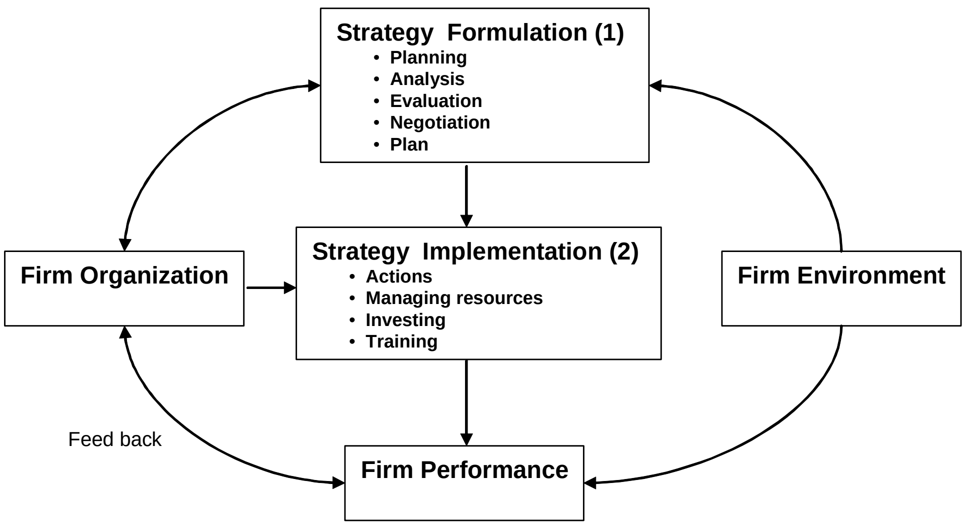
Strategy formulation is most closely associated with the need to match the company's internal resources and distinctive competencies with environmental opportunities and threats, so as to better meet overall goals and objectives (Andrews, 1971). Reviewing different literature we have found many useful definitions that can help us to understand the formulation process such as:

- The decision rule is to choose a strategy that capitalizes on the company's strengths, fixes its weaknesses, exploits its opportunities and defends or neutralizes threats (Barney, 1997 pp 99-120).
- Strategy needs to match firm resources with environmental opportunities and be consistent with organizational elements. Strategy also must be in line with managerial values and societal expectations (Andrews, 1971; Porter, 1980 pp 167-185).

However, in a dynamic environment we are obliged to extend these definitions in several ways. We must take into account the planning of sourcing alternatives, suggesting the need to evaluate the current supply strategy, as well as new alternatives. Moreover, the formulation cannot simply include internal and external analysis, synthesis or analyzing the existing environments. Rather, it must incorporate both intuition and invention to recognize oncoming changes. This point is important because it explains, in part, the elements that can be eventually used to formulate a dynamic strategy. By assuming changes in the environments from the onset of the formulation process, it is possible to develop a strategy that continuously co-aligns the company with its business environment.

According to Farjoun (2002), firm organization and firm environment interact with each of the sub-processes of strategic management – strategy formulation and strategy implementation. Going further, the roles of different elements of the firm's environment and organization are not restricted to solely being inputs to strategy but also extend to being a context for facilitating strategy development. *(see **Figure 10**)*.

Figure 10. *Strategy development process*



(Source: Adapted from Farjoun 2002)

At the same time external conditions (i.e., political, economic, social, technological, environmental and cultural, etc.) play an important role in defining sourcing plans. Internal conditions as the integration of organization and environment into each of the sub-processes suggest a view of strategic management as a process of managing changes. Thus, Farjoun (2002) highlights human engagement, the particular role of strategic leaders and the particular considerations associated with changes, such as lags, timing, duration, momentum, inertia and abortive efforts. Finally, Farjoun suggests that strategy formulation deals with the sensing, evaluating and planning of external and internal changes, rather than simple making choices. Therefore, it means that strategy realization deals with the implementation of changes, both planned and emergent.

During the formulation stage the process, management proposes more than two scenarios or solutions i.e., measures that could satisfy a company’s requirements. Before the right course of action is selected, among all of the alternatives, the potential outcomes must be assessed. Often during the execution phase, additional changes take place and the strategy itself may, in part, affect these changes. For example, the company management that considers entering into a new supplier relationship evaluates the industry structure and position of the potential supplier vis-à-vis the company's requirements and available resources. However, in today’s highly competitive markets, this approach is not sufficient.

Any number of changes will occur before and during formulation or execution (e.g., the simultaneous relations with other firms) and the following must be examined: what changes will be produced when changing the supplier (e.g., impact on core business)? What resources will be consumed during the process (e.g., managerial attention, human, financial, intellectual capital)? What implementation capability does the firm have (e.g., how efficient is the switching process likely to be) and how the internal and external stakeholders might support or interfere with the execution (e.g., reaction of incumbents, and employee support)?

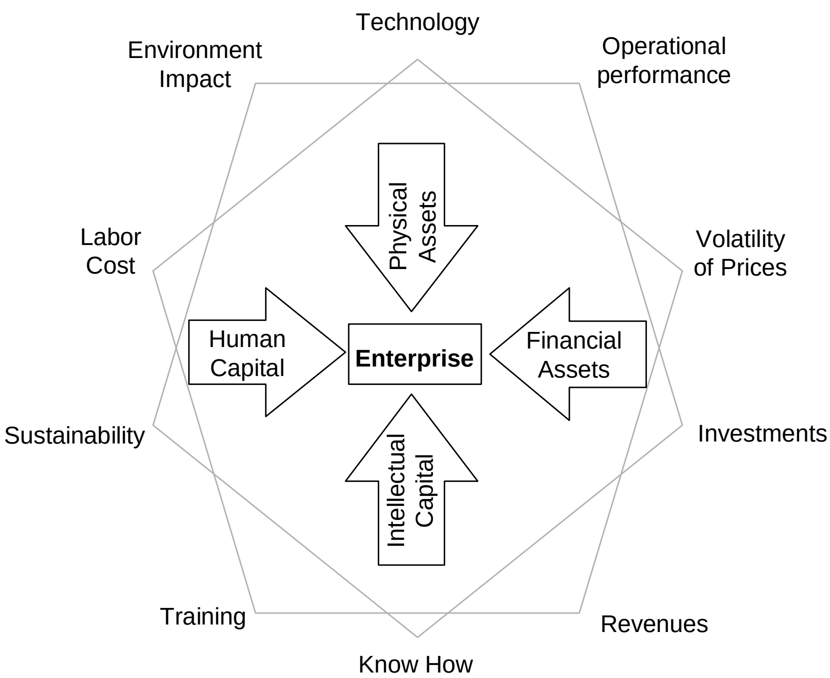
Critical Factors in the organization

Resources in the organization are related to the following: physical assets, financial assets, human capital and intellectual capital (Barney, 2001 pp 41-56). From these four basic dimensions we can build the main stream that integrates the organization's performance and its philosophy about operating and optimizing business practices.

Human and intellectual capital, physical and financial assets provide the main drivers that influence the performance and value creation of organizations. Some additional key performance factors are linked to these four drivers.

For example, new technologies can influence the operational and environmental performance of the company; these factors could be linked to physical assets. New investments and volatility of prices can affect the revenues of the firm and these are linked to the financial assets. On the other hand know-how, labor costs and better sustainability practices influence highly the intellectual and human capital. **Figure 11** describes the main factors that relates to the four dimensions.

Figure 11 *Environment in the organization*

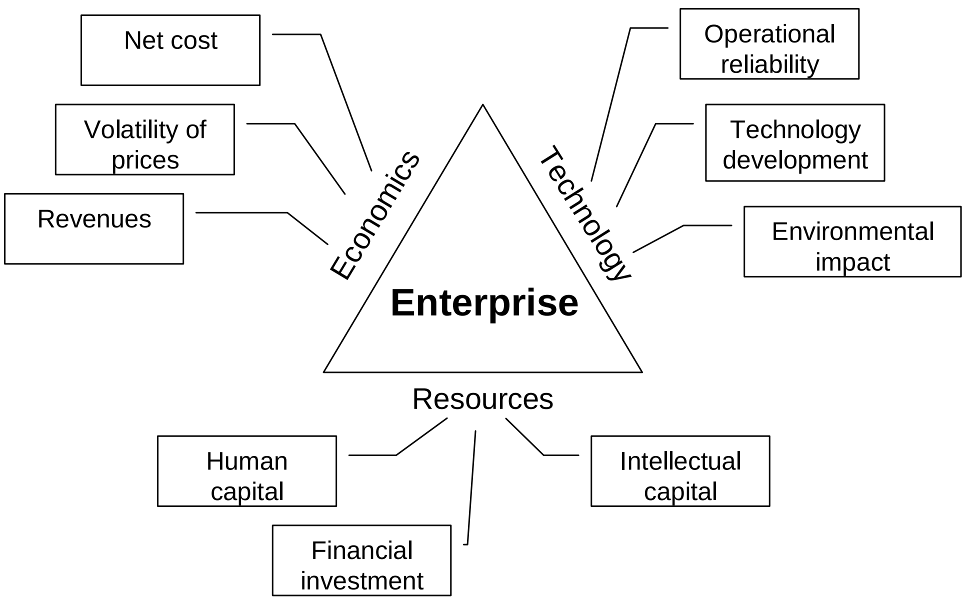


(Source: Treviño, 2010)

Beyond the question of how current strengths, weaknesses, opportunities and threats affect the choice of strategy there is an equally important consideration – what might be the extent to which an executed strategy affects the internal elements of the firm? Moreover, in the strategy exercise, a firm should give critical weight to main factors, either enablers or restrictions to the short-, medium- and long-term viability of the projects at hand, so critical in the electricity markets.

We have identified the three basic elements that are the most relevant dimensions within the organization: technological, economics and resources (TER). The technological elements provide the operational performance and its influence on the environmental impact. The economic elements include the business' financial performance with an evaluation of revenues and the cost of operation. Finally, the resources involved in the organization related to the financial, human and intellectual capital must also be considered. **Figure 12** describes the nine different factors that drive the performance of the firm.

Figure 12 *TER Model*



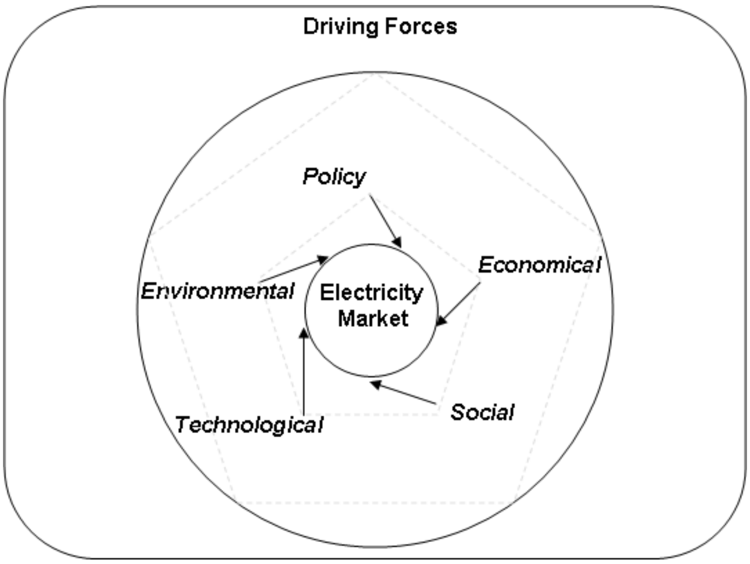
(Source: Treviño, 2010)

3.1.2 Electricity planning

Hodgson (2004) defines strategy for a company as, the way firms and its leaders fulfill its mission in the environment. He goes on to say that the external environment includes all kinds of factors that need to be taken into account – political, economical, social, technological and environmental (PESTE). Hodgson also suggests that without the exploration of the future to deal with possible uncertainties, strategic planning creates a default scenario – "A future that validates the plan and this view of the future dominates … decision making." Identifying PESTE influences is a useful way of summarizing the external environment in which the sourcing has to be made; it must be followed up by considering how a decision maker should respond to these influences (Aguilar 1967).

Synergist's PESTE Analysis is a perfect tool for decision makers, helping them to analyze the forces that are driving their industry and how these factors will influence their businesses and the industry as a whole. It also presents a brief profile of the industry, comprised of the sector's current market and future prospects. The trends of each dimension should be monitored over time *(refer to **Figure 13**).*

Figure 13 *PESTE Model*



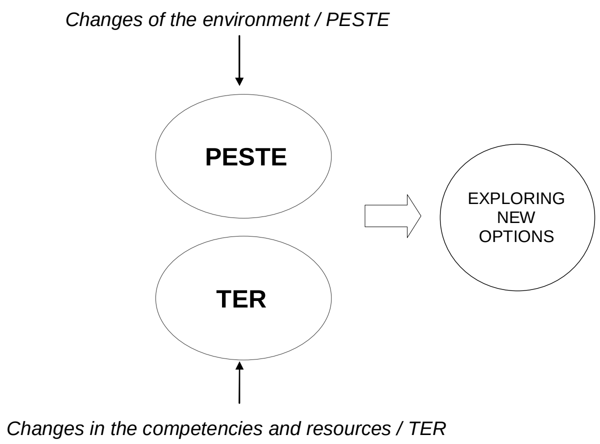
(Source: Modified application from Aguilar, F.J. 1967)

The strong focus on both the past and present to determine future strategy must be extended with a focus on the possible futures because all of the decisions are about the future but all of the knowledge is about the past. Thus, it is obvious that considering the future, as well the past and present, is an essential part of the strategy development process. By understanding the meaning of strategy, management can better assess how strategy development occurs and take the future into account during the strategic planning process.

Trends in the environment

Recognizing the need to consider the future only really became apparent since the external environment started to be more volatile and uncertain during the last quarter of the 20th century. Exploring what might happen is critical when business is faced with such uncertainty – current processes focused on the past and present do not provide the approaches, tools or methods that are required to understand the future. According to Mintzberg (1994), strategic planning is always about analysis – breaking down a goal or set of intensions into steps and formalizing those steps so that they can be implemented, as well as articulating the anticipated consequences or results of each step. Clearly, this is an activity requiring strongly analytical, logical, deductive and pragmatic thinking in order to ensure that things stay on track. It is generally intuitive, experimental and disruptive (Liedtka, 1998). Thus, "foreseeing into the future" in an organizational context is best conceived and positioned as an aspect of strategic thinking, which is meant to open up an expanded range of perceptions of the strategic options available – all in an effort to create a potentially wiser strategy. Only in the case of confronting an existing company's competencies and its environments with their potential changes, are we able to recognize new options *(refer to **Figure 14**).*

Figure 14 *Strategic process to develop new options*



(Source: Treviño, 2010)

According to Slaughter, a shared forward view can allow an organization to guide policy, shape strategy and explore new markets, products and services. Therefore, we can say that the development of strategic foresight is a critical step for better understanding the future. Since scanning and analyzing the present and past external environments are defined as separate steps in planning, then scanning and analyzing the future has to be defined as a separate step; tools and techniques to facilitate that scanning also have to be identified.

According to Conway and Voros (2002), planning based on foresight is, in fact, the aim – to integrate past and present information and work with staff to interpret that information in order to explore future strategic possibilities for the organization. The intent is to open up the conversation that leads to decision making and from which future strategies should be pursued. Foreseen trends or scenarios enrich that conversation, in order to identify potential options that may not have been visible before. This allows for the selection of a preferred option – one that is the most robust, irrespective of possible future events.

To build a power sourcing strategy, scenarios are used with the aim of foreseeing future market conditions that would be forces for strategy development and detect opportunities for strategy development. Moreover, the objective of the process is to:

- Challenge existing assumptions about the future in EU electricity markets.

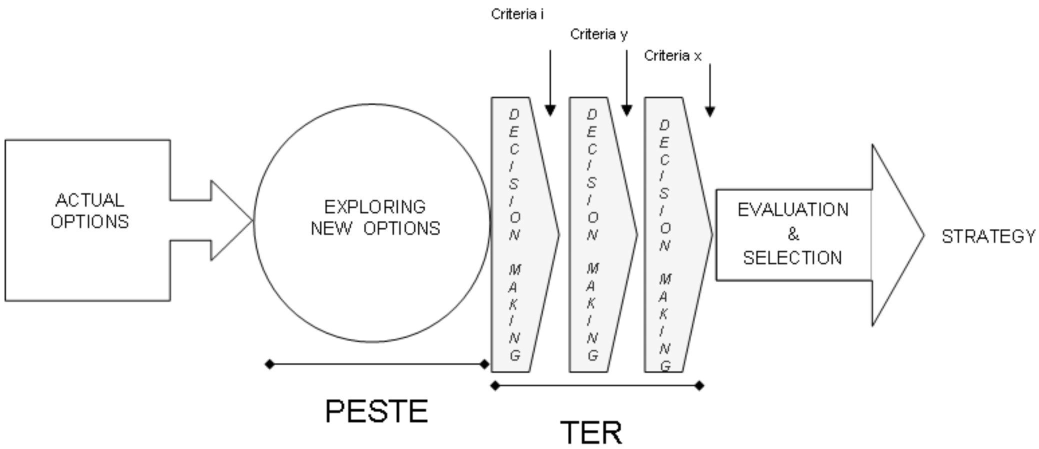
- Build future scenarios for use in strategic planning, assisting the large electricity consumers to develop future-oriented strategic plans for electricity sourcing.

By using scenarios, managers can explore the nature and shape of electricity sourcing under a variety of circumstances – some good and others that may not be as desirable. Therefore, by exploring these possibilities and examining their implications for the portfolio, management can be better prepared to react in more reasoned and thoughtful ways.

Before beginning strategy development, company management is advised to address potential changes in the context of key success factors and the resources required to undertake them. **Figure 15** describes the proposed strategy generation model in order to develop an electricity sourcing strategy. In this case, identifying the existing options is suggested, followed by identifying future trends in the environment through PESTE analysis. Then, an evaluation of the organization's internal criteria will provide specific recommendations that can be applied within the company.

After exploring new options, management is expected to make decisions based on those factors which satisfy the set of established criteria defined by the organization *(see **Figure 15**)*. Those criteria differ from company to company and are dependent upon the decision makers' preferences.

Figure 15 *Strategy generation model*



(Source: Treviño, 2010)

3.1.3 Electricity supply

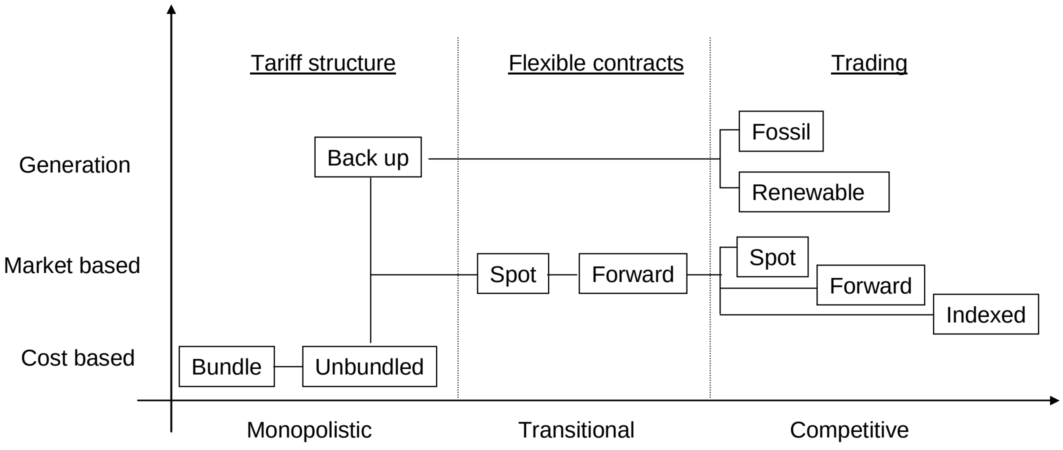
To survive in competitive markets, companies need to display an ability to appropriately adjust the scale and scope of their resources at a low cost and rapid rate (Hayek, 1945). Consequently, companies have been involved in decision making, such as choosing between producing and buying (Williamson, 1985; Quinn and Hilmer, 1994) and determining the number of suppliers to utilize (Min and Galle, 1991; Quayle, 1998; Zeng, 2000). Moreover, they have faced dilemmas about alternative sourcing structures, such as structuring of sourcing organization (Atkin and Brooks, 2005), supply base structuring (Gadde and Håkansson, 1994; Hines, 1995) and choosing the nature of the buyer-supplier relationship (Ellram and Carr, 1994; Steele and Court, 1996; Carr and Smeltzer, 1997).

The application of those decisions will be discussed and explained from a theoretical viewpoint, while practical examples will be analyzed. Our intention is actually not to present those decisions as examples from the real world, but rather to discuss the type of market challenges they can address.

Market dynamics evolve within the regulatory framework and consequently, within the market structure *(for this evolution, see **Figure 16**)*. The evolution of the market structure comes from bundle service and tariff structure to the development of competition that provides additional elasticity, including flexible contracts and the possibility of trading in the market.

We need to carry out a full strategic assessment and evaluation in which a number of factors must be considered, including the importance of the service to the core operations, the market or industrial's observed perception of the supplier's service quality and responsiveness, in addition to the current levels of service efficiency compared to other equivalent power suppliers in the market. (Blumberg, 1998).

Figure 16 *Evolution of the electricity supply market*



(Source: Treviño, 2010)

The two most common theoretical approaches to the make or buy decision are both transaction cost economics, or TCE, (Williamson, 1985) and the core competencies model (Quinn and Hilmer, 1994). These two theories can help companies solve the make or buy dilemma. Based on TCE, the extent to which resources will be allocated between different governance structures is based on transaction costs – the costs of writing, monitoring and enforcing contracts.

The core competence approach is of particular interest to purchasing because it highlights the central strategic importance of the make or buy decision (Ramsay, 2001). According to Quinn and Hilmer (1994), core competencies are the activities that provide long-term competitive advantages. These must be closely protected and all other activities are candidates for outsourcing. Hamel and Prahalad (1994) state that outsourcing allows the host organization to concentrate on those activities in which it can establish distinctive core competence.

Having other companies' specialize in the provision of supporting goods and services allows an organization to take advantage of strengths within the supply market. Focusing on core competencies it is possible to provide goods and services more efficiently, while improving quality through the application of specialist knowledge (Quinn and Hilmer, 1994).

In general specialized suppliers have a distinct comparative advantage, which is grounded in economies of scale, lower cost structure, specialized knowledge or stronger performance incentives (Venkatesan, 1992; Ramsay, 2001). However, supplier markets are imperfect and do entail some risks for both buyers and sellers with respect to price, quality, time and other key terms. In fact, a real problem can occur when the supplier's priorities do not match the buyer's (Quinn and Hilmer, 1994).

Self-generation

When a company's management makes the choice in favor of self-generation, it must be aware of additional investment costs with regard to specific assets. Specific asset investment – directly relevant to vertical integration – is thought to arise in a number of different contexts (Williamson, 1983, 1996), such as investment in physical, human and intangible assets.

Engineers who have contributed to improving the efficiency of the power generation process are examples of human asset specificity. Their combined knowledge can bring value to the whole supply activity. It will not only affect the generation process but have an impact on the whole chain of activities. But most importantly, this specific know-how may not have the same value if it is applied in any activity other than power generation. Adequacy to forecasting price environments might let a company to source in a switching manner to take advantage of price differences. But some of the price gaps depend on many economic and price distortionary conditions such as cross subsidies.

Investments are mostly frequently conceptualized as physical investments or those related to human capital and less often to intangible capital. However, the ability to create economic value from intangible assets is highly contingent on the management capabilities of individual firms. A key element to asset management is retaining the assets developed or acquired by a firm. As part of the intangibles, intellectual assets become a more important source of value creation; firms need to manage and retain their assets. Intellectual property rights (Barney 1991), like patents, copyrights and trademarks are used in conjunction with secrecy to protect knowledge. Licenses allow patent holders to share patented inventions, or other intellectual property, in a controlled way and receive revenue (such as royalties) or other benefits (like access to another company's knowledge).

If a company wants to gain the benefits of being vertically-integrated, it must be ready to support the cost of physical, human and intangible assets because spending on specific assets also increases their economic impact. Added to the difficulty of drawing the line between expenditure and investment, there is also the fact that specific assets are not always identifiable separately (Joskow, 2006). Indeed, they tend to be complementary and can overlap significantly.

A common barrier to vertical integration is the difference in required skills. The skills involved in power generation are substantially different from the characteristics of upstream activities (i.e., skills required in core business). The company needs to invest in human capital through training sessions, knowledge transfer, motivation processes, etc. With management competences and skills rest a host of other problems: the necessity of following different strategies for running the power plant and core operations; the difficulty of developing differing core competencies within the same over-all corporate organization and the need for preserving management incentives for differing activities.

Then, company management must be ready to share the capital investment between two independent businesses, such as using internal instead market incentives, knowing that market incentives are available only if the company sells the excess of generated power. Finally, the question arises as to the degree of corporate flexibility and the risk involved in retaining integrated non-core activity, such as power generation.

Supply structure

Since single sourcing implies the reduction of the number of suppliers a company does business with, the number of service providers can be reduced either by bundling different services together, such as energy and delivery organized by the same company (Atkin and Brooks, 2005), or by grouping sites under one contract by, for example, load aggregation (Meneghetti and Chinese, 2002). According to Cox (1996), in single sourcing the buying company can decide to have a single relationship with one preferred supplier who is granted a relatively permanent, preferential relationship, including a variety of tasks.

The basic philosophy behind developing a preferred service provider structure is to gain access to the best available product package in the particular service area (Newman, 1988). In addition, splitting the services reduces the supply risk for the service area (the supply risk is understood as the risk of the service provider not being capable of meeting the organization's requirements, which can result in the loss of company business and have negative effects on the organization's revenues and profits).

Often, managers purchase an individual service or a bundle of services with the same contract for a single site or a certain region with multiple sites. With market openings, these managers find it useful to aggregate their electricity needs in order to take advantage of economies of scale and gain better prices for service supply.

The range of inter-organizational relationships is often described as a continuum ranging from pure transactions to vertical integration (Webster, 1992; Cox, 1996). Thus, there exist some contractual solutions between vertical integration and a market-based solution that under certain circumstances may satisfy the buyer's needs (Heide, 1994). In general, the more of its production input the organization decides to buy instead of producing them internally, the more dependent it is on the supply base.

Some strategic sourcing choices deal with the forms of the different buyer-supplier relationships (Webster 1992; Mentzer, et al. 2000; Cousins, 2002) and the duration of contracts (Ramsay and Wilson, 1990; Parker and Hartley, 1997). Guidelines for selecting the type of relationship usually only identify partnership sourcing and competition as discrete categories (Macbeth, 1994). Arm's length relationships are usually described as short-term affiliations based on competitive bidding (Mentzer, et al., 2000). Whereas the short-term contracts create a very low level of contractual liability in the relationships, the use of long-term contracts develops closer relationships with selected suppliers and brings increased liabilities into alliances (Ramsay and Wilson, 1990), but can give rise to a hold-up problem or dependency on the supplier objectives, a typical case of imperfect contracts.

The literature reviewed suggests a growing interest among business organizations in managing relations between buyers and suppliers (Tucci and Cusumano 1994). Findings of past studies indicate the supplier can achieve higher profits by maintaining long-term relationships with their buyers. In fact, buyers and suppliers stressed the importance of close relationships because it is possible to achieve benefits in the form of lowered costs or improved profits (Ford, 1984; Kalwani and Narayandas, 1995; Iyer, 1996; Campbell, 1997; Anderson, Kock and Ahman, 2000). However, the studies presented in the literature have focused only on partial elements of sourcing strategy, mostly without any efforts toward integration. Since the goal is to build a methodology for strategy selection, the presented theories will be incorporated and used in defining the evaluation criteria for the final options selection.

Chapter 4. Development of the Methodology

4.1 Empirical study in the electricity market

In order to empirically define present and proposed methodologies for sourcing energy in Europe's changing and transitional environment, direct observation on how market and regulatory conditions, and how decision makers embrace decisions on power allocation and efficiency attainment, moved the present research project to prepare a survey of companies in various European countries, so that it could set a framework for a proposed strategic methodology of electricity sourcing. For the present reason, this chapter presents the methodology preparation through the results of a questionnaire among market participants in four countries of interest and under different status of liberalization and regulation change for this research: Croatia, Germany, Spain, and the UK.

In preparation for developing a methodology to be used in power sourcing, the survey was conducted in these European countries, the result of which is presented in the next section. Due to the complexity of the energy supply market and its uncertainty, qualitative methods and deep interviews are selected as the most convenient approach for exploration. To recognize and understand the main features of the supply market and caused behavior of market participants, the survey was found to be an appropriate source of empirical evidence. It helped to identify the opinion of the market players within a limited set of questions.

4.1.1 Questionnaires for deep interviews

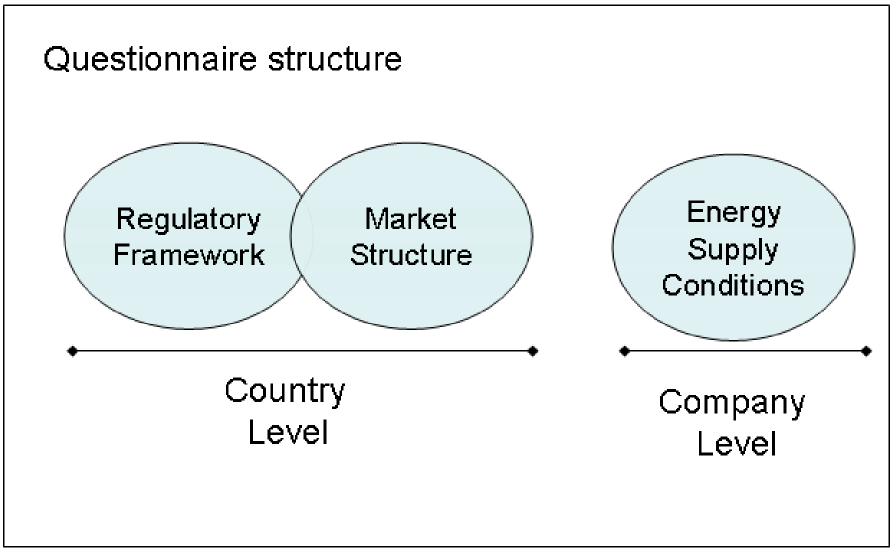
Because an electricity sourcing strategy is directly affected by market conditions, the research began by looking at the factors that characterize the electricity market and the way electricity is supplied. The study was laid out as a cross-sectional survey based on a standardized written questionnaire. There were two different questionnaires, one created to understand the features of market structures and the second one created to analyze the supply options used by large electricity consumers for each market structure.

The questionnaire on market structures (Questionnaire 1) was intended to generate the necessary data about the organization of Europe's supply markets. The document is organized by different topics with each one of them referring to a specific part of the energy sector. Therefore, survey participants (seven consumers, five suppliers, three regulators and one consultant) were asked about the following: Regulatory framework, generation and supply sectors, transmission system operators (TSO) and market operators (MO). Some of questions addressed include:

- Electricity market structure (for example, the existence of an organized market, the organization in charge of managing it, market players, degree of openness, final price development-structure, type of supply contracts, such as government support schemes, interaction between delivery charges, electricity – market or cost-based – and the like).
- Networks structure (such as, the existence of a central institution responsible for network organization, access to the network and network charges, connection to the network and relevant charges, required technical and administrative procedures, licensing procedures, etc.).
- Generation structure (for example, the main players, ownership of installed capacity, the existence of market power, level of competition, generation mix, fuel price development to electricity price volatility, access to wholesale market, etc.).
- Environmental issues (such as, the country's eligible producers, available RES promotion mechanisms, CO_2 cost calculation [national against international level], available policies that can be constraints for RES-E projects, administrative costs, licensing rules, etc.).

The entire questionnaire can be found in the **Appendix 1**. It is structured to gather data that provide a general picture about the organization of the electricity market in the country of interest *(see **Figure 17**)*.

Figure 17 *Structure of questionnaire 1*



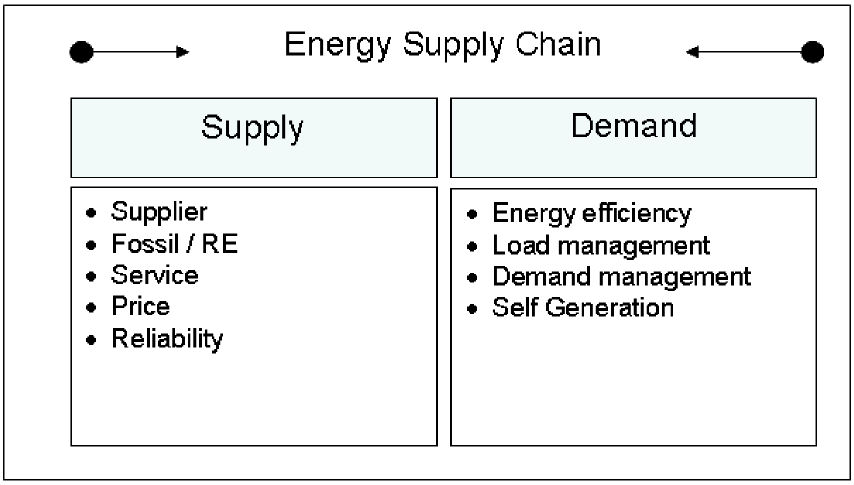
(Source: Treviño, 2010)

Going further, it will help to clarify the design of the regulatory framework, the country's energy policies and how this influences the operational flexibility of the end-user. The questionnaire was applied in all of the involved countries, while the sub-questions have been modified according to the specific conditions of their respective regulatory change stage. The main purpose was to understand and compare different markets in order to foresee changes throughout the liberalization process.

The questionnaire was delivered to seven different consumers located in Germany, Spain, The UK, and Croatia. All participants had similar backgrounds related to energy procurement or electricity sourcing. The original design of the questionnaire (Questionnaire 2) is attached in **Appendix 2**.

The purpose of the questionnaires was to collect data and to provide an explicit and a comprehensive picture of the purchasing behavior of large electricity consumers in specific market environments. Asking company managers how they supply power and manage demand can help readers learn about, and understand, the decision making process involved in the energy supply chain *(see **Figure 18**)*.

Figure 18 *Structure of questionnaire 2*



(Source: Treviño, 2010)

To provide the results of the analysis of the different options created, a decision tree map describing the flow of options reported by different players in the market is exhibited in **Appendix 3**. The analysis can help practitioners anticipate potential changes, which might affect the sourcing strategy.

4.1.2 Results overview

The research analysis has been organized from the development of research questions to the survey design in order to examine market behavior in different market segments. In order to understand how market evolution affects the changes in the sourcing decision, **Table 1** provides a detailed explanation of the results.

In those countries where the monopolistic regime is still dominant, vertically integrated utilities have the responsibility to supply electricity to residential, commercial and industrial retail consumers on the country level or within a defined geographic area *(see **Table 1**)*. This regime is still the rule, for example, in Croatia – vertically-integrated traders and generators are the only ones who can import and export electricity from and to neighboring countries; the supply and delivery rates are set under the regulated regime. The connection to the grid is limited or does not exist at all. All customers are integrated in the bundled service and the price is regulated according to the consumption pattern.

Table 1: *Supply Options in the function of the market evolution*

MARKET STRUCTURES	SUPPLY OPTIONS
Monopolistic • National Utility - single service provider • Bundled: generation and transmission • Restricted access to the grid • Export/Import: By national utility	**Supply options** ▪ Tariff price structure ▪ Long term contracts ▪ Bundled service **Demand options:** ▪ Energy efficiency & Load management ▪ Self-generation only for back-up
Transitional ▪ Few dominant service providers ▪ Price: Marginal cost ▪ Physical transactions ▪ Limited access to the grid	**Supply options** ▪ Bilateral agreements ▪ Short term contracts ▪ Load aggregation in single agreement **Demand options** ▪ Energy efficiency & Load management ▪ Incentives to have Interruptible contracts ▪ Generation only for self consumption
Competitive ▪ Large number of service providers ▪ Price listed in the power exchange ▪ Spot and forward transactions available ▪ Power prices index to commodities ex. Nat Gas ▪ Physical or Financial transactions ▪ Full access to the grid	**Supply options** ▪ Flexible contracts ▪ Unbundled service ▪ Consumer active in the market to buy and sell electricity **Demand options** ▪ Energy efficiency/load management ▪ Load management driven by electricity prices ▪ Load aggregation and Interruptible contracts

(Source: Treviño, 2010)

With market opening, a majority of countries have ruled out the cost-based model and have introduced market-based energy pricing. Incentives to have free access to the supplier’s choice and an active role in the energy market have been priorities for energy consumers. Consequently, the number of players has increased, affecting the variety of supply offers. At this stage of the market opening, and in an effort to limit the expenses related to price variations, energy consumers continue to use traditional operational actions such as energy efficiency and load management.

Market mechanisms are considered to be limited. Because industrials[11] are not allowed to resell the power, self-generation continues to be used only as a back-up. However, new incentives in the reduction of the CO_2 footprint have inspired the development of renewable energy technologies and promise new opportunities for industrial generators.

The regulations of competitive markets allow consumers to purchase from any retailer and to re-sell electricity to any buyer. This market organization is found in countries such as Germany and the UK. In these countries, different intermediaries can supply the electricity or the large electricity consumers can generate the electricity for their own use or participate as active players in the market and trade electricity among themselves or with other consumers.

The analysis of the collected data has shown that several elements influence an industrial facility's electricity purchasing strategy and those elements are primarily the following:

1. The existence of the electricity market with its maturity and liquidity.
2. The organization of the market – energy activities regulation.
3. The definition of electricity prices and service package.
4. The company's attitude, as well as financial and operational flexibility toward price risk.

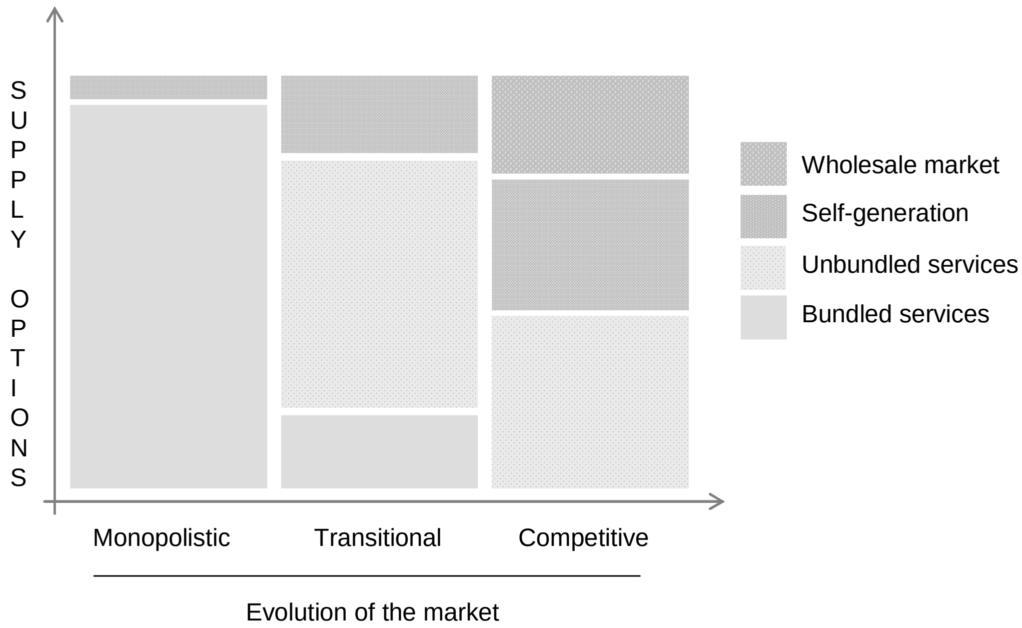
These elements differ from country to country and are highly dependent upon the changes of market structure. Also, the market's evolution has introduced new options to consumers by providing a better price structure and the flexibility to capitalize investments made in self-generation. Generating electricity for their use and reselling the surplus in the market could start to become a business opportunity, which has not been considered in the past.

In those countries where the regulated regime is still dominant, vertical utilities have the obligation to supply electricity to large electricity consumers on the country or regional level. Therefore, there are a moderate number of alternatives. However, as the number of suppliers has increased, a variety of offers has been introduced, making the selection process more complex. As a result, a more structured decision making process is needed.

[11] Industrials are considered large electricity consumers.

While in the past, large electricity consumers had no choice of suppliers, today they can buy electricity through either a supplier or/and generator, or go directly to the market and do it on their own. Moreover, the service package is not unbundled any more; rather, it is split into different services that can be arranged by separate contracts. **Figure 19** qualitatively illustrates the evolution of the electricity market and its intensity in terms of supply options, derived from observations in the selected countries and consumers.

Figure 19 *Supply options through the market changes*



(Source: Treviño, 2010)

Flexible and organized sourcing enables a company to act more freely, implementing new technologies or mechanisms that come from the external environment and which can be used for cost reduction. Therefore, one can conclude that the evolution of the market has created complexity in the supply of energy – a situation that large electricity consumers now face. These concerns have encouraged industrials to develop and support a decision making process.

4.2 Building the methodology

Before the methodology is put forth in detail, a description of the concepts used for developing the methodology should be introduced. As already highlighted, different theories have been joined to contribute to the development of the methodology. According to Andrews (1971) and Porter (1980), before the process of strategy building begins, developers must define the goal they want to accomplish through strategy implementation.

In power sourcing, the most frequently cited reasons for generating a strategic plan are to reduce the cost of supply, improve the reliability of supply, reduce the dependence on suppliers, manage the volatility of prices and find the most productive relation with suppliers (Ellarm and Carr, 1994; Spekman, 1985).

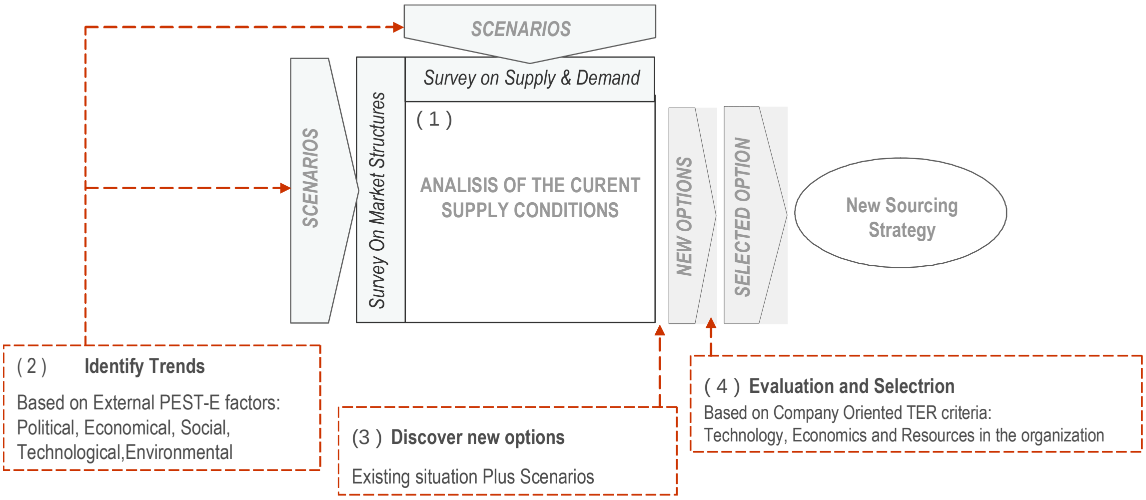
The plan of actions for strategy realization cannot be defined and organized without involving external market conditions and internal company competencies (Barney, 1991; Teece, et al., 1997), and confronting market conditions with internal resources and the organizational structure of the firm.

The big concern facing managers at large electricity consumers today is maintaining a continual responsiveness to changing market conditions (Van der Heijden, 1996). They are expected to monitor the related markets and their changes over time in order to be ready to act at just the right moment. Thus, exploring what “might” happen is critical when faced with such uncertainty. The challenge today is for management to foresee the changes that might affect their company’s method of supply.

Baxter and Calandri (1992) used scenarios to predict how the demand for electricity might change as a result of global warming. Thinking about the future has proven to be successful in energy planning, notably during the oil crises of the 1970s (Schwarz, 1996; Van der Heijden, 1996, Ringlad, 1998). Because the majority of large electricity consumers are not equipped to analyze and understand the future market conditions, the methodology includes steps for management to follow in order to foresee future events that might affect supply.

The result of joining all these theories is a model on strategy development process *(refer to **Figure 20**)*. The model embraces all of the necessary aspects utilized in strategy development.

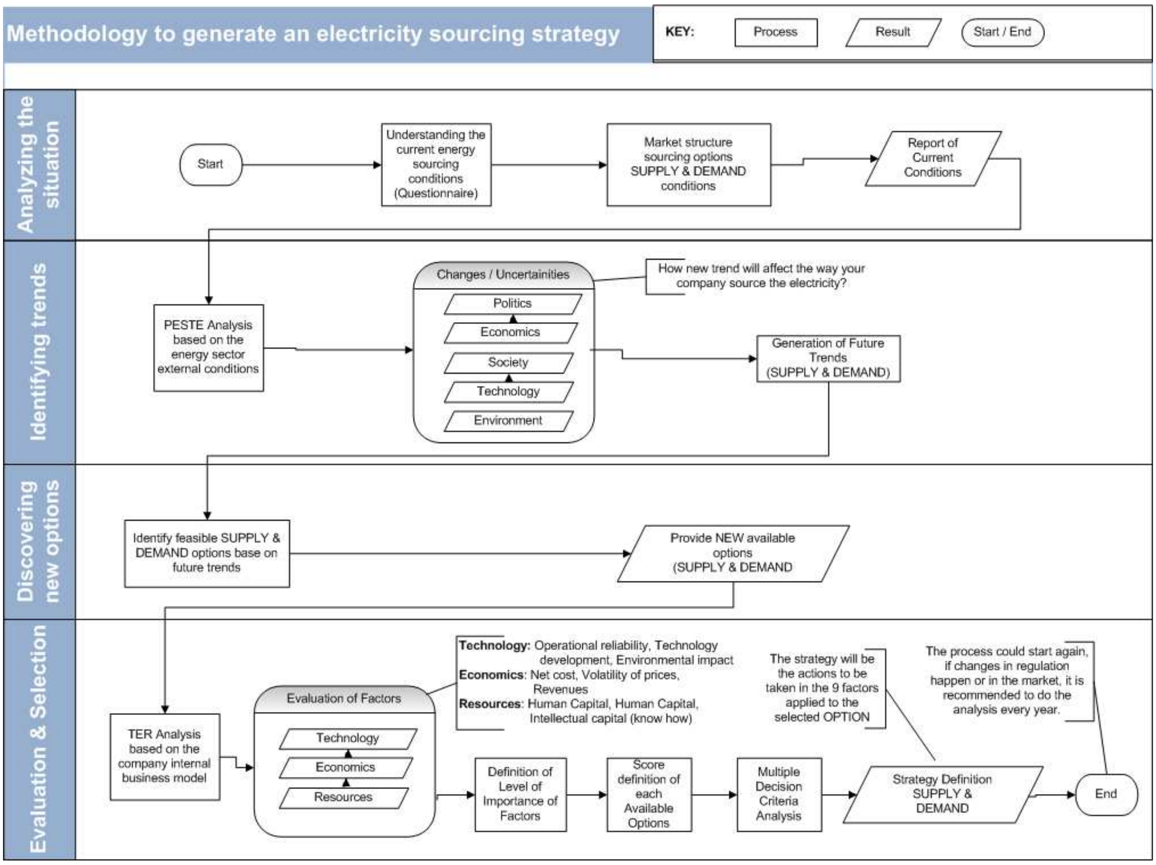
Figure 20 *Strategy development methodology*



(Source: Treviño, 2009)

In the following section, the entire strategy development process will be outlined. The whole process, and its required steps, will be explained through a four-stage methodology as shown next, with elements analyzed until this point *(see **Figure 21**)*.

Figure 21 *Detail flow diagram of the methodology*



(Source: Treviño, 2010)

The first step is called **analyzing the situation**. This involves monitoring both the external and internal environments with the aim of obtaining insight into existing market conditions and scanning available supply options. At the same time, management must analyze the current market conditions and internal capacities; managers should be aware of possible changes that can affect the way of supply. Therefore, the next logical step is to learn about the potential changes that might affect the supply market and its sourcing.

The second stage of the process is called **identifying the trends**. In complex market environments it is worth knowing what implications the future conditions might have on the identified sourcing options. Thinking more systematically about the future and planning to deal with possible changes in the environment is necessary, especially knowing that new market conditions provide new supply options.

After consumers learn about the potential future, they must be aware of options that the future might bring about; thus, the third stage of the process is known as **discovering options**. Actually, consumers are expected to discover how anticipated potential changes can change the availability of options. All new solutions must be evaluated and only those that are aligned with the company's goals and satisfy specific criteria should be taken in consideration as a potential final solution.

The next stage of the process is called **evaluation and selection**. The feasibility of the proposed options has to be measured through technical, economic and resources prisms. In fact, a comparison among alternative options, which is often based on conflict criteria, has to be done. All available options are called alternatives and they will be the basis for designing the final decision, such as the sourcing strategy. Since these alternatives are not necessarily exclusive, they can be integrated into a single decision. This should result in a decision that must be further developed into a final action plan. Each of these four steps will be explained in more detail within the following sub-sections.

4.2.1 Analyze the situation

The supply formulation process often includes an analysis of the external environment and an assessment of the organization's internal factors (Pearson & Gritzmacher, 1990; Carr & Smeltzer, 1997). Thus, the procurement decisions cannot, and do not have to be, made without analyzing the supply market (Kraljic, 1983; Ellarm & Handrick, 1995; Steele & Court, 1996; Van Weele, 2002). Because supply networks are embedded in the environment and interact with the available options, the optimal supply option may be sensitive to changes in the market environment (Choi, et al., 2001). Thus, before making any decisions, managers should analyze the country's electricity market within which they operate (Farmer & Weele, 1995).

However, due to new and changing market conditions, manager most be more explorative and work within an environment where qualitative methods, discussions, observations, interviews and surveys have proven to be effective techniques in getting this accomplished.

To better understand the relationship between the environment and the sourcing decision, we suggest that industrial users organize surveys, interviews and discussion sessions with various participants from the electricity industry, such as regulators, network and market operators, suppliers, generators, large electricity consumers, etc. to discuss both the existing market conditions and the supply market organization.

The data gathering process can be organized in semi-structured interviews. The main idea is to involve participants in a discussion about the predetermined topics and related questions (Rogers & Bouey, 1996). Thus, the researcher of the company is free to exercise his or her own initiative in following up an interviewee's answer to a question.

The main reason to propose this type of interview is that all related and unanticipated questions, which are not included on the original questionnaire, can be considered; depending on the answer provided by the interviewer (ibid). In addition, this may result in finding out unexpected and insightful information, thus enhancing the findings (Hair, et al., 2003).

The topics presented are not definitive and can be extended. Because the main purpose of the questionnaire is to allow the users to learn about the market organization and its characteristics, which can directly or indirectly affect the way of supply, the questions are defined to provide the information in the most valuable way.

As part of the empirical finding, it is highly suggested that management seek out the rich literature available in order to bring a different perspective to the research question. The example of the how the questionnaire was designed in order to obtain information about the current options available is described in the **Figure 22.**

After the surveys have been conducted and different interviews have been executed, the collected data must be organized and presented. There is no specific rule about how this step should be executed and it is up to the user to select the method to do so. The most important factor is that all users should leave this phase with a clear picture about the market conditions from which they source electricity, as well as have an understanding about how all available sourcing strategies can be found in the same market.

The benefit of doing the analysis of the existing situation is two-fold. First, the users can learn about the market conditions in the country where electricity should be sourced – the analysis should help them understand the market changes and their potential impact on sourcing decision. Second, the data can provide them with an update on best practices in the sourcing domain; this can be applied to the process in order to ameliorate and enrich their sourcing decisions. Both of these factors are necessary for building the decision making process.

Figure 22 *Current conditions questionnaire*

SUPPLY OPTIONS:

1. Freedom to select supplier (unbundled service)
2. Continue as bundled service with tariff structure
3. Move to unbundled service
4. Free access to the electricity market
5. Self Generation
6. Cost based
7. Market based
8. Real time price (spot)
9. Flexibility to fix prices in the forward market
10. Flexibility to index the electricity price with a commodity (ex. nat gas)

SELF GENERATION

11. Allowed to use the grid to interconnect self generation units
12. Generation units are required to maintain production (back up)
13. Fossil fuel technology (ex. nat. gas, fuel oil, etc)
14. Renewable (wind, solar, etc)
15. Subsidies to promote the investment in RES
16. Incentives to sell electricity from RES
17. On site generation
18. Self generation and inject excess into the grid
19. Allow to sell excess electricity in the market

CO2 MANAGEMENT

20. CO2 regulations in your country (fees on CO2, allowances, etc)

DEMAND OPTIONS

21. Energy efficiency actions.
22. Load management practice driven by electricity prices
23. Load management practice through operational flexibility
24. Interruptible contracts are available

(Source: Treviño, 2010)

4.2.2 Identify trends

After the existing market conditions are detected, the external environment should be monitored and analyzed with two purposes. First, it is critical to know the trends, or driving forces, regarding important factors which might affect the sourcing process and second, to detect the level of uncertainty of those factors, in order to better assess the risk involved in the decision making process.

In our case, anticipating the future will be used to explore the range of potential future contexts for the electricity supply market in EU countries. The objective of this study is not to find the best possible power supply strategy but rather, it is to anticipate future market conditions that may act as forces, which influence strategy development.

The use of trends enables procurement managers to explore the shape and nature of electricity sourcing under a variety of circumstances – some good and others not as preferable. Therefore, by exploring these possibilities and examining their implications for the portfolio, procurement managers will be better prepared to react in a more reasoned and thoughtful way, should these future events come to pass.

It is recommended that PESTE analysis be applied because it is concerned with the environmental influence on a business and can affect its strategic development, as is the case with a quality sourcing process. With major climate changes occurring (due to global warming) and increased awareness of this issue around the globe, the environment is an external factor, which is becoming a significant factor for company managements. The growing desire to protect the environment is affecting the energy industry, as well as how electricity is sourced. Therefore, industrial users are, in general, moving toward more environmental friendly options.

Regulation trends, including EU energy policy and environmental regulations, are leading to uncertain and significant changes in the electricity sector. They define what a firm is now allowed, or not allowed, to do for its electricity sourcing. Another significant driver in making a final sourcing decision is, of course, the price of electricity – defined by the technology, fuel, and CO_2 cost, as well as the supply and demand, which can shift up or down depending upon market conditions. Social trends encompass consumers' behavior and environmental awareness. Some factors in those trends are more predictable (demographics, for example) than others (such as consumers' preferences). However, the impact of all of these elements is significant when analyzing market conditions. In order to make this process less complex, a short explanation about the dimensions that dominate these five factors follows:

Political dimension. The EU Energy Policy and Environmental Regulations are leading drivers in terms of change in the energy and electricity sectors *(refer to **Table 2**)*. Factors to be considered within political dimensions are the different regulatory and policy changes that can either directly or indirectly affect the way electricity has been supplied.

Table 2 *Policy dimension of the PESTE analysis*

Policy	Energy policy and country regulations	Liberalization of the electricity market is in progress	☑	P1
		Unbundled service — supply and transmission can be negotiated separately	☐	P2
		Self generation will be allowed (back-up, partial generation, selling excess, etc)	☐	P3
		Access to the grid will be available to deliver electricity in different regions	☐	P4
		Allowed selling of electricity (self generated electricity to the market — new business opportunity)	☐	P5

(Source: Treviño 2010)

Those changes might include opening up the electricity market, the availability of freely choosing suppliers, a tendency towards building a single EU electricity market, an imperative on the diversification of energy supply, different regulations on network access, various policies to promote more secure and sustainable energy delivery, the increase of renewable energy, and the like.

Economic dimension. This covers different drivers influencing the future of the electricity market from an economic point of view, such as the economic growth of EU countries; the situation in financial markets and the existence of financial support for the particular sourcing options *(refer to **Table 3**)*. Those changes could take the form of financial support for renewable energy or penalties for the use of fossil based technologies or credit restrictions to access different electricity supply forward markets.

Table 3   *Economic dimension of the PESTE analysis*

Economic	Supply / Demand, RES/ Nuclear, Fossil fuel price	Fossil fuel prices will remain volatile and unpredictable	☑	Ec1
		Increasing number of support schemes for investment in renewable energy sources (RES)	☐	Ec2
		Increasing number of incentives for selling the electricity from renewable energy sources (RES)	☐	Ec3
		Increasing economic incentives for load management practices (load shedding and load shifting)	☐	Ec4
		Electricity purchasing through the market	☐	Ec5
		Electricity prices index to the spot market	☐	Ec6
		Electricity prices index to the forward market	☐	Ec7
		Electricity prices index to a commodity (exc., nat gas)	☐	Ec8
		Trend to build additional production capacity to improve load management practices	☐	Ec9
		The generation and transmission system have constraints and provide incentives for interruptible contracts	☐	Ec10

(Source: Treviño, 2010)

Electricity prices are the function of a supply/demand ratio; any changes in these two aspects must be taken into account. Moreover, the changes in the fuel markets must also be analyzed and their potential impact taken into account.

Social dimension. This refers to customer behavior and demographic changes. Population ages, becomes more or less affluent, changes on a regional basis and so on – all of these elements can have an important bearing on demand as a whole. Consumer attitudes and opinions, media views, education and fashion are also part of the social environment. Consumer preferences regarding different technologies (such as nuclear vs. green vs. fossil based), price acceptance, living standards, orientation to environmental issues (accepting practices such as reducing consumption, reuse the material, recycling, etc.), as well as their preferences and actions are all important factors for decision making *(see* ***Table 4****)*.

Table 4 *Social dimension of the PESTE analysis*

Social	Consumer (large industrials) preferences	People are becoming more concerned about the environmental changes — positive attitude about recycling, willingness to pay a higher price for "green" electricity	☑	S1

(Source: Treviño, 2010)

Technological dimension. The future of electricity market depends upon technological trends and improvement in the efficiency of existing technologies (for instance, fossil, some of renewable, nuclear) and development of new ones (such as carbon capture and storage, energy efficiency, clean technologies). Frequently, new technologies are categorized as being disruptive, such as semiconductors, power electronics, hydrogen, electrical storage, and the like. Some of the common disadvantages of these are the high costs, due to the fact that they are not mature enough to be standardized. Technology trends in other sectors – indirectly contributing to the electricity market – have to be captured and used. So, technological breakthroughs can create new markets, which might prove to be a threat to existing ones. In equal measure, new technology can be a useful input for different industries *(see **Table 5**)*.

Table 5 *Technological dimension of the PESTE analysis*

Technological	Electricity generation, Energy efficiency	Technology is available to generate electricity at a competitive cost	☑	T1
		Dominance of technologies to offset CO2 emissions (CO2 capture and storage is available)	☐	T2
		New renewable energy technologies (RES) will grow in the market (e.g., RE, nuclear, etc.)	☐	T3
		New automation technology will support energy efficiency and load management practices	☐	T4

(Source: Treviño, 2010)

Environment dimension. Refers to climate change an environment-related regulation in the EU community. The new regulation will restrict the allowance to emit CO_2 in the atmosphere affecting the price of electricity. This may lead to changes in the EU's economy *(see **Table 6**).*

Table 6 *Environmental dimension of the PESTE analysis*

Environmental	Environmental issues	New regulations regarding pollution and the environment are expected to intensely affect the prices of CO2 and electricity	☑	E1
		New environmental regulations will not affect the price of CO2	☐	E2

(Source: Treviño, 2010)

The main idea behind monitoring the trends is to help users expand their thinking beyond the urgency and immediacy of the here and now, as well as to identify the external factors that may have an anticipated impact on the electricity market today and, consequently, on the decision making process tomorrow.

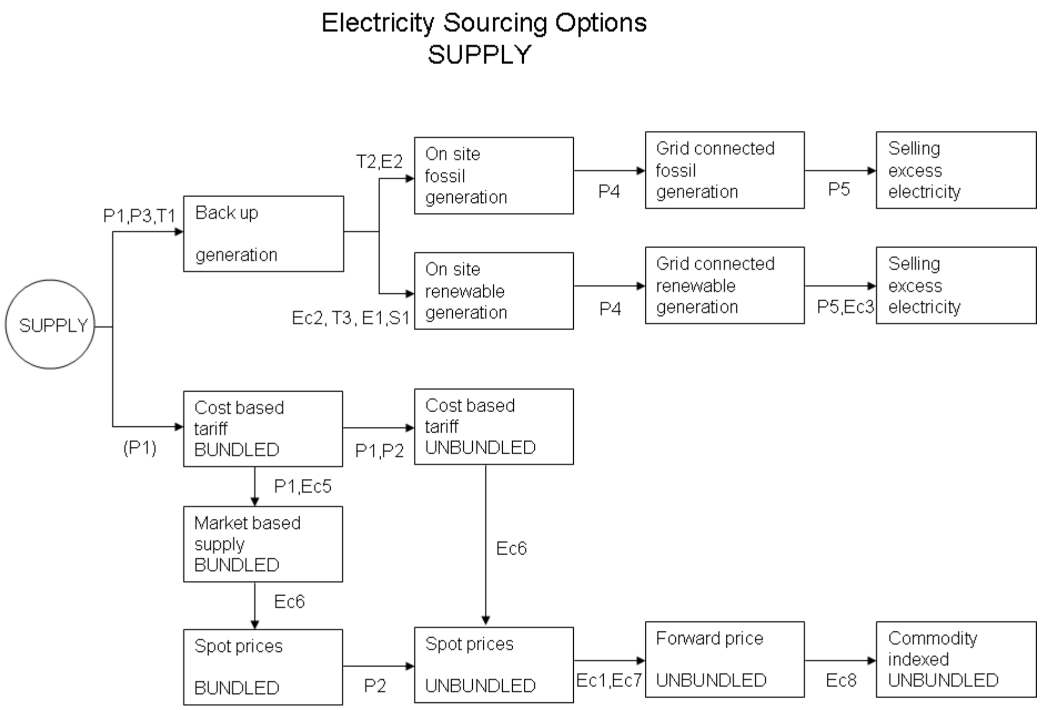
Applying PESTE, users will find that some of the expected changes are more predictable than others. Apart from the predictable or expected changes, users may also recognize changes with a high level of variation and unexpected behavior – these are called uncertainties and deserve our full attention, due to the fact that their impact on the sourcing process may be enormous and unpredicted. The responsibility of the strategist is to keep monitoring these uncertain changes and be prepared to react to them as fast and as rationally.

Usually, consumers face a great challenge in perceiving upcoming changes and evaluating their potential impact. After managers recognize the existing market conditions and have learned about potential changes, they are ready to explore the new options. Therefore, the next step is to build a profile of new options.

4.2.3 Discover new options

After the market structure has been reviewed, and an analysis of upcoming changes has been made, the company management is ready to analyze how those changes might affect the existing market conditions and review the relevant supply options. Market structure and regulations are the main determinants regarding the sourcing options available to a company. Depending upon how the regulatory system changes, the available options differ from market to market. Other conditions, such as type of technology, credit lines and contract arrangements could influence the available options in each structure. In this phase, we suggest company management identify the future conditions that apply to them in conjunction with all of the elements in the energy market. The evolution of electricity sourcing options related to the regulatory framework, technological and environmental aspects, as well as the social influence, are presented in **Figure 23**. The figure is structured into boxes and arrows, where each box represents a supply solution and an arrow, a trend that the electricity market is following during the liberalization process.

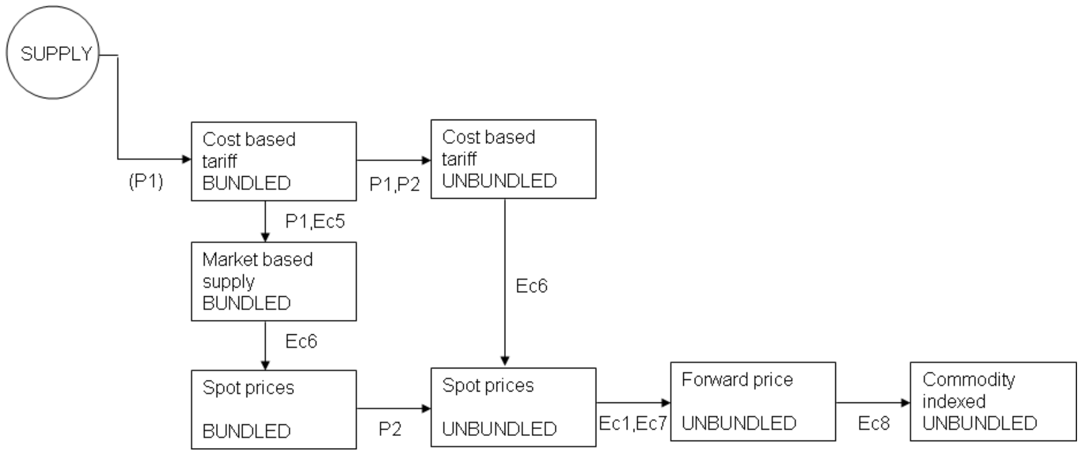
Figure 23 *Electricity sourcing options model*



(Source: Treviño, 2010)

For example, large electricity consumers in some EU countries are still supplied under the cost-based tariffs. The liberalization process has introduced new trends where the new market condition will provide incentives to unbundled the service and introduce incentives to trade electricity in the spot forward markets. The evolution of the electricity supply contracts is described in **Figure 24**.

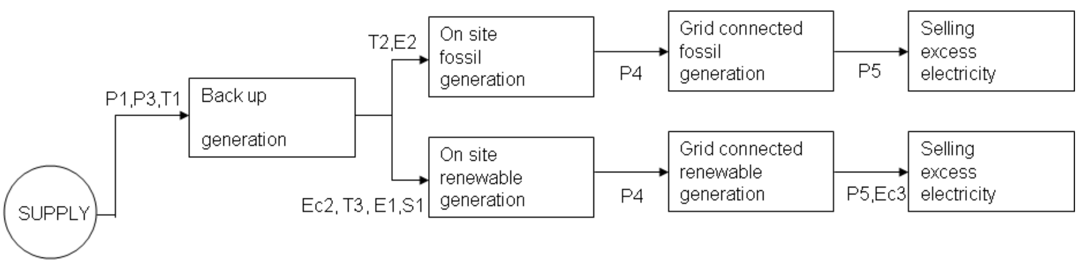
Figure 24 *Evolution of electricity supply contracts*



(Source: Treviño, 2010)

Going further, changes in energy laws that favor the selling of electricity (P5) by industrial users might motivate large electricity consumers to begin to self-generate electricity, controlling the cost through electricity selling *(refer to **Figure 25**)*.

Figure 25 *Introduction of self-generation as a new way of supply*

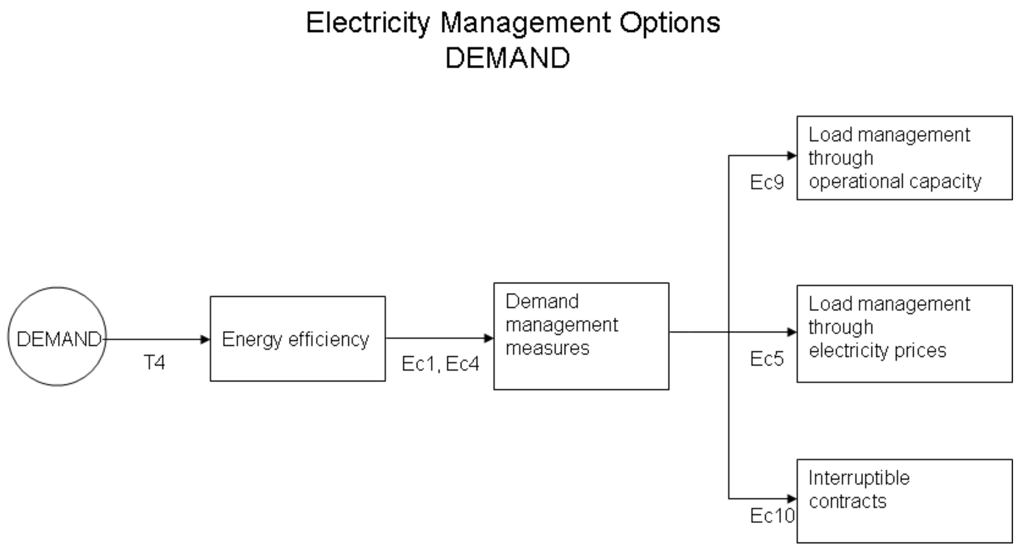


(Source: Treviño, 2010)

To make this option feasible, some other trends, including technological (T), economic (Ec), environmental (E) and social (S) dimensions, have to be evaluated as well. Depending upon which of these trends are likely to happen, the type of self-generation and the cost of supply will be defined.

Many changes in technology (for example, the introduction of new metering points, automated solutions, remote control for supply, etc.) and market changes (such as the introduction of a spot market for electricity supply, interruptible contracts, uncertainty of fuel prices, etc.) may encourage large electricity consumers to leave the traditional approach to managing demand and apply new technological solutions and market-based practices *(refer to **Figure 26**).*

Figure 26 *Evolution of demand side measures*



(Source: Treviño, 2010)

The logic used in this process can be explained in the following way: the trends detected in the PESTE analysis have been considered to be either facilitators or barriers for an option to become available. Moreover, while not all of the trends have the same weight, we have differentiated those options that are necessary from those that are simply available. For each decision made, the system provides a logical explanation, presenting the "necessary" trends that have been used to justify the final decision. After the user reviews the report on possible changes, they will be asked to continue the process so they are able to generate a report on all available options for specified market conditions *(see **Table 7**)*.

Table 7 *New available options*

SUPPLY
A.- BUY **Bundled Service** 1.- Electricity price is market based. **Unbundled Service:** 1.- Real time price (spot). 2.- Flexibility to fix prices in the forward market. 3.- Flexibility to index the electricity price with a commodity (ex. Nat Gas) .
B.- MAKE **Generation of Electricity:** 1.- Fossil fuel for Back up. 2.- Fossil fuel partial supply. 3.- Fossil fuel complete supply (grid connected). 4.- Fossil fuel supply and selling excess to the market. 5.- Renewable energy for Back up. 6.- Renewable energy partial supply. 7.- Renewable energy complete supply (grid connected). 8.- Renewable energy and selling excess to the market. 9.- Renewable energy and selling excess with government incentives.

DEMAND
DEMAND RESPONSE 1.- Energy efficiency actions. 2.- Load management practice driven by electricity prices. 3.- Load management practice through operational flexibility. 4.- Interruptible contracts.

(Source: Treviño, 2010)

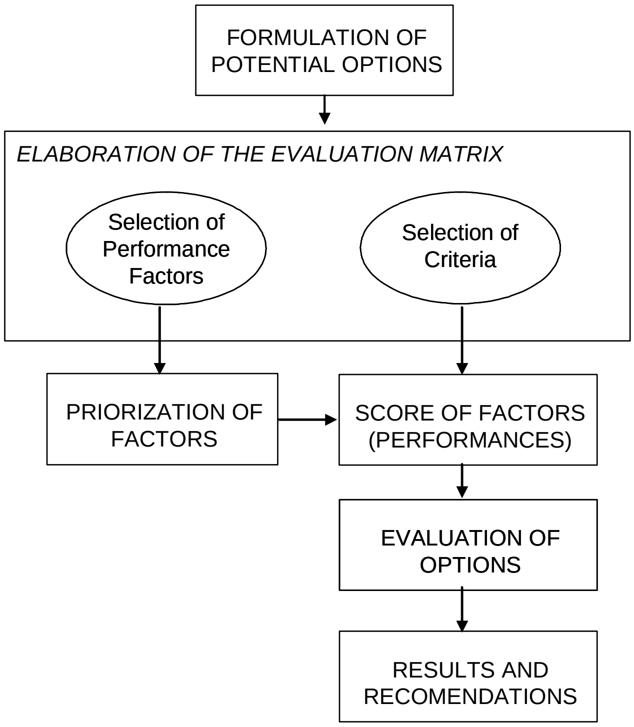
After the company management has identified emerging market conditions and options that come with those changes, it is expected to select only those options that might bring the company to the desired results and add value. The selection route is developed in the next phase of the process.

4.2.4 Evaluation and selection

In the past, the choice between alternative sourcing options was based on cost reduction.. The aforementioned multi-criteria considers the involvement of a number of actors in the decision making process. Multiple, and conflicting, objectives seem to be the key difficulties in assessing the alternatives. These demand that the decision makers utilize multi-criteria decision aid (MCDA) techniques. Beinat (1997) presented multi-criteria decision aid techniques as well-known, transparent assessment procedures, intended to assist decision makers in staying aligned with their general objectives and support the efficient accomplishment of the decision processes. The basic idea behind the MCDA approach is to evaluate all the alternatives against the different criteria and select the one that best promises the required results. It includes a few basic steps that need to be followed *(see **Figure 27**)*.

This model facilitates the integration of actions that have to be taken to develop the assessment of different electricity sourcing options. Once the factors are defined, we can then organize and prioritize them according to the company's business procedures. Depending upon the available options, each one can potentially have, or not have, an impact on business performance, which is why it is important to apply a score and evaluate the level of success for the business.

Figure 27 *Decision making model MCDA*



(Source: Modified from Georgopoulou, et al., 1996)

The basic consideration integrated the in TER[12] analysis integrates criteria that affect the performance of the organization in the three basic dimensions: Technological, economic and resources. **Table 8** describes the criteria that support the basics of these factors, driven mainly by operational performance through sustainable production and improvement of the economic performance related to cost production and revenue increase for the company. The organization's available resources should support the new electricity sourcing strategy, whether they originate from the financial, human or the intellectual capital of the company.

Companies in competitive markets, tend to be risk takers and promote actions to improve their market share and revenues through operational efficiency and cost reduction programs.

[12] TER: Technology, Economics, Resources

Table 8 *Definition of TER criteria*

CATEGORY	FACTORS	DESCRIPTION
Technology	Operational reliability	Supply of electricity to provide operational continuity
	Technology development	New option based on a technology with the ability to bring potential savings and cost reduction
	Environmental impact	Supply with zero or low environmental impact (noise, air pollution, water pollution, land deterioration, etc).
Economics	Net cost	Potential for cost reduction
	Volatility of prices	Supply dependent or indifferent on price changes
	Revenues	Additional income related to new business opportunities
Resources	Human capital	The additional number of employees required to get new option implemented and keep it running
	Financial capital	The financial resources required to invest and operate the new option
	Intellectual capital (know-how)	The possibility to gain the intellectual capital through implementing the new option

(Source: Treviño, 2010)

After assessing the technical solution for the problem, the user is then expected to identify the economic value of the potential options. Therefore, the economic assessment of the various options can be made through the net cost of supply and potential revenue that can be realized by implementing and running the selected option. In this case, the volatility of fuel markets must be taken into consideration, knowing that any change in fuel commodity markets directly affects the price of electricity.

After the technical and economic sides of the proposed options have been evaluated, the resource-based requirements must be determined. All three dimensions of the resource dimension are taken into account, such as human, financial and knowledge capitals. While human capital refers to the number of employees that must be hired to manage and deal with the new option, the financial aspect refers to the capital investment needed to implement the option. This option should also be evaluated against the possibility of generating additional intellectual capital in the terms of know-how and intangible assets (Barney 1991).

Weights assigned to the factors

After decision makers agree on the criteria to be used during the evaluation process, they must determine the weight of each factor, as presented in Chapter 3, along with its criteria. Determining the weight of each criterion, or level of its importance, requires making an assessment of the effect that each of the factors may have in business performance. The techniques for acquiring the weights and the level of importance are elaborated by Vincke (1992). However, the level of importance for each criterion varies, depending upon the conditions in the country and the business structure of the company.

For example, **Table 9** describes the prioritization of the factors related to a company that has rated operational reliability as the main objective for the supply option – they need to have a very high level of continuity in the production process since the quality of their products is very sensitive to interruptions or blackouts. The second priority is then based on financial resources, meaning that the company has a very restricted flexibility to finance or invest in a new solution. In this case, we can assume that options related to the acquisition of new assets will have a lower possibility of success.

Environmental impact represents the next priority level. In this case, the company may be interested in having a sustainable operation, wishing to reduce their environmental foot print and welcome environmental friendly solutions, while the rest of the criteria are more related to the new option's economic performance. The volatility of prices, in this instance, is mainly driven by fossil fuel and the net cost of procurement related to electricity should be maintained as stable and kept as low as possible.

In the end, the options representing the lowest impact for the organization are the ones related to the intellectual regime, since the value brought out by know-how cannot be extracted; therefore, the importance of this factor will be rated low.

The company management can organize these nine factors in a way that place a higher value on the conditions which influence the business performance and a lower importance on the factors that have a neutral, or low, effect on the business[13].

[13] Refer to Chapter III page 41 / Critical factors in the organization.

Table 9 *Prioritization of the factors used to evaluate sourcing alternatives*

CATEGORY	FACTORS	LEVEL OF IMPORTANCE	SCORE	DEFINITION OF THE CRITERIA
Technology	Operational reliability	9	1	The option has a **low** level of operational reliability
			2	The option has a **medium** level of operational reliability
			3	The option has a **high** level of operational reliability
	Technology development	4	1	The option is based on **old** technology
			2	The option is based on **traditional** technology
			3	The option is based on **new** technology developments
	Environmental impact	7	1	The option has a **high** environmental impact
			2	The suggested option has a **low** environmental impact
			3	The option has **no** environmental impacts
Economics	Net cost	5	1	The net cost of supply might be **higher** than the current net cost
			2	The net cost of supply might be **equal** than the current net cost
			3	The net cost of supply might be **lower** than the current net cost
	Volatility of prices	6	1	**High** volatility of prices. The option is related to the spot market prices or fossil fuels
			2	**Low** volatility of prices. The option is related to the forward market prices
			3	**Zero** volatility of prices. The option is not related to the market
	Revenues	2	1	The option provide **zero** increase in the revenues
			2	The option provide **low** increase in the revenues
			3	The option provide **high** increase in the revenues
Resources	Human capital	3	1	**New** employees have to be hired to manage the new option
			2	**Same** level of employees is required to manage the new option
			3	**Fewer** employees required to manage the new option
	Financial	8	1	The option is **high** capital intensive and new investments are required
			2	The option is **low** capital intensive and no major investments are required
			3	The option is **Zero** capital intensive and no investments are required
	Intellectual capital (know how)	1	1	**Zero** new intellectual capital is generated
			2	**Low** new intellectual capital is generated
			3	**High** new intellectual capital is generated

(Source: Treviño, 2010)

Scoring the options

After the prioritization of the factors has been made, the next step is to assign "weights" to attributes, indicating the relative importance and contribution in relation to the criteria. The value of the score is given to provide a higher, or lower, level of effect on the operation and business performance in each individual option. **Table 10** provides the details of each factor and the specific criteria that can go from a 1) low, 2) medium, or 3) high score. Here is a more detailed explanation:

1. Lower value than the value generated with the existing solution or there is no added value/high cost.
2. Same value to the value generated with the existing solution or low added value/low cost.
3. Higher value than the value generated with the existing solution or high value added/no cost.

Once the level of importance to the individual criteria is determined, the next step is to integrate these scores in the matrix, where the available options are represented. In this case, the level of success of each individual option is evaluated in relation to the nine different factors by providing the scores explained previously. Therefore, decision makers are expected to evaluate a potential alternative against the attributes identified at the beginning using the established scales/metrics. Once candidate options are given scores and/or ratings against each attribute, it is then necessary to aggregate these scores and/or ratings in the selected mathematical model *(see **Table 11**)*.

The model integrates all of the available options from the supply dimension (buy or make) to the demand response options. This part of the methodology is the first time that the available options are combined with the company philosophy. In this stage, the score provided to evaluate the performance of the suggested option indicates the level of value that the option can provide to the business performance. Since all of the options might have a different impact on the business in the three main categories (technological, economic, and resources), these scores are combined to calculate a total value indicating the relevance of this option in future electricity sourcing strategies.

Table 10 *Score and definition of the criteria by factor*

	FACTORS	SCORE	DEFINITION OF THE CRITERIA
TECHNOLOGY	Operational reliability	1	The option has a **low** level of operational reliability
		2	The option has a **medium** level of operational reliability
		3	The option has a **high** level of operational reliability
	Technology development	1	The option is based on **old** technology
		2	The option is based on **traditional** technology
		3	The option is based on **new** technology developments
	Environment impact	1	The option has a **high** environmental impact
		2	The suggested option has a **low** environmental impact
		3	The option has **not** environmental impacts
ECONOMICS	Net cost	1	The net cost of supply might be **higher** than the current net cost
		2	The net cost of supply might be **equal** than the current net cost
		3	The net cost of supply might be **lower** than the current net cost
	Volatility of prices	1	**High** volatility of prices/The option is related to the spot market prices or fossil fuels
		2	**Low** volatility of prices/The option is related to the forward market prices
		3	**Zero** volatility of prices. The option is not related to the market
	Revenues	1	The option provide **zero** increase in the revenues
		2	The option provide **low** increase in the revenues
		3	The option provide **high** increase in the revenues
RESOURCES	Human capital	1	**New** employees have to be hired to manage the new option
		2	**Same** level of employment is required to manage the new option
		3	**Fewer** employees required to manage the new option
	Financial	1	The option is **high** capital intensive and new investments are required
		2	The option is **low** capital intensive /no major investments are required
		3	The option is **zero** capital intensive and no investments are required
	Intellectual capital (know how)	1	**Zero** new intellectual capital is generated
		2	**Low** new intellectual capital is generated
		3	**High** new intellectual capital is generated

(Source: Treviño, 2010)

Table 11 Scoring the options, mathematical model

CATEGORY	Technology			Economics			Resources		
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human Capital	Financial	Intellectual capital (knowhow)
IMPORTANCE	9	4	7	5	6	2	3	8	1
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE		
SUPPLY									
TYPE OF SUPPLY									
BUY									
Bundled Service									
Bundled Service - - Electricity price is **market** based	2	2	2	2	3	2	3	1	1
Unbundled Service									
Real time price (spot)	2	2	3	1	1	1	1	1	2
Flexibility to fix prices in the forward market	2	2	3	1	2	1	1	1	2
Flexibility to index the electricity price with a commodity (ex. Nat Gas)	2	2	3	2	2	3	1	1	2
MAKE									
Generation of Electricity									
Fossil fuel for Back up	2	1	1	2	1	1	2	2	2
Fossil fuel partial supply	2	1	1	2	1	2	2	2	2
Fossil fuel complete supply (grid connected)	2	1	1	1	1	1	1	1	2
Fossil fuel supply and selling excess to the market	2	1	1	3	1	3	1	2	2
Renewable energy for Back up	2	2	2	1	3	1	2	1	3
Renewable energy partial supply	2	2	2	1	3	1	2	1	3
Renewable energy complete supply (grid connected)	2	2	2	1	3	1	2	1	3
Renewable energy and selling excess to the market	2	2	2	1	3	1	2	2	3
Renewable energy and selling excess with government incentives	2	3	3	3	3	3	2	2	3
DEMAND									
DEMAND RESPONSE									
Energy efficiency actions.	2	1	2	1	2	2	1	3	1
Load management practice driven by electricity prices	2	3	3	3	2	3	3	3	2
Load management practice through operational flexibility	1	2	3	2	2	2	3	2	1
Interruptible contracts.	1	3	2	2	2	2	2	2	2

(Source: Treviño, 2010)

Evaluation and results

After scoring each available options for power procurement, the result is recalculated by multiplying each value from cells with the value of the importance factor. The new scores are automatically calculated and presented in **Table 12.** The evaluation process integrates the calculation of the scores and the prioritization of the factors in relation to company needs. The highest value that can be achieved in the calculation is 135 points and the lowest value is 45 points. The higher score means that the available options have matched the company’s business strategy and the conditions from which to implement this option are in place to achieve success.

Table 12 *Evaluation of the options*

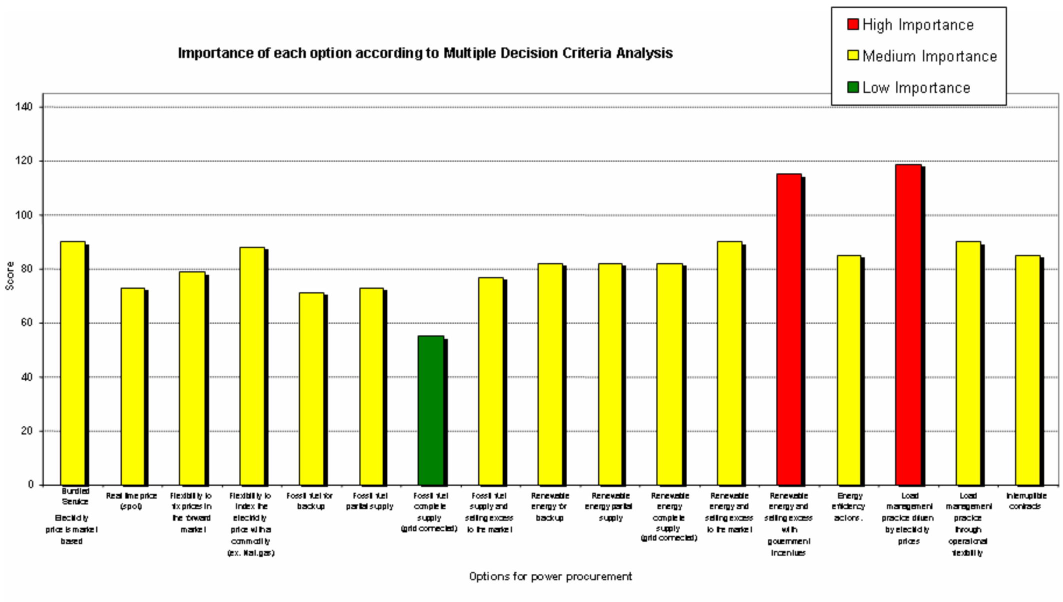
CATEGORY	Technology			Economics			Resources			TOTAL
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human Capital	Financial	Intellectual capital (know how)	
IMPORTANCE	9	4	7	5	6	2	3	8	1	
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE			
SUPPLY										
TYPE OF SUPPLY										
BUY										
Bundled Service										
Bundled Service - - Electricity price is market based	18	8	14	10	18	4	9	8	1	90
Unbundled Service										
Real time price (spot)	18	8	21	5	6	2	3	8	2	73
Flexibility to fix prices in the forward market	18	8	21	5	12	2	3	8	2	79
Flexibility to index the electricity price with a commodity (ex. Nat Gas)	18	8	21	10	12	6	3	8	2	88
MAKE										
Generation of Electricity										
Fossil fuel for Back up	18	4	7	10	6	2	6	16	2	71
Fossil fuel partial supply	18	4	7	10	6	4	6	16	2	73
Fossil fuel complete supply (grid connected)	18	4	7	5	6	2	3	8	2	55
Fossil fuel supply and selling excess to the market	18	4	7	15	6	6	3	16	2	77
Renewable energy for Back up	18	8	14	5	18	2	6	8	3	82
Renewable energy partial supply	18	8	14	5	18	2	6	8	3	82
Renewable energy complete supply (grid connected)	18	8	14	5	18	2	6	8	3	82
Renewable energy and selling excess to the market	18	8	14	5	18	2	6	16	3	90
Renewable energy and selling excess with government incentives	18	12	21	15	18	6	6	16	3	115
DEMAND										
DEMAND RESPONSE										
Energy efficiency actions.	18	4	14	5	12	4	3	24	1	85
Load management practice driven by electricity prices	18	12	21	15	12	6	9	24	2	119
Load management practice through operational flexibility	9	8	21	10	12	4	9	16	1	90
Interruptible contracts.	9	12	14	10	12	4	6	16	2	85

(Source: Treviño, 2010)

By combining the scale and graphic interpretation of the results, the user can clearly see the options that are, or are not, acceptable, with respect to the set of criteria that had been prioritized. The results are provided in two dimensions: The supply side and the demand side. A graphic representation of the results is provided in **Figure 28.**

This last part of the methodology provides decision makers with a clear vision about the strategy that should be followed. The best available option should be considered and implemented as part of the company's business strategy. The process of identifying trends in the market and the company's priorities, in relationship to the critical factors, should be reviewed frequently in order to integrate changes in the way the business operates. Furthermore, economic analysis should be made to evaluate the return of investment or the cost savings expected by applying this option.

Figure 28 *Graphical results*



(Source: Treviño, 2010)

This final consideration is not included in the scope of this dissertation because its concentration is on the methodology to identify current available options, trends in the main domains of the environment and the criteria used by companies to select options based on their business philosophy.

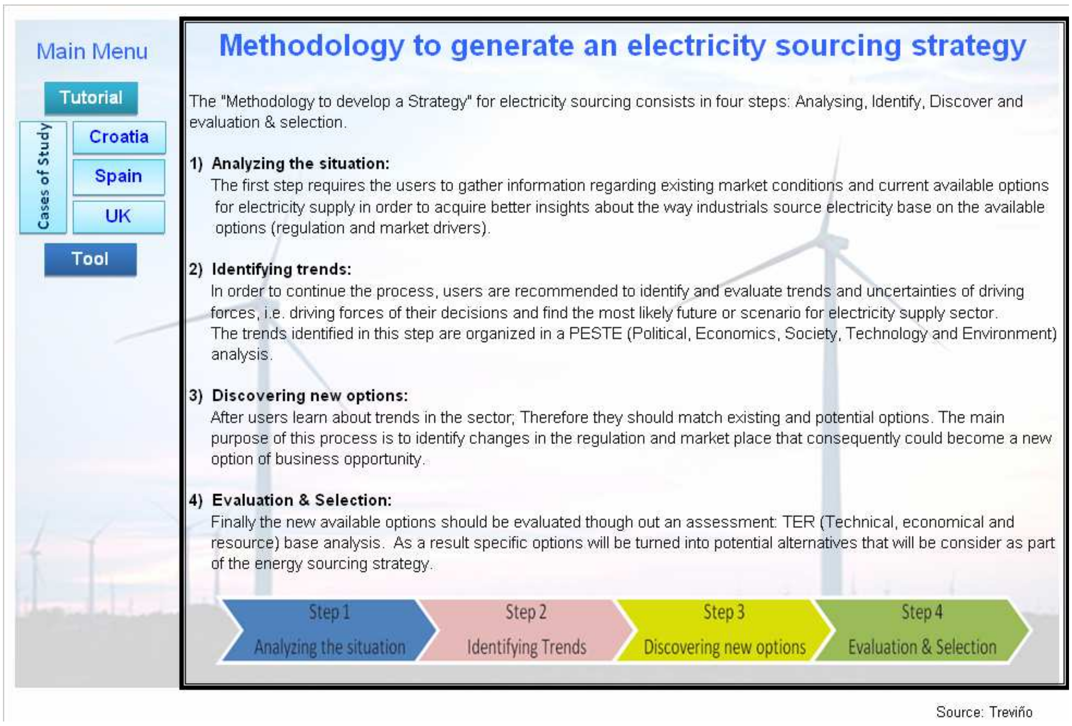
4.3 Methodology tool

This methodology has been integrated in a tool that has been designed to help managers follow all of the steps in a methodical and systematic way. The tool provides the possibility of building scenarios and creating conditions that can be used to assess the options that energy intensive companies have to source their electricity needs. **Figure 29** depicts the modules integrated in the methodology to analyze the electricity sourcing options and ends the present chapter. The tool consists of three parts:

1. Tutorial – where the users can find an overview about each of the steps integrated in the methodology.

2. Case studies – detailed information about the application of the methodology in three different countries with different market structures: Croatia, Spain and the UK. (Chapter 5).
3. Tool – Application ready for use by a company's management.

Figure 29 *Main menu methodology tool*



(Source: Treviño, 2010)

Chapter 5. Applying the Methodology: Case Studies

5.1 Introduction

Although the liberalization process started 15 years ago, the development of regulation and markets has progressed differently in Europe. This chapter analyzes three different countries with varying market structures. Thus, the characteristics of the electricity markets can be identified as monopolistic in Croatia, transitional in Spain and competitive in the UK. Also, the selected companies come from a variety of energy intensive industries, such as chemical, cement and steel.

The selection of these country-company was based on the availability of information provided by previous work in electricity procurement. I had substantial data about external factors that affects the development of the electricity sector, as well as internal business criteria in the organization. These elements are considered define the prioritization of the factors and scores to the different available options. Additionally the above country-company cases were also elaborated on the fact that these markets had various levels of development useful for testing the methodology with some constrains in time and budget.

The chapter begins with a brief overview of the electricity sector in Europe, providing information about the evolution of electricity prices, the electricity generation mix and the development of renewable electricity initiatives. The case studies include a general overview of the country's economy, the power system including the generation capacity, the electricity network and the main electricity players. Because electricity intensive users play an important part in energy consumption, the case studies provide information about the energy players in different parts of the sector as well as providing details about the electricity profile of each company.[14] The methodology has been followed and each part of the four steps has been documented with detailed information about current conditions, trends in the external environment, identifying new sourcing options and evaluating the options, in relation to the company's business philosophy.

[14] Company electricity profile is related to the electricity consumer. The details included are about the electricity demand and consumption, as well as the current electricity supply strategy.

Three different companies in Europe were selected: ELECTRON[15] in Croatia, NEUTRON[16] in Spain and the UK's PROTON.[17] These companies represent the industrial sector – they are important players in the electricity market and need to develop an electricity sourcing strategy to improve their respective competitive advantage.

This chapter is an important part of the dissertation – by providing information about the application of the methodology, its value for the electricity intensive industry is better understood.

5.2 Europe's electricity sector

Europe is the leading region in the promotion of liberalizing the electricity sector. This part of the chapter will provide a brief description of Europe's electricity profile to aid in obtaining a better understanding of the environment. The description will give us a quick overview of the current conditions faced in Europe, as well as some macroeconomic statistics regarding electricity prices, generation mix and an overview of the renewable targets.

Economics

By 2006, roughly 22,000 enterprises in the EU-27's energy sector generated turnover of approximately € 885 billion and employed over 1.2 million people, (3% of the total industrial workforce). At the same time, these enterprises generated a value-added of € 180 billion, 9% of the total industry.[18]

Europe is becoming increasingly dependent up on imported hydrocarbons. The projection is that the EU's energy import dependence will jump from 50% of the total EU energy consumption today to 65% in 2030.

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[15] ELECTRON: Large electricity consumer in Croatia, the name of the company has been modified.
[16] NEUTRON: Large electricity consumer in Spain, the name of the company has been modified.
[17] PROTON: Large electricity consumer in the UK, the name of the company has been modified.
[18] Europe Economics 2006. a report by Europe Economics and Fraunhofer ISI with BSR Sustainability and The Krakow Institute for Sustainable Energy. Page 99 - 128

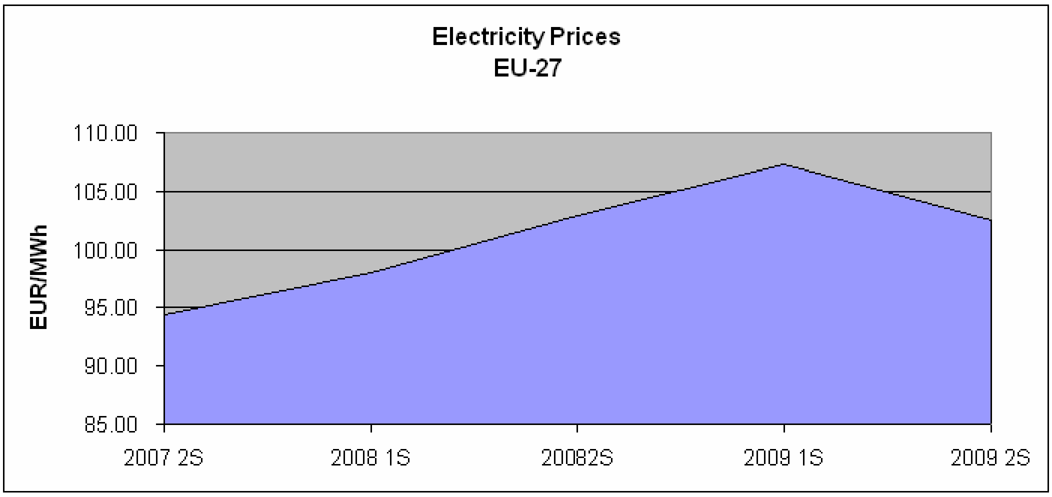
Electricity prices

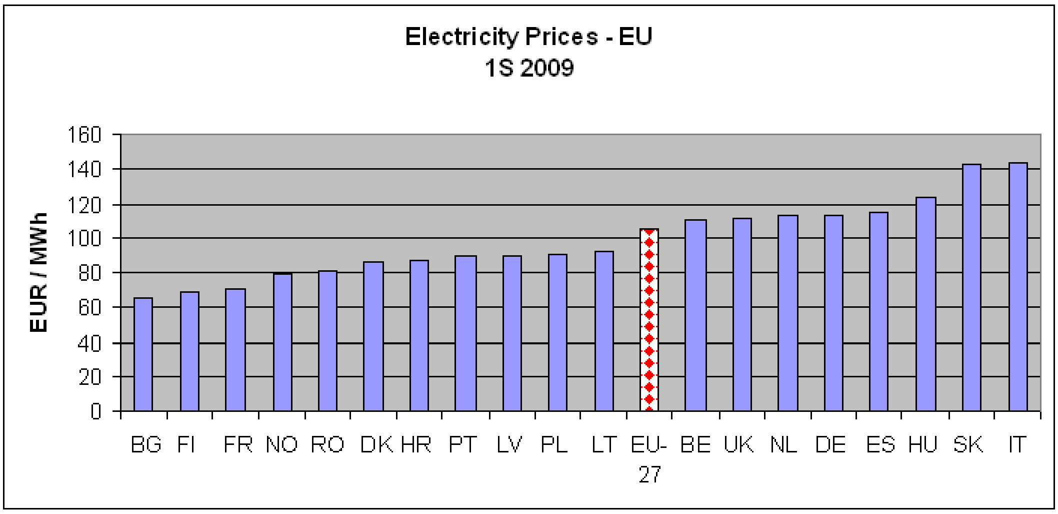
Prices paid by consumers for electricity in Europe depend on a number of factors, and these prices are market driven. The final electricity price paid by consumers in Europe usually consists of the following: the price paid by electricity in the market, a charge for transmission, distribution and taxes. In some European countries there are also special tariffs to promote renewable energy sources or special taxes to prevent CO_2 emissions. The electricity price decreased in the second semester of 2009, due to the economic slow down; this was a change in the price tendency but for 2010, the price is expected to rise again as the economy recovers. See **Figure 30** for a representation of the development in the average electricity price (generation + transmission + distribution + taxes) paid in the European Union.

Electricity generation

Total gross electricity generation in the EU was 3.4 million Gigawatt hours (GWh) in 2006, of which close to 30% came from nuclear power plants. Natural gas and coal-fired power stations each accounted for around one-fifth of the total. Lignite-fired and oil-fired power stations accounted for 10% and 4%, respectively.

Figure 30 *EU electricity prices*

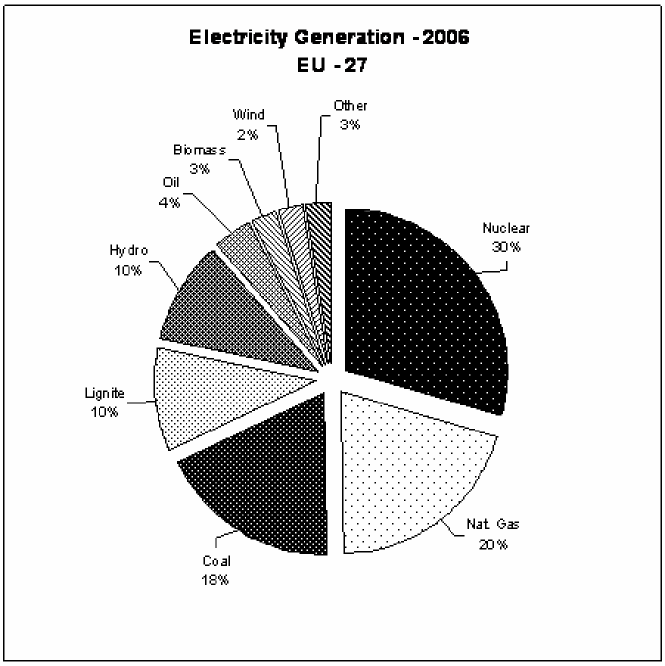




(Source Eurostat 2009) page 5 -7

Renewable energy sources (RES), had the largest share, hydropower, providing 10% of the total, followed by biomass-fired power and wind power, which each generated between 2% and 3% of the total. EU-27 Electricity Generation *(refer to **Figure 31**).* Electricity generation in the EU grew, on average, by 1.7 % per year between 1996 and 2006.

Figure 31 *EU-27 Electricity generation*



(Source: Eurostat 2006)

Market share

Germany and France were the principal electricity generators in the EU, with shares of 19% and 17%, respectively, while the UK was the only other country to report a share above 10%. Given the increasing risks related to the security of energy supplies and climate change, the European Commission[19] has committed to take action in these areas.

The European Commission (EC) has addressed five points that chart the policy priorities from which to secure energy; they are the following:

- Infrastructure needs and the diversification of energy supplies.
- External energy relations.
- Oil and gas stocks and crisis responses mechanisms.
- Energy efficiency.
- Making the best use of the EU's indigenous energy resources.

[19] Consultation of the future "EU 2020" strategy.

Renewable energy sources

Electricity generated from all renewable energy sources combined contributed 14.5% of the EU's gross national electricity consumption in 2006, although several Member States had much higher ratios reflecting a greater relative importance of renewables. In particular, large proportions of electricity from hydropower and, in some cases, from biomass were generated in Austria (56.6%), Sweden (48.2%) and Latvia (37.7%). In contrast, the relatively high share of renewable energy in Denmark (25.9%) was due mainly to wind power and, to a lesser extent, to biomass (Maza et al., 2009).

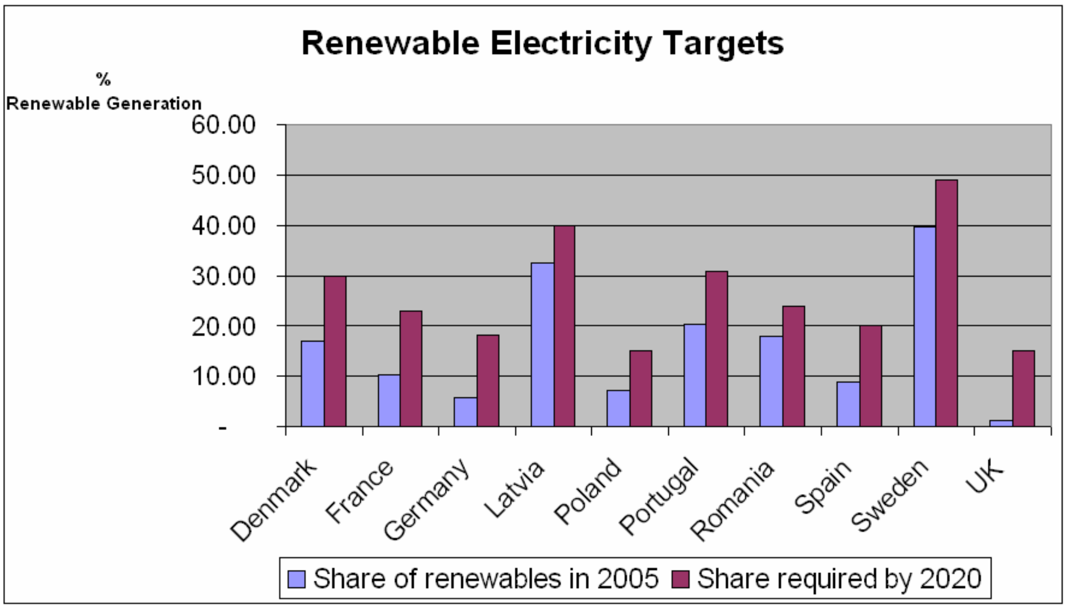
EU CO_2 emissions will increase by about 5% by 2030 and global emissions will rise by 55%. The new energy and climate change policies will affect the way the energy is being generated, transmitted and consumed in order to achieve the target to reach 20% of renewable energy by 2020.[20]

The EU countries are currently the global leaders in the development and application of renewable energy. Promoting the use of renewable energy sources is important, both to the reduction of the EU's dependence on foreign energy imports and in meeting targets to combat global warming.

In 2005, renewable energy accounted for 6.7% of total primary energy consumption in the EU-27, compared to a share of 4.4% in 1990.[21] Also, the share of renewable energy in final consumption has also increased from 6.3% in 1991 to 8.6% in 2005. Renewable energy sources are increasing in Europe and the tendency is that they will become more common in the coming years *(refer to **Figure 32**)*.

[20] EEA Report No 6/2008. pages 19 - 25
[21] Energy and Environment Report 2008.

Figure 32 *EU renewable electricity targets*



(Source: European Environment Agency 2008)

5.3 Croatia case study

Croatia is located in the Southeastern part of Europe, bordering the Adriatic Sea (a 5,835 km coastline), between Bosnia and Herzegovina and Slovenia. The resources of the country are petroleum, some coal, bauxite, low-grade iron ore, calcium, natural asphalt, silica, mica, salt, clays and hydropower. A map of the current Croatian territory is shown in **Figure 33**.

Figure 33 *Map of Croatia*

(Source: worldtravels)

5.3.1 Economic overview

In Croatia, the state retains a large role in the economy because privatization efforts are progressing at a relatively slow rate. The EU accession process should accelerate fiscal and structural reform. While long-term growth prospects for the economy remain strong, Croatia's high foreign debt, weak export sector, strained state budget and reliance on tourism revenue will result in a low economic development over the medium-term.

In 2008, Croatia produced 17,580 bbl of oil/day and consumed 105,000 bbl of oil/day. Crude oil is produced on 36 oil fields and gas condensate from ten gas and condensate fields, capacities for the processing of crude oil at the refineries in Rijeka, Sisak and Zagreb amount 4.9 million tons annually; petroleum products are sold at 774 petrol stations.

Regarding natural gas, Croatia produced 2.847 billion m3 and consumed 3.205 billion m3. Natural gas is produced at 20 natural gas fields, transported via 1,657 km of high pressure gas pipelines and stored at an underground facility called Okoli with a capacity of 620 million m3.[22]

The extraction of crude oil and natural gas, production of petroleum products and electricity, natural gas, steam and hot water supply (including production, transmission and distribution activities) accounted, in total, for 16.1% of industrial gross domestic production for 2007. In terms of employment figures, these activities accounted for 10% of the Croatian industrial workforce. HEP[23] is the biggest company in the electricity sector.

[22] Index Mundi details information about the macroeconomic activity in Croatia.
[23] HEP: Hrvatska Elektroprivreda has made several changes to react to the electricity market liberalization in Croatia.

5.3.2 Power system

Croatia has four major hydroelectric plants in two main areas of the country – the region near the Slovenian-Hungarian border and the area along the Adriatic coastline. The Varazdin hydro plant is located near the Slovenian-Hungarian border and the three hydro plants along the Adriatic coastline are Senj, Obrova and Zakucac – all owned and operated by the national electricity company, Hrvatska Elektroprivreda (HEP).

The 486 megawatt (MWe) Zakucac hydroelectric plant is the largest power plant in Croatia. A tender has been announced for the new 68.5 MWe Ombla hydroelectric plant proposed for a site on the Rijeka Dubrovacka River. Two additional hydropower plants have also been proposed, the 106 MWe Virje plant and the 42 MWe Lesce plant.

The Croatian electric power transmission system is owned and operated by HEP. The electricity distribution grid has three different voltages; there are 903 kilometers of 400-kV lines, 1,224 kilometers of 220-kV lines and 4,760 kilometers of 110-kv lines. There are also five 400 kilovolt (kV) substations, fifteen 220/110-kV substations and 140 110-kV substations.[24]

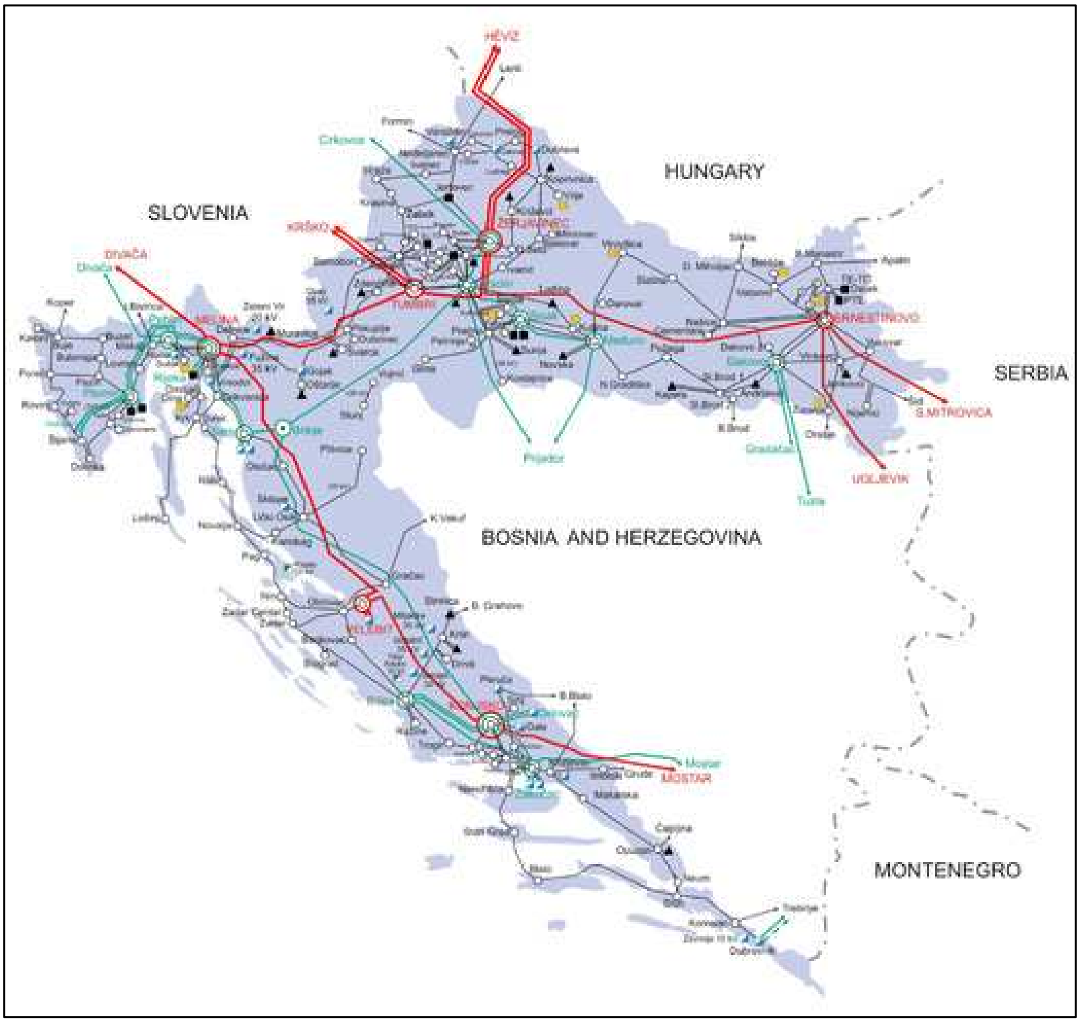
The Croatian power system is comprised of plants and facilities for electricity production, transmission and distribution in the territory of the Republic of Croatia. By size, the Croatian power system is one of Europe's smallest power systems. Due to its geographical position and location of generating plants, electricity is transported for most of the year from the south to the north, and vice versa, and from the north toward the east.

By putting the newly constructed 400/220/110 kV Žerjavinec substation into operation, and the reconstructed 400/110 kV Ernestinovo substation, transmission capacity, security and reliability of the power system have significantly increased, especially in the country's Northwestern and Eastern areas.

[24] Global Energy Network Institute, GENI: An Energy Overview of Croatia pp.12-23

The Croatian power system is a controlled area run by HEP OPS. Together with the Slovenian power system and the power system of Bosnia and Herzegovina, it constitutes the control block SLO-HR-BIH within the UCTE grid.[25] The map of the Croatian Power System is shown in **Figure 34.**

Figure 34 *Croatian power system*



(Source: HEP)

[25] See also HERA webpage: www.hera.hr. Croatia's power system is under development to accommodate the interconnection required to exchange and trade electricity in the region.

Generation capacity

In 2008 Croatia produced 11,419 GWh of primary energy and the total consumption amounted to 17,996 GWh. The produced electricity can be divided into the following: 5,277 GWH from hydro power plants, 6,075 GWh from thermal power plants and 67 GWh from industrial and wind power plants.[26]

The majority owner of generation capacities in Croatia is Hrvatska Elektroprivreda d.d (HEP), a daughter company of HEP-Proizvodnja (Generation), which carries out the activity of electricity and heat energy production. HEP presently generates around 95% of Croatia's electricity; the remaining 5% of electricity generation comes from industrial power plants and privately-owned plants.

Industrial power plants generate electricity, heat, mechanical energy for their own use in industrial processes, while the electricity surplus can be sold to the transmission or distribution grid. These power plants are not a part of HEP but they have purchase agreements and can feed the power they produce into the power system.

Most of the power generated in Croatia in 2008 came from thermal (53%) and hydro (46%) power plants. The rest was generated by other sources and renewable energy technology that has recently been growing in the country *(refer to **Figure 35**)*.

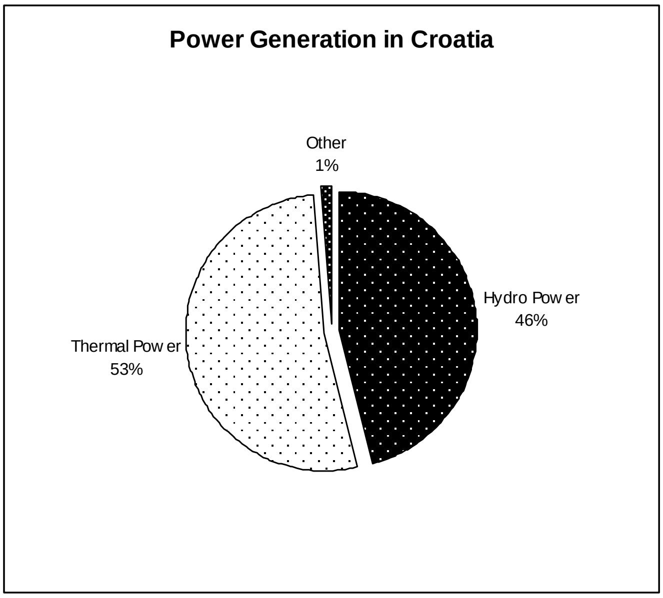
The total installed capacity of generating plants built in the territory of Croatia is 3,745 MW, of which 2,079 MW is from hydro power plants and 1,666 MW is from thermal power plants. Hydro power plants are the storage type and located in the Croatian coast area; the run-of river plants are located mainly in the northwestern area of Croatia. Thermal power plants run on liquid fuel (fuel oil, extra light oil), while others use coal or natural gas.

Installed capacity of industrial power plants in the Republic of Croatia is 210 MW. Two wind farms are integrated into the Croatian electricity power system – Ravne on the island of Pag with 6 MW of nominal power and Trtar Krtolin near Šibenik of 11 MW with nominal power. Even though wind power is being promoted and has been increasing in Croatia, it is still a very small part of the total generation (0.23%).

[26] Energy Community Regulatory Board (ECRB) Section of the Energy Community Secretariat (ECS). Page 24 - 26

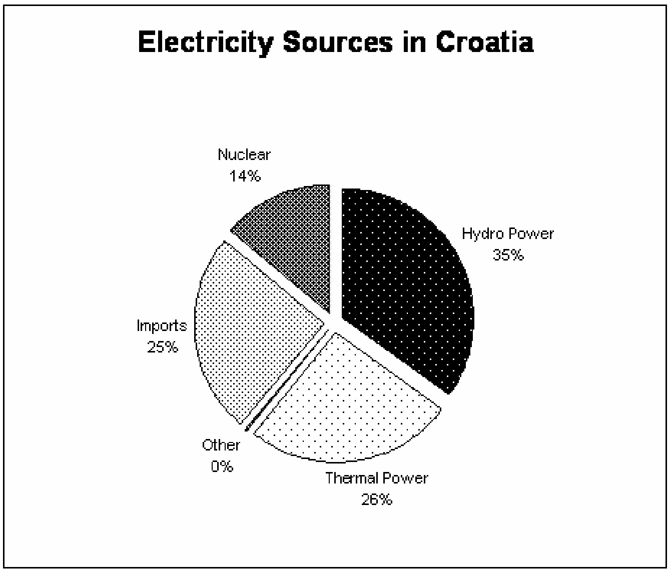
The electricity sources in Croatia in 2009 are represented in **Figure 36**. Thermal and Hydro power are the most common sources with more than 60% of the power sources. New technologies, such as wind and solar power are still in development in the country and represent less than 1% of the energy sources.

Figure 35 *Electricity production in Croatia – 2008*



(Source: HEP 2008 pp 10 - 18)

Figure 36 *Electricity supply by type of sources in Croatia – 2009*



(Source: HEP Opskrba 2009)

Electricity network

All grid users have the right to access the transmission grid based on the principle of regulated access of third parties (Law on Electricity Market) and in accordance with the Electricity Market Act[27] – general conditions for electricity supply, grid code of the electricity system, as well as with UCTE Operational Handbook. Electricity generators and buyers are obliged to obtain consent of the transmission grid operator for access to the grid. A transmission system operator may deny access to the grid in the event of limited technical or operating capabilities of the grid.

The Croatian transmission grid consists of lines on three different voltage levels, namely 400, 220 and 110 kV. The total length of high-voltage lines is 7259 km. The transmission network is connected with the neighboring electric power systems of Bosnia and Herzegovina, Serbia, Slovenia, and Hungary. The total km of high voltage lines and substations in the Croatian power system are displayed in **Table 13.**

Table 13 *Substations and power lines in Croatia*

Substations			Lines (km)	
Voltage level	**Number**	**MVA**	**Voltage**	**Total**
400/x kv	5	4,100	400 kv	1,159
220/x kv	6	2,120	220 kv	1,144
110/x kv	110	4,944	110 kv	4,747
			Medium Voltage	209
TOTAL	**121**	**11,164**	**TOTAL**	**7,259**

(Source: HEP 2008)

HEP Operator Distribucijskog Sustava or HEP-ODS (a Hrvatska Elektroprivreda subsidiary) remains the largest distributor to both industry and households. Its distribution grid is 129,618 km long, with 26,471 transformers installed, totaling 14,106 MVA of power.

[27] Article 3, paragraph 2 of the Electricity Market Act (official Gazette 177/04) and Decision of the Croatia Energy Regulatory Agency concerning approval of Electricity Market Rules, Class: 310-02/06 – 01/71, File No.: 371-01-06-96 dated December 2006, the Croatia Energy Market Operator adopted on 9 December 2006

In order to have a better interconnection between the Croatian electricity system and neighboring countries and to increase electricity trading possibilities, a double-circuit line towards Hungary will be built by 2010, 2x400 kV; documentation is also being prepared for the construction of a submarine cable towards Italy, Konjsko-Villanova (HEP).

Electricity players

Croatian energy functions, such as generation, transmission, distribution and retail supply are integrated within an individual electric utility. These activities are still carried out by the state own utility, Hrvatska Elektroprivreda d.d (HEP).

A market participant in the Croatian electricity market is any producer, supplier, trader or eligible customer. Any participant must have a license for performing energy activity, issued by the Croatian Energy Regulatory Agency.

In Croatia, HROTE[28] is responsible for the organization of the electricity market and HEP-Operator prijenosnog sustava (HEP-TSO) is responsible for electricity transmission, maintenance, development and construction of transmission system and power system control; HEP-Operator Distribucijskog Sustava (HEP-DSO) is responsible for electricity distribution, maintenance, development and construction of distribution system.[29]

Producers

A producer is an energy entity with a license to produce electricity. Producers can sell the electricity to a trader, a supplier – HEP-TSO for system services, transmission network losses or system balancing and HEP-DSO for distribution network services or distribution network losses.

There are three types of producers in Croatia: 1) A producer within the system of the public service, 2) an eligible producer, and 3) an independent producer. Eligible producers can obtain the necessary status through production of electricity from

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[28] HROTE: Energy Market Operator

[29] POYRY-UNECE – Regional Analysis of Policy Reforms to promote Energy Efficiency and Renewable Energy Investments.

renewable and cogeneration. The Energy Act, the Electricity Market Act[30] and secondary legislation, such as electricity production and the purchase or sale of electricity produced from renewable sources and cogeneration.

In 2008, there were a total of nine licensed energy producers in Croatia. HEP Proizvodnja, Thermal power plant Plomin and INA-INDUSTRIJA NAFTE are the three oldest licensed producers in the country and have been in operation since 2003. The other six producers were licensed between 2007 and 2008 *(refer to **Table 14**).*

Table 14 *Electricity producers in Croatia – 2008*

Name of energy operator	Date of issuing the license	Duration of license (years)
HEP Proizvodnja d.o.o.	10/12/2003	15
Thermal power plant Plomin d.o.o.	11/12/2003	15
INA-INDUSTRIJA NAFTE d.d.	13/12/2003	15
Adria Wind Power d.o.o.	28/03/2007	5
Valalta d.o.o.	26/06/2007	5
EKO d.o.o.	05/12/2007	5
Wind power plant Trtar-Krtolin d.o.o.	07/01/2008	5
Hidro-Watt d.o.o.	10/01/2008	5
TUDIC ELEKCTRO CENTAR d.o.o.	10/07/2008	5

(Source: HERA 2008, page 13)

Traders

A trader is an energy entity, which purchases and sells electricity after having obtained a license for trading. A trader can purchase electricity from a producer, supplier or another trader and is allowed to sell it to a supplier, another trader, HEP-TSO and HEP-DSO.

All electricity market participants willing to participate in the cross-border electricity exchanges must obtain an EIC[31] code, which is valid all across Europe.

[30] Electricity Market Act (official Gazette 177/04).
[31] EIC: Energy Identification Code

Suppliers

A supplier can purchase electricity from a producer, trader or another supplier. They can sell electricity to eligible customers in accordance with the customer's supply contracts, tariff customers in a regulated contract, a trader and another supplier. Every supplier has to off-take a minimal share of electricity produced from renewable energy sources. According to a list provided by the Croatian Energy Regulatory Agency (HERA), the companies with a license to carry out the electricity supply are: HEP-Opskrba d.o.o, KORLEA d.o.o, HEP-Operator distribucijskog sustava d.o.o and HEP-Toplinarstvo d.o.o.

In order for the Croatian market to become competitive, more suppliers are needed. Three out of the four available suppliers are part of the HEP group.

Prices of electricity

In 2010, for a standard Croatian industrial with a consumption of 3,500 MWh/year, the average price of electricity is € 93.8/MWh. However, the EU-25 average price (this price is weighted with 2004 national consumption) is € 145.2/MWh. For a consumption of 2,000 MWh/year, large electricity consumers pay € 60.7/MWh, while EU-25 average price is € 90/MWh.[32]

There are two groups of customers in Croatia – one is eligible and the second is tariff customers. A customer obtains the eligible customer status under the Electricity Market Act. An eligible customer can freely choose a supplier and negotiate the electricity price. Total electricity price for eligible customers consists of an electricity price contracted with a supplier, transmission network fee or distribution network fee and an incentive fee for electricity production from renewable energy sources. Even though companies can have eligible status, most of them decide to continue paying all of the included energy prices (tariff) – an average of € 60.7/MWh. Transmission and distribution charges represent 29% of the total energy price (HEP).

The promotion of renewable energy sources is a strategic objective of the EU's energy policy, as expressed in the EU energy legislation and a directive about the promotion of the electricity use from RES. The Directive requires Member States to establish a RES

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[32] Panorama of Energy EUROSTAT 2007.

incentive system. Each EU Member State sets its own national target for RES-produced electricity and Croatia, as a candidate country, did this in mid-2007.

5.3.3 Regulation

The electricity market in Croatia has been open since 1 July 2008, meaning that all customers have the legal right to choose their electricity supplier. The regulatory conditions are in place to promote market transactions but the state-owned supplier and the tariff structure is still in place, providing economic incentives to remain there.

A new CO_2 regulation has been in place in the electricity sector.[33] Currently, a CO_2 tax is being charged to the consumers; by 2011 Croatia will join the EU ETS program.

5.3.4 Industrial sector

Croatia's dominant industries are chemicals and plastics, machine tools, fabricated metal, electronics, pig iron and rolled steel products, aluminum, paper, wood products, construction materials, textiles, shipbuilding, petroleum and petroleum refining, food and beverages, as well as tourism.

The textile industry is particularly well-developed and includes over 400 enterprises – the majority of which are engaged in cooperative activities with foreign manufacturers.

Shipbuilding dominates the industrial sector with exports of over € 1 billion annually, accounting for over 10% of exported goods. The food processing and chemical industries constitute significant portions of industrial output and are responsible for a significant portion of exported goods. The industrial sector represents 27% of Croatia's total economic output, with agriculture representing 6%.

Tourism is a notable source of income, particularly during the summer months but also, more recently, in the winter months, due to an increase in popularity of winter snow sports, such as skiing. With over ten million foreign tourists annually, tourism is important because it generates revenues in excess of € 7 billion. Tourism is not an energy

[33] EC CROATIA 2008 PROGRESS REPORT describes the actions taken in Croatia to prepare for its entrance into the EU.

intensive industry but may strongly influence environmental regulations. To continue increasing the tourism trade, the country can try to reduce the intensity of the electricity generators and industrial consumers.

5.3.5 ELECTRON´s electricity profile

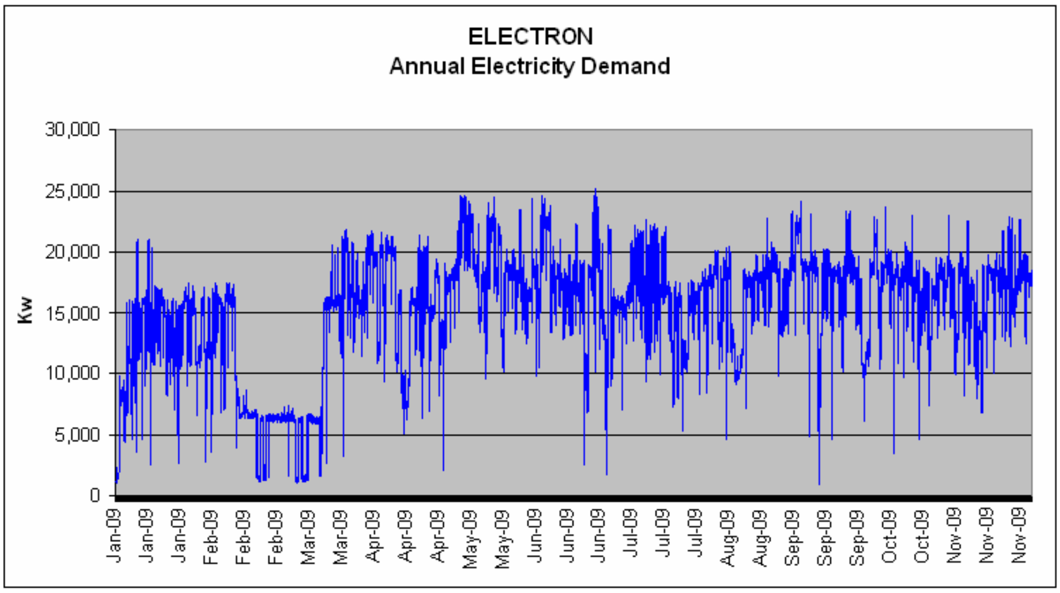
ELECTRON is the company selected for this case study – a firm that belongs to the chemicals sector. It has gained eligible status in the country, so it is allowed to freely choose its supplier and has the flexibility to manage the supply cost. The company's annual electricity consumption is 250 GWh. The current average electricity price is € 60.7/MWh (generation + transmission + distribution + VAT + RES fee); they are supplied by HEP Distribucija in a tariff-based contract. The current electricity tariff model used by ELECTRON is High Voltage – White HV from HEP Opskrba. The tariff items for billing are:

- RVT – electricity higher daytime tariff item.
- RNT – electricity lower daytime tariff item.
- SVT – power demand at time of higher tariff.
- OIE – renewable charge.
- Includes metering of electricity in two tariffs HT, LT.
- Power demand is metered in higher tariff – SVT Meters capable of storing load curve are fitted at metering point.

This tariff structure provides incentives to reduce the electricity cost by using large parts of the consumption during off peak time (22:00-06:00 hours). ELECTRON's maximum demand in the year is 25 MW by the month of June.[34] The average demand in the year is 15 MW. During February and March the company conducts major equipment maintenance. This is also linked to the seasonal product demand and is related to the weather conditions *(see **Figure 37**)*.

[34] Maximum electricity demand and annual consumption are considered to be base lines for electricity supply agreements.

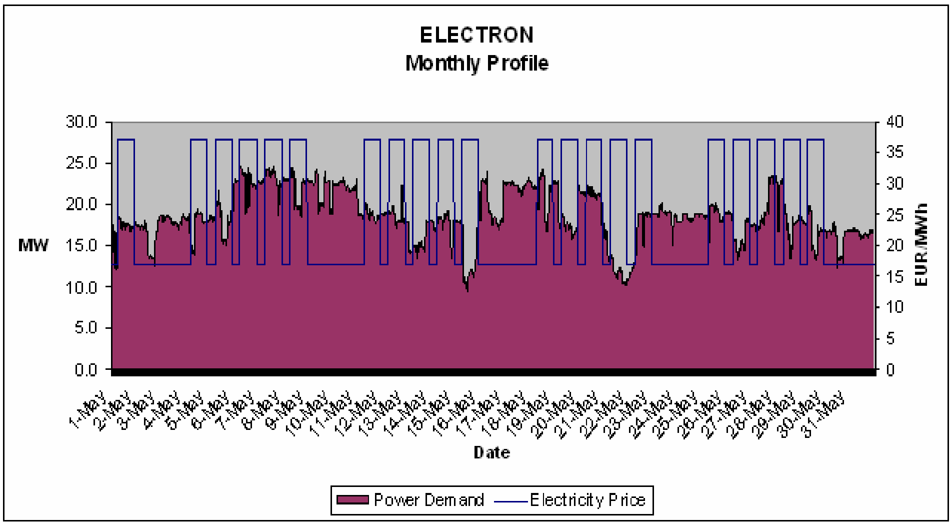
Figure 37   *ELECTRON annual electricity demand – 2009*



(Source: Modify from ELECTRON operational records)

The electricity prices offer an important incentive to implement the load management practice. ELECTRON needs to optimize its electricity demand *(see to **Figure 38**)*.

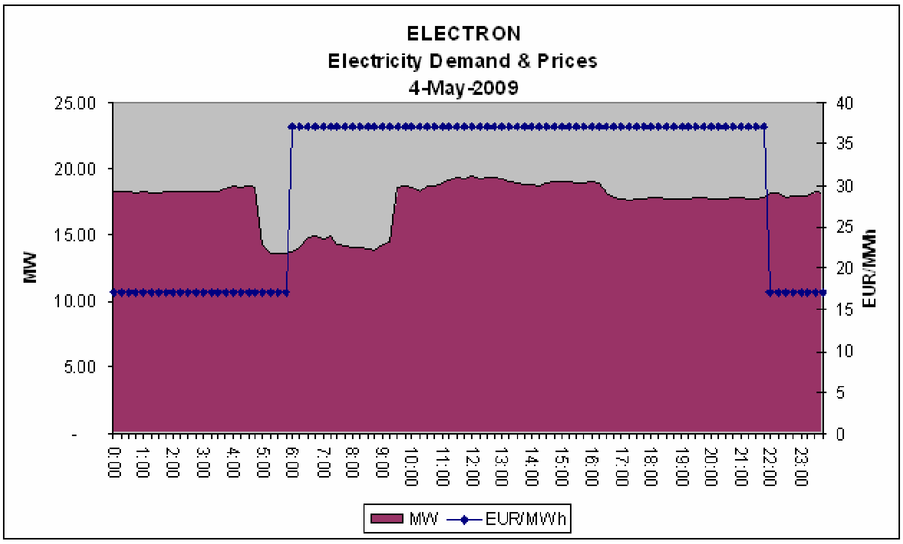
Figure 38   *ELECTRON electricity demand and prices – May 2009*



(Source: Modify from ELECTRON operational records)

The company is supplied by a peak tariff-based contract; peak hours are from 6:00-22:00 and off peak hours from 22:00-6:00. Currently, the company is not taking full advantage of the demand management practice as described in **Figure 39.**

Figure 39 *ELECTRON monthly electricity demand and prices – 4 May 2009*



(Source: Modify from ELECTRON operational records)

5.3.6 Electricity sourcing methodology

ELECTRON will test the proposed methodology and based on its outputs will get an opportunity to change their sourcing options and demand management practices. While testing the methodology, they will be asked to do the analysis of their current situation, anticipate market trends and highlight their priorities – doing everything with the aim to develop and finalize a strategy.

Step 1: Current conditions

To provide details about the current conditions available in the country and how ELECTRON is operating, an energy expert in the company filled out the questionnaire. The result of the survey is described in the following report:

Supply

1. Supply structure: The service can be bundled or unbundled, dependent mainly on consumer preferences. Because the government still subsidizes the price of electricity, the majority of large electricity consumers are still supplied through a cost-based tariff.
2. Price determination: In 2007, Croatia introduced the market-based pricing mechanism for consumers that had gained the eligible status. However, large electricity consumers still prefer to stay in the cost-based model mainly because of the uncertainty in the energy market and the high volatility of fuels and CO_2.
3. Type of market-based contract: The traditional contracts are currently available and real time pricing has not been introduced since the market has not yet been developed.

Self-generation

1. Reliability of Supply: The country has developed grid connections to improve the reliability of supply and the main connection to Italy is frequent congested. However, the country, in general, does not have the problem of maintaining a reliable supply.
2. Generation Technology: The electricity production in the country is fossil based; therefore, industrial generation-sites are based mainly on this technology. However, in the future the government may promote the development of renewable energy sources.
3. The Croatian government may provide limited incentives for RES usage (e.g., feed-in-tariff).
4. Grid connection is still limited in Croatia. New renewable energy projects will influence the need to provide free access to the grid.
5. The trading of electricity is not available in the country.

CO_2 management

1. CO_2 regulations: At the moment all large electricity consumers pay a CO_2 tax that has been calculated by the Croatian government. Croatia will join the European Emission Trading Scheme in 2011.

Demand

1. What types of measures are used to manage demand? Traditionally, energy efficiency actions have been the main approach to reducing consumption during peak hours, since tariff structure is still available. Load management activities, through operational capacity, are available in the power contract.

General Questionnaire

The questionnaire will provide information about the current market conditions and the current supply structure of the company.

Subject:	Score
Supply	
1. Freedom to select supplier (unbundled service)	✓
2. Continue as bundled service with tariff structure	✓
3. Move to unbundled service	✓
4. Free access to the electricity market	✗
5. Self-generation	✗
6. Cost-based	✓
7. Market-based	✓
8. Real time price (spot)	✗
9. Flexibility to fix prices in the forward market	✗
10. Flexibility to index the electricity price with a commodity	✗
11. Allowed to use the grid to interconnect self-generation unit	✗
12. Generation units are required to maintain production (back-up)	✗
13. Fossil fuel technology (ex., nat. gas, fuel oil, etc)	✓
14. Renewable (wind, solar, etc)	✗

15. Subsidies to promote the investment in RES ✗
16. Incentives to sell electricity from RES ✓
17. On-site generation ✓
18. Self-generation and inject excess into the grid ✗
19. Allowed to sell excess electricity in the market ✗
20. CO_2 regulations in your country (fees on CO_2, allowances, etc) ✗

Demand

21. Energy efficiency actions ✓
22. Load management practice driven by electricity prices ✗
23. Load management practice through operational flexibility ✗
24. Interruptible contracts are available ✗

Step 2: Identifying trends

It is important to try and identify the main factors that influence market conditions in the electricity sector. These trends can be organized in several topics, including policy (regulatory), economical, social, technological and environmental (PESTE).

Policy

The number of market players in supply and generation are increasing and this will affect the cost of generation and the price of electricity. At the moment, industrial producers are not allowed to sell electricity but this option will become available as the market gets more competitive. At this time, the only option is to sell green electricity to the state electricity company.

Croatia has several sources of primary energy. About 49% of its primary energy supply is covered by domestic sources, although in the future it is very likely to be reduced to less than 25%. The remaining energy needs will be covered by imports. These conditions will affect the way electricity is being traded and will promote the market's evolution to provide more incentives regarding bilateral agreements. Croatia will continue to be a net importer of electricity and prices will be driven by market conditions in the region. A summary of the policy's future trends is presented in **Table 15.**

Table 15 *Energy policy trends in Croatia*

Policy	Energy policy and country regulations	Liberalization of the electricity market is in progress	☑	P1
		Unbundled service — supply and transmission can be negotiated separately	☑	P2
		Self generation will be allowed (back-up, partial generation, selling excess, etc)	☑	P3
		Access to the grid will be available to deliver electricity in different regions	☐	P4
		Allowed selling of electricity (self generated electricity to the market — new business opportunity)	☐	P5

(Source: Treviño, 2010)

Economic

Croatia is expected to join the EU in 2013. This will bring additional incentives to develop renewable energies.. Economical incentives from the EU will add additional generation capacity, especially from green energy.

As electricity sources start to develop, energy consumers will be able to purchase electricity from new generation-sites of cross border producers. It is unlikely that in the short-term new market conditions, like spot market and the forward market, will be available. A summary of the economic future trends is presented in **Table 16.**

Table 16 *Economic trends in Croatia*

Economic	Supply / Demand, RES/ Nuclear, Fossil fuel price	Fossil fuel prices will remain volatile and unpredictable	☑	Ec1
		Increasing number of support schemes for investment in renewable energy sources (RES)	☐	Ec2
		Increasing number of incentives for selling the electricity from renewable energy sources (RES)	☐	Ec3
		Increasing economic incentives for load management practices (load shedding and load shifting)	☑	Ec4
		Electricity purchasing through the market	☑	Ec5
		Electricity prices index to the spot market	☑	Ec6
		Electricity prices index to the forward market	☑	Ec7
		Electricity prices index to a commodity (exc., nat gas)	☐	Ec8
		Trend to build additional production capacity to improve load management practices	☐	Ec9
		The generation and transmission system have constraints and provide incentives for interruptible contracts	☐	Ec10

(Source: Treviño, 2010)

Social

The country has been generating green electricity mainly from their hydropower plants. This has positioned the country as being an excellent example of how to integrate and balance generation from different sources, both fossil and non fossil.

The environmental concern in the country is very strong, due to the interest in joining the EU, in addition to the strong influence that the tourism industry plays in the economy. The country's government will try to maintain all its natural resources and maintain a low level of environmental impact. A summary of the future social trends is presented in **Table 17.**

Table 17 *Social trends in Croatia*

Social	Consumer (large industrials) preferences	People are becoming more concerned about the environmental changes — positive attitude about recycling, willingness to pay a higher price for "green" electricity	☑	S1

(Source: Treviño, 2010)

Technological

The main factors that will support the use of renewable energy are the new policies and laws regarding CO_2 trading and emission reduction that will come into play after the country joins to the EU ETS in 2011. There will be more opportunities to implement new technologies related to CO_2-free electricity generation in Croatia. Further developments in hydropower and wind generation will also provide more incentives while considering the country's geographical and topographic conditions.

It is unlikely that other technologies – like CO_2 capture and storage – will be implemented in the short- or medium-term, since the technology is far from being available commercially and economic incentives for demonstration-sites are more likely to be located in Western Europe.

There are good opportunities to implement basic load management and energy efficiency practices. The current power agreements provide incentives that should be considered. A summary of the technological future trends in Croatia is presented in **Table 18.**

Table 18 *Technological trends in Croatia*

Technological	Electricity generation, Energy efficiency	Technology is available to generate electricity at a competitive cost	☑	T1
		Dominance of technologies to offset CO2 emissions (CO2 capture and storage is available)	☐	T2
		New renewable energy technologies (RES) will grow in the market (e.g., RE, nuclear, etc.)	☐	T3
		New automation technology will support energy efficiency and load management practices	☑	T4

(Source: Treviño, 2010)

Environmental

The environmental goal is to reduce the CO_2 emissions by at least 5% in the period from 2008 to 2012. After Croatia joins the EU in 2013, there will be new and more rigorous laws regarding $CO_{2.}$ A summary of environmental future trends is presented in **Table 19.**

Table 19 *Environmental trends in Croatia*

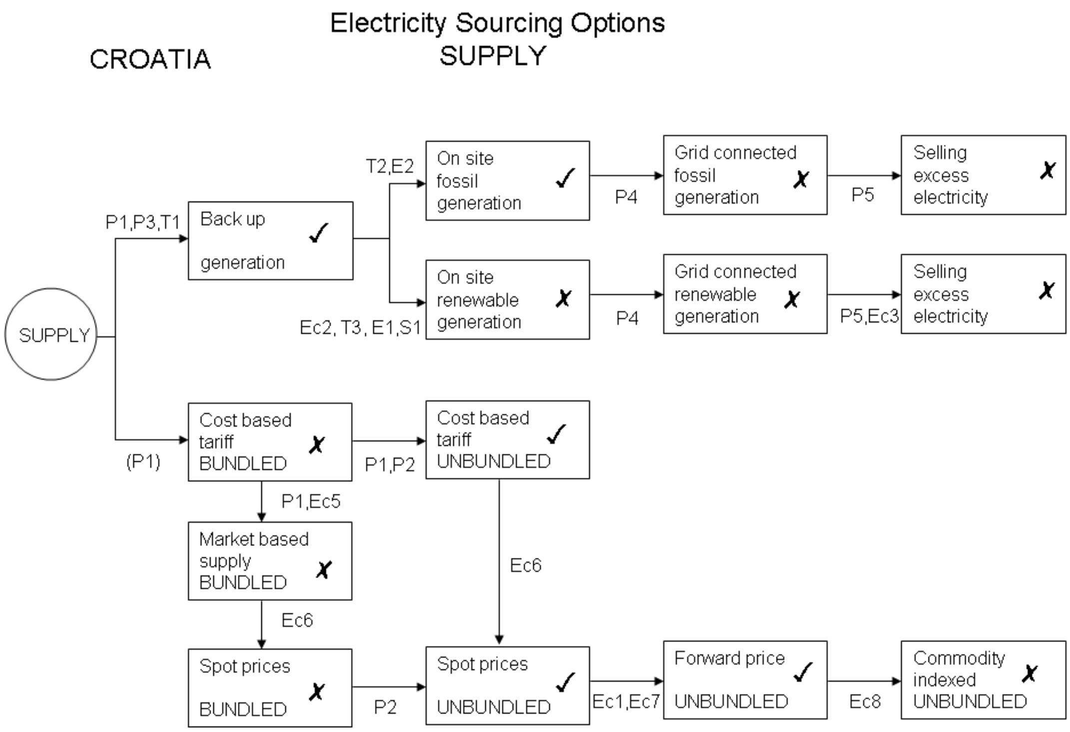
Environmental	Environmental issues	New regulations regarding pollution and the environment are expected to intensely affect the prices of CO2 and electricity	☑	E1
		New environmental regulations will not affect the price of CO2	☐	E2

(Source:, Treviño, 2010)

Step 3: Discovering new options

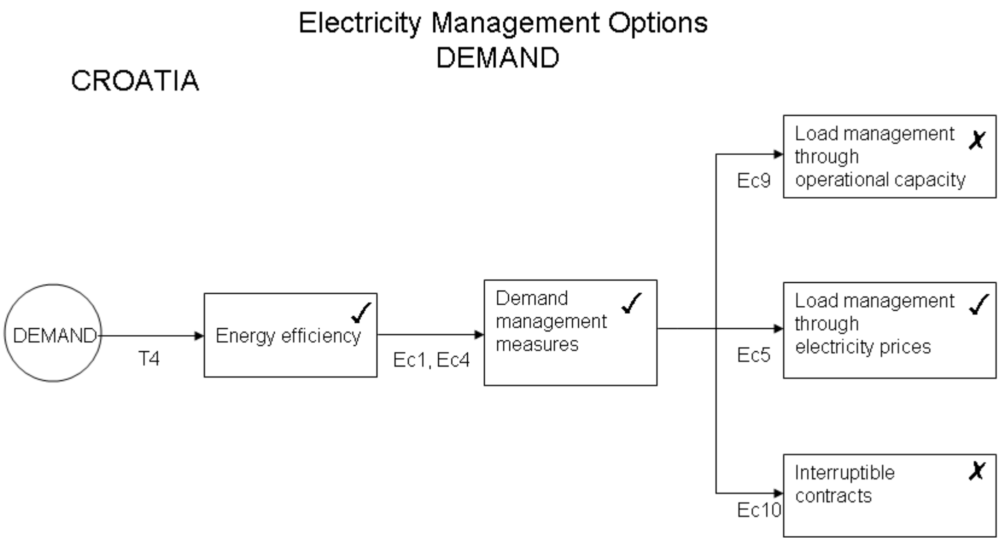
The methodology considers the integration of the current available options and the trends in the external environmental conditions. The following supply and demand diagrams show the new available options that will apply to the electricity market. The supply electricity options are described in **Figure 40** and the demand electricity options in **Figure 41**.

Figure 40 *Supply: Electricity sourcing options for ELECTRON*



(Source: Treviño, 2010)

Figure 41 *Demand: Electricity sourcing options for ELECTRON*



(Source: Treviño, 2010)

After the methodology is applied, and the country's future trends are evaluated, ELECTRON's current electricity supply and management options are shown *(see to **Table 20**)*.

Table 20 *Supply: Available options for ELECTRON*

SUPPLY
A.- BUY **Bundled Service** 1.- Electricity price is market-based **Unbundled Service** 1.- Real time price (spot) 2.- Flexibility to fix prices in the forward market
B.- MAKE **Generation of Electricity** 1.- On-site fossil generation, Back-up.

DEMAND
DEMAND RESPONSE 1.- Energy efficiency actions. 2.- Load management practice driven by electricity prices

(Source: Treviño, 2010)

Available options summary

Supply

The main available options relate to maintaining the current electricity contract, in the short-term, with the tariff structure. For the medium-term, ELECTRON will be able to integrate into the new energy market by participating in the spot and forward markets. This option will be driven mainly by the need to import additional electricity into the country and the lack of power generation from the local producers.

In the long-term, the options to generate electricity will be primarily driven by renewable electricity with the various options depending upon the location of the natural resource. This depends highly on the grid infrastructure connectivity.

Demand

An extended possibility to implement energy efficiency and load management practice will have a strong influence on ELECTRON from the demand side. Additional flexibility regarding operation capacity will bring value to the energy demand capacity, adjusting the production schedule to reduce the electricity cost and, at the same time, fulfill the production orders.

Load management via spot prices will not be possible at this stage, since there is no spot or day-ahead market. This possibility should remain available for future market condition changes.

Interruptible contracts will be available to incentive electricity users, reducing demand during some periods of the year. This automatically helps the grid system to better manage the generation-sites without having to develop additional infrastructure investments.

Step 4: Evaluation and selection

The ELECTRON business strategy will influence the way the company sources electricity. The company will have to define its strategy in nine different dimensions, related to the three main categories: Technology, Economics and Resources.

Technology

The current electricity sourcing strategy at ELECTRON is based on energy efficiency. Through the normal operation of the facility, management has tried to reduce the electricity demand during peak hours without success. Energy management and control systems can be installed and programmed to strategically shed loads to keep the peak demand within a specified range. A couple of main objectives have been defined at ELECTRON, which are to maintain supply reliability and keep the production schedule and product quality under control. Then, the operational flexibility should be maintained to provide more flexibility and productivity within its processes. The philosophy at ELECTRON is to have a sustainable development through the implementation of energy friendly initiatives, such as renewable energy projects, since the integration to the EU ETS will bring additional regulation in CO_2 emissions

Economic

The changes in the Croatian regulatory framework will not create a dynamic energy market in the short-term. Still, dependency on generating fossil fuel will continue to be dominant. The way to reduce volatility is for the national company to continue with the tariff structure. Increased revenues, due to the selling of electricity, are unlikely to happen in the medium-term because the number of projects and permits and incentives are limited at this stage.

Resources

The main concern for the company is the financial resources required to develop an initiative. At this moment, high capital investments are not being considered. Initiatives requiring the same number of employees, or even a reduction of employees due to productivity or efficiency, will have a positive effect on accepting any new sourcing option. The company will support the creation of new intellectual capital. ELECTRON has set their electricity sourcing priorities on a scale from 1 to 9, with 9 being the most important factor and 1 being the least important *(see **Table 21**).*

Table 21 *Prioritization of factors for ELECTRON*

CATEGORY	FACTORS	LEVEL OF IMPORTANCE	SCORE	DEFINITION OF THE CRITERIA
Technology	Operational reliability	9	1	The option has a **low** level of operational reliability
			2	The option has a **medium** level of operational reliability
			3	The option has a **high** level of operational reliability
	Technology development	4	1	The option is based on **old** technology
			2	The option is based on **traditional** technology
			3	The option is based on **new** technology developments
	Environmental impact	7	1	The option has a **high** environmental impact
			2	The suggested option has a **low** environmental impact
			3	The option has **no** environmental impacts
Economics	Net cost	5	1	The net cost of supply might be **higher** than the current net cost
			2	The net cost of supply might be **equal** than the current net cost
			3	The net cost of supply might be **lower** than the current net cost
	Volatility of prices	6	1	**High** volatility of prices. The option is related to the spot market prices or fossil fuels
			2	**Low** volatility of prices. The option is related to the forward market prices
			3	**Zero** volatility of prices. The option is not related to the market
	Revenues	2	1	The option provide z**ero** increase in the revenues
			2	The option provide **low** increase in the revenues
			3	The option provide **high** increase in the revenues
Resources	Human capital	3	1	**New** employees have to be hired to manage the new option
			2	**Same** level of employees is required to manage the new optio**n**
			3	**Fewer** employees required to manage the new option
	Financial	8	1	The option is **high** capital intensive and new investments are required
			2	The option is **low** capital intensive and no major investments are required
			3	The option is ze**ro** capital intensive and no investments are required
	Intellectual capital (know-how)	1	1	**Zero** new intellectual capital is generated
			2	**Low** new intellectual capital is generated
			3	**High** new intellectual capital is generated

(Source: Treviño, 2010)

The company evaluates the available options and selects the best strategy for managing supply and demand, with the help of the methodology tool. All available options are evaluated based on multi-decision criteria – a technique used to filter options and alternatives in order to obtain the opportunity potential on which the company can base its new supply strategy. ELECTRON management's priorities are set and the evaluation takes place. The evaluation integrates all the factors with the specific criteria that can go from a 1) low, 2) medium, or 3) high value as shown in **Table 22.**

Table 22 Scores related to each factor for ELECTRON

Croatia

CATEGORY	Technology			Economics			Resources		
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)
IMPORTANCE	9	4	7	5	6	2	3	8	1
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE		
SUPPLY									
TYPE OF SUPPLY									
BUY									
Bundled Service									
Bundled Service - Electricity price is **market** based	2	2	2	2	3	2	3	1	1
Unbundled Service									
Real time price (spot)	2	2	3	1	1	1	1	2	2
Flexibility to fix prices in the forward market	2	2	3	1	2	1	1	2	2
MAKE									
Generation of Electricity									
On site fossil generation, Back up.	2	2	2	1	3	1	2	2	2
DEMAND									
DEMAND RESPONSE									
Energy efficiency actions.	2	3	3	2	2	2	3	3	1
Load management practice driven by electricity prices	2	3	3	3	2	3	3	3	2

(Source: Treviño, 2010)

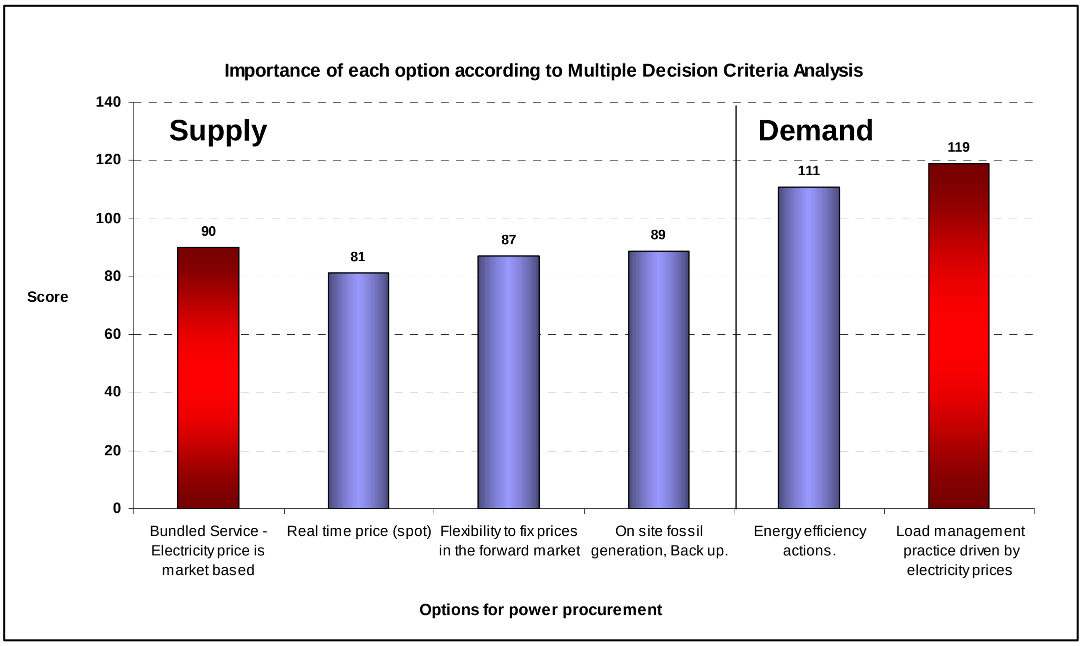
Based on the set criterion, the company's management evaluates every available option to decide on the one that better suits its needs. After scoring each option, management will automatically see a table including the final scores for each option, as well as the highest scoring options for supply and demand management, which will be highlighted. The final scores for each option are calculated by multiplying the score assigned by the company for their level of importance; the final score is the sum of all of the factors. **Figure 42** and **43** represents the final results with the highest scored options highlighted.

Figure 42 *Results by each available option ELECTRON*

CATEGORY	Technology			Economics			Resources			
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)	TOTAL
IMPORTANCE	9	4	7	5	6	2	3	8	1	
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE			
SUPPLY										
TYPE OF SUPPLY										
BUY										
Bundled Service										
Bundled Service - Electricity price is market based	18	8	14	10	18	4	9	8	1	**90**
Unbundled Service										
Real time price (spot)	18	8	21	5	6	2	3	16	2	81
Flexibility to fix prices in the forward market	18	8	21	5	12	2	3	16	2	87
MAKE										
Generation of Electricity										
On site fossil generation, Back up.	18	8	14	5	18	2	6	16	2	89
DEMAND										
DEMAND RESPONSE										
Energy efficiency actions.	18	12	21	10	12	4	9	24	1	111
Load management practice driven by electricity prices	18	12	21	15	12	6	9	24	2	**119**

(Source: Treviño, 2010)

Figure 43 *Graphic results by each available option ELECTRON*



(Source: Treviño, 2010)

Recommendation

After the evaluation of the available options with the considered factors, the highest rated supply option is to stay with bundled service; supply and transmission service are integrated and the best option for demand management is to implement load management practices in order to reduce peak demand during high electricity prices.

Supply

The company should continue with the tariff structure and the bundled service. The deregulation process is still in an early stage and the incentives to enter into the free market will be delayed for some time. Self-generation for back-up is not compulsory since the reliability of the network has proven to provide good service.

Demand

As for demand, the company should implement an energy efficiency program. This project should provide an important energy cost reduction with a low investment level. Also, the load management program has to be implemented through electricity prices. The current production capacity can be used to reschedule the production program during the night shift and still cover the need at a lower electricity cost. At this stage, the network operator does not provide significant incentives for interruptible contracts.

5.4 Spain case study

An EU Member State, Spain is located in southwestern Europe, on the Iberian Peninsula. Its mainland is bordered on the south and east by the Mediterranean Sea, except for a small land boundary with Gibraltar, to the north by France, Andorra and the Bay of Biscay and to the Northwest and West by the Atlantic Ocean and Portugal. See **Figure 44** for a map of the country.

The country is a democracy and is organized in the form of a parliamentary government under a constitutional monarchy. It is a developed country with the ninth or tenth largest economy in the world by nominal GDP. Spain also has a very high living standard of living (ranked 15th on the Human Development Index), including the 17th highest rating in the world on the quality of life index. The country is a member of the UN, NATO, OECD and WTO.

Figure 44 *Map of Spain*

(Source: worldtravels)

5.4.1 Economic overview

According to the World Bank, Spain's economy is the ninth largest worldwide and the fifth largest in Europe. However, after almost 15 years of above average GDP growth, the Spanish economy began to slow down in late 2007 and entered a recession in the second quarter of 2008. The economy is projected to resume a modest growth sometime in 2010, making Spain the last major economy to emerge from the global recession. The reversal in Spain's economic growth reflects a significant decline in the construction sector, an oversupply of housing, falling consumer spending and slumping exports.

In 2008, Spain produced 28,130 barrels of oil/day and consumed 1.562 million barrels of oil/day. The country is considered to be one of the biggest oil importers in the world (12th) with an import rate of 1.813 million barrels of oil/day and an export rate of approximately 280, 000 barrels of oil/day. In 2008 Spain produced 17 million m3 of natural gas, but consumed 38.18 billion m3, meaning that Spain has to import 38.59 billion m3 of natural gas, making it the world's seventh natural gas importer.[35]

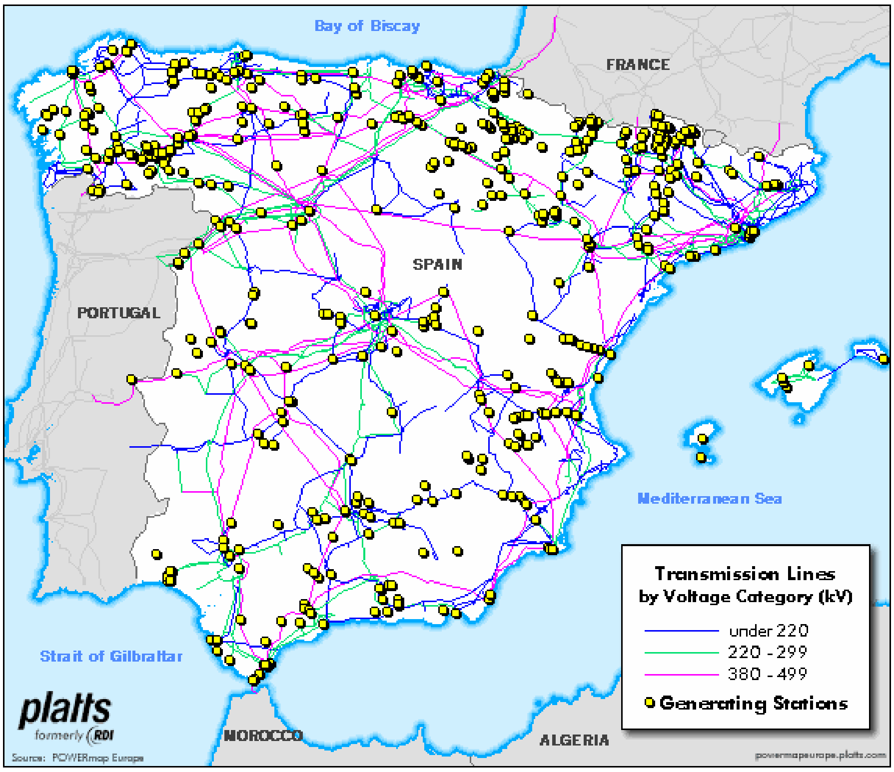
5.4.2 Power system

Spain has the fifth largest electricity market in Europe (behind Germany, France, the UK and Italy) and it is growing quickly. Electricity demand for 2001 was estimated to be 210.4 billion kilowatt-hours (bkwh), a 5% increase over 2000. Red Eléctrica[36] runs the power system in Spain. It ensures a safe, continuous power flow from the power generators to the centers of consumption. It is the manager of the transmission grid and, as such, acts as the sole transmission company.

[35] Index Mundi detail information about the macroeconomic activity in Spain.
[36] Red electrica also see: http://www.ree.es

Red Eléctrica[37] owns 99% of the high voltage transmission grid and is, therefore, the only company specialized in power transmission in Spain. The Spanish transmission grid is composed of more than 34,700 kilometers of high voltage electrical lines, more than 3,300 substations (Red Electrica, 2009) positions and has an excess of 62,000 MVA of transformation capacity. These assets make up a safe and reliable meshed grid that offers the highest service quality rates to the electrical system. The map of the electricity network in Spain is presented in **Figure 45.**

Figure 45 *Spanish power system*



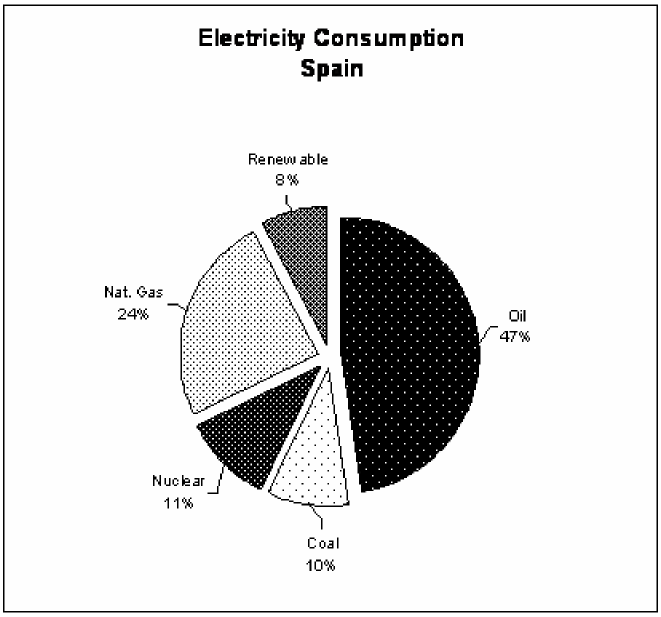
(Source: POWERmap Europe)

[37] Red electrica is the transmission system operator; it plans the development of the grid, manages the grid and guarantees access to the grid by all agents.

Generation capacity

Spain had an installed capacity of 85,937 MW and produced 24,836 GWh of energy in 2007. Spain produces electricity through various technologies using several sources. The main sources are nuclear, oil and gas[38]. Fossil fuel technology is the most common in Spain supported by the combined gas cycle technology that dominates the self-generation market. The energy consumed in Spain during 2008, by type of source is shown in **Figure 46.**

Figure 46 *Electricity consumption in Spain by type of source*



(Source: EC report 2008)

Electricity network

The following Spanish companies provide electricity distribution services in the Spanish market: Endesa, Iberdrola, Union Fenosa, HC Energia and Viesgo. **Table 23** describes the development of Spain's transmission grid (Crampes and Fabra 2004).

[38] SPAIN – Energy Mix Fact Sheet - EC report 2008

Table 23 *Development of the transmission grid in Spain*

Development of transmission grid						
Km de circuit	2004(1)	2005(1)	2006	2007	2008	2009
400 kV	16,548	16,808	17,004	17,134	17,686	17,977
220 kV and lower	11,461	16,288	16,498	16,535	16,636	16,777
Total	28,009	33,096	33,502	33,669	34,322	34,754

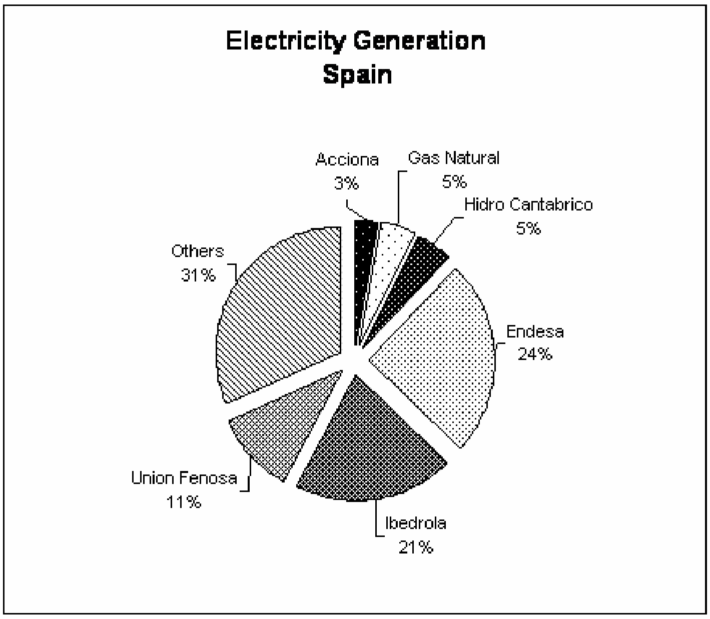
(Source: Red Eléctrica de España)

Electricity players

Producers

Electricity production in Spain is starting to develop into a competitive market, managed by OMEL[39]. The main electricity producers in Spain are presented in Figure 47.

Figure 47 *Electricity producers in Spain*



(Source: EESG - 2007)

[39] OMEL: Operador del Mercado Electrico IBERIA

Endesa and Ibedrola control more that 45% of the country's electricity generation capacity. Recently, new companies that had specialized in the renewable electricity business have acquired assets from fossil fuel capacity. This is the case of Acciona, a company whose management made an important acquisition in 2008 by integrating Endesa, the biggest player in their business.[40]

Suppliers

Since 2007, the electricity supply in Spain has been liberalized for large energy consumers. Since that time, new companies have started to supply electricity but the incumbents are still dominant in the market.[41] The list of the electricity suppliers in the Spanish market is included in **Table 24.**

Table 24 *Electricity suppliers in Spain*

Market Electricity Suppliers in Spain	
Aduriz Energía SLU	Céntrica Energía Generación, S.L.U.
Céntrica Energía S.L.U.	Cide Hcenergía, S.A.
Comercializadora Eléctrica de Cádiz, S.A.U.	Comercializadora Suministros Especiales Alginetenses, S.L.
Bassols Energía Comercial S.L.	Céntrica Energías Especiales S.L.U.
Comercializadora Lersa, S.L.	Comercializadora Suministros Especiales Alginetenses, S.L.
Compañía Escandinava de Electricidad de España, S.L.	Electra Caldense Energía, S.A.
Electra del Cardener Energía, S.A.	Electra Energía, S.A.U.
Electracomercial Centelles, S.L.U.	Eléctrica Serosense, S.L.
Eléctrica Sollerense, S.A.U.	Elektrizitäts-Gesellschaft Laufenburg España, S.L.
Endesa Energía, S.A.U.	Enerco Cuellar, S.L.
Eon Energía, S.L	Estabanell y Pahisa Mercator, S.A.
Factor Energía, S.A.	Gas Natural Servicios SDG, S.A.
Gesternova, S.A.	Hidrocantábrico Energía, S.A.U
Hidroeléctrica del Cantábrico, S.A.	Hidroeléctrica del Valira, S.L.
Iberdrola Generación, S.A.U.	Iberdrola S.A.
Naturgas Energía Comercializadora, S.A.U.	Nexus Energía, S.A.
Orus Energía, S.L.	Unión Fenosa Comecial, S.L.

(Source: CNE, 2010)

[40] Acciona annual report No 37, 2007.
[41] European Regulators' Group for Electricity and Gas Report 2007.

Consumers

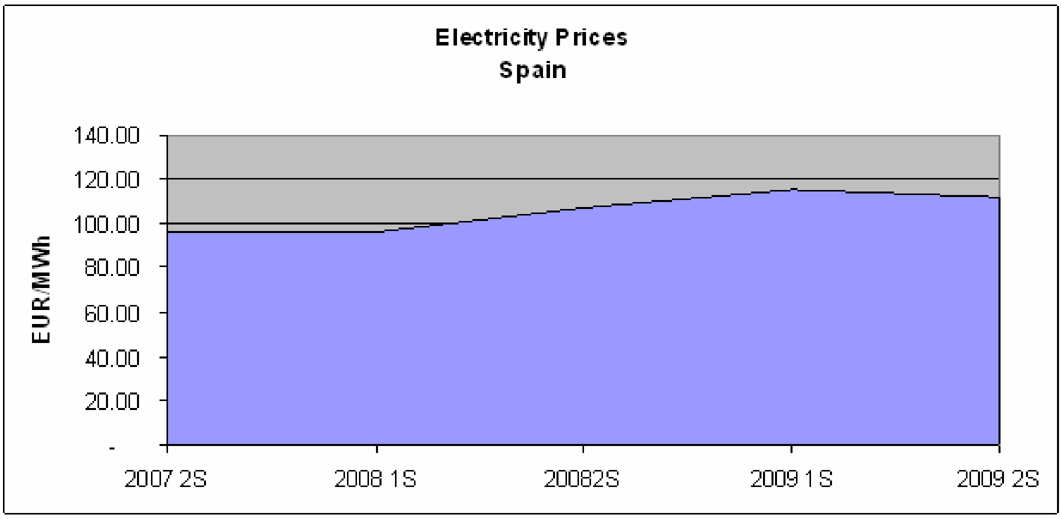
Some of the electricity intensive users have add all of their demand in load aggregation contracts to improve their presence in the market and create better negotiating conditions.[42]

New technologies have been applied to add load from different locations. Online metering and organized production schedules uses load aggregation techniques (Escrivá, Álvarez, Valencia, 2009).

Electricity prices

The economic crises has affected both the demand and prices of electricity. The average electricity price in Spain for a consumption of 2,000 MWh/year maximum is € 0.0882 per kWh and for a consumption of 24,000 MWh/year maximum is € 0.0761 per kWh. The evolution of the electricity prices in Spain from 2007 to 2009 is represented in **Figure 48.**

Figure 48 *Electricity prices in Spain*



(Source: Eurostat 2009)

[42] Commonwealth of Massachusetts – Office of Consumer Affairs and Business Regulation – Division of Energy Resources – *GUIDE TO MUNICIPAL ELECTRIC AGGREGATION IN MASSACHUSETTS.*

The components of the price paid for electricity in the Spanish market are the following: the daily and intra-daily electricity market price, adjustment services charges and capacity charges. In Spain, the number of customers buying electricity in the market is growing because the tariff structure is no longer available.

5.4.3 Regulation

Regulatory reforms have affected large electricity consumers: They are obliged to leave the cost-based tariff system to enter into a new market base model.[43] The large electricity consumers who have gained the status of privileged consumers can choose either, 1) a new tariff structure, based on "real time pricing," where prices vary hour by hour and an all-inclusive electricity price is paid through long-term arrangements (contracts), or 2) negotiate the price of energy, paying separate energy and delivery charges through new, shorter-term contract arrangements.

5.4.4 Industrial sector

Industry contributes about 35% of Spain's GDP but it is still somewhat dependent up to foreign investment. The most common sectors are automobile, steel, textiles, chemicals and marine. Industry in Spain is concentrated in the Northern part of the country, unlike the Southern region where tourism and agriculture are the main economical activity. The heavy industries (iron, steel and derivates) are concentrated in the north and the chemical industry is based in the country's Northeast region. On the country's coast side, there is heavy naval industry, located in Bilbao, El Ferrol and Cádiz. The oil related industry is located in Tarragona, Cádiz and Huelva. The automotive industry is one of the biggest in Spain; it is centered in the Andalucía community, an area that has seen the arrival of many multinational companies (Fernández, 2006).

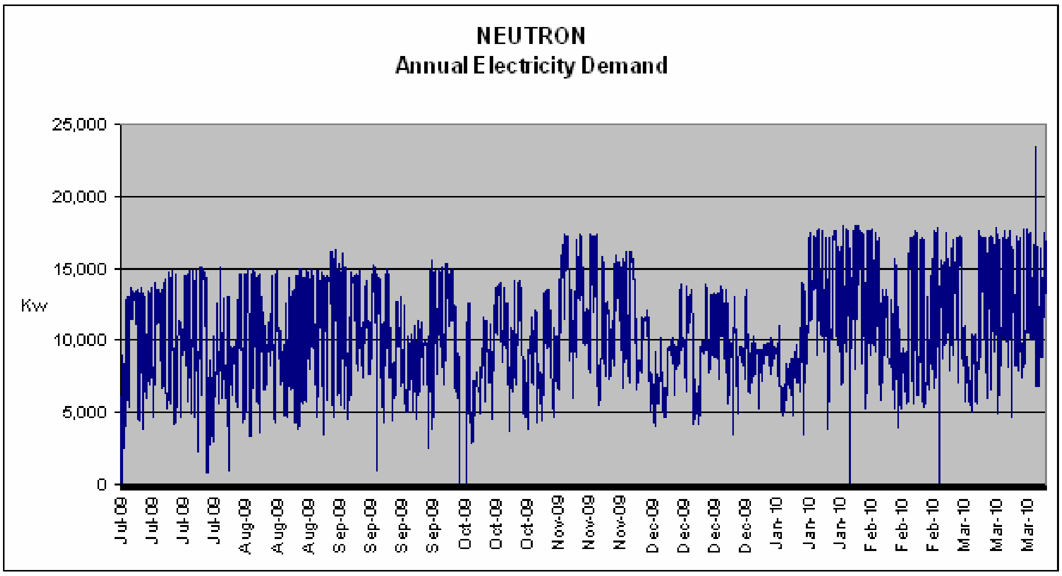
[43] Since 2007, large electricity consumers have to enter into the market base mechanism.

5.4.5 NEUTRON´s electricity profile

NEUTRON's annual production is almost 2.5 millions tons of synthetic steel and the yearly energy consumed is 230 GWh. The price of electricity is an average of € 88.2/MWh and Iberdrola is their supplier through a real time Spot contract.

The company is participating in several initiatives to improve energy efficiency. Load management is being implemented and is providing partially good results. The annual electricity demand of NEUTRON[44] is presented in **Figure 49** and the weekly electricity demand can be seen in **Figure 50.**

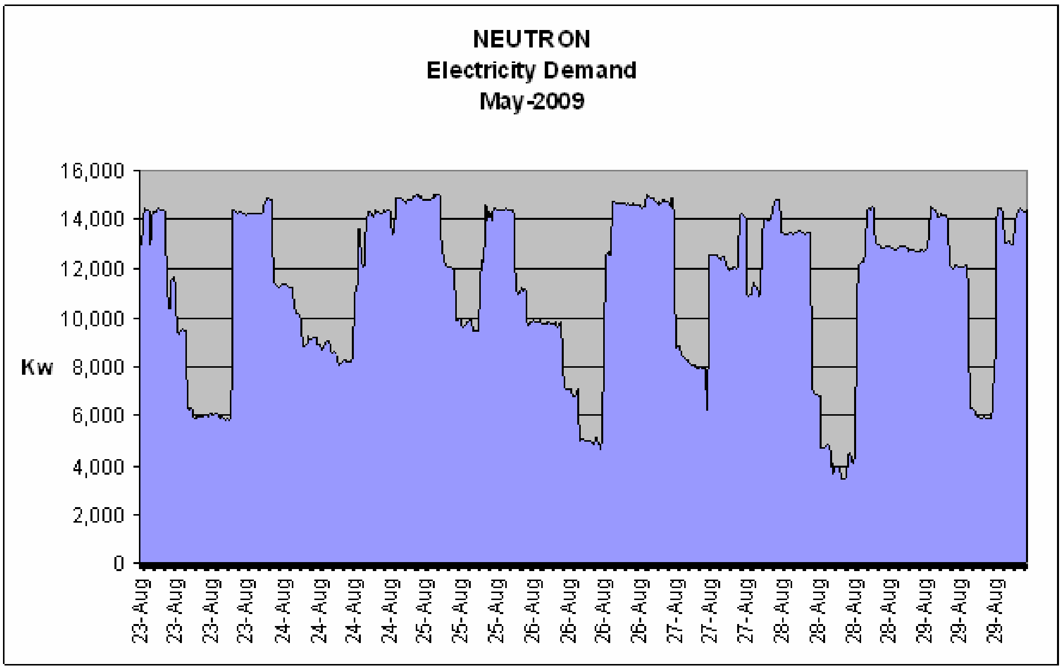
Figure 49 *NEUTRON annual electricity demand 2009 to 2010*



(Source: Modify from NEUTRON operational records)

[44] Maximum electricity demand and annual consumption are considered as a base line for electricity supply agreements.

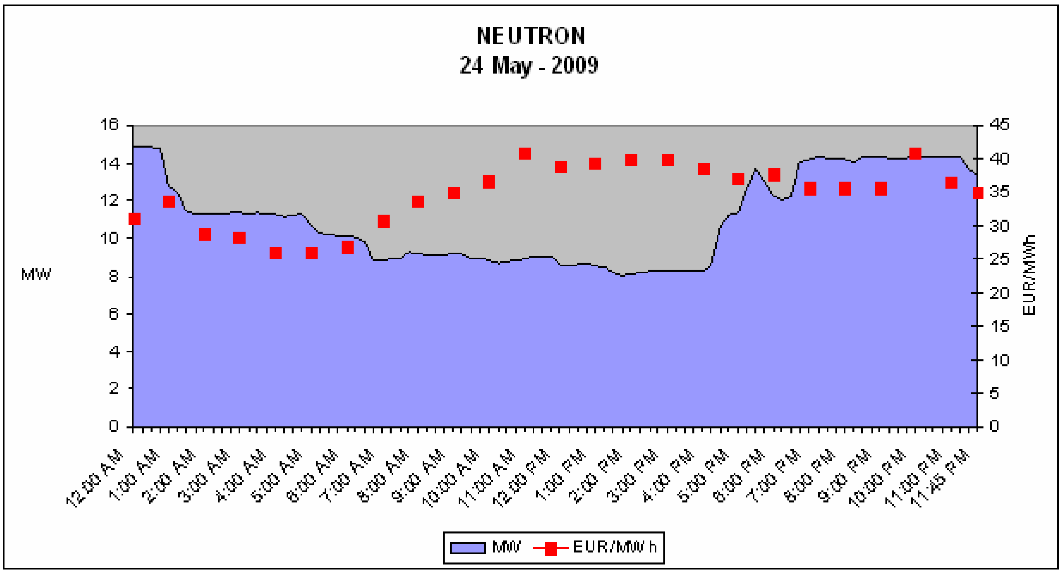
Figure 50 *NEUTRON weekly electricity demand 2008 to 200****9***



(Source: Modify from NEUTRON operational records)

The daily electricity demand shows the flexibility of the production process to react to electricity prices. In this case, the prices of electricity increase from 07:00 throughout the rest of the day and the operation reduces consumption by 6 MW. As can be seen in the figure below, there is the possibility of optimizing the production schedule to take better advantage of the electricity prices, especially during the night shift. Daily electricity demand and prices are presented in **Figure 51**.

Figure 51 *NEUTRON electricity demand and prices, 24 May 2009*



(Source: Modify from NEUTRON operational records)

5.4.6 Electricity sourcing methodology

NEUTRON has been in need of a recommendation about how to improve their electricity sourcing strategy and demand management practices. As described, Spain's electricity supply has recently changed from a tariff structure to a transitional market. New opportunities in the generation sector from renewable electricity could provide important value for the company.

Step 1: Current conditions

To provide details about the current conditions available in the country and how the company is operating, NEUTRON filled out the questionnaire included in the tool. The result of the survey is described in the following report:

Supply

1. Supply structure: Since 2007 to 2008, Spain no longer supports cost-based energy for energy intensive users. All large electricity consumers are obliged to leave the cost-based tariff. The wholesale market created on 1 January 1998 includes a series of transactions that are carried out by market agents in the daily and intraday market sessions. Self-generation of electricity is allowed; the deregulation process and the introduction of competition in the electricity sector provide incentives, particularly with renewable energy programs.
2. Price determination: cost-based tariffs are no longer supported in Spain.
3. Type of market-based contract: market base products with a tariff structure and spot prices are the most common sourcing options. The electricity forward market and the price indexed to a commodity will take some time to be developed.

Self-generation

1. Grid connections: access to the grid ruled by (TSO) Red Electrical España (REE).
2. Reliability of Supply: there is no special need to install back-up capacity to support the energy supply. The network is very well managed and incentives are provided to large electricity consumers to sign interruptible contracts.
3. What type of technology could be used for self-generation? Fossil fuel technology is clearly dominating the energy supply. Power generation is based on the combined gas cycle technology. However, the Spanish government is providing subsidies to RES technologies.
4. Renewable Energy Incentives: self-generated electricity, created from renewals, is being promoted by the Spanish government through the mechanisms of both the "feed-in-tariff" and "premium price system." Grid operators are obliged to buy the electricity generated from renewable sources.

5. Type of self-generation: the two options – onsite and grid connected generation – are available in Spain. However, connection to the grid can provide additional incentives to generators.
6. Trading of electricity: The day ahead market provide incentives to sell renewable electricity. Electricity can be exported to Portugal, Morocco or France.

CO_2 management

1. CO_2 regulations: Spain is part of European Trading Scheme (ETS). At the moment, all producers receive the allowances for free but starting in 2013, it will be compulsory to buy them..

Demand

1. Energy efficiency actions provide incentives to reduce the cost of electricity. Due to the current economical condition, providing additional production capacity that can be used to better manage the load and reduce the cost of electricity is important. The electric companies provide incentives to energy intensive users to reduce demand through interruptible contracts.

General questionnaire

This questionnaire will provide information about the current conditions in the market and the current supply structure of the company.

Subject:	Score
Supply	
1. Freedom to select supplier (unbundled service)	✓
2. Continue as bundled service with tariff structure	✗
3. Move to unbundled service	✓
4. Free access to the electricity market	✓
5. Self-generation	✓
6. Cost-based	✗
7. Market-based	✓
8. Real time price (spot)	✓

9. Flexibility to fix prices in the forward market ✗
10. Flexibility to index the electricity price with a commodity ✗
11. Allowed to use the grid to interconnect self-generation unit's ✓
12. Generation units are required to maintain production (back-up) ✗
13. Fossil fuel technology (ex. nat. gas, fuel oil, etc.) ✓
14. Renewable (wind, solar, etc.) ✓
15. Subsidies to promote the investment in RES ✗
16. Incentives to sell electricity from RES ✓
17. On-site generation ✓
18. Self-generation and inject excess into the grid ✓
19. Allow to sell excess electricity in the market ✓
20. CO_2 regulations in your country (fees on CO_2, allowances, etc.) ✓

Demand

21. Energy efficiency actions ✓
22. Load management practice driven by electricity prices ✗
23. Load management practice through operational flexibility ✓
24. Interruptible contracts are available ✓

Step 2: Identifying trends

It is important to identify the main factors that influence market conditions in the electricity sector. These trends can be organized into several topics: policy (regulatory), economical, social, technological and environmental (PESTE).

Policy

The liberalization of the electricity market has add a full range of options for Spanish suppliers and consumers. The possibility of choosing a supplier with integrated electricity generation assets has increased the possibilities to source the electricity supply.

The government is providing important incentives in the renewable electricity business. Feed-in-tariff programs have been established to promote investments in this sector. The country is very well located geographically, especially for the production of solar electricity and wind generation. A summary of the energy policy trends is presented in **Table 25.**

Table 25 *Energy policy trends Spain*

Policy	Energy policy and country regulations	Liberalization of the electricity market is in progress	☑	P1
		Unbundled service — supply and transmission can be negotiated separately	☑	P2
		Self generation will be allowed (back-up, partial generation, selling excess, etc)	☑	P3
		Access to the grid will be available to deliver electricity in different regions	☑	P4
		Allowed selling of electricity (self generated electricity to the market — new business opportunity)	☑	P5

(Source: Treviño, 2010)

Economic

Importantly, the slowdown of the economy will create additional available capacity. The influence of natural gas companies on the market is increasing and electricity prices are becoming more correlated to natural gas prices. Selling electricity will represent a new business opportunity for large electricity consumers.

The spot market is dominant but it is expected that the forward market and the commodity index contracts will play an important role in electricity market. A summary of the economic future trends is presented in **Table 26.**

Table 26 *Economic trends in Spain*

Economic	Supply / Demand, RES/ Nuclear, Fossil fuel price	Fossil fuel prices will remain volatile and unpredictable	☑	Ec1
		Increasing number of support schemes for investment in renewable energy sources (RES)	☐	Ec2
		Increasing number of incentives for selling the electricity from renewable energy sources (RES)	☑	Ec3
		Increasing economic incentives for load management practices (load shedding and load shifting)	☑	Ec4
		Electricity purchasing through the market	☑	Ec5
		Electricity prices index to the spot market	☑	Ec6
		Electricity prices index to the forward market	☑	Ec7
		Electricity prices index to a commodity (exc., nat gas)	☐	Ec8
		Trend to build additional production capacity to improve load management practices	☑	Ec9
		The generation and transmission system have constraints and provide incentives for interruptible contracts	☑	Ec10

(Source: Treviño, 2010)

Social

Consumers are more interested in renewables technologies and they are willing to pay more for green electricity. **Table 27** presents the social trends that are affecting the company.

Table 27 *Social trends in Spain*

Social	Consumer (large industrials) preferences	People are becoming more concerned about the environmental changes — positive attitude about recycling, willingness to pay a higher price for "green" electricity	☑	S1

(Source: Treviño, 2010)

Technological

Due to strong financial incentives, the installed capacity of renewable generation (wind and solar) is rapidly increasing. Spain is now one of the fastest growing renewable markets in the world. With a current share of 9%, the national target of 20% in 2020 seems well within reach.

The wind power market has developed impressively; and, the solar PV market has grown even faster with more than a 50% growth rate in the last couple of years. Also showing great promise is the development of new RES technologies, such as offshore tidal power, offshore wind farms, thermal solar, biomass, geothermal units and biogas.

Several research programs have been launched concerning CO_2 capture in plants but these technologies are still not available in the short-term. It is expected to become a more common practice in the future in an effort to reduce CO_2 emissions.

Energy efficiency and load management practices will play dominant roles to reduce the cost of electricity. New automation technology and monitoring systems – complemented with various economic incentives – will promote the use of interruptible contracts. A summary of the technological uncertainties that can affect the company is presented in **Table 28.**

Table 28 *Technological trends in Spain*

Technological	Electricity generation, Energy efficiency	Technology is available to generate electricity at a competitive cost	☑	T1
		Dominance of technologies to offset CO2 emissions (CO2 capture and storage is available)	☑	T2
		New renewable energy technologies (RES) will grow in the market (e.g., RE, nuclear, etc.)	☑	T3
		New automation technology will support energy efficiency and load management practices	☑	T4

(Source: Treviño, 2010)

Environmental

Starting in 2013, large electricity consumers will be obliged to buy CO_2 allowances on the market. This will increase the cost of generation dramatically. Future cost of CO_2 is expected to be € 30-40/ton CO_2. The summary of the environmental uncertainties and future trends that may affect the company is presented in **Table 29**.

Table 29 *Environmental trends in Spain*

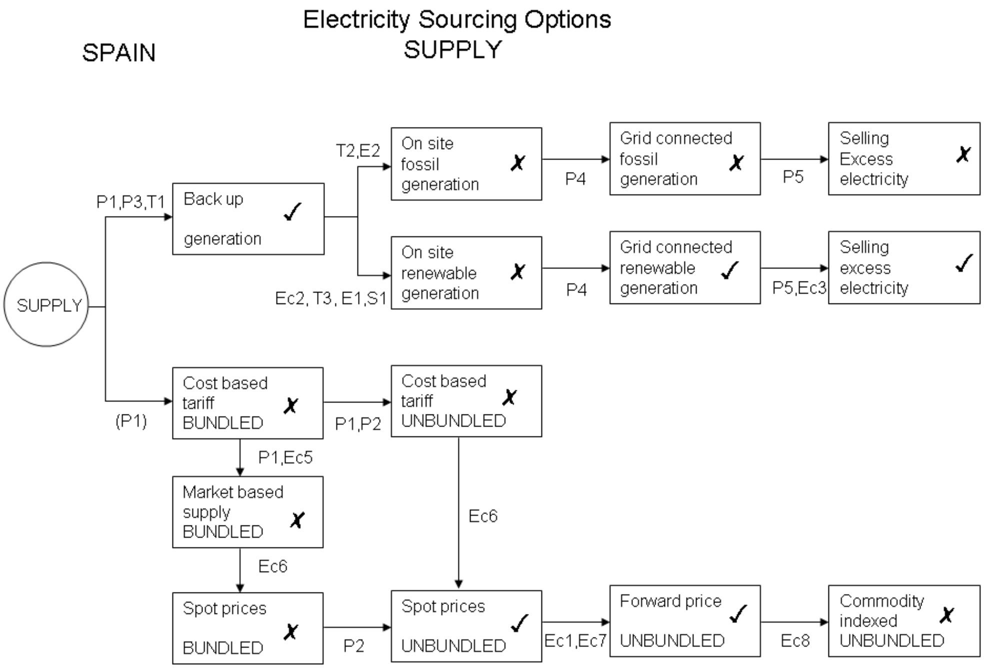
Environmental	Environmental issues	New regulations regarding pollution and the environment are expected to intensely affect the prices of CO2 and electricity	☑	E1
		New environmental regulations will not affect the price of CO2	☐	E2

(Source: Treviño, 2010)

Step 3: Discovering new options

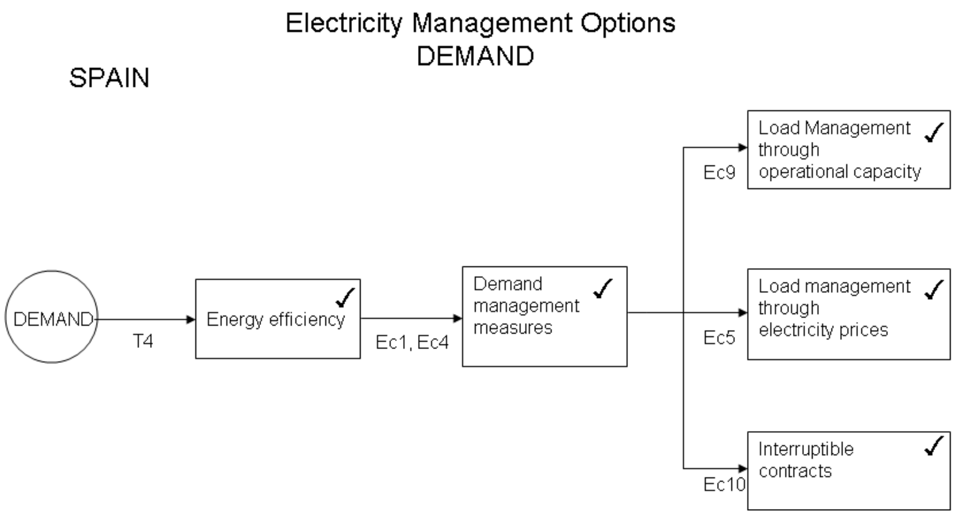
The methodology considers the integration of current available options with the trends in the external environmental conditions. The following supply and demand diagrams show the new available options that apply to the electricity market. The electricity supply options are described in **Figure 52** and the electricity demand options in **Figure 53**.

Figure 52 *Supply: Electricity sourcing options for NEUTRON*



(Source: Methodology electricity sourcing, Treviño)

Figure 53 *Demand: Electricity sourcing options for NEUTRON*



(Source: Treviño, 2010)

After the methodology is applied, and the country's future trends are evaluated, NEUTRON's current electricity supply and management options are seen in **Table 30**.

Table 30 *Available options for NEUTRON*

SUPPLY
A.- BUY **Bundled Service** 1.- Electricity price is market based. **Unbundled Service** 1.- Real time price (spot). 2.- Flexibility to fix prices in the forward market.
B.- MAKE **Generation of Electricity** 1.- Renewable energy complete supply (grid connected). 2.- Renewable energy and selling excess to the market. 3.- Renewable energy and selling excess with government incentives.

DEMAND
DEMAND RESPONSE 1.- Energy efficiency actions. 2.- Load management practice driven by electricity prices. 3.- Load management practice through operational flexibility. 4.- Interruptible contracts.

(Source: Treviño, 2010)

Available options summary

Supply

The main available options are related to accessing the electricity market with the possibility of participating in the spot and forward markets.

If the company can invest, the option to generate electricity will be mainly driven by the self-generation of renewable electricity with grid connection, since the natural resources are not necessarily located near the production site. This is highly dependant up to the grid infrastructure, connectivity and incentives provided by the government.

Demand

A prolonged possibility of implementing energy efficiency and load management practice will have a strong influence on the demand side. Additional flexibility from the operation capacity will bring value by adjusting the production schedule to reduce electricity cost, while at the same time fulfilling the production orders.

Interruptible contracts will be available to incentivize users to reduce demand during some periods of the year. This automatically helps with the grid system, better managing the generation sites without additional infrastructure investments.

Step 4: Evaluation and selection

NEUTRON's business strategy will influence the way the company sources electricity. The TER analysis includes the actions that the company is management is willing to take in executing the suggested sourcing option – a course of action that will require defining levels of priority.

Technology

The company has recently left the bundled service with tariff structure. At the moment, NEUTRON is being supplied with short-term contracts and any change in demand versus contracted load is being balanced out in the spot market. The company is planning to generate electricity to supply their own installations by using the grid. The Spanish government has promoted the use of renewables to generate electricity through a variety of incentives, encouraging the company to initiate its self-generation practices. However, it has been difficult for management to decide which type of renewables would be most reliable and cost effective.

Economic

Since the elimination of the tariff structure, the cost of electricity has increased. There is a high level of difficulty in terms of implementing a strategy that can help the company reduce the cost of electricity. The self-generation project can bring additional revenues when excess electricity is sold in the market.

Resources

Long-term agreements can provide a solution in the forward market without a major capital investment. This contract could be integrated with those of other large electricity consumers, providing additional flexibility. Productivity or efficiency initiatives, with the same number of employees or even a reduced number of employees, will have a positive impact on new sourcing options. The company will support the creation of new intellectual capital. **Table 31** represents how NEUTRON, with the aid of the tool, has set their electricity sourcing priorities. The scale is from 1 to 9, 9 being the most important factor for the company and 1 representing the least.

Table 31 *Prioritization of factors for NEUTRON*

CATEGORY	FACTORS	LEVEL OF IMPORTANCE	SCORE	DEFINITION OF THE CRITERIA
Technology	Operational reliability	6	1	The option has a **low** level of operational reliability
			2	The option has a **medium** level of operational reliability
			3	The option has a **high** level of operational reliability
	Technology development	2	1	The option is based on **old** technology
			2	The option is based on **traditional** technology
			3	The option is based on **new** technology developments
	Environmental impact	5	1	The option has a **high** environmental impact
			2	The suggested option has a **low** environmental impact
			3	The option has **not** an environmental impacts
Economics	Net cost	8	1	The net cost of supply might be **higher** than the current net cost
			2	The net cost of supply might be **equal** than the current net cost
			3	The net cost of supply might be **lower** than the current net cost
	Volatility of prices	7	1	**High** volatility of prices. The option is related to the spot market prices or fossil fuels.
			2	**Low** volatility of prices. The option is related to the forward market prices
			3	**Cero** volatility of prices. The option is not related to the market
	Revenues	4	1	The option provide **zero** increase in the revenues
			2	The option provide **low** increase in the revenues
			3	The option provide **high** increase in the revenues
Resources	Human capital	3	1	**New** employees have to be hired to manage the new option
			2	**Same** level of employees are required to manage the new option
			3	**Less** employees required to manage the new option
	Financial	9	1	The option is **high** capital intensive and new investments are required
			2	The option is **low** capital intensive and no major investments are required
			3	The option is **zero** capital intensive and no investments are required
	Intellectual capital (know-how)	1	1	**Zero** new intellectual capital is generated
			2	**Low** new intellectual capital is generated
			3	**High** new intellectual capital is generated

(Source: Treviño, 2010)

The company evaluates the available options and selects the best supply and demand management strategy with the help of the tool. All available options are evaluated based on multi-decision criterion.

The companies' priorities are set and the evaluation takes place. **Table 32** shows the scores assigned by NEUTRON to each of its available options. The evaluation integrates all of the factors with the specific criteria that can go from, 1) low, 2) medium, or 3) high value.

Table 32 *Scores related to each factor for NEUTRON*

Spain

CATEGORY	Technology			Economics			Resources		
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)
IMPORTANCE	6	2	5	8	7	4	3	9	1
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE		
SUPPLY									
TYPE OF SUPPLY									
BUY									
Bundled Service									
Bundled Service - Electricity price is market based	2	2	2	2	2	1	2	3	1
Unbundled Service									
Real time price (spot)	2	2	2	2	2	1	2	3	2
Flexibility to fix prices in the forward market	3	3	2	2	2	1	3	3	2
MAKE									
Generation of Electricity									
Renewable energy complete supply (grid connected)	2	2	2	1	3	1	1	1	1
Renewable energy and selling excess to the market	2	2	2	1	3	3	1	1	1
Renewable energy and selling excess with government incentives	2	2	2	2	3	3	1	1	1
DEMAND									
DEMAND RESPONSE									
Energy efficiency actions.	3	1	3	2	2	1	2	2	3
Load management practice driven by electricity prices	3	1	2	2	1	1	2	2	1
Load management practice through operational flexibility	3	1	3	3	2	3	2	1	2
Interruptible contracts.	2	1	3	3	3	3	2	3	2

(Source: Treviño, 2010)

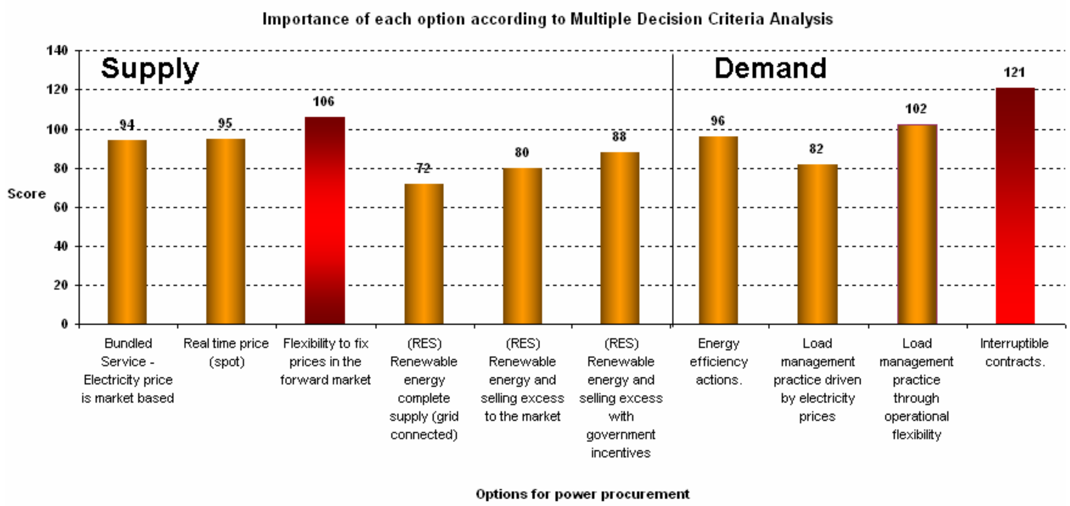
Based on the set criterion, the company evaluated every available option to decide on the one that better suits their needs. After scoring each option, NEUTRON will automatically see a table with the final scores for each of those options; the best supply and demand management options are highlighted. The final scores for each option are calculated by multiplying the company assigned score by the level of importance; the final score is the sum of all of the factors. **Figure 54** and **55** represents the results.

Figure 54 Results by each available option for NEUTRON

Spain										
CATEGORY	Technology			Economics			Resources			
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)	TOTAL
IMPORTANCE	6	2	5	8	7	4	3	9	1	
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE			
SUPPLY										
TYPE OF SUPPLY										
BUY										
Bundled Service										
Bundled Service - Electricity price is market based	12	4	10	16	14	4	6	27	1	94
Unbundled Service										
Real time price (spot)	12	4	10	16	14	4	6	27	2	95
Flexibility to fix prices in the forward market	18	6	10	16	14	4	9	27	2	**106**
MAKE										
Generation of Electricity										
Renewable energy complete supply (grid connected)	12	4	10	8	21	4	3	9	1	72
Renewable energy and selling excess to the market	12	4	10	8	21	12	3	9	1	80
Renewable energy and selling excess with government incentives	12	4	10	16	21	12	3	9	1	88
DEMAND										
DEMAND RESPONSE										
Energy efficiency actions.	18	2	15	16	14	4	6	18	3	96
Load management practice driven by electricity prices	18	2	10	16	7	4	6	18	1	82
Load management practice through operational flexibility	18	2	15	24	14	12	6	9	2	102
Interruptible contracts.	12	2	15	24	21	12	6	27	2	**121**

(Source: Treviño, 2010)

Figure 55 Graphical results by each available option for NEUTRON



(Source: Treviño, 2010)

Recommendation

Begin utilizing a contract with the flexibility to fix prices in the forward market. The option for demand management is to start using interruptible contracts with your supplier.

Supply

The company should implement a flexible contract with the possibility to fix prices in the forwards market. The new renewable energy regulations provide an incentive to invest in these technologies. Financial resources, however, may be a significant obstacle considering the economic slow down in the Spanish economy.

Demand

The company should continue to add interruptible contracts to get the financial benefit of the program. Load management practices can be used to reduce the cost of electricity. This can be the structure to earn revenues by selling unused electricity in the market. Additional investment in operational capacity is not under consideration at this moment. Additional production capacity is not required or may not pay back the investment required for electricity cost reductions.

5.5 The UK case study

The UK is located in the Northwestern coast of continental Europe. It is an island country, spanning an archipelago, which includes Great Britain, the Northeastern part of the island of Ireland and many small islands. Northern Ireland is the only part of the UK with a land border, sharing it with the Republic of Ireland. Apart from this land border, the UK is surrounded by the Atlantic Ocean, the North Sea, the English Channel and the Irish Sea. Great Britain, the largest island, is linked to France by the Channel Tunnel. A map of the UK is presented in **Figure 56**.

The UK has a strong economic, cultural, military, scientific and political influence in the region. It is an EU Member State, a permanent member of the UN Security Council and is a member of the Commonwealth of Nations, G8, G20, NATO, OEC, as well as the WTO.

Figure 56 *Map of the UK*

(Source: worldtravels)

5.5.1 Economic overview

The UK's economy is made up of the economies of England, Scotland, Wales and Northern Ireland. Based on market exchange rates, today the UK is the sixth largest economy in the world and the third largest in Europe, after Germany and France.

The UK, a leading trading power and financial center, is one of the trillion dollar economies of Western Europe. The UK has large coal, natural gas and oil resources; however, its oil and natural gas reserves are declining and the country became a net importer of energy in 2005. Services, particularly banking, insurance and business services account for the largest proportion of GDP, while industry continues to decline in importance.[45]

The UK has a small coal reserve in addition to significant, yet continuously declining natural gas and oil reserves. Over 400 million tons of proven coal reserves have been identified in the UK.

5.5.2 Power system

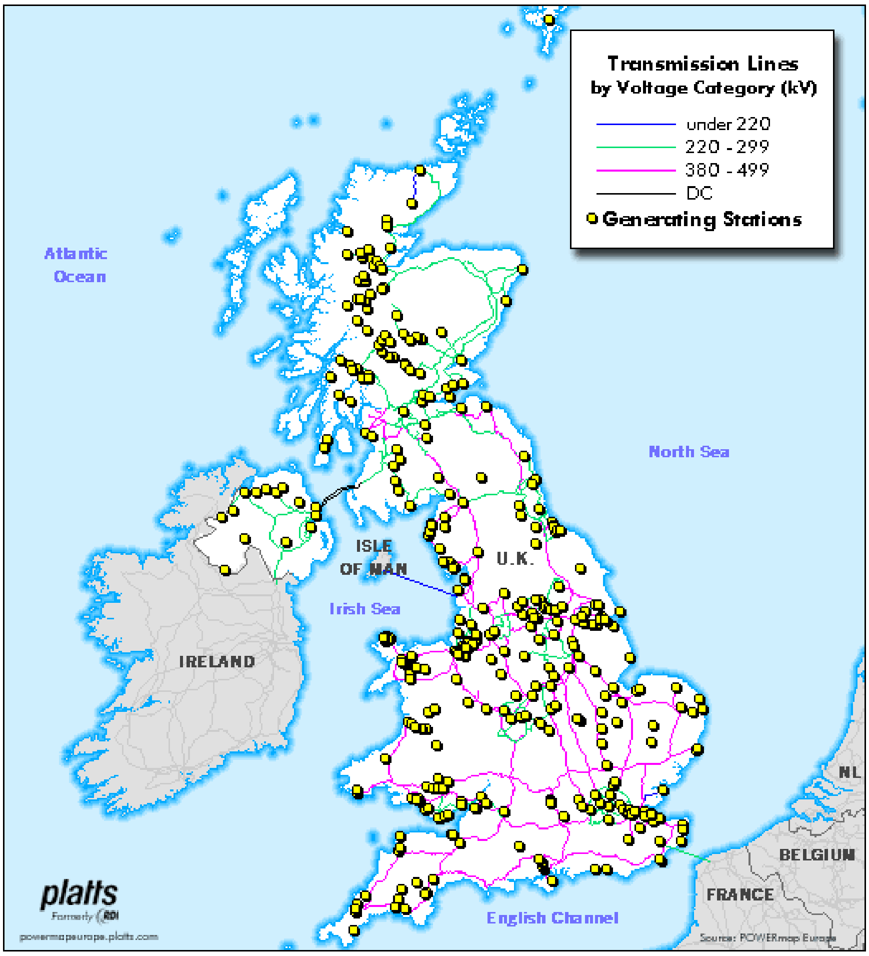
The electricity transmission networks in Great Britain are owned by National Grid Electricity Transmission (NGET) in England and Wales, Scottish Power Transmission Limited (SPTL) in South and central Scotland and Scottish Hydro Electric Transmission Limited (SHETL) in the North of Scotland.

The UK transmission system broadly comprises all of the circuits operating at 400kV, 275kV and 132kV, although the majority of the latter is in Scotland where transmission also includes 132kV networks. The fully interconnected transmission system not only provides for a consistently high quality of supply but also allows for the efficient bulk transfer of power from remote generation to demand centers. As a requirement of The British Electricity Trading and Transmission Arrangements (BETTA),[46] Great Britain's system operator of the national grid (NG)[47] produces the Great Britain Seven-Year

[45] Index Mundi detail information about the macroeconomic activity in the UK.
[46] Energy Act 2004. BETTA was introduced to include Scotland grid into the NG.
[47] National Grid: Report to the Gas & Electricity Markets Authority GB Transmission System Performance Report, 2007 – 2008.

Statement annually, containing a wide range of technical and non-technical information relating to the GB Transmission System. The map of The UK Power System is exhibited in **Figure 57.**

Figure 57 *The UK's power system*

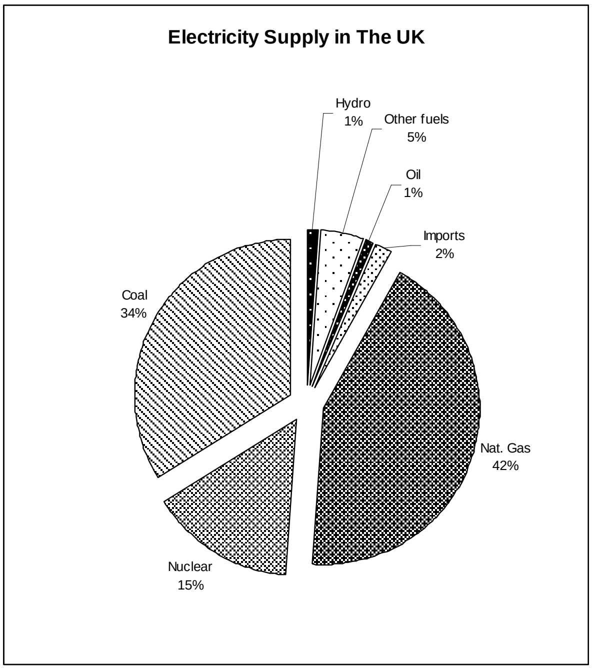


(Source: Platts)

Generation capacity

The electricity price in the UK is primarily driven by fossil fuel prices, since about 76% of the electricity supplied is generated from gas fired or fuel fired power plants.[48] The breakdown of how the electricity is supplied by source in the UK is shown in **Figure 58**.

Figure 58 *The UK's electricity supply*



(Source: BERR[49] 2007 page.23)

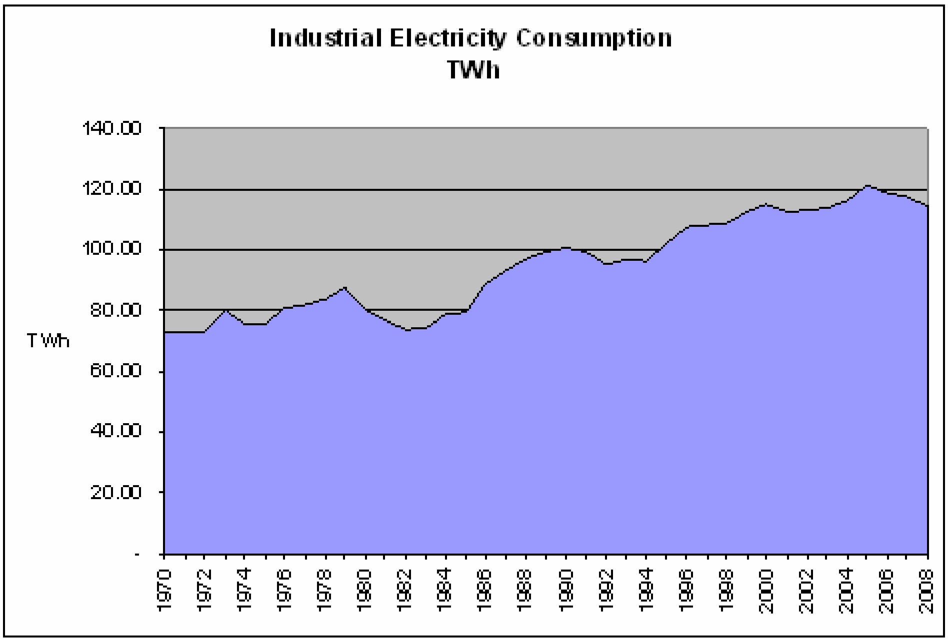
The total UK electricity generated in 2008 was roughly 400 TWh**.** The UK electricity demand has increased by almost 50% during the last 20 years and was characterized by a sharp decline in the share of industrial consumption from about 50% in 1960 to 28% in 2008.[50] The industrial electricity consumption in the UK can be seen in **Figure 59**.

[48] The Institute of Physics; also see: www.iop.org

[49] Department for Business, Enterprise & Regulatory Reform (BERR).

[50] Department of Energy and Climate Change, Digest of UK Energy Statistics, 2008; also see http://www.decc.gov.uk/en/content/cms/statistics/statistics.aspx

Figure 59	*Industrial electricity consumption in the UK*



(Source: DECC)

Electricity network

The UK has 72.4 million kilowatts of installed electric capacity, about 80% of which is thermal, 18% nuclear and 2% hydropower. The country generated 355.8 billion kilowatt hours (bkwh) of electricity in 2000, making it the third-largest electricity production in Europe (behind Germany and France).

In 2001, only 37.2% of the UK's electricity generation was coal fired. The remainder was generated with natural gas (31.5%) and primary electricity sources, such as nuclear and hydroelectricity (25.8%).[51]

[51] GENI: UK report.

Network companies are responsible for the maintenance, operation and expansion of the electricity networks. The high voltage network in the UK is managed by the transmission network owner (TNO), while the medium and low voltage network is administered by different distribution network operators, or DNO (Breucker, Driesen, Belmans, 2006).

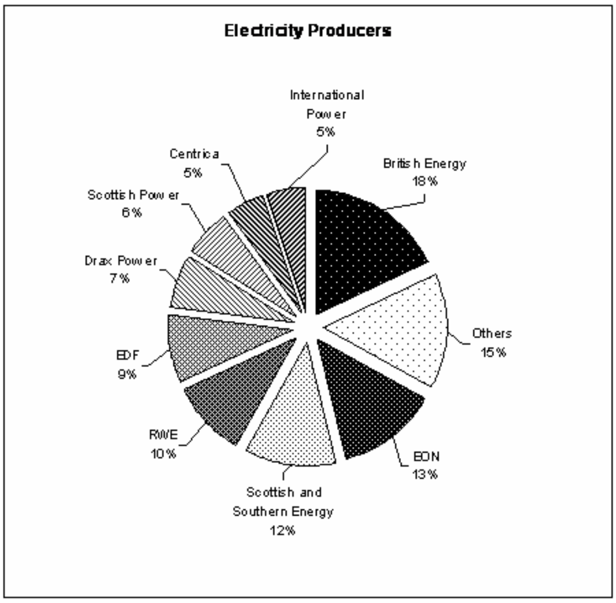
The TNO operates a 400KV and 250KV network of supply from major generation outlets to strategically located "grid supply points."

Electricity players

Producers

Most electricity is generated at large power stations connected to the national transmission network. However, electricity can also be generated in smaller scale power stations, which are connected to the regional distribution networks.[52] The competitive electricity generation market can be shown in the distribution of the generated electricity in **Figure 60**.

Figure 60 *Electricity producers in the UK*



(Source: Ofgem[53])

Distributors

[52] AEPUK; also see, http://www.aepuk.com/about-electricity/structure-of-the-industry/
[53] The Office of Gas and Electricity Markets.

There are 14 licensed DNOs, each responsible for a distribution services area. Those DNOs are owned by seven different groups and there are also four independent network operators who own and operate smaller networks embedded in the DNO networks.[54]

Domestic, as well as most commercial consumers, buy their electricity from suppliers who pay the DNO´s for transporting their customers' electricity along their networks. Suppliers pass these costs on to consumers. Distribution costs account for about 20% of electricity bills.

Electricity distribution networks are monopolies because there is only one owner/operator for each area. The economic regulator of Great Britain's electricity market (OFGEM) administers a price control regime, ensuring that efficient distributors earn a fair return after capital and operating costs while limiting the amounts that customers can be charged.

Suppliers

In the UK, the electricity market is considered to be competitive because the number of suppliers and the flexibility in the electricity supply contracts provide incentive to have electricity prices in the spot and forwards market. The sophistication of the market provides additional options where the electricity can be indexed to a commodity like natural gas. It is common to find products in the market related to the electricity prices indexed to the coal prices, CO_2 or renewable electricity. The suppliers have a strong interest in the renewable electricity market, since the authority has placed a challenging 20% renewable electricity target by 2020.[55]

[54] National Grid – DNO.; also see, http://www.nationalgrid.com/uk/Electricity/AboutElectricity/DistributionCompanies/
[55] EC – The Support of Electricity from Renewable Energy Sources Report, 2008.

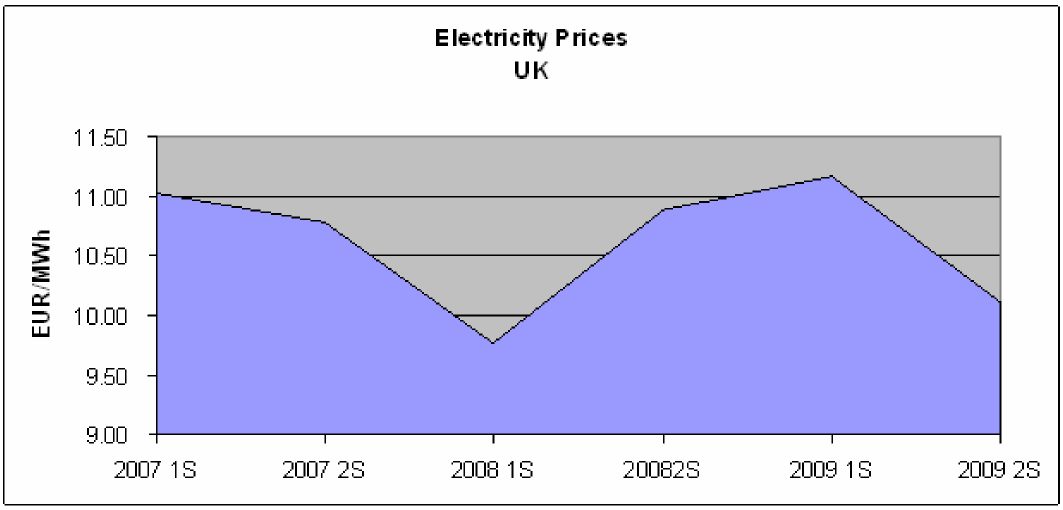
Consumers

Large electricity consumers are starting to become more interested in self-generation. Managers of companies have recognized ownership as being a physical hedge against electricity price fluctuations, not excluding the possibility of using self-supply to improve reliability. The main reason is that this market structure has provided them with an opportunity to sell electricity on the market instead of to an identified end-user.

Electricity prices

The final price of electricity for an industrial contains other components apart from the price of energy, such as balancing cost and distribution. The average electricity price in the UK for a consumption of 2,000 MWh/year maximum is € 0.1249 per kWh and for a consumption of 24,000 MWh/year maximum is € 0.0990 per kWh. In the UK, large electricity consumers pay more for electricity than in any other EU country. A chart with the historic prices in the UK is presented in **Figure 61.**

Figure 61 *Electricity prices in the UK*



(Source: Eurostat 2009, page 24)

The final price paid by consumers in the UK is comprised of the unit price of electricity, which is typically 70% of the final price, while the pass-through charges involved constitute the other 30% of the final price paid. The unit price refers to the price per unit of energy and the pass-through charges – the cost that the electricity industry incurs while delivering energy.

A renewable obligation (RO) is the main support scheme for renewable electricity projects in the UK. The RO accounts for approximately 2% of the total electricity price. With the introduction of the Climate Change Levy in 2001, and its exemption for renewable energy resources (such as solar and wind, renewable energy sources), alternative energy sources are beginning to gain more attention.[56]

5.5.3 Regulation

The liberalization of the electricity market in the UK has changed the way the electricity sector is organized. The government has privatized all of the generation and transmission assets and has created market conditions that are being regulated by the Office of Gas and Electricity Markets (OFGEM). The UK's electricity market is considered to be a fully competitive one with more that 20 companies involved in the electricity supply.

In the case of the UK, electricity is being purchased by an intermediary (i.e., supplier) and for the first time consumers can be active players in the market and have a "buy and sell" status. The trading of electricity is made under BETTA and went into operation in April 2005, covering Great Britain's electricity grid.

5.5.4 Industrial sector

The main industries in the UK are machine tools, industrial equipment, scientific equipment, shipbuilding, aircraft, motor vehicles, electronic machinery, computers, processed metals, chemical products, coal mining, oil production, paper, food processing, textiles, clothing and other consumer goods.

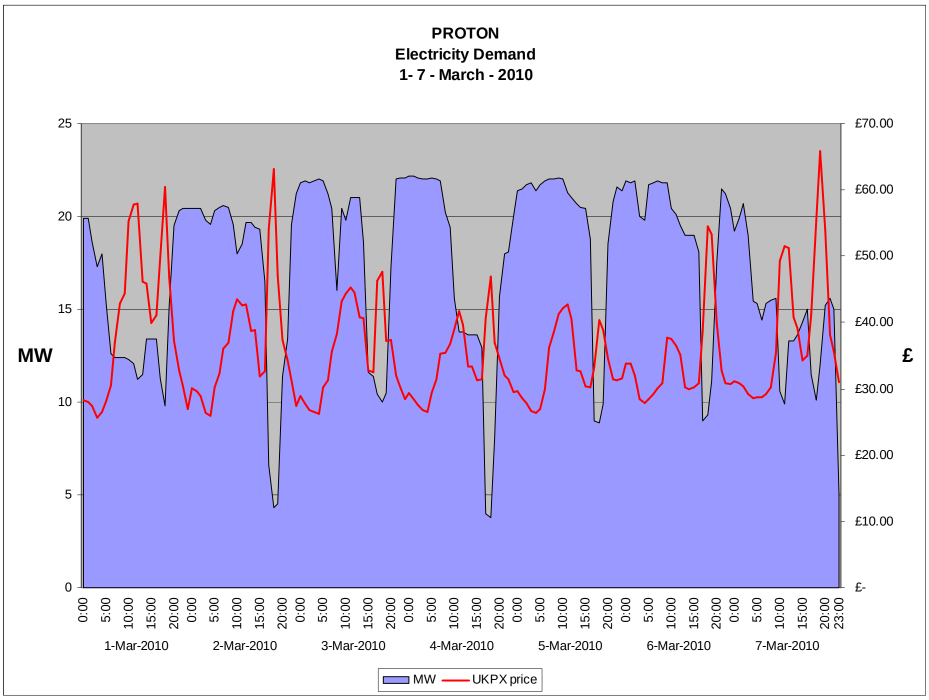
Energy consumption is highest in the energy, gas and water industries, which in 2007 accounted for 28.7% of all energy used from fossil fuels. The manufacturing, transport and communication industries accounted for a further 15.9% and 14.7%, respectively, of energy generated from fossil fuels.[57]

[56] EC – Renewables Obligation – Introduction of a banding mechanism and specific support to wave and tidal stream generation.
[57] UK Energy Consumption Report 2001 – DTI.

5.5.5 PROTON's electricity profile

PROTON has an annual production of 1.5 millions tons of products. The yearly electricity consumption is 284 GWh with a maximum demand of 22 MW. The price of electricity is € 0.1249/KWh and the current supplier is providing electricity with a contract in the forward market. The company is working with an intensive load management program. The prices of electricity are presented in the day-ahead market and the production schedule for the following day is adjusted accordingly. **Figure 62** provides details about the prices of electricity and the electricity demand.[58]

Figure 62 *PROTON's weekly electricity demand*



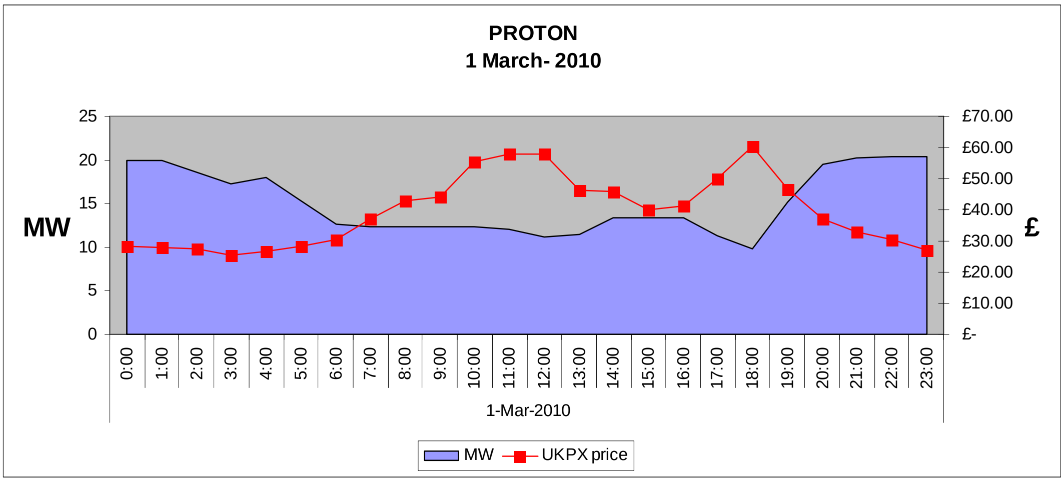
(Source: Modified from PROTON's operational records)

PROTON daily demand profile and the electricity price can be seen in **Figure 63**. The company intensifies the production process during the night shift from 20:00 to 04:00.

[58] Maximum electricity demand and annual consumption are considered to be a base line for electricity supply agreements.

The electricity prices increase by 100% during the day shift. The only equipment that remains in production is the furnace that has a 24-hour operation.

Figure 63 *PROTON daily electricity demand and prices*



(Source: Modified from PROTON's operational records)

5.5.6 Electricity sourcing methodology

PROTON is a company based in the UK that is looking to study a new electricity supply and demand strategy.

Recently, the government has incorporated a new scheme that provides economic incentives for electricity generation from a renewable source. The renewable electricity certificate provides additional incentives for electricity generation. These new changes in the regulatory framework and the high volatility of the fuel market have motivated PROTON to consider a change in their electricity sourcing strategy.

Step 1: Current conditions

To provide details about the current conditions available in the country and how the company is operating, PROTON filled out the questionnaire included in the tool. The result of the survey is described in the following report:

Supply

1. Supply structure: No tariff structure exists in the UK anymore. Bilateral contracts between generators and trading of electricity through a series of markets that operate on a rolling half hourly basis.
2. Self-generation is considered to be a way to hedge the price of electricity.
3. Type of market-based contract: contracts are indexed to a large extent on market prices and often also include a link to gas forward prices. As a result, industrial prices are usually more volatile in the UK than in other European countries.

Self-generation

1. Grid connections: to promote competition in the energy and supply sectors, network access and connection are available.
2. Reliability of Supply: according to the TNO, the overall reliability of supply for the GB Transmission System during 2008 to 2009 was 99.9%.
3. What type of technology is used in self-generation? Fossil fuel technology is the most common in UK. More than 80% of the UK's energy consumption comes from fossil fuel technology.
4. Renewable Energy Incentives: for the large electricity consumers willing to generate electricity, the British Government provides incentives for RES usage (e.g., green certificates). An option for electricity supply companies to meet their obligation are the renewals obligation certificates (ROCs) – to pay a buy-out fund contribution equals € 43.17 MWh in 2008 to 2009, which increases each year with the retail price index (RPI).
5. Type of self-generation: companies in the UK have the opportunity to decide if they want to self generate on-site or connect to the grid. Connecting to the grid may result in a new business opportunity by selling the excess energy produced but transmission cost should be considered.

6. Trading of electricity: the trading of electricity is made under BETTA, an organization that began operating in April 2005 and covers Great Britain's electricity grid.

CO_2 management

1. CO_2 regulations: the UK as part of European Trading Scheme (ETS) must report CO_2 emissions. Other regulations for carbon pricing are the carbon tax (Climate Change Levy) or the "cap and trade" carbon emissions trading scheme.

Demand

1. What types of measures are used to manage demand? Cost effective options for saving electricity among major industrial users in the UK are limited since they are usually already highly energy efficient and often meet high international benchmarks regarding power intensity. Aside from self-generation, large electricity consumers still use load management to reduce and change power consumption. The decision about which practice is applied depends on the company's strategy. It is also possible to have an interruptible contract with one supplier.

General questionnaire

This questionnaire will provide information about the current conditions in the market and the current supply structure of the company.

Subject:	Score
Supply	
1. Freedom to select supplier (unbundled service)	✓
2. Continue as bundled service with tariff structure	✗
3. Move to unbundled service	✓
4. Free access to the electricity market	✓
5. Self-generation	✓
6. Cost-based	✗
7. Market-based	✓

8. Real time price (spot) ✓

9. Flexibility to fix prices in the forward market ✓

10. Flexibility to index the electricity price with a commodity ✓

11. Allowed to use the grid to interconnect self-generation unit's ✓

12. Generation units are required to maintain production (back-up) ✗

13. Fossil fuel technology (ex., nat. gas, fuel oil, etc.) ✓

14. Renewable (wind, solar, etc.) ✗

15. Subsidies to promote the investment in RES ✗

16. Incentives to sell electricity from RES ✓

17. On-site generation ✓

18. Self-generation and inject excess into the grid ✓

19. Allow to sell excess electricity in the market ✓

20. CO_2 regulations in your country (fees on CO_2, allowances, etc.) ✓

Demand

21. Energy efficiency actions ✓

22. Load management practice driven by electricity prices ✓

23. Load management practice through operational flexibility ✓

24. Interruptible contracts are available ✓

Step 2: Identifying trends

It is important to try and identify the main factors that influence market conditions in the electricity sector. These trends can be organized by several topics: policy (regulatory), economical, social, technological and environmental (PESTE).

Policy

The UK has a fully competitive supply industry and trends indicate that more competitors will join the market. Self-generation will represent a good opportunity, especially from renewable electricity sources due to the EU ETS carbon price and because fossil fuel prices are considered to be volatile. A summary of the energy policy trends affecting the company can be seen in figure **Table 33**.

Table 33 *Energy policy trends in the UK*

Policy	Energy policy and country regulations	Liberalization of the electricity market is in progress	☑	P1
		Unbundled service — supply and transmission can be negotiated separately	☑	P2
		Self generation will be allowed (back-up, partial generation, selling excess, etc)	☑	P3
		Access to the grid will be available to deliver electricity in different regions	☑	P4
		Allowed selling of electricity (self generated electricity to the market — new business opportunity)	☑	P5

(Source: Treviño, 2010)

Economic

It is estimated that by 2020, average electricity prices will be 12% higher for domestic customers and 34% higher for non-domestic consumers[59]. Proportionally, the EU ETS carbon price on the wholesale electricity price will rise until about 2015. This is due to the high targets in CO_2 reduction set by the EU.

Interruptible contracts will become more attractive and this initiative will provide a good solution in maintaining a reliable supply in the UK.

A fully competitive supply market offers a variety of contracts to large electricity consumers and additional flexibility is expected to provide additional value to consumers based on the profile of demand. A summary of the economic trends is presented in the **Table 34.**

[59] TDI 2009, Department of Trade and Industry

Table 34 Economic trends in the UK

Economic	Supply / Demand, RES/ Nuclear, Fossil fuel price	Fossil fuel prices will remain volatile and unpredictable	☑	Ec1
		Increasing number of support schemes for investment in renewable energy sources (RES)	☑	Ec2
		Increasing number of incentives for selling the electricity from renewable energy sources (RES)	☑	Ec3
		Increasing economic incentives for load management practices (load shedding and load shifting)	☑	Ec4
		Electricity purchasing through the market	☑	Ec5
		Electricity prices index to the spot market	☑	Ec6
		Electricity prices index to the forward market	☑	Ec7
		Electricity prices index to a commodity (exc., nat gas)	☑	Ec8
		Trend to build additional production capacity to improve load management practices	☑	Ec9
		The generation and transmission system have constraints and provide incentives for interruptible contracts	☑	Ec10

(Source: Treviño, 2010)

Social

In the UK, people are concerned about the environment but an important program for the development of renewable electricity has not been integrated. The level of renewable electricity should increase in the coming years. More awareness campaigns will be in place. **Table 35** represents the social trends that are affecting the company.

Table 35 Social trends in the UK

Social	Consumer (large industrials) preferences	People are becoming more concerned about the environmental changes — positive attitude about recycling, willingness to pay a higher price for "green" electricity	☑	S1

(Source: Treviño, 2010)

Technological

The target in UK for the usage of renewals by 2010 to 2011 is set at 10.4%, increasing to 15.4% for 2015 to 2016 (OFGEM, 2009 pp 23). The country intends to generate 20% of its electricity from renewable sources by 2020.

Table 36 represents the future trends that may affect the company.

Table 36 *Technological trends in the UK*

Technological	Electricity generation, Energy efficiency	Technology is available to generate electricity at a competitive cost	☑	T1
		Dominance of technologies to offset CO2 emissions (CO2 capture and storage is available)	☑	T2
		New renewable energy technologies (RES) will grow in the market (e.g., RE, nuclear, etc.)	☑	T3
		New automation technology will support energy efficiency and load management practices	☑	T4

(Source: Treviño, 2010)

Environmental

The UK committed to an 18% cut of the total carbon dioxide emissions by 2020, based on 2008 levels. After 2013, large electricity consumers will be obliged to buy allowances for each tone of CO_2 emitted. UK energy policy goals are oriented to decrease carbon dioxide emissions in 60% by about 2050. Based on the methodology, the trends that may affect the company in the future are shown in **Table 37**.

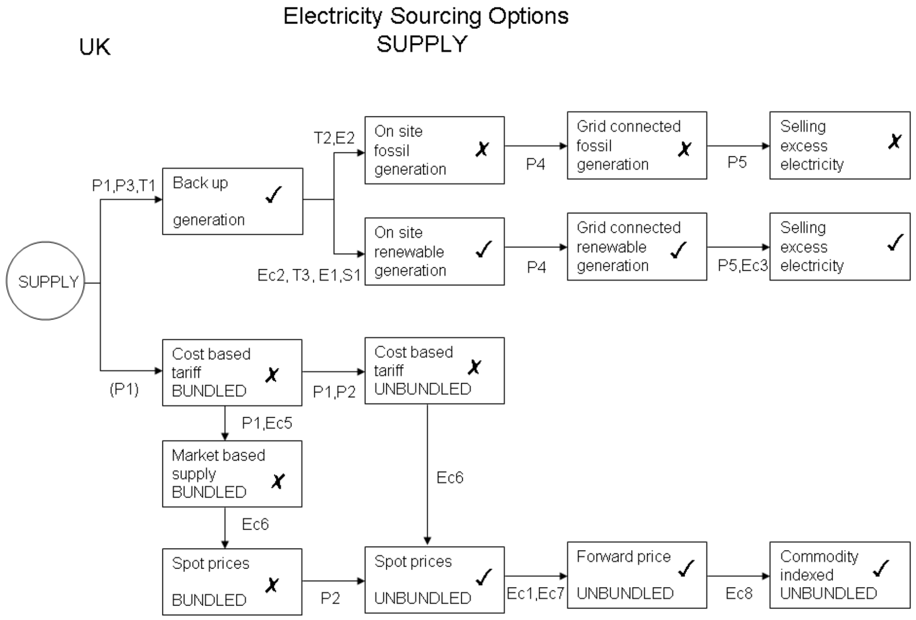
Table 37 *Environmental trends in the UK*

(Source: Treviño, 2010)

Step 3: Discovering new options

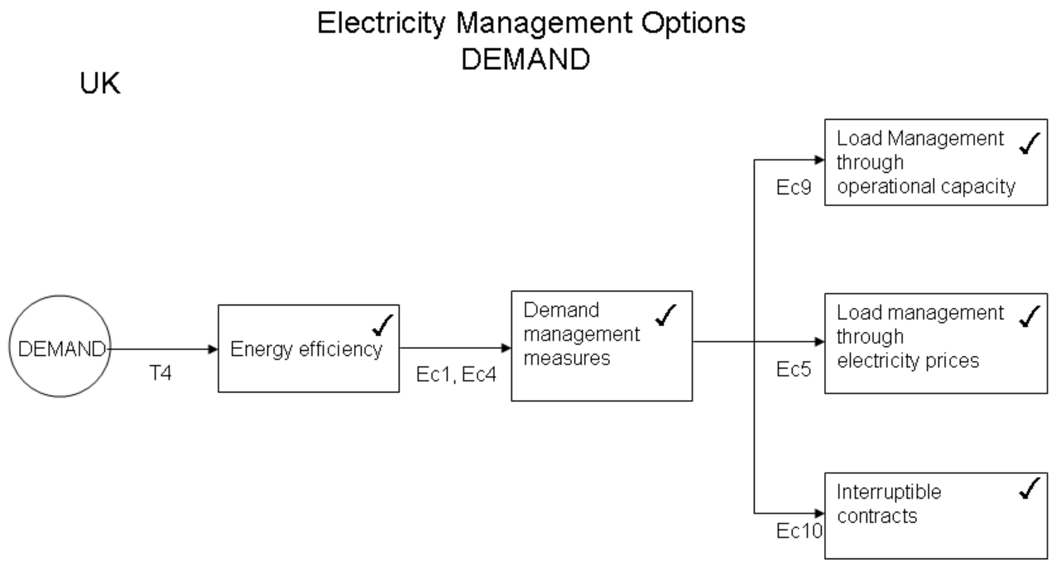
The methodology considers the integration of the current available options and the trends in the external environmental conditions. The following supply and demand diagrams show the new available options that will apply to the electricity market. The supply electricity options are described in **Figure 64** and the demand electricity options are exhibited in **Figure 65**.

Figure 64 *Supply: Electricity sourcing options for PROTRON*



(Source: Treviño, 2010)

Figure 65 *Demand: Electricity sourcing options for PROTON*



Source: Treviño, 2010)

Evaluating the company's current situation and the future trends of the country, PROTON's current options for electricity supply and demand management options are shown on ***Table 38***.

Table 38 *Available options for PROTON*

SUPPLY
A.- BUY **Unbundled Service** 1.- Real time price (spot). 2.- Flexibility to fix prices in the forward market. 3.- Flexibility to index the electricity price with a commodity (ex. Nat Gas)
B.- MAKE **Generation of Electricity** 1.- Renewable energy partial supply (on side). 2.- Renewable energy complete supply (grid connected). 2.- Renewable energy and selling excess to the market.

DEMAND
DEMAND RESPONSE 1.- Energy efficiency actions. 2.- Load management practice driven by electricity prices 3.- Load management practice through operational flexibility 4.- Interruptible contracts.

(Source: Treviño, 2010)

Available options summary

Supply

The main available option is to continue to index the cost of electricity to the price of natural gas.

If the company has no difficulty with a investment, the options to generate electricity will be driven mainly by self-generation with all of the different renewable electricity options, depending on the location of the natural resource. The current economic incentives for renewable electricity provide opportunities in a country with high wind potential, both on- and off-shore.

Demand

Load management programs can be coordinated with other electricity consumers in the country. Load aggregation provides additional value the consumers.

Interruptible contracts will be available to incentivize the users to reduce demand during some critical periods of the year. Also, load aggregation in the interruptible contracts increases the value of the initiative because higher demand could be added.

Step 4: Evaluation and selection

PROTON's business strategy will influence the way the company sources electricity. The company will have to define its strategy in nine different dimensions related to the three main categories: technology, economics and resources.

Technology

PROTON supplies its electricity in the forward market and could implement load aggregation for all of its sites. The company is willing to add self-generation units in several locations to reduce its dependency on the market volatility. Renewable energy projects will have significant subsidies in the short-term. The company is very environmentally oriented – self-generation by using renewals has been a relevant activity in the company to hedge electricity prices and also offset CO_2 prices while reducing net costs and increasing revenues. However, given the importance of addressing environmental issues, green technologies have had a significant development in this country and the UK government has been introducing new policies and penalties to reduce the impact of GHG emissions.

Economic

PROTON has been affected in the past years by high energy prices and the volatility of the fossil fuel prices. The current agreement has provided important energy savings to the company, due to load management practices and securing electricity prices in the forward market. Additional revenues could be achieved by increasing the number of sites in the existing power supply agreement through load aggregation.

Resources

Taking into account that the new regulations incentivize investment in renewable energy generation, the company is interested in developing a partnership with a financial entity or a supplier to install generation capacity. Initiatives could be implemented with the same number of employees, or even with a reduced staff, due to increased productivity or efficiency that will have a positive impact on accepting any new sourcing option. The company will support the creation of new intellectual capital, especially in the field of renewable electricity. Management sees value in the creation of intellectual property. **Table 39** exhibits how PROTON has set its electricity sourcing priorities with the tool. The scale is from 1 to 9, 9 being the most important factor for the company and 1 being the least important.

Table 39 *Prioritization of factors for PROTON*

CATEGORY	FACTORS	LEVEL OF IMPORTANCE	SCORE	DEFINITION OF THE CRITERIA
Technology	Operational reliability	6	1	The option has a **low** level of operational reliability
			2	The option has a **medium** level of operational reliability
			3	The option has a **high** level of operational reliability
	Technology development	4	1	The option is based on **old** technology
			2	The option is based on **traditional** technology
			3	The option is based on **new** technology developments
	Environmental impact	5	1	The option has a **high** environmental impact
			2	The suggested option has a **low** environmental impact
			3	The option has **not** an environmental impacts
Economics	Net cost	8	1	The net cost of supply might be **higher** than the current net cost
			2	The net cost of supply might be **equal** than the current net cost
			3	The net cost of supply might be **lower** than the current net cost
	Volatility of prices	7	1	**High** volatility of prices. The option is related to the spot market prices or fossil fuels
			2	**Low** volatility of prices. The option is related to the forward market prices
			3	**Cero** volatility of prices. The option is not related to the market
	Revenues	9	1	The option provide **zero** increase in the revenues
			2	The option provide **low** increase in the revenues
			3	The option provide **high** increase in the revenues
Resources	Human capital	2	1	**New** employees have to be hired to manage the new option
			2	**Same** level of employees are required to manage the new option
			3	**Less** employees required to manage the new option
	Financial	3	1	The option is **high** capital intensive and new investments are required
			2	The option is **low** capital intensive and no major investments are required
			3	The option is **zero** capital intensive and no investments are required
	Intellectual capital (know-how)	1	1	**Zero** new intellectual capital is generated
			2	**Low** new intellectual capital is generated
			3	**High** new intellectual capital is generated

(Source: Treviño, 2010)

The company evaluates the available options and selects the best strategy for supply and demand management with the help of the tool. All available options are evaluated based on multi-decision criterion, a technique used to filter options and alternatives in order to obtain the best opportunity on which the company can base its new supply strategy. The company's priorities are set and the evaluation takes place. **Table 40** shows the scores assigned by NEUTRON to each of its available options. The evaluation have all the factors with the specific criteria that can go from, 1) low, 2) medium, or 3) high value.

Table 40 *Scores related to each factor for PROTON*

United Kingdom	Technology			Economics			Resources		
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)
IMPORTANCE	6	4	5	8	7	9	2	3	1
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE		
SUPPLY									
TYPE OF SUPPLY									
BUY									
Unbundled Service									
Real time price (spot)	2	1	2	2	2	1	2	2	1
Flexibility to fix prices in the forward market	2	1	2	2	2	1	2	2	1
Flexibility to index the electricity price with a commodity (ex. Nat Gas)	2	1	2	3	1	1	2	2	1
MAKE									
Generation of Electricity									
Renewable energy partial supply	2	3	3	1	3	1	1	2	2
Renewable energy complete supply (grid connected)	2	3	3	1	3	2	1	2	2
Renewable energy and selling excess to the market	2	3	3	2	3	3	2	2	2
DEMAND									
DEMAND RESPONSE									
Energy efficiency actions.	3	1	3	2	2	1	2	3	2
Load management practice driven by electricity prices	3	1	3	3	3	3	2	3	1
Load management practice through operational flexibility	2	1	3	3	2	2	2	1	1
Interruptible contracts.	1	1	3	3	2	3	2	3	1

(Source: Treviño, 2010)

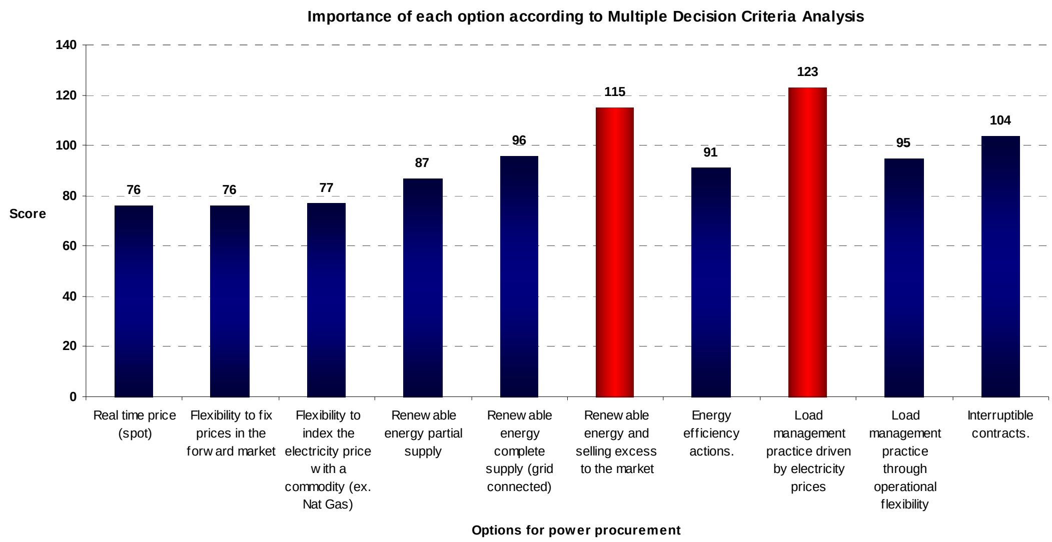
Based on the set criteria, the company evaluated every available option to decide on the one that best suits its needs. After scoring each option, PROTON will automatically see a table with the final scores for each option and the highest ranked options for supply and demand management are highlighted. The final scores for each option are calculated by multiplying the score assigned by the company by its level of importance; the final score is the sum of all of the factors. **Figure 66** and **67** represents the results of the evaluation; the highest rated options are highlighted.

Figure 66 Results by each available option for PROTON

USER AVAILABLE OPTIONS	Technology			Economics			Resources			TOTAL
FACTOR	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)	
IMPORTANCE	6	4	5	8	7	9	2	3	1	
	SCORE			SCORE			SCORE			
SUPPLY										
TYPE OF SUPPLY										
BUY										
Unbundled Service										
Real time price (spot)	12	4	10	16	14	9	4	6	1	76
Flexibility to fix prices in the forward market	12	4	10	16	14	9	4	6	1	76
Flexibility to index the electricity price with a commodity (ex. Nat Gas)	12	4	10	24	7	9	4	6	1	77
MAKE										
Generation of Electricity										
Renewable energy partial supply	12	12	15	8	21	9	2	6	2	87
Renewable energy complete supply (grid connected)	12	12	15	8	21	18	2	6	2	96
Renewable energy and selling excess to the market	12	12	15	16	21	27	4	6	2	**115**
DEMAND										
DEMAND RESPONSE										
Energy efficiency actions.	18	4	15	16	14	9	4	9	2	91
Load management practice driven by electricity prices	18	4	15	24	21	27	4	9	1	**123**
Load management practice through operational flexibility	12	4	15	24	14	18	4	3	1	95
Interruptible contracts.	6	4	15	24	14	27	4	9	1	104

(Source: Treviño, 2010)

Figure 67 Graphical results by each available option for PROTON



(Source: Treviño, 2010)

Recommendation

After evaluating the available options with the considered factors, the highest rated option on the supply side is to develop a self-generation project with renewable electricity, allowing the flexibility to sell the excess capacity to the market. From the demand side, the recommendation is to continue to have the load management practice driven by electricity prices.

Supply

The company should implement a renewable energy strategy and sell the excess electricity to the market. The new regulation for renewable energy provides an incentive to invest in these technologies – financial aid can be accessed with government incentives provided by the renewable obligation certificates that are given for each KWh generated from a renewable source.

A long-term agreement with a supplier can help to finance the new generation capacity. The market provides additional incentives, since the excess electricity generated by the new assets could be sold to the market.

Demand

In the UK load management and interruptible practice can be extended to other sites. Electricity consumption could be adjusted in relation to the electricity prices in the market, the production capacity and the self-generation capacity. These initiatives clearly provide to PROTON an increase in the value of the company’s electricity sourcing with the possibility of having additional revenues for the business.

5.6 Conclusion

The methodology has been tested in three different configurations of the electricity sector related to the level of liberalization with a wide range of external factors such as: policy, economic, social, technological and environmental.

Current supply conditions were indentified by utilizing the standard questionnaires, trends in the market were evaluated and the discovering of new available options have been integrated as possible solutions for large electricity consumers.

The evaluation and selection of the best available option was achieved through the usage of the questionnaire where the business criteria is set and the prioritization of the factors and the scores of the new available options are selected. All these elements have proven that the methodology can accept a wide range of external and internal conditions.

The methodology could be utilized in other countries. For example, Mexico has changed its regulatory framework since 1992 and self supply generation is now allowed. Recently new green electricity projects have been developed such as EURUS in the state of Oaxaca. This wind project (250 MW) generates and deliver electricity to large electricity consumers by using the national grid from Oaxaca to the rest of the country.

Finally, the case studies helped me to identify additional functionality required to improve the effectiveness of the methodology. The suggested changes are presented in Chapter 6.

Chapter 6. Improvements to the Electricity Sourcing Methodology

6.1 Introduction

In general terms, the value of the methodology was proven by the fact that it provided solutions to the electricity consumers in a way that they could reduce both electricity costs and selection time, as well as being able to formulate an electricity sourcing strategy that can be incorporated to management practice, thus fulfilling the need for a reliable electricity supply at a competitive cost.

This chapter incorporates new elements to identify, define, analyze and implement an electricity sourcing strategy. This process, for example, can be coordinated by a sourcing council that highlights and rules the electricity sourcing strategy with various players within the organization.

The goal of this chapter is to offer a practical guide to write better contracts to aid in becoming more competitive and versatile in the new electricity environment. A point that needs to be stressed is that the relationship with suppliers plays an important role in a long-term and sustainable business relation, as the organization adapts electricity sourcing to the new power environment.

6.2 What has been learned

The development of the energy sector in Europe has changed during the past decade, moving from vertically-integrated utilities that provided all services through their generation, transmission and distribution networks, to a liberalized market where more competition and options for consumers have come into play.

Traditionally, the supply was characterized by having a secure source of electricity from a single supplier without any opportunity to diversify the supply and price structure. In recent years, the number of independent suppliers has been introducing and increasing competition into the supply sector. The new supply market structure now provides the end-users with a wide range of options to improve their competitiveness, increase supply options and reduce transaction costs.

New regulations will bring additional business opportunities to the marketplace. However, additional complexity in energy supply practices have to be addressed through a methodology supporting the understanding of regulation dynamics, supply and demand factors and new technologies to mitigate climate change.

The proposed methodology helps to identify the evolving electricity price that has been greatly affected by unstable CO_2 and fuel prices. Consequently, large electricity consumers today face two challenges. The first is to address the question of whether their position allows them to change geographical location, according to how the electricity price is formed. The second is whether integrating an energy sourcing strategy will help them optimize the electricity supply in a reliable and cost-effective way.

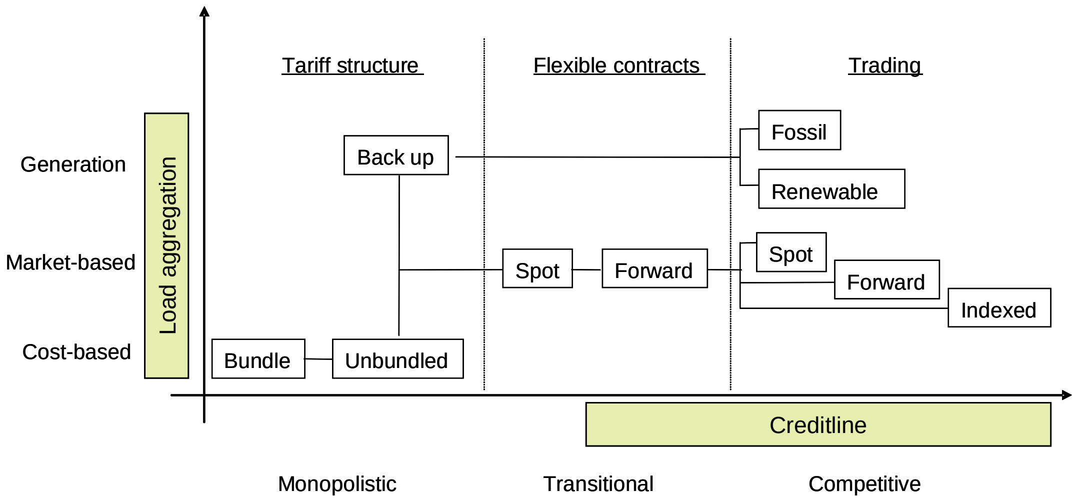
The methodology also provides support to identify new climate change regulations. Climate change policies are designed to promote the development of clean technologies while, at the same time, new market regulations may motivate on-site generators to participate in large projects. Involvement in activities from load management to partial generation of full vertical integration should be analyzed to identify the best available option.

Load management practices, such as production shifting and peak hour generation are typical of low-scale projects with a small investment during the regulated and transitional period of market restructuring. Full ownership requires higher investment and involves a greater risk. In addition to the investment needed to build or acquire a generation facility, human capital is also required to manage the new operation. The new business will assume additional risk as the process of adopting of the new strategy is created.

6.3 *Analysis of the existing methodology and extensions*

The electricity sourcing methodology has been tested in three countries with different market conditions; it has shown consistent results, highlighting current electricity sourcing actions that energy intensive users are following in each market. The results of the case studies demonstrated the need to add load aggregation and credit line availability in the methodology as shown in Figure **68**.

Figure 68 *New conditions applied to the electricity sourcing methodology*

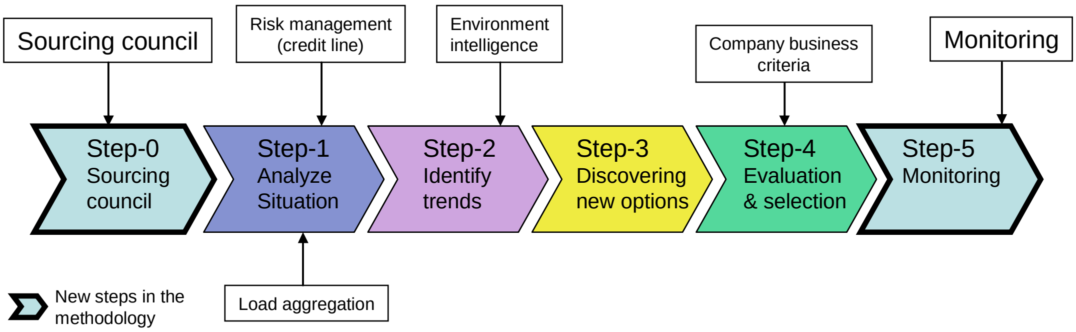


(Source: Treviño, 2010)

6.3.1 Additional steps to improve the methodology

The main recommendations are intended to improve the methodology in its functionality in two dimensions. The first suggestion is to add new steps in the methodology to better define the original objective of the new strategy and to control and monitor the selected strategy's performance. The second recommendation relates to the additional analysis required to evaluate strategy performance in practice and add new links to the organization's decisions (as shown next in **Figure 69**).

Figure 69 *Improvements to the proposed methodology*



(Source: Treviño, 2010)

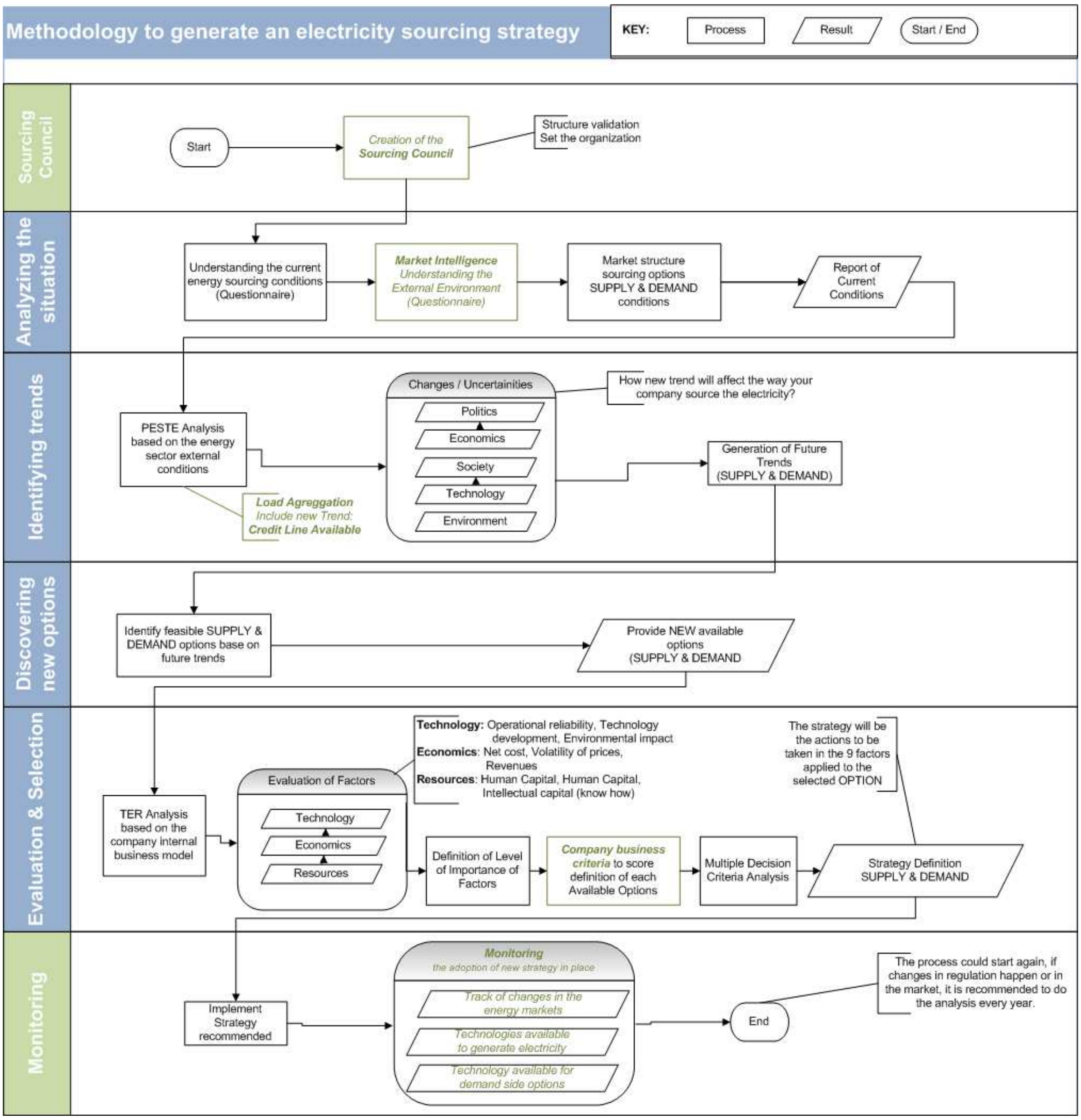
Step 0 – Sourcing council

The creation of a sourcing council is suggested in order to integrate the organization's key players and decision makers that have the ability to set the main criteria for developing an electricity sourcing strategy.

Step 5 – Monitoring

The implementation of a monitoring mechanism can assist the organization to keep track of the new strategy's performance. The monitoring should be extended to the external environmental conditions that could affect the performance of the selected electricity sourcing strategy. The new flow diagram incorporates the new steps in the methodology and the additional functionality is presented in ***Figure 70.***

Figure 70 *Extended methodology flow diagram*



6.3.2 External environment intelligence

The evaluation of external environmental conditions plays a very important part in the formulation of a new electricity sourcing strategy. The integration of an external environment intelligence module can help keep track of changes in the critical topics related to policy, economics, social, technological and environmental and supports the decision making process.

6.3.3 Risk management

An important part of the new competitive electricity market is related to the flexibility of sourcing electricity on market-based mechanisms, such as forward agreements and financial derivatives that might provide additional flexibility. Additionally, these new schemes require financial support to structure long-term agreements. The availability of credit lines has become a very important aspect of supply options, especially during economic crises when the ratings, such as those issued by Standard & Poor's, are affecting the credit line of large electricity consumers.

6.3.4 Load aggregation

The possibility to aggregate load from the same company in other locations around a country (or region), or to establish new partnerships with other large electricity consumers, brings added value to the electricity sourcing strategy. The main benefit is related to increasing the size of electricity consumption in kWh. On the one hand, suppliers wishing to increase the size of their market share may be willing to reduce the cost per kWh. But, on the other hand, the total demand (kW) charge would be significantly reduced by adding the demand of all partner consumers into a single aggregated load. Simply by coordinating all of the independent site demands – and trying to avoid having the maximum demand at the same time substantial savings can be created.

6.4 Improvements to the methodology for internalizing the company strategy

Based on the experience learned from the case studies, there are several changes that can be implemented in the methodology in order to have more coherence in the analysis of the external and internal conditions such as: financial flexibility to contract in the forward market, load aggregation studies, external environment intelligence techniques, scoring the company business criteria and the implementation of a monitoring process that allows to keep track of technological changes in time.

6.4.1 Credit line availability for market-based products

Houston-based Enron has changed the way of doing business by not only providing physical delivery but by also providing energy services. The use of futures, swaps, options, financial derivatives, collars, over the counter options and other contractual forms provide important flexibility in electricity sourcing (Handfield 2004).

Nevertheless, credit lines have become an important factor in the decision making process for a new electricity sourcing strategy. Financial entities have incorporated new rules to select and consider customers. Most of the new market-based products are on tight credit lines. Commitments in the forward market have to be backed up. The cost of credit lines may affect the cost of the market-based products. For the above reasons, a complete financial assessment has to be incorporated into the process of selecting the best energy sourcing alternative.

In order to add credit availability to the methodology, a new economic option needs to be added – Ec11, which asks the user if the company has, or is expected to have, credit availability. If the user agrees with this condition, the options for a forward market contract and a contract indexed to a commodity will be available to the user *(refer to **Table 41**)*.

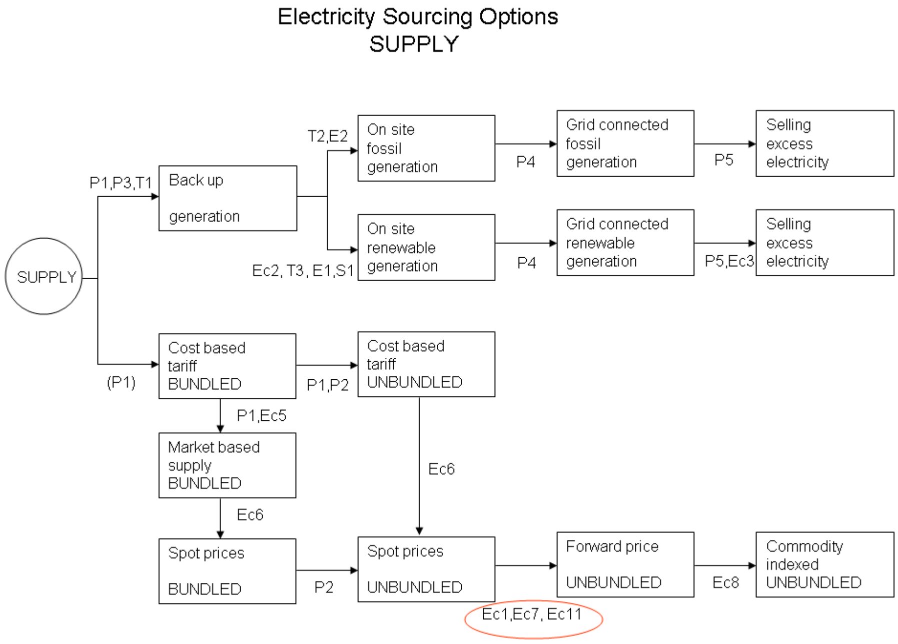
Table 41 *Economic trends after the addition of Ec11*

Economic	Supply / Demand, RES/ Nuclear, Fossil fuel price	Fossil fuel prices will remain volatile and unpredictable	☑	Ec1
		Increasing number of support schemes for investment in renewable energy sources (RES)	☑	Ec2
		Increasing number of incentives for selling the electricity from renewable energy sources (RES)	☑	Ec3
		Increasing economical incentives for load management practices (load shedding and load shifting)	☑	Ec4
		Electricity purchasing through the market	☑	Ec5
		Electricity prices index to the spot market	☑	Ec6
		Electricity prices index to the forward market	☑	Ec7
		Electricity prices index to a commodity (exc., nat. gas)	☑	Ec8
		Trend to build additional production capacity to improve load management practices	☑	Ec9
		The generation and transmission system have constrains and provides incentives for interruptible contracts	☑	Ec10
		Credit line will be available for the company to develop forward contracts.	☑	Ec11

(Source: Treviño, 2010)

The new electricity sourcing diagram describes the addition of the credit line criteria, which will affect the available options related to forward contracts and commodity indexed products. The new decision tree of the electricity sourcing options is presented in ***Figure 71***.

Figure 71 *Supply: Electricity sourcing options – including credit line – Ec1*



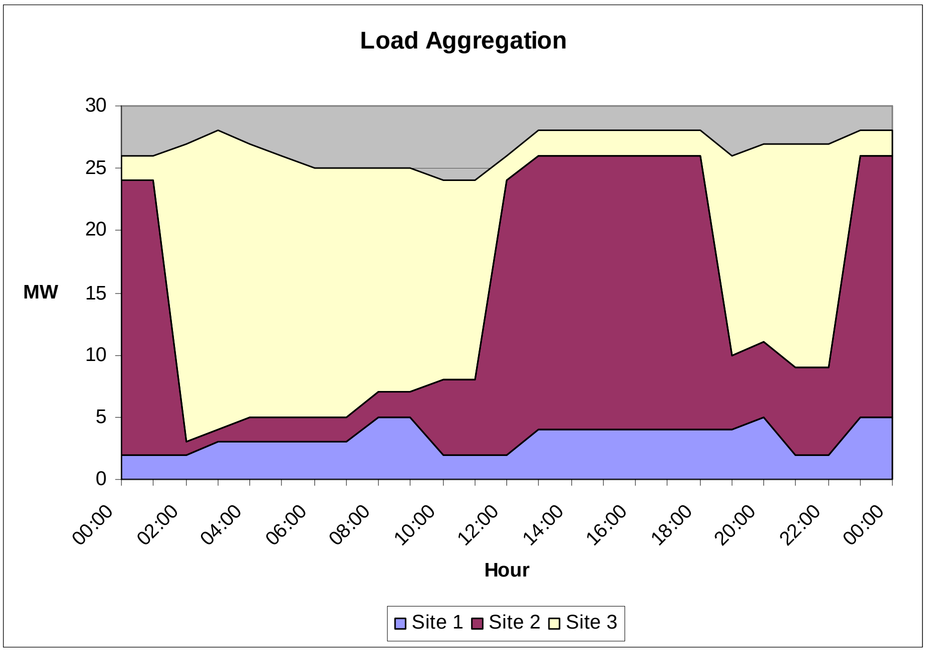
(Source: Treviño, 2010)

6.4.2 Load aggregation and management of volatile sites

The new rules in the electricity market facilitate the possibility of aggregating the load of several industrial sites from a country, or region, with one single supplier. This brings interesting opportunities with regard to reducing the cost of electricity. ***Figure 72*** describes the integration of three large electricity consumers integrated into one single demand. As an example shown in the chart, consider that the maximum total demand has been achieved at 04:00 hrs (28 MW). On the one hand, the overall combined demand is maintained in a range from 22 to 28 MW during the day. On the other hand, the independent demand for each location has varied very much in terms of changes, particularly in the case of the site 2 and site 3.

The flexibility to coordinate the demand from different locations is recognized as a value for both the consumer and the supplier. Lower electricity cost and efficiency of the power system is achieved.

Figure 72 *Load aggregation profile*



(Source: Treviño, 2010)

6.4.3 External environment intelligence

The external environment intelligence can be incorporated into the second step of the process (Identify Trends) to better assess the future trends in the PESTE analysis in some key fundamental parts of the electricity sector. This process can be considered to be the generation of electricity, transmission and distribution, market-based products, CO_2 and load management capabilities. The technology intelligence and innovation strategy model[60] (Rohrbeck, et al 2006) helps to identify trends in market conditions.

[60] "The Technology Radar – An Instrument of Technology Intelligence and Innovation Strategy." Deutsche Telekom Laboratories, 2006.

Table 42 describes the external environment intelligence process that will then be used to generate technology radars, following the steps from identification, selection, assessment, and dissemination in an organization, as will be shown in the next section. Additionally, the relative importance of low, medium, and high is brought to the present addition as described in chapter 4.

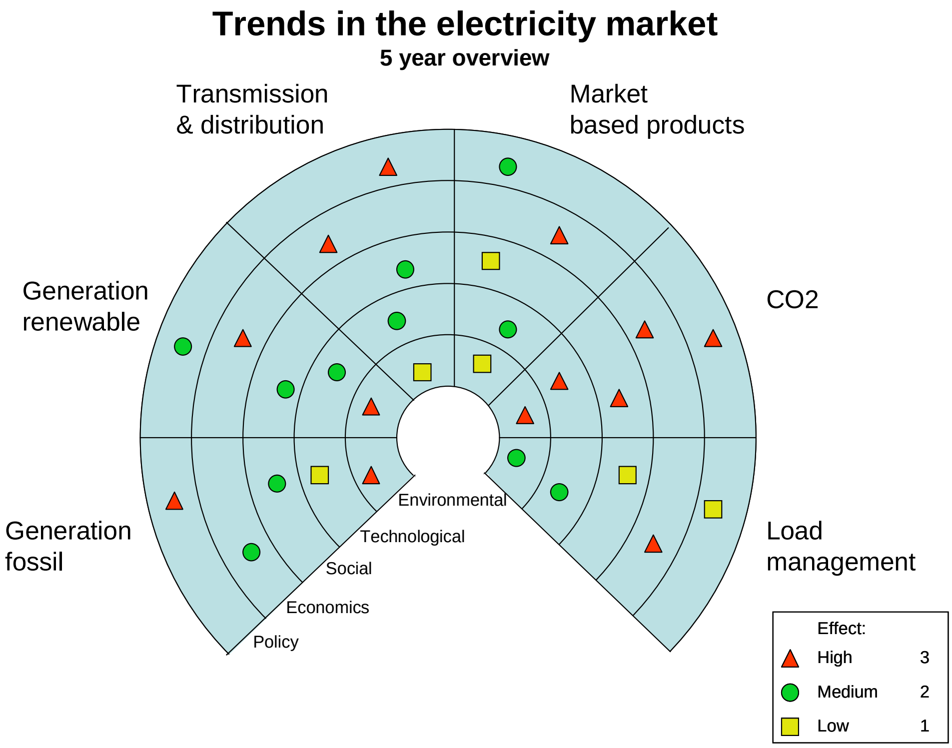
Table 42 *External environment intelligence process*

Identification	Selection	Assessment	Dissemination
• **Technology trends identified**	• **Key innovation trends with high impact** • **Based on expert group input following common criteria**	• **Potential implementation scenarios** • **Cross-impact analysis**	• **Outcome of technology monitoring** • **Technology radar**

(Source: Modified from Rohrbeck 2006)

The effect this trend has on the five dimensions described in the PESTE model will provide an indication about the sensitivity of changes that some electricity-related technologies and sectors experience. ***Figure 73*** describes the critical areas being affected in the coming five years. As described in the figure, the CO_2 effect in electricity sourcing will have a high level of significance in the decision making process. The result of the external environment intelligence will provide valuable information to be considered in the questionnaire of electricity sourcing strategy (step 2).

Figure 73 *Dimensions of PESTE and weighted Trends in the Electricity Market*



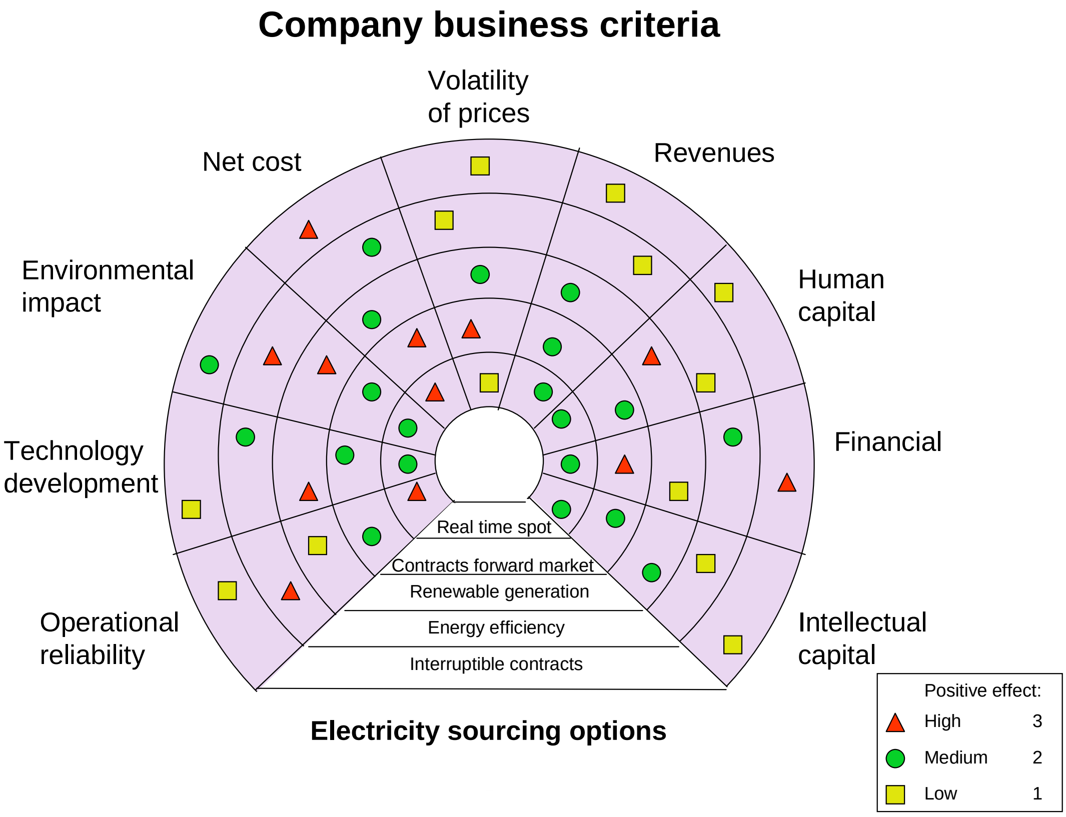
(Source: Modified from Deutsche Telekom Laboratories, 2006)

6.4.4 Scoring the company business criteria

In order to facilitate the definition of the business criteria related to the new sourcing options, the main criteria explained in Technology, Economics and Resources (TER) and its sub-dimensions in a radar model[61] are incorporated. This model facilitates the integration of the scores related to the importance to the company business model. ***Figure 74*** describes the radar integrating the business criteria and the level of importance of the business model.

[61] Modified from "The Technology Radar – An Instrument of Technology Intelligence and Innovation Strategy." Deutsche Telekom Laboratories, 2006.

Figure 74 *Company business criteria model*



(Source: Modified from Deutsche Telekom Laboratories - 2006)

Once the "effects" are identified in relation to the available options, it is then time to proceed to incorporating the results in the 4th step of the methodology. The scores will be placed in the related table and the assessment of the available options will be provided, as presented in ***Table 43*** from the case of The UK.

Table 43 *Scores related to each factor*

United Kingdom	Operational reliability	Technology development	Environmental impact	Net cost	Volatility of prices	Revenues	Human capital	Financial	Intellectual capital (know-how)
CATEGORY	Technology			Economics			Resources		
IMPORTANCE	6	4	5	8	7	9	2	3	1
USER AVAILABLE OPTIONS	SCORE			SCORE			SCORE		
SUPPLY									
TYPE OF SUPPLY									
BUY									
Unbundled Service									
Real time price (spot)	2	1	2	2	2	1	2	2	1
Flexibility to fix prices in the forward market	2	1	2	2	2	1	2	2	1
Flexibility to index the electricity price with a commodity (ex. Nat Gas)	2	1	2	3	1	1	2	2	1
MAKE									
Generation of Electricity									
Renewable energy partial supply	2	3	3	1	3	1	1	2	2
Renewable energy complete supply (grid connected)	2	3	3	1	3	2	1	2	2
Renewable energy and selling excess to the market	2	3	3	2	3	3	2	2	2
DEMAND									
DEMAND RESPONSE									
Energy efficiency actions.	3	1	3	2	2	1	2	3	2
Load management practice driven by electricity prices	3	1	3	3	3	3	2	3	1
Load management practice through operational flexibility	2	1	3	3	2	2	2	1	1
Interruptible contracts.	1	1	3	3	2	3	2	3	1

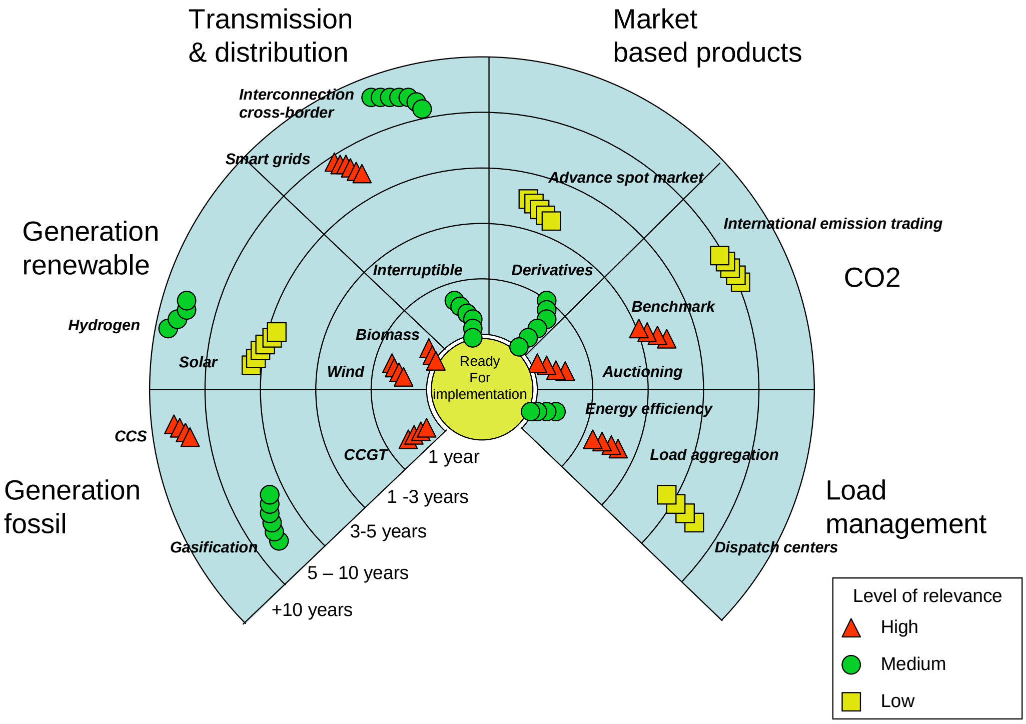
(Source: Treviño, 2010)

6.4.5 Monitoring

The monitoring process has been incorporated in the electricity sourcing methodology, since it is important to keep track of changes in the energy markets, the technologies that are available to generate electricity and the dynamics the demand side options. ***Figure 75*** exemplifies the evolution of the technologies over time (say, a ten-year period), and keeps track of the evolution of time. Some of the technologies are ready to be implemented and these will be considered as new available options.

The monitoring process should also consider the recording of the performance of the selected strategy. The organization should maintain a close look at the savings that the new strategy has generated.

Figure 75 *Tracking technologies*



(Source: Modified from Ernst & Young, "Universal Change," 2006)

This tracking process will help electricity consumers identify changes over time and could generate an early warning system informing the sourcing council, or the overall organization, to assess the electricity sourcing strategy. It is recommended that the electricity sourcing conditions be revisited every six months to a year – a timeframe allowing the user better control over the evolution of changes and giving him time to prepare for those changes with his supplier. Normally, the electricity markets have a seasonal behavior (winter and summer) and this should also be taken into consideration in order to estimate the real annual saving of the new sourcing strategy.

6.4.6 Conclusions

The improvements to the methodology suggested in this chapter provide extensions to the methodology used for the case studies in The UK, where the electricity market operates in a competitive environment.

Credit line availability is an important part of the process for selection of the best electricity sourcing option. On the other hand, the flexibility to add several consumes to a single electricity contract has to be integrated to the electricity sourcing methodology, since this has become a common practice in developed markets.

Additionally, an important part of the methodology has been adapted by adding the development of external environmental intelligence. The proposed evaluation of the technological trends improves the way we can analyze how the trends in the market can affect the electricity sourcing options. Companies in a dynamic transitional electric environment need to adapt and develop projects to make electricity and power to become competitive edges.

The changes in the company business criteria model provide a direct link of the electricity sourcing options and the company business criteria facilitating the decision making process in the selection of the best available option.

Chapter 7. General Conclusion and Future Research

7.1 Introduction

This final chapter provides the general conclusion and a summary of the dissertation with an overview of the main factors that affect the electricity sourcing in Europe and my projected research plan. The main contributions are described with its direct effect on practical and research activities. Further research is suggested on different topics that can contribute to facilitate the development in this subject.

7.2 General conclusion

The liberalization of the electricity sector in Europe has increased the complexity of sourcing and procurement of electricity. First of all, there are regulatory changes in the sector promoted by the liberalization reforms, adaptation of the industry and micro-strategic-management at the firm level. Secondly, there is a new wave sourcing options, towards unbundling service that brings new sourcing opportunities, that implies an increase in the number of suppliers and the flexibility to self-supply electricity with more electricity sourcing options as new apparent set of business opportunities. Thirdly, the electricity cost has been very much affected by the fossil fuel price volatility and new environmental regulation incorporated in the new European emission trading scheme – regulation that introduced a new market for emission rights and which has directly affected electricity consumers since the cost is passed on to the end-user in various contracting schemes and conditions.

Additionally, new aggressive environmental targets have promoted the development of renewable electricity projects. EU Member States now encourage investment in trading of renewable electricity. This has created important financial incentives for large electricity consumers to consider self-generation projects where they can participate in different stages of project development, from construction to operation and to trading of electricity.

The evolution of the electricity sector from monopolistic to transitional and competitive markets has provided more alternatives than any time before and thus adds flexibility for large electricity consumers. This research was about developing a methodology at the company level, to define electricity sourcing strategies. The proposed methodology can help identify currently available options and trends in the market to better prepare a strategy for electricity sourcing. It will help organizations to better manage their electricity sourcing and to better control their electricity costs.

Additionally, this dissertation analyzes the new regulations in the electricity sector that allow large electricity consumers to participate in the market through different alternative linkages along the supply chain to increase the level of vertical integration that can provide more competitive advantages and new business opportunities. The management will need to adapt to the new business model. Additional human capital, as well as physical and intellectual assets may all need to be incorporated.

A fundamental part of the strategy development process is related to the tracking of trends in the external environment. Changes in the political, economical, social, technological and environmental conditions influence the outcomes of any electricity sourcing strategy. Monitoring these factors will facilitate the success and adaptation of the electricity sourcing strategy.

This research provides a framework to deepen knowledge about the electricity sector in Europe as was described in the case studies in three countries with different supply structures. The methodology can be utilized by energy suppliers and energy consumers to test scenarios and identify new electricity sourcing options.

The complexity of sourcing electricity in the new liberalized market has motivated me to find a solution to create an electricity sourcing strategy through a systematic approach. The research in the electricity market, strategy formulation techniques, and decision making process have provided all the elements for the development of the methodology tool that has been tested and improved. This research can be extended and adapted to other regions with similarities in the liberalization of the electricity sector.

7.2 Summary of the dissertation project

Chapter 1 provides a general introduction to the European electricity markets, and delineates the objectives of the study. Chapter 2 describes the electricity market and both the development of the liberalization process and effects of the fuel and climate change across Europe.

Following Farjoun (2002), in Chapter 3 the strategy formulation process is described and linked to alternatives for electricity sourcing at the firm level. It also addresses the PESTE study at various levels in Europe's energy sector. The main references are from Barney (2001), Genoud and Finger (2002), Handfield (2004), Hogan (2007), Ibarra (2007), Kessides (2003), and Joskow (2006).

A new proposed methodology is then presented in Chapter 4. The main concepts developed involved contributions from Coopers and Vivet (2004), EC (2007) and EIA (2007). The testing process takes place in Chapter 5 to a set of three countries: Croatia, Spain, and the UK, economies that presently face various stages of liberalization.

Improvements to the methodology were maid in Chapter 6 where the results from the case studies suggested changes in the electricity procurement for the forward market through credit lines and load aggregation. Advance monitoring and tracking techniques were suggested to improve the capabilities to identify trends in the external environmental conditions of the electricity sector.

No additional changes in the methodology are required after the disaster (2011) in Fukoshima, Japan since fossil fuel technologies will continue to be dominant in the generation mix.

7.3 Main contributions

Throughout the dissertation, the research work integrates the contributions. First, the objective was to generate a practical framework to deeply understand regulatory change and market alternatives in Europe.

In the past, the sourcing analysis was focused mainly to understand cost behavior and profit maximization. The main contribution is to provide a methodology that establishes an interconnection between the regulation of the electricity sector and the buy-make decision making process. The dissertation also created a framework to identify and analyze scenarios about the best electricity sourcing option.

The developed methodology was integrated into a new tool that can be used to create, test and monitor the effect of changes in external and internal conditions. The methodology was tested in three countries with different regulatory structures – Croatia (monopolistic), Spain (transitional) and the UK (competitive). The evaluation and results have been validated with large electricity consumers in each of the countries. The recommendations provided by the methodology were considered in their business plans.

Additionally the research can assist supply managers in learning about the electricity supply market and electricity sourcing by incorporating a set of questionnaires to identify the electricity sourcing options and calculations.

The methodology can be applied for a wide range of scenarios from basic decision making to more complex analysis like the technology radar techniques that could facilitate the work to identify trends in the external environmental conditions.

The research project was related to the electricity sector in Europe focusing on large electricity consumers. Other parts of the world are experimenting diverse policy issues, such as connectivity in the USA, or energy pools in Nordic economy or Canada-US trade in electricity that are not emphasized here. However, the theoretical framework, and then the proposed methodology could easily be adapted to other regions and companies in alternative sourcing conditions.

7.4 Future research

Further research can be focused in the major changes that the sector might experience in the regulatory framework, trends of the electricity generation, and the dilemma to whether to buy or make electricity to source energy needs.

Future analysis can address topics such as: reforms and regulation in the electricity sector and regulatory reforms to promote green electricity. New regulation in the electricity sector will have a direct effect in the way electricity is generated, delivered and consumed. Also, further studies could analyze incentives to promote green electricity and their effects for large electricity consumers.

Another area for research is vertical integration and market power in electricity markets. This is an important topic to promote competitive advantage. Depending upon the complexity of the power supply and the level of vertical integration, further research can be extended to study how to manage an organization within this framework.

7.5 Final thought

The present doctoral research project has given me an opportunity to both become a knowledgeable investigator of the sector, and also to be aware of the fact that a project such as this is a platform to conduct further research and consulting in the near future.

REFERENCES

Aguilar, F.J. (1967). *Scanning the business environment*. PESTLE stands for Political, Economic, Sociological, Technological, Legal, Environmental. New York: Macmillan.

Alonso, F. (2009). *Regulation and policy impacts on electricity prices in the UK and the implications for energy intensive industries*. Warwick: Warwick Business School.

Ancarani, A., Capaldo, G., Pontrandolfo, P. & Salaris, A. (2004). Procurement in public organizations: Choosing between integrated facility services and separated ones, Proceedings of the 13th IPSERA Conference, pp. W-49 – W-57.

Andersson, A. H, Kock, S. & Ahman, S. (2000). Managing buyer-supplier relationships in a supply network – The buyer's perspective, Swedish School of Economics and Business Administration.

Anderson, J.C., Schroeder, R.G. and Cleveland, G. (1991). The process of manufacturing strategy: Some empirical observations and conclusions, *International Journal of Operations & Production Management*, Vol. 11, No. 3, pp. 86-110.

Andrews, K.R. (1971). *The concept of corporate strategy*. New York: Dow Jones-Irwin.

Annual Report 2008. (2009). Zagreb: Croatian Energy Regulatory Agency.

Arbnor, I. and Bjerke, B. (1997). *Methodology for creating business knowledge*. Sage Publications Ltd.

A.T.Kerney, Inc. (2007). *Key supply strategies for tomorrow: Perspective on the future of purchasing and supply*. Chicago: Carter, L.P., Carter, R.J. & Monczka, M.R.

Atkin, B. and Brooks, A. (2005). *Total facilities management*. Oxford: Blackwell Science, pp. 238.

Bain, J. S. (1956). *Barriers to new competition*. Cambridge: Harvard University Press.

Bain, J. S. (1959). *Industrial organization*. New York: John Wiley & Sons.

Baldick, R. Kolos, S. Tompaidis, S. (2006). Interruptible Electricity Contracts from an Electricity Retailer's Point of View, *Valuation and Optimal Interruption*, Vol. 54, No. 4, pp. 627–642.

Baldwin, R. & Cave, M. (1999). *Understanding regulation: Theory, strategy and practice*. Oxford: Oxford University Press.

Barney, J. B. (1991), Firm resources and sustained competitive advantage, *Journal of Management*, No. 17, pp. 99-120.

Baxter, L.W. & Calandri, K. (1992). Global warming and electricity demand: A study of California, *Energy Policy*, Vol. 20 No. 3, pp. 233-244.

Becalli, M, Cellura, M. & Mistretta, M. (2003). Decision-making in energy planning: Application of the method at regular level for the diffusion of renewable energy technology, *Renewable Energy*, Vol. 28, pp. 2063-2087.

Becker, W. & Freeman, V. (2006). Going from global trends to corporate strategy, *The Mckinsey Quarterly*, Vol. 3, pp.17-28.

Beinat, E. (1997). *Value functions for environmental management*. The Netherlands: Kluwer Academic Publishers, pp. 239.

Bell, W. (2000), An overview of futures studies, Slaughter, R. (ed.), *The Knowledge Base of Futures Studies*, Vol. 1, pp. 1.

Belmans & K. Purchala, R., KU Leuven L. Exarchakos, A.D. Hawkes (2005). *Distributed generation and the grid integration issues.* London: Imperial College.

Belmans, R. (2006). *CO_2 trading scheme report*, IEEE.

Blumberg, D. (1998). Strategic assessment of outsourcing and downsizing in the service market, *Managing Service Quality*, Vol. 8, No. 1, pp. 5-18.

Blumberg, B.F. (2001). Cooperation contracts between embedded firms, *Organization Studies*, Vol. 22, No. 5, pp. 825-852.

Blyth, W. & Yang, M. (2007). *Modeling investment risk and uncertainties with real options approach*. IEA/OECD/2007.

Boisseleau, F. & Hakvoort, R. (2002). *The liberalization of the European electricity Market(s): An unstructured restructuring process?* The Energy Studies Review, Vol.13, No. 2.

Bonneville, E. (2006). *Demand Side management for residential and commercial end-users,* AERE .

Bouttes, J.P. & Saab, A. (2003). *Generation investment and electricity market design.* Electricité de France.

Bozon, J.H.I., Campbell, J.W. & Lindstrand, M. (2007). *Global trends in energy.* The McKinsey Quarterly, Vol.1.

Breucker S., Driesen J., Belmans R., (2006). *Power quality in transmission grids: Guaranteed standards for consumers in France, UK and the Netherlands,* Katholieke Universiteit Leuven (K.U. Leuven, Catholic University of Leuven).

Brink, M.G. (2006). Sourcing strategy: Factors that play a role in defining the sourcing strategy from an operations management point of view (Master thesis business administration, Change management, 2006), University of Groningen, Faculty of Management and Organization.

Bröchner, J., Olsson, H., & Sinik, D. (2004). Serviced offices: Capabilities for FM coordination, *Facilities*, Vol. 22, No. 3/4, pp. 74-78.

Brummell, A. & MacGillivray, G. Scenario planning: *A tool for navigating strategic risk.* Scenarios to Strategy, Inc.

Brummell, A. & MacGillivray, G., Undated, Introduction to scenarios, *Scenarios to strategies inc*, pp. 5.

Bushnell, J. & Ishii, J. (2007). *An equilibrium model of investment in restructured electricity market*, Center for the study of energy markets (CSEM WP 164).

Campbell, N. (1985). An interaction approach to organizational buying behavior. *Journal of Business Research*, Vol. 13, pp. 35-48. Published in ed. Ford, D. (2002), *Understanding business marketing and purchasing*, 3rd edition, Thomson Learning, London, pp. 488.

Campbell, A. (1997). Buyer-supplier partnerships: Flip sides of the same coin, *Journal of Business & Industrial Marketing*, Vol.12, No. 6, pp. 417-434.

Carr, A. and Smeltzer, L. (1997). *An empirical based on operational definition of strategic purchasing*, European Journal of Purchasing and Supply Management, Vol. 3, No. 4, pp. 199-207.

Cartal, A. (2006). *EU ETS: Quel Impact pour la compétivité des industries?* Mémoire pour le Master 4129 – Economie Industrielle, Université Paris Dauphine, Paris.

Carter, J. R. & Narasimhan, R. (1996). Is purchasing really strategic? *International Journal of Purchasing and Materials Management*, Vol. 30, pp. 13.

Cedric, P. & Reinaud, J. (2004). *Emissions trading: Taking stock and looking forward*, OECD and IEA Information Paper, June, Paris.

Center for the Study of electricity market, CSEM (2007). *Electricity rate structures and the economics of solar PV: Could mandatory time-of-use rates undermine California's solar photovoltaic subsidies?*

Cerjak M, Mesic, Đuric. (2009). *AgriPolicy report.*

Chakravarthy, B.S. (1986). Measuring strategic performance. *Strategic Management Journal*, 7 (5), pp.437-458.

Chandler, A.D. (1962). *Strategy and structure: Chapters in the history of the American enterprise*. Cambridge: MIT Press.

Choi, T., Dooley, K. and Rungtusanatham, M. (2001). Supply networks and complex adaptive systems: Control versus emergence, *Journal of Operations Management*, 19, pp. 351–366.

Comision Nacional de Energia (2009). *Informacion Basica de los Sectores de Energia*.

Coenraads, R. (2006). *Analysis of barriers for the development of electricity generation from renewable energy sources in the EU-25*. OPTRES Report.

Considine T.J. (2000). *The impacts of weather variations on energy demand and carbon Emissions.* Ressource and energy economics, 22, pp. 295-314.

Conway, M. & Voros, J. (2002). Integrating foresight and strategic planning. Paper presented at Organisational Foresight Conference, University of Strathclyde, Glasgow.

Coppens, F. & Vivet, D. (2006). *The single European electricity market: A long road to convergence.* NBB Working Paper Nr. 84, May 2006.

Copper (2006). *Distribution generation and renewables. Copper Development Association.* Institute of Engineering and Technology Endorsed Training Provider.

Corley, K.G. and Gioia, D.A. (2004). Identity ambiguity and change in the wake of a corporate spin-off, *Administrative Science Quarterly*, Vol. 49, pp. 173–208.

Cory, K. S. (2005). State approaches to financing new renewable energy projects. *Energy Analysis Office – NREL*. Presented at Green Power Marketing Conference, October 26, 2005.

Cousins, P.D. (1999), Supply base rationalization: Myth or reality? *European Journal of Purchasing & Supply Management*, Vol. 5, No. 3/4, pp. 143-155.

Cousins, P. (2002), A conceptual model for managing long-term inter-organizational relationships, *European Journal of Purchasing & Supply Management*, Vol. 8, No. 2, pp. 71-82.

Cox, A. (1996). Relational competence and strategic procurement management – Towards an entrepreneurial and contractual theory of the firm, *European Journal of Purchasing & Supply Management*, Vol. 2, No. 1, pp. 57-70.

Crampes C., Fabra N. (2004) The Spanish electricity industry: Plus ça change. Université de Toulouse and Universidad Carlos III - (GREMAQ and IDEI).

Creswell, J. (2004). *Research design: qualitative & quantitative approaches*. Thousand Oaks: SAGE.

D'Aveni, R. A. & Ravenscraft, D. J. (1994*). Economies of integration versus bureaucracy costs: Does vertical integration improve performance?* Academy of Management Journal, 37, pp. 1167-1197.

Davenport, T.H., Jarvenpaa, S. & Linder, J.C. (2003*). Toward Innovation sourcing strategy.* MIT Sloan management review, Summer 2003, pp. 43-49.

Damsø Pedersen, C. (2005). *EU Renewable Energy Policy*. Master Thesis for Department of Environment, Technology and Social Studies Roskilde University, May 2005.

Danwitz Von, T. (2006). Regulation and liberalization of the European electricity market, *Energy Law Journal*, Vol.27.

De Boer, L., Holmen, E. and Pop-Sitar, C. (2003). Purchasing as an organizational design problem: The case of non-product-related items and services, Management Decision, 41:9, pp. 911-922.

Dewulf, G. & Van der Schaaf, P. (1998). Portfolio management in the midst of uncertainties: How scenario planning can be useful, *Journal of Corporate Real Estate*, 1, pp.19-28.

Dubois, A. and Gadde, L-E. (1999). Case studies in business market research: An adductive approach, Paper presented at the 15th Annual IMP Conference, University College, Dublin.

EASAC (2006). *Price setting in the electricity markets within the EU single market*.

Easterby-Smith, M., Thorpe, R. & Lowe, A. (2002). *Management research, an introduction*, Sage Publications.

EC (2003a) Directive 2003/54/Ec of the European Parliament and of the Council concerning common rules for the internal market in electricity and repealing directive 96/92/EC, *Official Journal* L 176, 15.07.2003.

EC (2003c) Regulation 1228/2003 of the European Parliament and the Council on conditions for access to the network for cross border exchanges in electricity, *Official Journal* L 176, 15.07.2003.

EC (2004). Electricity from Renewable Energy Sources – Encouraging Green Electricity In Europe. *Commission of the European Communities*.

EC (2005). Communication from the Commission – The support of electricity from renewable energy sources. *Commission of the European Communities*.

EC (2007). DG Competition Report on Energy Sector Inquiry. *Commission of the European Communities.*

EC (2009) Directive 2009/72/EC of the European Parliament and of the Council concerning common rules for the international market in electricity and repealing Directive 2003/54/EC.

EER, Emerging Energy Research (2007). Cost of electricity- Base case comparison with EUR 30 Carbon Penalty.

EFET (2000). A European single market in electricity: the way forward, *EFET Position Paper*.

Egenhofer, C. & Jansen, J.C. (2006*).* A timetable for harmonization of support schemes for renewable electricity in the EU, *European Review of Energy Markets*, Vol.1, No. 2.

Eisenhardt, K. (1989), Building theories from case study research, *Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Electric Power Research Institute, Inc (EPRI) (2007). Technology innovation: 2007 R&D portfolio and showcase projects.

Ellram, L. & Carr, A. (1994). *Strategic purchasing: A history and review of the literature*, International Journal of Purchasing and Material Management, Spring, pp 10-18.

Ellram, L.M. & Hendrick, T.E. (1995). Partnering characteristics: A dyadic perspective, *Journal of Business Logistics*, Vol. 16, No. 1, pp. 41-64.

Ellram, L. (1993), Total cost of ownership: Elements and implementation, *Journal of Supply Chain Management*, Fall.

Energy Business Group, EBG (2004*).* Emission trading and European electricity markets: Conceptual solution to minimize the impact of EU emissions trading scheme on electricity prices, *Energy Policy*, Volume 33, Issue 6, April 2005, pp. 787-798.

Energy (2008). Zagreb: Croatian Chamber of Economy – Industry and Technology Department.

Energy Consumption in the UK - Industrial Data Tables (2009). London: Department of Energy & Climate Change.

Energy Security and Security Policies: The Republic of Croatia in comparative perspective. Faculty of Political Science, University of Zagreb.

Escrivá G., Álvarez C., Valencia I (2009). Method for modeling space conditioning aggregated daily load curves: Application to a university building, *Energy and Buildings*, Vol. 42, Issue 8, August 2010, pp. 1275-1282.

Estache, A. & Martimort, D. (1999). Politics, transaction costs, and the design of regulatory institutions. *World Bank Policy Research Working Paper*, No. 2073.

ETSO (2005). Integration of renewable energy sources in the electricity system – grid issue. *European Transmission System Operators*.

Ettore, B. (1995). Purchasing performance measurement's influence on concurrent engineering activities customer-supplier relationships, *International Journal of Business and Marketing.*

EU Energy and Transport in Figures (2009). Belgium: European Communities.

European Federation of Energy Traders (EFET) (2000). Unbundling as a crucial factor in the completion of European electricity and gas market liberalization, Position paper, 18 September.

European Monitoring Centre on Change (EMCC) (2008). Trends and drivers of change in the EU energy sectors: Scenarios, *European Foundation for the Improvement of Living and Working Conditions*. Dublin, Ireland.

Eurrostat – Environment and Energy Statistics, http://ec.europa.eu/eurostat

EWEA (2003-2004). *Wind energy – the facts.* European Wind Energy Association and Directorate General for Transport and Energy.

EWEA (2005). *The Spanish wind market – dynamic and focused*. European Wind Energy Association.

EWEA (2005). *The second wave: Europe's growing markets.* European Wind Energy Association.

EWEA (2006). *Focus on 2030*. European Wind Energy Association.

Farjoun, M. & Lai, L. (1997). Similarity judgments in strategy formulation: Role, process and implications, *Strategic Management Journal*, Vol. 18, No. 4, Retrieved by: http://www.jstor.org

Farjoun, M. (2002), Towards an organic perspective on strategy, *Strategic Management Journal*, Vol. 23, No. 7, pp. 561-594, Retrieved by: http://www.jstor.org

Farmer, D. & van Weele, A. J. (1995). (Ed.) Gower, *Handbook of Purchasing Management*, pp. 581.

Ford, D. (1984), The development of buyer-seller relationship in international industrial markets, in Ford, D. (Ed.): *Understanding business markets-interaction, relationships, networks*, Academic Press Limited.

Fernández 2006 *US Investments in Spain (1898-2005)*. Helsinki Congress of the International Economic History Association, 21-25 August 2006: Session 93.

Finger, M.& Varone, F. (2006). *Governance of network industries: Towards European regulators, differentiated regulations, or self-regulation*, Conference at the University of Bath, ECPR European Consortium for Political Research.

Gadde, L.-E. & Håkansson, H (1994). The changing role of purchasing: Reconsidering three strategic issues, *European Journal of Purchasing and Supply Management*, Vol. 1, pp. 27-36, in Ford, D. (Ed.): *Understanding Business Marketing and Purchasing*, 3rd edition, London: Thomson Learning, 2002, pp. 488.

Gadde, L.-E. & Snehota, I. (2000). Making the most of supplier relationships, *Industrial Marketing Management*, Vol. 29, No. 4, pp. 305-316.

Galbraith, J.R. & Nathanson, D.A. (1978). *Strategy implementation: The role of structure and process*, St Paul, MN: West.

Genoud, C. & Finger, M. (2002). *Regulatory convergence? The example of the European electricity sector.* Working paper de l'IDHEAP 8/2002, Institute de Hautes Etudes en Administration Publique.

Georgopoulou, E., Lalas, D. & Papagiannakis, L. (1996). A multicriteria decision aid approach for energy planning problems: The case of renewable energy option, *European Journal of Operational Research*, Vol.103, pp. 38-54.

Glachant, J.M. &Lévêque, F. (2005). *Electricity internal market in the European Union: What to do next?.* SESSA research project on European electricity regulation.

Goffin, K, Szwejczewski, M. & New, C. (1997). Managing suppliers: When fewer can mean more, *International Journal of Physical Distribution & Logistics Management*, Vol. 27, No. 7, pp. 422-436.

Goldstein, W.M. (1990). Judgments of relative importance in decision making: Global vs. local interpretations of subjective weight, *Organizational Behavior and Human Decision Processes*, Vol. 47, pp. 313-336.

Grega L. (2003). Vertical integration as a factor of competitiveness of agriculture, *Agricultural Economy – Czech*, 49 (11), 520-525.

Grönroos, C. (2000), *Service management and marketing – A customer relationship management approach*, 2nd edition, Chichester: Wiley.

Grover, V. & Malhotra, M.K. (2003). Transaction cost framework in operations and supply chain management: Theory and measurement, *Journal of Operations Management*, Vol. 21, No. 4, pp. 457-473.

Gross, R., Leach, M. & Bauen, A. (2002). *Progress in renewable energy*, Environ. International.

Gummesson, E. (1991), *Qualitative methods in Management Research*, Newbury Park: Sage Publications, Inc.

Hair, J.F. Jr., Babin, B., Money, A.H., & Samouel, P. (2003). *Essentials of business research methods*, Hoboken: Wiley.

Hamel, G. & Prahalad, C.K. (1994). Competing for the future, *Harvard Business Review*, July-August, pp. 122-128.

Handfield, B.R. & Moore, B. (2000). *Deregulation in the energy industry: A vision of the future.* Center for Advanced Purchasing Studies.

Handfield, B.R. (2004). The impact of energy deregulation on sourcing strategy, *The Journal of Supply Chain Management*, Spring 2004.

Harland, C. (1996). Supply chain management: Relationships, chains and networks, *British Journal of Management*, Vol. 7, pp. 63-80.

Harrigan, K. R. (1983). A framework for looking at vertical integration, *Journal of Business Strategy*, Vol. 3, pp. 30-37.

Harrigan, K. R. (1984). Formulating vertical integration strategies, *Academy of Management Review*, Vol. 9, pp. 638-652.

Harrigan, K. R. (1985). Strategies for intrafirm transfers and outside sourcing, *Academy of Management Journal*, Vol. 28, pp. 914-925.

Harrigan, K. R. (2001). Strategic flexibility in the old and new economy, in C. W. L. Hitt, R. E. Freeman, & H. J. S. (Eds.), *Handbook of Strategic Management*, Malden, MA: Blackwell, pp. 97-123.

Harrison, E. F. (1999), *The Managerial Decision-Making Process* (5th ed.), Boston: Houghton Mifflin.

Hass, R. & Auer, R. (2005). *The prerequisites for effective competition in restructured wholesale electricity markets*, IEEE.

Hayek, F.A. (1945). The use of knowledge in society, *American Economic Review*, Vol. 34, No. 3, pp. 519-53.

Heide, J.B. (1994), Interorganizational governance in marketing channels, *Journal of Marketing*, Vol. 58, No. 1, pp. 71-85.

Hines, P. (1995). Network sourcing: A hybrid approach, *International Journal of Purchasing and Materials Management*, Spring, pp. 18-24.

Hodgson, T. (2004). *Strategic thinking with scenarios*.

Hogan, S. & Maede, R. (2007). *Vertical integration and market power in electricity markets.*

Hogan, W., Rosellón, J. & Vogelsang, I. (2007). Toward a combined merchant-regulatory mechanism for electricity transmission expansion, Conference Proceedings, 9th IAEE European Energy Conference, Florence, Italy.

Hokkanen, J. & Salminen, P. (1995). Choosing a solid waste management system using multicriteria decision analysis, *European Journal of Operational Research*, Vol.98, pp. 19-36.

Hokkanen, J., Salminen, P., Rossi, E. & Ettala, M. (1995). The choice of a solid waste management system using the ELECTRE II decision-aid method, *Waste Management and Research* 13, pp. 175-193.

Hope, E. & Torsten, B. (2004). Electricity market reform: The Norweigen experience, Discussion Papers No. 433, Statistics Norway, Research Department.

Iyer, G. R (1996). Strategic decision making in industrial procurement: Implications for buying decision approaches and buyer-seller relationships, *Journal of Business & Industrial Marketing*, Vol. 11, No. 3/4, pp. 80-93.

IEA (2005). *CO_2 Emission from fuel combustion*, 2005 edition. IEA/OCDE, Paris.

IEA Information Paper (2007). CO_2 *allowances and electricity price interaction: Impact on industry`s electricity purchasing strategies in Europe*.

IEEE/PES (2007). *Supply and demand for electricity in a deregulated market*. Power System Planning and Implementation Committee.

Ibarra Yunez, A. (2005). Strategic conduct and access discrimination, in the semi-liberalized electricity sector in Mexico, *Frontiers in Finance and Economics*, 1(1). Retrieved August 28, 2008.

Jamasb, T. & Pollitt, M. (2005). Center for Energy and Environmental Policy Research (CEEPR), Electricity market reform in the European Union: Review of progress toward liberalization and integration. *Energy Journal - Special Issue on European Electricity Liberalization*, pp. 11-41.

Jick, T.D. (1979). Mixing qualitative and quantitative methods: Triangulation in action, *Administrative Science Quarterly*, Vol. 24, No. 4, pp. 602-611.

Joskow, P. L. (2006). Incentive regulation in theory and practice: Electricity distribution and transmission networks, Working Papers in Economics 0607. Faculty of Economics, University of Cambridge.

John, G. and Weitz, G.A. (1988). Forward integration into distribution: An empirical test of transaction cost analysis, *Journal of Law, Economics, and Organization*, Vol. 4, No. 2, pp. 337-355.

Johnson, G. & Scholes, K. (1999). *Exploring corporate strategy*, 6^{th} edition, Pearson education limited, Essex.

Joskow, P. L. (1985). Vertical integration and long term contracts: The case of coal burning electric generating stations, *Journal of Law*.

Joskow, P. L. (2006). Incentive regulation in theory and practice: Electricity distribution and transmission networks, Working Papers in Economics 0607, Faculty of Economics, University of Cambridge.

Kalwani, M. U. & Narayandas, N. (1995). Long-term manufacturing supplier relationships: Do they pay off for supplier firms? *Journal of Marketing*, Vol. 59, pp. 1-16.

Keeney, R.L. & Raiffa, H. (1976). *Decisions with multiple objectives: Preferences and value tradeoffs*, John Wiley & Sons: New York.

Keeney, R.L. (1982). Decision Analysis: An overview, *Operations Research*, Vol. 30, No. 5.

Kessides, I. (2003). *Infrastructure Regulation Promises, Perils, and Principles*. AEI-Brookings Joint Center for Regulatory Studies, Related Publication 03-15.

King A.A. & Tucci C.L. (2002). Incumbent entry into new market niches: The role of experience and managerial choice in the creation of dynamic capabilities, *Management Science*, Vol. 48, No.2, February 2002, pp. 171-186.

King, R. (2007*). The regulatory state in an age of governance: Soft words ad big sticks,* Basingstoke, UK: Palgrave Macmillan.

Kraljic, P. (1983). *Purchasing must become supply management*, Harvard Business Review, Vol. 61, No. 5, pp. 109-117.

Kumar, D. (2001). *Market power in electricity supply*, IEEE Transactions on Energy Conversion, Vol.16, No. 4.

Krumm, P., Dewulf, G. & de Jonge, H. (1998). Managing key resources and capabilities: Pinpointing the added value of corporate real estate management, *Facilities*, Vol. 16, No. 12/13, pp. 372-379.

Künneke, RW. & Fens, T. (2007). Ownership unbundling in electricity distribution: the case of the Netherlands, *Energy Policy*, 35, pp. 1920-1930.

Lehtonen, T. and Salonen, A. (2006). An empirical investigation of procurement trends and partnership management in FM services – A Finnish survey, *International Journal of Strategic Property Management*, Vol. 10, No. 2.

Levitt, B. & March, J.G. (1988). Organizational learning, *Annual Review of Sociology*, Vol. 14, pp. 319-340.

Lillis, K. (1997). *Electricity Reform Abroad and U.S. Investment: Electricity Restructuring and Privatization in the United Kingdom*.

Littlechild, S. (2008). *Regulation, Over-Regulation and Deregulation*. Centre for Study of Regulated Industries, Occasional Lecture 22.

Liedtka, J. M. (1998), Linking strategic thinking with strategic planning, *Strategy and Leadership, Vol.* 26, No. 4, pp. 30–35.

Ljiljana, O. (2009). *Statistical Information 2009*. Zagreb: Central Bureau of Statistics of the Republic of Croatia.

Lonsdale, C. (1999). Effectively managing vertical supply relationships: A risk management model for outsourcing, *Supply Chain Management: An International Journal*, Vol. 4, pp. 176-183.

Madlener, R. & Stagl, S. (2004). *Sustainability-guided promotion of renewable electricity generation*, Ecological Economics.

Magnet A. (2008). Methodological Approach to Power Supply - Spanish Case. Lausanne: College of Management of Technology.

Maza A,;Hierroa M. & Villaverdea J. (2009) *Renewable electricity consumption in the EU-27: Are cross-country differences diminishing?* Renewable Energy Volume 35, Issue 9, September 2010, Pages 2094-2101

McCall, Morgan W., Jr., & Kaplan, Robert K. (1990), *Whatever it takes: The realities of managerial decision making* (2nd ed.), Englewood Cliffs, NJ: Prentice-Hall.

McCutcheon, D. & Stuart, F.I. (2000). Issues in the choice of supplier alliance partners, *Journal of Operations Management*, Vol. 18, No. 3, pp. 279-30.

Meneghetti, A. & Chinese, D. (2002). Perspectives on facilities management for industrial districts, *Facilities*, Vol. 20, No. 10, pp. 337-348.

Mentzer, J.T., Min, S. & Zacharia, Z.G. (2000). The nature of interfirm partnering in supply chain management, *Journal of Retailing*, Vol. 76, No. 4, pp. 549-568.

Miles, M. B., & Huberman, A. M. (1994), *Qualitative data analysis*. Thousand Oaks: Sage, London.

Mintzberg, H., Quinn, J. and Ghoshal, S. (1999). *The Strategy Process*, revised edition, Pearson Education Limited, pp. 1036.

Min, H. & Galle, W. (1991). International purchasing strategies of multinational U.S. firms, *International Journal of Purchasing and Material Management*, pp. 9-18.

Mintzberg, H. (1978). Patterns in strategy formation, *Management Science*, pp. 934- 948.

Mintzberg, H., & McHugh, A. (1985). Strategy Formation in Adhocracy, *Administrative Science Quarterly*, Vol. 30, No. 2, pp. 160-197.

Mintzberg, H., & Waters, J. (1982). Tracking strategy in an entrepreneurial firm, *Academic of Management Journal*, pp. 465-499.

Mintzberg, H. & Waters, J. (1985). Of Strategies, Deliberate and Emergent, *Strategic Management Journal*, Vol. 6, pp. 257-272.

Mintzberg, H. (1994). *The rise and fall of strategic planning*. New York: Prentice Hall.

Mintzberg, H., Quinn, J. & Ghoshal, S. (1999). *The Strategy Process*, revised edition. Pearson Education Limited, pp. 1036.

National Grid (2009). *GB Transmission System Performance Report.* London.

National Renewable Energy Laboratory, NREL (2002). *Renewable energy cost trends.*

National Rural Electric Cooperative Association (NRECA) (2007). *White paper on distributed generation.*

Newbery, D. (2002). *Mitigating market power in electricity networks*. Mimeo, Department of Applied Economics, Cambridge University, May 2002.

Newman, R. (1988). Single source qualification, *Journal of Purchasing and Materials Management*, Summer, pp. 10-17.

Niiniluoto, I. (1984), johdatus tieteen filosofiaan. Käsitteen ja teorian muodostus. (Introduction to *Philosophy of science*, *building theory and a concept*), Helsinki: Otava.

Oko Institute & Ilex Consulting (2006). *Carbon countdown: Emission trading to combat Climate Changes.* PowerSwitch.

Owen, G. (2006). Sustainable development duties: New roles for UK economic regulators, *Utilities Policy*, 14, pp. 208-217.

Ognajanovic, D. (2007). *Energy Sector in Croatia.* Lausanne: College of Management of Technology.

Parker, D. & Hartley, K. (1997). The economics of partnership sourcing versus adversarial competition: A critique, *European Journal of Purchasing & Supply Management*, Vol. 3, No. 2, pp. 115-125.

Patton, M.Q. (1999). Enhancing the quality and credibility of qualitative analysis, *Health Services Research*, Vol. 34, No. 5, pp. 1189-1208.

Platts (2004). *Power in Europe, periodical publications.* London: McGraw-Hill.

Pearson, J. & Gritzmacher, K. (1990). Integrating purchasing into strategic management, *Long Range Planning*, Vol. 23, No. 3, pp. 91-99.

Plourde (eds.), Proceedings of the 26th Annual IAEE International Conference *New Challenges for Energy Decision Makers* (Prague, Czech Republic, 4-7 June 2003), International Association of Energy Economics.

Porter, M. (1976). Please note location of nearest exit: Exit barriers and strategic and organizational planning, *California Management Review*, 19, 21-33.

Porter, M. E. (1985), *Competitive advantage*. New York: Free Press.

Porter, M.E. (1991). Towards a dynamic theory of strategy. *Strategic Management Journal*, Vol. 12, Special issue: Fundamental research issue in strategy and economics, pp.95-117.

Porter, M. (1998). *Competitive Strategy. Techniques for Analyzing Industries and Competitors*, Free Press, pp. 396.

Quayle, M. (1998). Industrial procurement: factors affecting sourcing decisions, *European Journal of Purchasing and Supply Management*, Vol. 4, pp. 199-205.

Quinn, J.B. (1980). *Strategies for change: Logical incrementalism*. Homewood, IL: Richard D. Irwin.

Quinn, J. & Hilmer, F. (1994). Strategic outsourcing, *Sloan Management Review*, Summer, pp. 43-55.

Quinn, J., Mintzberg, H. & James, R. (1988). *The strategy Process. Concepts, contexts, and cases.* Englewood Cliffs: Prentice-Hall.

Quinn, J.B. (1980). *Strategies for change: Logical incrementalism*, Homewood, IL: Richard D. Irwin.

Quinn, J. & Hilmer, F. (1994). Strategic outsourcing, *Sloan Management Review*, Summer, pp. 43-55.

Quinn, J., Mintzberg, H. & James, R. (1988). *The strategy Process. Concepts, Contexts, and Cases.* Englewood Cliffs: Prentice-Hall.

Ramsay, J. (2001). Purchasing's strategic irrelevance, *European Journal of Purchasing & Supply Management*, Vol. 7, No. 4, pp. 257-263.

Ramsay, J. & Wilson, I. (1990). Sourcing/Contracting strategy selection, *Operations & Production Management*, Vol. 10, No. 8, pp. 19-28.

Reinaud, J. (2005). *Industrial Competitiveness and the EU Emissions Trading Scheme*, IEA, Information Paper, IEA/OECD, Paris.

Reinaud, J. (2005). *The European Refinery under the EU Emissions Trading Scheme - Competitiveness, Trade flows and Investment Implications*, IEA Information Paper, IEA/OECD, Paris.

Remeney, D., Williams, B., Money, A., & Swartz, E. (1998). *Doing Research in Business and Management*, Sage Publications.

Ringland, G. (1998). *Scenario Planning: Managing for the Future*. Chichester: John Wiley & Sons.

Robson, C. (2002). *Real World Research: resource for social scientists and practitioner researchers (2nd. ed).* Blackwell Scientists Inc.

Robinson, J. (1988). Unlearning and backcasting: Rethinking some of the questions we ask about the future, *Technological Forecasting and Social Change*, Vol. 33, No. 4, pp. 325–338.

Rogers, G. & Bouey, E. (1996). Collecting your data, in Tutty, L.M., Rothery, M., and Grinnell, R.M. Jr. (Eds.), *Qualitative research for social workers – Phases, steps, & tasks*. Boston: Allyn and Bacon, pp. 50-87.

Rohrbeck et al (2006) *The Technology Radar – an Instrument of Technology Intelligence and Innovation Strategy.* Deutsche Telekom Laboratories.

Remeney, D., Williams, B., Money, A., & Swartz, E. (1998). *Doing Research in Business and Management*. Sage Publications.

Ropenus, S. & Skytte, K (2005). *Regulatory Review and Barriers for the Electricity Supply System for Distributed Generation in EU-15*. RISO National Laboratory.

Saunders, M., Lewis, P. & Thornhill, A. (2000). *Research Methods for Business Students*, Prentice Hall.

Schoemaker, P. (1995), Scenario planning: A tool for strategic thinking, *Sloan Management Review*, Winter edition, pp. 25-40.

Schoemaker, P. J. H. & Schuurmans, F. (2003). Opportunity in uncertainty: Techniques for turning an unpredictable future to your advantage, *Association Management*, Vol. 55, pp. 49-52.

Schwarz, P. (1996). *The art of the long view: Planning for the future in an uncertain world.* New York: Doubleday.

Sioshansi, F. & Pfaffenberger, W (2006). *Market reform and International perspective*, Elsevier Ltd.

Slaughter, R. (1999). *Futures for the third Millennium: Enabling the forward view*, Prospect Media, Sydney.

Smeltzer, L. (1997). Conditions that create influence for purchasing in corporate strategic planning, *The Center for Advanced Purchasing Studies, CAPS*, pp. 88.

Sonmez, M. (2006). A review and critique of supplier selection process and practices, *Occasional Papers Series: 2006/1*. Loughborough University.

Spekman, R. E. (1985). Competitive procurement strategies: Building strength and reducing vulnerability, *Long Range Planning*, Vol.18, No. 1, pp. 94-99.

Steele, P. & Court, B. (1996). *Profitable purchasing strategies, A manager's guide for improving organizational competitiveness through the skills of purchasing*, McGraw-Hill, London, pp. 232.

Stern, J. & Cubbin, J. S. (2005). *Regulatory effectiveness: The impact of regulation and regulatory governance arrangements on electricity industry outcomes*. World Bank Policy Research Working Paper, No. 3536.

Steuer, R. (1986). *Multiple Criteria Optimization: Theory, Computation and Application.* New York: Wiley.

Streimikiene, D. (2001). Applying multi-criteria aid for decision making in favor of clean coal technologies, *Environmental research, engineering and management*, Vol. 4, No. 18, pp.11-18.

Talluri, P. (2004). *Purchasing electricity for the cement industry in regulated markets and deregulated markets*, IEEE.

Tanner, J. F. (1998). Users' role in the purchasing: their influence, satisfaction and desire to participate in the next purchase, *Journal of Business & Industrial Marketing*, Vol. 13, No. 6, pp. 479-491.

Teece D.J., Pisano G. & Shuen A. (1997). Dynamic capabilities and strategic management, *Strategic Management Journal*, Vol. 18, No. 7, pp. 509-533.

Thorelli, H.B. (1986). Networks: between markets and hierarchies, *Strategic Management Journal*, Vol. 7, No. 1, pp. 37-51.

Tucci, C.L. & Cusumano M.A. (1994). *Benefits and pitfalls of international strategic technology alliances*. The International Center for Research on the Management of Technology, Sloan Working Paper, No. 3706-94.

Tirole, J. (1988). *The theory of industrial organization*. Cambridge: MIT Press.

Treviño, L. (2007). *Power regulatory framework & opportunities for self-supply*. Lausanne: College of Management of Technology – Norway 10th International conference on Technology Policy and Innovation.

Treviño, L. (2007). *Electricity sourcing methodology to build a strategy*. Lausanne: College of Management of Technology – Portugal The 4th European Congress Economics and Management of Energy in Industry.

Treviño, L. (2008). *Necessities and resources of industrials – United Kingdom Case*. Lausanne: College of Management of Technology, Working Paper.

Treviño, L. (2008). *Liberalization of the electricity market in Europe*, Lausanne: College of Management of Technology, Working Paper.

Treviño, L. (2008). *Large industrials and electricity sourcing during the process of liberalization.* Lausanne: College of Management of Technology, Working Paper

Trevino, L. (2008). *Reliability of electricity supply in Bangladesh*, Lausanne: College of Management of Technology – Working Paper.

Treviño, L. (2009). *Methodology to build a power sourcing strategy*. Lausanne: College of Management of Technology – DAVOS R´09 Twin World Conference-Resource and technology for material and energy efficiency.

Treviño, L. (2009). *Vertical integration as response to market changes.* Lausanne: College of Management of Technology, 2nd Annual Conference on Competition and Regulation in Network Industries – Centre for European Policy Studies, Brussels, Belgium.

Treviño, L. (2010). *The Cement Industry and the Clean Development Mechanism, Success Commissioning of 250 MW EURUS Wind Farm in Oaxaca Mexico* – CEMTECH – DUBAI – International Cement Conference.

UIC (2007). Renewable energy and electricity, *Nuclear Issues Briefing Paper 28*, Australian Uranium Association.

UKERC (2006). *The costs and impact of intermittency: An assessment of the evidence on the costs and impacts of intermittent generation on the British electricity network.* Report of the Technology and Policy Assessment Function of the UK Energy Research Centre.

UNEP (2004). *Financial risk management instruments for renewable energy projects – Summary Document*, United Nations Environment Programme Division of Technology, Industry and Economics.

Union of Electricity Industry (UEI) (2004). *Ensuring investments in liberalized electricity sector,* ref: 2004-180-0001.

Van Weele, A. (2002), *Purchasing and supply chain management – analysis, planning and practice*. London: Thomson Learning.

Van der Heijden, K. (1996). *Scenarios: The art of strategic conversation*. John Willey & Sons.

Van Weele, A. (2002). *Purchasing and supply chain management – analysis, planning and practice*. London: Thomson Learning.

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002*).* Case research in operations management, *International Journal of Operations & Production Management*, Vol. 22, No. 2, pp. 195-219.

Venkatesan, R. (1992). Strategic sourcing – Make or not to make, *Harvard Business Review*, Vol. 70, No. 6, pp. 98-107.

Ventovuori, T. (2004). Sourcing strategies in real estate services in proceedings of the 13th IPSERA Conference, pp. DP-56 – DP-60.

Verma, R. & Pullman, M. (1998). An analysis of the supplier selection process, *Omega, International Journal Management Science*, Vol .26, No. 6, pp.739-750.

Vincke, P. (1992). *Multicriteria Decision Aid*. New York: Wiley.

Von Winterfeldt, D. (1980). Structuring decision problems for decision analysis, *Acta Psychol*, Vol. 45, pp. 71-93.

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management, *International Journal of Operations & Production Management*, Vol. 22, No. 2, pp. 195-219.

Voros, J. (2003). A generic foresight process framework, *Foresight, the Journal of Future Studies, Strategic Thinking and Foresight*, Vol. 3, No. 1, pp.10-21.

Wals, A. F., Cross, E. & Van Sambeek, E. J. W. (2003). *Review of current electricity policy and regulation.* Energy Research Centre of the Netherlands (ECN).

Walsh, P. (2005). Dealing with the uncertainties of environmental change by adding scenario planning to the strategy reformulation equation, *Management Decision*, Vol. 43, No. 1, pp. 113-122.

Weber, C.A., Current, R.J. & Benton, W.C. (1991). Vendor selection criteria and methods, *European Journal of Operational research*, Vol.50, pp. 2-28.

Webster, F.E. Jr. (1992). The changing role of marketing in the corporation, *Journal of Marketing,* Vol. 56, No. 4, pp. 1-17.

Whitham, J. (1996). *Utility deregulation and the role of standby generators*. ENCORP, Inc.

Williams, W. S. (2002*). Making better business decisions: Understanding and improving critical thinking and problem solving skills*. Thousand Oaks, CA: Sage Publications.

Williamson, E.O. (1971). The vertical integration of production: Market failure considerations, *American Economic Review*, Vol. 61, pp. 112-123.

Williamson, E. O. (1975*). Markets and Hierarchies: Analysis and Antitrust Implications.* New York: Free Press.

Williamson, E. O. (1983). Credible commitments: Using hostage to support exchange, *American Economic Review*, Vol. 73, pp. 519-540.

Williamson, E. O. (1985). *The Economic Institutions of Capitalism.* New York: The Free Press.

Williamson, E. O. (1996). *The mechanisms of governance*. New York: Oxford University Press.

Wiser, R. & Bolinger, M. (2004). *The value of renewable energy as a hedge against fuel price risk.* Submitted for Publication. Proceedings: World Renewable Energy Congress VIII. August 29 – September 3, 2004. Denver, Colorado.

Wilson, I. (2000). *From scenario thinking to strategic action*, *Technological Forecasting and Social Change*, Vol. 65, Issue 1, September 2000, pp. 23-29.

Yin, R. (1994). *Case study research: Applied Social Research Methods Series*. Vol. 5, Thousand Oaks, CA: Sage Publication.

Yin, R. (2003). *Case Study Research*: *Design and methods* (3rd ed.). Beverly Hills, CA: Sage Publishing.

Zeng A. (2000). A synthetic study of sourcing strategies, *Industrial Management & Data Systems*, Vol. 100, No. 5, pp. 219-226.

ANNEX 1

Questionnaire: Energy market structure

The aim of this questionnaire is to obtain your feeback on liberalization process in your country. This would help then me to better understand the factors affecting different electricity market structure in EU countries and to understand how liberalization porocess has been progressing under different circumstances within Europe.

The whole questionnaire is divided into three topics, as they follow:

Part 1: The first part of the questionnaire is related to the regulatory framework in energy sector for particular country;
Part 2: The second part to the organization of generation activity; and
Part 3: The third part to the electricity supply market.

The gathered info should provide a general picture about the electricity market for the country of interest, and help me to recognize what would be or what are barriers or opportunities for large industrials in power sourcing domain. The company`s representative is expected to answer on set of questions, that are defined either as yes-no questions or as multiple answer questions. Only minority of questions require more detail explanantions to be answered.

Before you start filling up the form, please state the data related to your company:

Country:

Company's name:

Contact email address:

Choose on of proposed functions that describe your position on the energy market. Multiple answers possible.

a) Regulator
b) Supplier
c) Generator
d) Trader
e) Consumer
f) Other:

Questions

Part 1: Objective - To understand the Regulatory Framework of the country

1 **Do you recognize any institution in your country as Energy Regulator?**

- Yes
- No

2 **Do you recognize any institution in your country as Transmission System Operator?**

- Yes State: ______
- No

3 **Do you recognize any institution in your country as Market Operator?**

- Yes State: ______
- No

4 **How could you characterize Generation and Supply sectors in your country:**

- Bundled - generation and supply activities managed by Vertical Utility (private or state owned)
- Generation sector theoretically unbundled, but in practice mainly managed by Vertical Utility (private or state owned)
- Supply sector theoretically unbundled, but in practice mainly managed by Vertical Utility (private or state owned)
- Unbundled - full competion in generation and supply sectors

Part 2: Objective - To gain an overall picture about generation sector in your country

5 **Please describe the situation in generation sector in your country:**

- [ ] Monopoly - state or private owned company
- [ ] Oligopoly - One big player and few small generators
- [ ] Competitive - Many independent power producers, having operations on equal basis
- [ ] Other. State: ______________________

6 **Do large industrial users as self-generators have the possibility to connect their facilility to the grid?**

- [ ] Yes
- [ ] No (go to 10)

7 **If so, can they sell generated electricity?**

- [ ] Yes
- [ ] No (go to 10)

8 **Could you choose the answer which describes the way how generated power by large industrials has been sold (multiple answers are possible):**

- [ ] To the State or Private owned, dominant supplier
- [ ] On Wholesale Market
- [ ] On Retail Market
- [ ] As part of RE Promotion mechanisms
- [ ] Other State: ______________________

9 **Sold - generated power is priced as (multiple answers are possible):**

- [ ] Fixed - cost based price
- [ ] Floating - market based price
- [ ] According to the RE Mechanims, state the type of the mechanism: ______________________
- [ ] Other, state: ______________________

Part 3: Objective - To gain an overall picture on power supply in your country

10 **How could you describe supply sector in the country where you source power:**

- [ ] Monopoly - state or private owned vertical utility
- [ ] Oligopoly - One dominant state-owned supplier
- [ ] Oligopoly - one dominant private-owned supplier
- [ ] Competitive environment - Many suppliers
- [ ] Other, state: ____________

11 **Does anyone in the country have possibility to choose power supplier:**

- [ ] Privileged consumers State conditions: ____________
- [ ] Anyone (housholds, commercials, industrials, etc.)
- [ ] None

12 **Could you please choose which of proposed characteristics describe the contract structure for power supply ? Multiple answers possible**

Length of the contract:

- [ ] Long- term contract
- [ ] Short-term contract

Price structure:

- [ ] Tariff structure - bundled payment
- [ ] Unbundled - separately charges for energy and delivery

Price determination:

- [ ] Cost based
- [ ] Market based

Can large users negotiate the contract conditions, either energy price or delivery charges or payment conditions:

- [ ] Anyone Which of these three factors: ____________
- [ ] Priviledged users - Only under specific conditions: ____________
- [ ] None

Is Aggregated contract available:

- [ ] Yes
- [ ] Only under the specific conditions State conditions: ____________
- [ ] No

Call on interruptibility is possible to be set as a part of supply contract:

- [ ] Yes
- [ ] Only under the specific conditions State conditions: ____________
- [ ] No

Can large users re-negotiate or adjust the initial contract on supply, whenever it is required or necessary:

- [ ] Yes
- [ ] Only under the specific conditions State conditions: ____________
- [ ] No

13 **Can a large industrial gain the status of "The Agent of the market" and be in position to re-sell electricity:**

- [ ] Anyone
- [ ] Only under the specific conditions State conditions: ____________
- [ ] None

14 **If they act as Agent of the market, do they have the possibility to import or export power ? Multiple answers possible**

- [ ] Yes, both
- [ ] Import is allowed under the specific regime State conditions: ____________
- [ ] Export is allowed under the specific regime State conditions: ____________
- [ ] None of activities is allowed

ANNEX 2

Questionnaire: Sourcing Options

The purpose of this questionnaire is to collect data, relevant to provide an explicit and comprehensible picture on sourcing strategies, used by large customers to source power in current market conditions. This would help me to better understand how liberalization process has affected the sourcing habit of energy intensive users.

The whole questionnaire consists of three parts according to three market structures:
- Part 1: Pre-competitive Market structure,
- Part 2: Transitional Market structures, and
- Part 3: Competitive Market structure,

which could be found since the process of liberalization started.

Before filling out the questionnaire, the company's representative is kindly asked to chose the appropriate market structure, specific for the country where does the company source its needs. Based on selected market structure, the representative is expected to answer on set of questions, that are defined either as yes-no questions or as multiple answer questions. Only minority of questions require more detail explanantions to be answered.

Before you start filling up the form, please state the data related to your company.

Country:

Company's name:

Contact email address:

Questions

Part 1: Objective - To provide information on supply options used by large industrials in PRE-COMPETITIVE MARKET STRUCTURE

1 **Could you state how does the company source electricity?**

- ☐ Under the tariff structure
- ☐ Self generating (go to 12)

2 **What is the structure of the price:**

- ☐ Peak tariff (go to 4)
- ☐ Flat tariff price
- ☐ Other tariffs (go to 4) State: ______

3 **Can the company switch from flat to peak tariff structure?**

- ☐ Yes
- ☐ No

4 **Mark the level of interruptions or reliability of supply:**

- ☐ Low (highly reliable supply)
- ☐ Medium
- ☐ High (not reliable supply)

5 **Which of the following best describes how does the company manage its demand?**

- ☐ Doing nothing (energy efficiency actions)
- ☐ Interruptable contract (go to 8)
- ☐ Load management activities (changing demand curve) (go to 8)
- ☐ Self-generating (go to 10)

6 **Does the company have an operational flexibility to change the consumption pattern?**

- ☐ Yes
- ☐ No (go to 8)

7 **Can you arrange interruptible contract?**

- ☐ Yes
- ☐ No

8 **Is it feasible for the company to generate electricity ?**

- ☐ Yes
- ☐ No (finish)

9 **If the company decides to generate electricity, is it allowed to sell generated electricity?**

- ☐ Yes
- ☐ No (go to 18)

9a **Could you choose the answer which describes the way how generated power could be sold (multiple answers are possible):**

- [ ] To the State or Private owned, dominant supplier
- [ ] As part of RE Promotion mechanisms
- [ ] Other State: ____________________

10 **Which of the following best describes the way generation unit is used:**

- [ ] Only in peak hours (cost reduction) (go to 11)
- [ ] Back-up to improve reliability of supply (go to 11)

11 **Please provide some data concerning the power unit:**

- [ ] KWh Installed capacity
- [ ] % Power output vs. Company's demand

12 **Please select the type of fuel used for power generation:**

- [ ] RES (go to 15)
- [ ] Fossil fuel (go to 13)

13 **As the company uses fossil fuel for power generation, which of the following actions describes the way how is the CO_2 cost managed?**

- [ ] using CO_2 allowances (go to 14)
- [ ] through CO_2 capture projects (go to 16)
- [ ] In the country there are not regulations on CO_2 emissions (go to 16)

14 **The company is allocated with CO_2 allowances using one of two proposed methods:**

- [ ] Free allocation (go to 16)
- [ ] Purchasing allowances (go to 16)

15 **Does the company use some subsidies to generate power using RES?**

- [ ] Yes
- [ ] No

16 **Does the company sell the produced electricity?**

- [ ] Yes
- [ ] No (go to 18)

17 **How does the company sell or could sell the power generated?**

- [ ] The company has an arrangement with the Government (fossil or renewable based).
- [ ] The company sells RE according to the RES promotion regime.
- [ ] They can not sell the power at all.

18 **Could you state why the company does not sell or can not sell generated power?**

- [ ] Grid connection is not allowed
- [ ] Government is not interested to purchase the power
- [ ] Profitability reasons (low price)
- [ ] Power purchase is a new option appeared recently

Part 2: Objective - To provide information on supply options used by large industrials in TRANSITIONAL MARKET STRUCTURE

1 **Could you state how does the company source electricity?**

- [ ] Vertical Utility
- [ ] Any other supplier than vertical Utility
- [ ] Self-generating (go to 10)

2 **Could you please select the contract structure:**

- [ ] Bundled contract
- [ ] Unbundled contract with fixed energy price (go to 5)
- [ ] Unbundled contract with variable energy price (go to 5)

3 **As the company pays all-included electricity price, could you please state type of tariff structure used?**

- [ ] Flat tariff
- [ ] Peak tariff (go to 5)
- [ ] Real time pricing (market based tariff) (go to 5)

4 **Does the company have the right to switch the contract structure and negotiate the price of energy?**

- [ ] Yes
- [ ] No

5 **Mark the level of reliability of your current supply option:**

- [ ] Low
- [ ] Medium
- [ ] High

6 **Which of the following best describes the energy cost reduction strategy taken by your company (mulpiple answers possible):**

- [ ] Doing nothing
- [ ] Load management actions
- [ ] Interruptible contracts
- [ ] Contracts on adjustement
- [ ] Aggregated load contracts
- [ ] Cross market contracts
- [ ] Indexed contracts
- [ ] Contracts based on fixed quantity and floating energy price
- [ ] Self-generation (go to 8)

7 **Does the company have operational flexibility to change load pattern?**

- [ ] Yes
- [ ] No (go to 9)

8 **If the company generates electricity (back-up or main supply option), could you please provide some data concerning to the power unit?**

- [ ] kWh Installed capacity
- [ ] % Power output vs. Company's demand

9 **Which of the following best describes the way generation unit is used:**

- [ ] Self-supply
- [ ] Only in peak hours
- [ ] Back-up to improve reliability of supply

10 **Please select the type of fuel used for power generation:**

- [ ] Renewable energy sources (RES)
- [ ] Fossil fuel (go to 12)

11 **Does the company use some subsidies to generate power using RES?**

- [ ] Yes (go to 14)
- [ ] No (go to 14)

12 **As the company uses fossil fuel for power generation, which of the following actions describes the way how is the CO_2 cost managed?**

- [ ] using CO_2 allowances
- [ ] through CO_2 capture projects (go to 14)
- [ ] In the country there are not regulations on CO_2 emissions (go to 14)

13 **The company is allocated with CO2 allowances using one of two proposed methods:**

- [ ] Free allocation
- [ ] Purchasing allowances

14 **Does the company sell the produced electricity?**

- [ ] Yes
- [ ] No (go to 16)

15 **How does the company sell or could sell the power generated?**

- [ ] The company has an arrangement with the Government (fossil or renewable based)
- [ ] The company sells RE according to the RES promotion regime.
- [ ] To wholesale market

16 **Could you state why the company does not sell or can not sell generated power?**

- [ ] Grid connection is not allowed (finish)
- [ ] Market power (finish)
- [ ] Profitability reasons (finish)

Part 3: Objective - To provide information on supply options used by large industrials in COMPETITIVE MARKET STRUCTURE

1 **Could you state how does the company supply electricity?**

- [ ] Intermediarry (supplier)
- [ ] Market (go to 4)
- [ ] Self-generating (go to 6)

2 **Could you please select the contract structure arranged?**

- [ ] Bundled contract: tariff structure (real timing pricing) (go to 5)
- [ ] Unbundled contract

3 **Chosse types of supply contracts you have been using:**

- [ ] Interuptible supply contract (go to 5)
- [ ] long-term contracts with the price indexed to the price of other commodity (go to 5) Commodity: ____________
- [ ] Contract on adjustement (go to 5)
- [ ] Re-negotiable supply contracts (go to 5)
- [ ] Fixed-price supply contract (go to 5)

4 **Which is the type of market used?**

- [ ] Spot
- [ ] Forward
- [ ] Wholesale

5 **Which of the following best describes the energy cost reduction strategy taken by your company?:**

- [ ] Back up generation (go to 6)
- [ ] Energy efficiency actions (go to 12)
- [ ] Load management (reducing and shedding the load) (go to 12)
- [ ] Futures(go to 12)
- [ ] Contract with fixed price and quantities (go to 12)
- [ ] Contracts with fixed quantuties but floating prices (go to 12)
- [ ] Cross market contracts(go to 12)
- [ ] interuptible contracts (go to 12)
- [ ] Indexed contracts , state the name of commodities: ________________ (go to 12)
- [ ] Load agregation contracts (go to 12)
- [ ] Forward contracts (go to 12)

6 **Which of the following best describes the reason for generation unit use:**

- [ ] To improve reliability of supply
- [ ] To manage the price of power

7 **As the company generates electricity, could you please provide some data concerning the power unit?**

- [ ] KWh Installed capacity
- [ ] % Power output vs demand

8 **Please select the type of fuel used for power generation:**

- [ ] Renewable energy sources (RES)
- [ ] Fossil fuel (go to 10)

9 **Does company use some subsidies to generate power using RES?**

- [ ] Yes (go to 12) Sate: ________________
- [ ] No (go to 12)

10 **As the company uses fossil fuel for power generation, could you state the way how does it manage CO_2 emissions cost?**

- [ ] The company is allocated by CO_2 allowances
- [ ] The company pays fee for CO2 emissio, calculated on national basis (go to 12)
- [ ] In the country there are not regulations on CO_2 emissions (go to 12)
- [ ] The company implemented CO_2 capture projects (go to 12)

11 **The company is allocated by CO2 allowances through:**

- [ ] Free allocation
- [ ] Purchasing allowances

12 **In the case, you are generating electricity, are you allowed to sell generated power?**

- [ ] Yes
- [ ] No (go to 14)

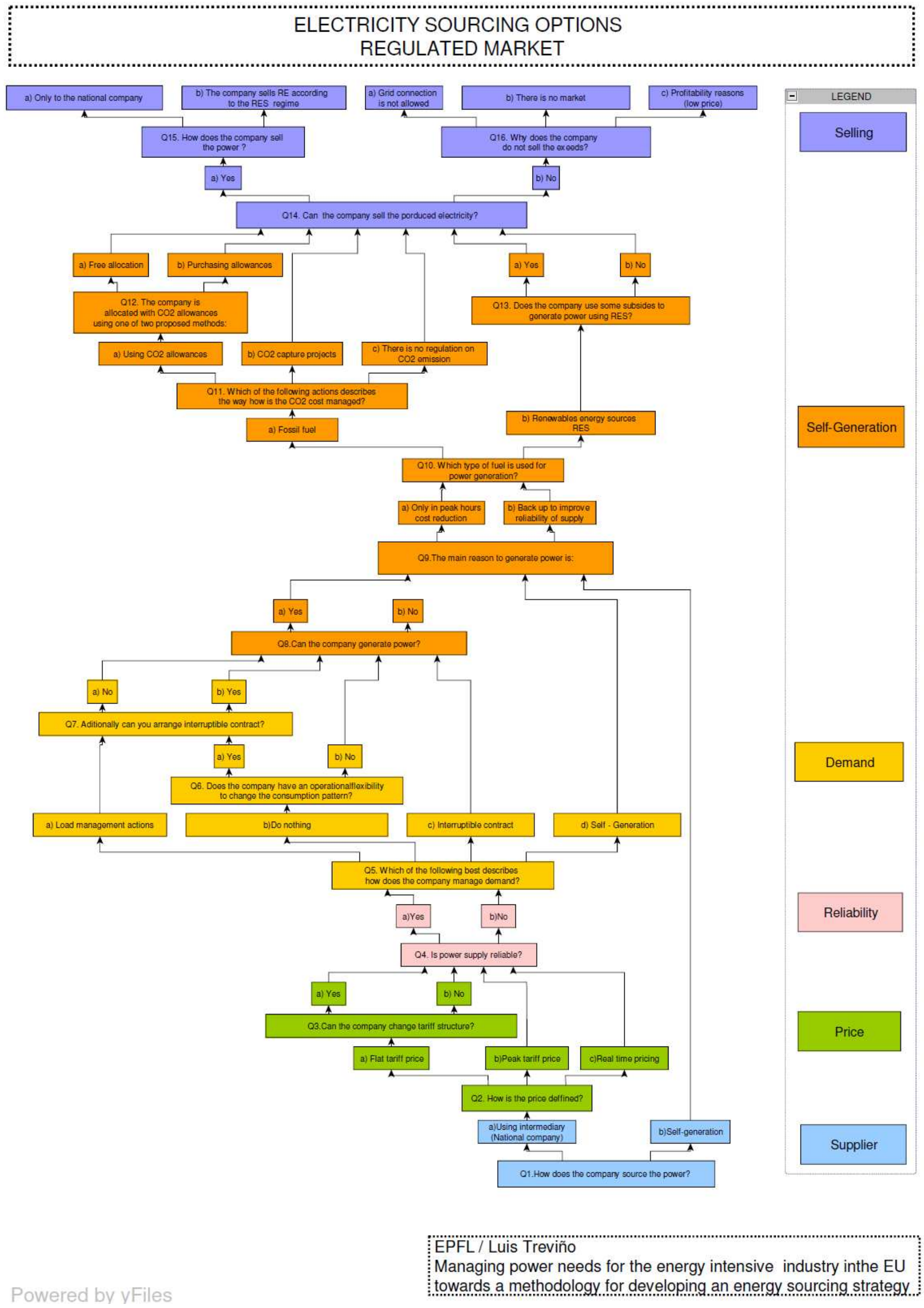
13 **How does /How might the company sell electricity?**

- [ ] The company sells RE according to the RES promotion regime State: ________________
- [ ] To the Government based on the special regime
- [ ] On retail market
- [ ] On wholesale market

14 **If the company does not sell power, could you state reasons?**

- [ ] Grid connection is not allowed (in the casse of self-generators) (Finish)
- [ ] Price of generated power is not competitive (Finish)
- [ ] "Agent of the market" status is not available yet (Finish)

ANNEX 3



ELECTRICITY SOURCING OPTIONS
REGULATED MARKET
a) Only to the national company
b) The company sells RE according to the RES regime
a) Grid connection is not allowed
b) There is no market
c) Profitability reasons (low price)
Q15. How does the company sell the power ?
Q16. Why does the company do not sell the exeeds?
a) Yes
b) No
Q14. Can the company sell the porduced electricity?
a) Free allocation
b) Purchasing allowances
a) Yes
b) No
Q12. The company is allocated with CO2 allowances using one of two proposed methods:
Q13. Does the company use some subsides to generate power using RES?
a) Using CO2 allowances
b) CO2 capture projects
c) There is no regulation on CO2 emission
Q11. Which of the following actions describes the way how is the CO2 cost managed?
a) Fossil fuel
b) Renewables energy sources RES
Q10. Which type of fuel is used for power generation?
a) Only in peak hours cost reduction
b) Back up to improve reliability of supply
Q9.The main reason to generate power is:
a) Yes
b) No
Q8.Can the company generate power?
a) No
b) Yes
Q7. Aditionally can you arrange interruptible contract?
a) Yes
b) No
Q6. Does the company have an operationalflexibility to change the consumption pattern?
a) Load management actions
b)Do nothing
c) Interruptible contract
d) Self - Generation
Q5. Which of the following best describes how does the company manage demand?
a)Yes
b)No
Q4. Is power supply reliable?
a) Yes
b) No
Q3.Can the company change tariff structure?
a) Flat tariff price
b)Peak tariff price
c)Real time pricing
Q2. How is the price deffined?
a)Using intermediary (National company)
b)Self-generation
Q1.How does the company source the power?
LEGEND
Selling
Self-Generation
Demand
Reliability
Price
Supplier
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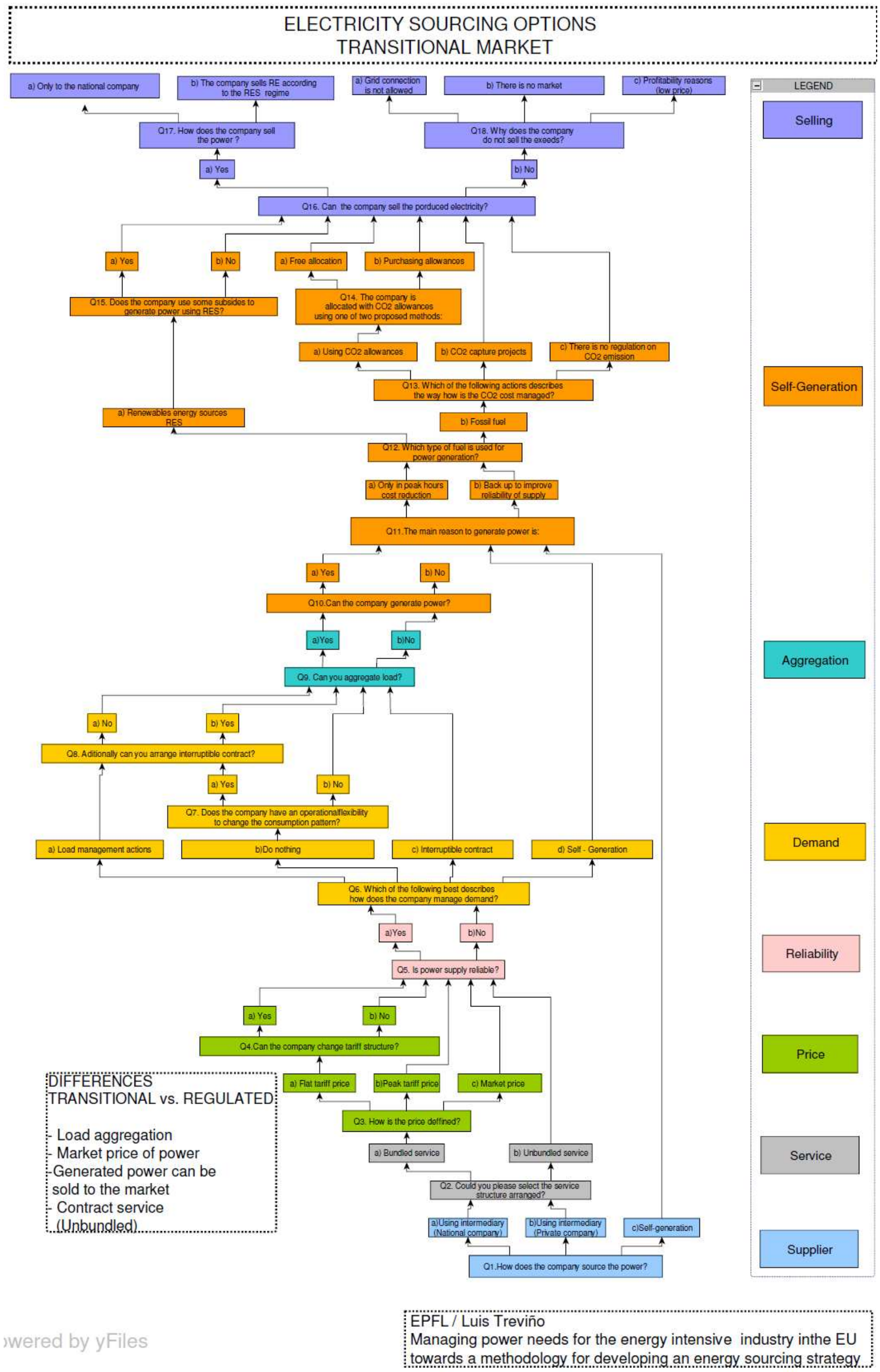
ELECTRICITY SOURCING OPTIONS
TRANSITIONAL MARKET
a) Only to the national company
b) The company sells RE according to the RES regime
a) Grid connection is not allowed
b) There is no market
c) Profitability reasons (low price)
Q17. How does the company sell the power ?
Q18. Why does the company do not sell the exeeds?
a) Yes
b) No
Q16. Can the company sell the porduced electricity?
a) Yes
b) No
a) Free allocation
b) Purchasing allowances
Q15. Does the company use some subsides to generate power using RES?
Q14. The company is allocated with CO2 allowances using one of two proposed methods:
a) Using CO2 allowances
b) CO2 capture projects
c) There is no regulation on CO2 emission
Q13. Which of the following actions describes the way how is the CO2 cost managed?
a) Renewables energy sources RES
b) Fossil fuel
Q12. Which type of fuel is used for power generation?
a) Only in peak hours cost reduction
b) Back up to improve reliability of supply
Q11.The main reason to generate power is:
a) Yes
b) No
Q10.Can the company generate power?
a)Yes
b)No
Q9. Can you aggregate load?
a) No
b) Yes
Q8. Aditionally can you arrange interruptible contract?
a) Yes
b) No
Q7. Does the company have an operationalflexibility to change the consumption pattern?
a) Load management actions
b)Do nothing
c) Interruptible contract
d) Self - Generation
Q6. Which of the following best describes how does the company manage demand?
a)Yes
b)No
Q5. Is power supply reliable?
a) Yes
b) No
Q4.Can the company change tariff structure?
a) Flat tariff price
b)Peak tariff price
c) Market price
Q3. How is the price deffined?
a) Bundled service
b) Unbundled service
Q2. Could you please select the service structure arranged?
a)Using intermediary (National company)
b)Using intermediary (Private company)
c)Self-generation
Q1.How does the company source the power?
LEGEND
Selling
Self-Generation
Aggregation
Demand
Reliability
Price
Service
Supplier
DIFFERENCES
TRANSITIONAL vs. REGULATED
- Load aggregation
- Market price of power
-Generated power can be sold to the market
- Contract service (Unbundled)
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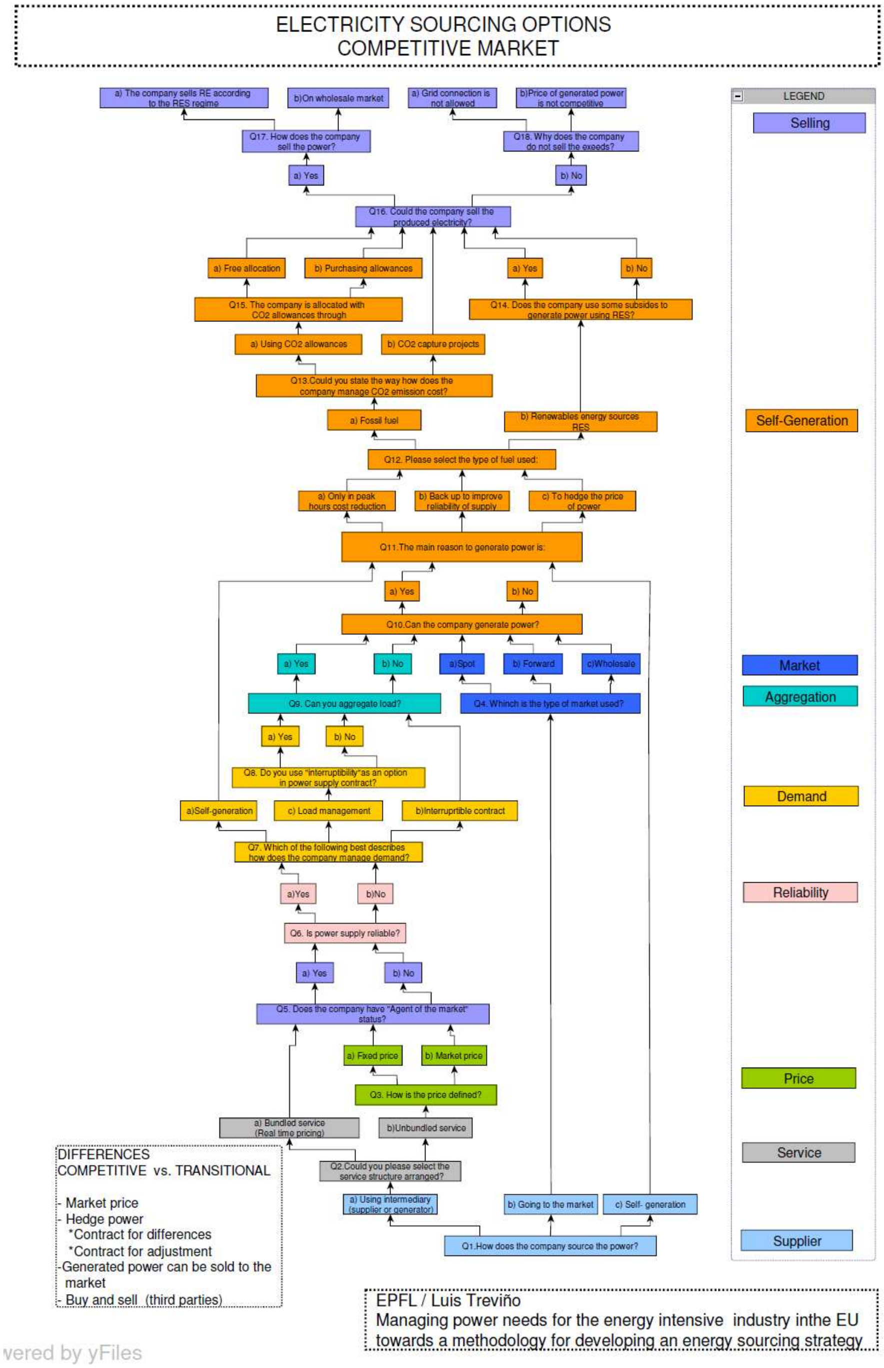

ELECTRICITY SOURCING OPTIONS
COMPETITIVE MARKET
a) The company sells RE according to the RES regime
b)On wholesale market
a) Grid connection is not allowed
b)Price of generated power is not competitive
Q17. How does the company sell the power?
Q18. Why does the company do not sell the exeeds?
a) Yes
b) No
Q16. Could the company sell the produced electricity?
a) Free allocation
b) Purchasing allowances
a) Yes
b) No
Q15. The company is allocated with CO2 allowances through
Q14. Does the company use some subsides to generate power using RES?
a) Using CO2 allowances
b) CO2 capture projects
Q13.Could you state the way how does the company manage CO2 emission cost?
a) Fossil fuel
b) Renewables energy sources RES
Q12. Please select the type of fuel used:
a) Only in peak hours cost reduction
b) Back up to improve reliability of supply
c) To hedge the price of power
Q11.The main reason to generate power is:
a) Yes
b) No
Q10.Can the company generate power?
a) Yes
b) No
a)Spot
b) Forward
c)Wholesale
Q9. Can you aggregate load?
Q4. Whinch is the type of market used?
a) Yes
b) No
Q8. Do you use "interruptibility"as an option in power supply contract?
a)Self-generation
c) Load management
b)Interruprtible contract
Q7. Which of the following best describes how does the company manage demand?
a)Yes
b)No
Q6. Is power supply reliable?
a) Yes
b) No
Q5. Does the company have "Agent of the market" status?
a) Fixed price
b) Market price
Q3. How is the price defined?
a) Bundled service (Real time pricing)
b)Unbundled service
Q2.Could you please select the service structure arranged?
a) Using intermediary (supplier or generator)
b) Going to the market
c) Self- generation
Q1.How does the company source the power?
LEGEND
Selling
Self-Generation
Market
Aggregation
Demand
Reliability
Price
Service
Supplier
DIFFERENCES
COMPETITIVE vs. TRANSITIONAL
- Market price
- Hedge power
*Contract for differences
*Contract for adjustment
-Generated power can be sold to the market
- Buy and sell (third parties)
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ACRONYMS

BETTA	British Electricity Trading Transmission Arrangements
BIH	Bosnia and Herzegovina
CCGT	Combined Cycle Gas Turbine
CCS	CO_2 Capture and Storage
CDM	Clean Development Mechanism
CER	Certificate of Emission Reductions
CEEPR	MIT Center for Energy and Environmental Policy Research
CO_2	Green House Gas
CSEM	Center for the Study of Energy Markets, University of California
DNO	Distribution Network Operator
EASAC	European Academies Science Advisory Council
EC	European Commission
EDP	Energias de Portugal, S.A.
EER	Emerging Energy Research
EFET	European Federation of Energy Traders
ELECTRA	EU Electrical Engineering Industry
ELECTRON	Electricity Consumer in Croatia
EMCC	European Monitoring Center on Change
EPRI	Electric Power Research Institute
ERU	Emission Reduction Unit
ETSO	European Transmission System Operator
EU	European Union
EUA	European Unit Allowance
EU ETS	European CO_2 Emission Trading Scheme
EUROSTAT	EU Statistical Information Service
EU 27	European Union 27 Member States
EWEA	European Wind Energy Association
GDP	Gross Domestic Product
GENI	Global Energy Network Institute
GHG	Green House Gases

GWh	Gigawatt hour
GW	Gigawatt
G8	The Group of Eight
G20	The Group of Twenty
HEP	Hrvatska Elektroprivreda
HEP OPS	HEP-Operator prijenosnog sustava d.o.o.
HEP DSO	HEP Distribution System Operator
HEP TSO	HEP Transmission System Operator
HERA	Croatian Energy Regulatory Agency
HR	Croatia
HT	High Tension
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IGCC	Integrated Gasification Combined Cycle
ISO	Independent System Operator
JI	Joint Implementation
KW	Kilowatt
KWh	Kilowatt hour
LT	Low Tension
MCDA	Multi Criteria Decision Aid
MO	Market Operator
MS	Member States
MVA	Megavolt Ampere
MWh	Megawatt hour
MW	Megawatt
NAP	National Allocation Plan
NATO	North Atlantic Treaty Organization
NEUTRON	Electricity Consumer in Spain
NG	National Grid
NGET	National Grid Electricity Transmission
NREL	National Renewable Energy Laboratory

OECD	Organization for Economic Co-operation and Development
OFGEN	Regulator for the Gas and Electricity Infrastructure and Supply Ind.
PESTE	Policy Economical Social Technological and Environmental Model
PROTON	Electricity Consumer in the UK
PV	Photovoltaic
RBV	Resource Base View
RE	Renewable Energy
RES	Renewable Energy Source
R&D	Research and Development
RO	Renewable Obligation
ROC	Renewable Obligation Certificate
SCP	Structure Conduct Performance
SLO	Slovenia
SHETL	Scottish Hydro Electric Transmission Limited
SPTL	Scottish Power Transmission limited
SSP	Strategy Structure Performance
TER	Technological Economical and Resources Model
TCE	Transaction Cost Economics
TNO	Transmission Network Owner
TSO	Transmission System Operator
TWh	Terawatt hour
UCTE	Union for the Co-ordination of Transmission of Electricity
UEI	Union of Electricity Industry
UKERC	UK Energy Research Centre
UN	United Nations
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WTO	World Trade Organization

CURRICULUM VITAÆ

Luis Treviño Villarreal
Born on September 12, 1967 in Monterrey, Mexico
Mexican

Strengths:

- Business management and trading operations for Energy & CO_2 under the emission trading system in Europe.
- Managing the energy supply for US and Mexican operations.
- Developing the intellectual property portfolio and technical research & development.
- Management Research and Development.

Education:

2006 – 2010	PhD Candidate EPFL, Ecole Polytechnique Fédérale de Lausanne, Suisse Dissertation: "Managing Electricity Sourcing in Europe for the Industrial Energy Consumers"
1998 – 1999	MBA in Industrial Management Sheffield Hallam University, England UK. Dissertation: Supply Chain Management in the Cement Industry
1994 – 1996	Master in Business Administration Tec of Monterrey, Mexico
1985 – 1989	Mechanical Engineer and Management Tec of Monterrey, Mexico
1984 – 1985	Shore Regional High School West Long Branch, NJ, USA

Professional Experience:

2011 – 2011	PEPSICO, Monterrey, Mexico Director Mexico-Central America and Caribbean for Energy – Sustainability & Health and Safety
2006 – 2010	CEMEX, Biel, Switzerland Director, CEMEX Global Center for Technology and Innovation Director, Energy and CO_2 Development Carbon trading and development of clean development mechanism projects
2001 – 2005	CEMEX, Monterrey, Mexico Director, Planning and Control of Energy Energy sourcing & cost control for Mexican and US operations
1992 – 2000	CEMEX, Monterrey, Mexico Consultant: Process, Operations & Technology
1991 – 1992	CEMEX, Ensenada, Baja California, Mexico Process Engineer
1990 – 1991	DuPont – AKRA – ALFA Production Engineer

Language Skill

Spanish	Mother tongue
English	Spoken and written fluent
French	Spoken and written basic
German	Understand basic

Conference & Papers

- **Treviño, L. (2007).** Power regulatory framework & opportunities for self-supply , Lausanne: College of Management of Technology – Norway 10th International conference on Technology Policy and Innovation
- **Treviño, L. (2007).**Electricity Sourcing Methodology to build a Strategy, Lausanne: College of Management of Technology – Portugal The 4th European Congress Economics and Management of Energy in Industry
- **Treviño, L. (2008).** Necessities and Resources of Industrials - United Kingdom Case. Lausanne: College of Management of Technology.- Working Paper
- **Treviño, L. (2008).** Liberalization of the electricity market in Europe, Lausanne: College of Management of Technology – Working Paper
- **Treviño, L. (2008).** Large industrials and electricity sourcing during the process of liberalization, Lausanne: College of Management of Technology – Working Paper
- **Trevino, L. (2008).** Reliability of electricity supply in Bangladesh , Lausanne: College of Management of Technology – Working Paper
- **Treviño, L. (2009).** Methodology to build a power sourcing strategy, Lausanne: College of Management of Technology – DAVOS R´09 Twin World Conference – Resource and technology for material and energy efficiency.
- **Treviño, L. (2009).** Vertical integration as response to market changes, Lausanne: College of Management of Technology - 2nd Annual Conference on Competition and Regulation in Network Industries – Centre for European Policy Studies, Brussels, Belgium
- **Treviño, L. (2010).** The Cement Industry and the Clean Development Mechanism, Success Commissioning of 250 MW EURUS Wind Farm in Oaxaca Mexico – CEMTECH - DUBAI – International Cement Conference