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Liberalization of the Electricity Market in Europe : An overview of the electricity technology and the market place

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Abstract

The electric power industry in European Union is undergoing profound regulatory and operational changes. The underlying rationale behind these transformations is to move only highly monopolized vertically-integrated industry from a centralized operation approach to a competitive one. European energy liberalization is underway to develop an internal market for electricity. Energy initiatives for EU are occurring in conjunction with measures to implement energy efficiency, renewable energy, and emissions trading of greenhouse gases. In response to EU Directives and policies and national initiatives, the EU market is evolving at the same time as environmental measures for energy are being considered. This paper discusses the process by which the countries of the EU have restructured their electricity markets. It shows that the restructuring process has focused on legal and organizational issues, but it doesn't contain specific prescription for economic design of the market. Apparently, the lack of regulatory framework harmonization is particularly harmful to the economic design of the market handling market power problems.

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INTRODUCTION

It is widely recognized that electricity underpins growth is vitally important to the development and welfare of nations. Because of its versatility, convenience, and relative ease of transport, it makes possible many of the goods and services that we associate with modern life. Developed nations typically have very high levels of electrification, and over the last hundred years electricity has gradually replaced other forms of energy to operate industrial and commercial processes, as well as becoming increasingly predominant in the household sector.

Early industry leaders and politicians shared the view that electricity could be most efficiently supplied by vertically-integrated monopolies. In the United States, these were largely privately owned and operated, with the government playing a role as regulator. In Europe, the electric utilities were under state control. In many other nations around the globe, the state assumed the primary responsibility for the development and operation of the electricity structure. There were a number of historical and practical reasons for this. The state had the ability to raise the capital required, and the widespread view that such a strategic asset must be under the control of central government. Economies of scale were achieved by building larger and larger generation plants, in tandem with transmission and distribution networks that gradually extended to even the most remote consumers. Further economies were achieved through additional vertical integration into the upstream energy resources sector especially oil, coal and gas.

Over the last two decades, the old idea that electric power generation, transmission and distribution represent a “natural monopoly” best handled centrally, has given way to a general consensus among policy-makers, regulators, industry analysts and economists that the generation and retailing elements of the power supply industry would be more efficiently delivered by firms operating in freely competitive energy markets (Electricity Sector Deregulation, Asia Pacific Energy Research Centre, March 2000).

A number of factors have contributed to this change in theoretical stance, and become forces for change. In addition to the current focus on economic efficiency, these forces include a shortage of capital in rapidly industrializing nations, recent technological and information management innovations, emerging global competition, and consumer demand for more sophisticated and diversified products and services.

In a liberalized market, generation and transmission investment decisions are decoupled, so that more grid is necessary. The European transmission grid is the backbone of the internal electricity market that besides serving the market has to ensure security of supply and to allow connecting renewables. Transmission grid investments are clearly needed, especially to increase the scarcely available cross-border transfer capacities. In this paper it is discussed the regulation that is already in place will deliver the investments crucial for the success of the liberalization process in Europe

1. HISTORICAL CONTEXT

For nearly a century, electricity around the world was typically produced by vertically integrated utilities, which operated facilities for all three stages of electricity service: generation, transmission and distribution. In many cases, utilities were state-owned monopolies. When private ownership was present, the companies nonetheless operated as monopolies in designated franchise areas regulated by governments that set rates and oversaw investments (Patterson 1999).

The main attributes of this monopoly system are that there is no competition and no consumer choice. Typically, this system is characterized by the existence of one vertically and horizontally integrated entity. In some cases, a number of vertically integrated monopolies may exist, but each has their own separate franchise area of operation – usually mandated in law. The monopoly utility owns and operates all generation plants, and transmission and distribution networks. It may be under an obligation to supply consumers, but consumers for their part are captive and have no choice of supplier. The service area may be national in coverage. The utility is usually also tightly regulated – usually through price control.

The involvement of the public sector in the electricity industry is partly explained by the sector's technical and economic evolution. As utilities pursued economies of scale both in supply and in demand, electricity systems became highly centralized large scale technological. Creating such a network is a highly capital-intensive project with long payback periods (but significant society-wide benefits), and, as a result, has required public sector oversight of electricity supply in many countries. Even where private firms were active from the outset in the electricity business (e.g. the USA, Germany, and Japan), governments have played an important role in building electric networks – sometimes as a supporter of, and at other times as a competitor to, private power.

While electricity systems built by public and/or private monopolies made large-scale production and consumption of electricity possible in many parts of the world, their operation also created serious problems. For example, large scale hydro-dams, nuclear reactors and coal fired power plants have became sources of serious ecological degradation and have crowed out public spending on other social projects, especially in developing countries. Too often, important decisions, regarding electricity supply were made by a closed circle of technical experts, government bureaucrats, and large corporate clients. Such a governance structure, coupled with the monopoly status of utilities, resulted in electricity industries development into powerful organizations with their own political and economic agendas.

The shortfalls of a vertically-integrated monopoly structure have really only become evident in recent years, and in economies with relatively large and mature electricity supply industries. With technological advances allowing for the construction and sitting of smaller-scale generation plants closer to demand centers, advances in information technology, the deregulation and development of competition in other infrastructural industries, and the realization that the sale of the product can be speared from the means of transport, it has become increasingly difficult to sustain the argument that a vertically-integrated monopoly structure is the only way of structuring the electricity sector. Additionally, the vertical-integrated utilities are identified as companies with political interference in decision making process, lack of incentives to improve services and lower costs.

2. FORCES FOR CHANGES: TECHNICAL INNOVATION, ENERGY EFFICIENCY AND CONSUMER CHOICE

A number of important factors have contributed to the far-reaching changes in global electricity markets. Economic efficiency has been a strong driver. The new neo-classical economic theory emerging in the early 1980s insisted that free and competitive markets were more efficient than government agencies at delivering basic services, and that divestiture of state-owned assets would have flow-on social benefits in terms of improved resource allocation, innovation, and ultimately greater employment opportunities.

By the middle part of the 20th century, electricity was viewed as a national strategic asset, in much the same way that coal, and than oil, were viewed. A stable and secure supply of electricity to all consumers was considered an essential ingredient of the national infrastructure by the more developed economies, and a goal to aim for by the developing economies. Obligations to supply were commonplace, along with vertically-integrated and state owned monopolies.

This view of the electricity sector has undergone significant change. Not only as a result of economic pressure to increase economic efficiency through deregulation and restructuring, but also as a result of a paradigm shift with respect to the delivery of services – brought on by the information revolution and other technological advances. Many leaders in government and industry alike are now recognizing that electricity sector deregulation can make it responsive to changes in business and technology, and more open to the forces of free-market competition.

Next to the drive to achieve greater economic efficiency, the greatest force for change is quite probably the inexorable advance of technological innovation. In discussing the origin of electricity restructuring, many note that recent technology innovation in electricity generation has made obsolete the logic of scale economies, which had earlier justified monopoly status for suppliers. Improvements in small-scale, natural gas-fired, combustion technology have arguably diminished the economic edge that large plants once had.

In the electricity sector, two important areas of innovation are having a major impact on the industry. The first is the development of the *natural gas combined cycle turbine* (CCGT). With this technology, power producers were allowed to operate with higher efficiency. In comparison with the 30-40% efficiencies achieved by old single cycle turbines installed 20 years ago, today's systems are running at 50-60% efficiency, and improving with time[1]. High thermal efficiency means low emission levels, and this in turn means that power plants can now be situated closer to centers of demand.

The second innovation likely to have a major impact on the electricity sector is the *electronic information revolution*. Markets, such as wholesale ones now be operated largely through electronic means such as Internet, with buying and selling designed to match demand on a five minute basis throughout the day and night. With the ability of market players to have access to real time information on all aspects of their operations, and on constantly changing market prices for electricity, it is now feasible to operate a disaggregated industry structure with high levels of economic efficiency.

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[1] Electricity Sector Deregulation, Asia Pacific Energy Research Centre, March 2000.

If one looks at recent reforms, one prominent feature has been an explosion in technological innovation and in *the bewildering choice of products and services*, consumers can now enjoy. Many energy industry experts are now becoming increasingly convinced that change on a similar scale could occur in the energy sector once the effects of deregulatory reform become widespread.

Substantial changes that will bring a wide array of new goods and services to electricity consumers are already emerging in economies that have fully deregulated their electricity markets. Already, the market power of large industrial electricity consumers is having a significant impact on the behaviour of electricity industry participants. As the power to choose between suppliers reaches down to small businesses and residential consumers, this will act as a further spur to the development of even more goods and services tailored to meet individual needs. Although there are barriers to switching suppliers, there is evidence to suggest the new metering technology and a better understanding of the market by small consumers will in time lead to true retail competition, and then to further stimulation of electricity markets as retailers compete to provide a more diverse and higher quality range of goods and services (Bradford 1999).

3. DERREGULATION OF THE MARKET

The deregulation of the European electricity sector was launched on December 1996, the date on which Directive 96/92/EC - "concerning common rules for the internal market in electricity" was adopted. The liberalization aims at increasing efficiency, harmonizing and reducing electricity prices, improving public services, cutting reserve production capacities, making a better use of resources, giving customers the right to choose their supplier and providing customers with a better service.

The intension of the Directive was to subdivide the electricity sector into four segments: generation, transmission, distribution and supply. The competition had to be introduced in generation and supply sectors, whereas transmission and distribution had to remain monopolistic. The principal requirements of the Directive were:

- Integrated companies must keep separate accounts for transmission, distribution, other electricity-related activities and other non-electricity-related activities. This separation of accounts aims at avoiding discrimination, cross-subsidies and distortion of competition;
- The generation segment should be opened up to competition, either by an authorization procedure and/or by a tendering procedure [2];
- Transmission and distribution remain monopolies. Non-discriminatory rules on access to the transmission and distribution networks should be established. Member States can choose between regulated third party access (rTPA), negotiated third party access (nTPA) or single buyer model[3].

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[2] Under an ***authorization procedure***, any company may build and operate a new electricity-generating plant, provided that it complies with the planning and energy supply criteria for authorization specified in the Member State in question. Alternatively, under a tendering procedure, whenever there is a necessity for new generating capacity on the basis of regular long-term planning forecasts, an independent body draws up an inventory for new means of production and the requisite capacity is allocated by a tendering procedure.

[3] Under a ***negotiated third party*** access system, each network user negotiates the terms of access with the system operator. With ***regulated third party access***, the tariffs are set in advance by the relevant authorities,

The transmission system should be operated by an independent system operator (ISO/TSO) responsible for operating, maintaining and developing the network and its interactions;

- The supply segment is also opened up to competition - “eligible customers” are free to switch suppliers. Member States (MS) can provide their own definition of eligible consumer though they have to meet minimum requirements (e.g. consumers connected to the transmission grid, consumers reached specified annual consumption, etc.);
- Member States must also designate a competent and independent authority to settle disputes relating to the contracts and negotiations.

The Directive 96/92/EC allowed the countries to choose the regime how to implement proposed changes, which corresponds best to their particular situation. The gradual opening introduced by this document resulted in significant differences between Member States regarding the level of market opening. The existence of negotiated third party access regimes, the level of unbundling obligations (lack of legal and management separation) and the lack of an obligation to establish a national energy regulator were also viewed as obstacles to create competitive markets. To address these concerns, further measures were proposed by the Commission leading to the adoption of Directive 2003/54/EC and Regulation No 1228/2003 (“Cross Border Electricity Trading Regulation”).

The main issues identified by these two documents concerned network access, tarification, market power in electricity production and different degrees of market opening between Member States (MS). Directive 2003/54/EC, repealing Directive 96/92/EC, provides the main characteristics such as:

- The timetable for market opening was extended to households;
- This directive requires legal unbundling as well as management unbundling for network operators;
- Non-discriminatory access to the networks is based on ex ante fixed access tariffs (i.e. regulated third party access);
- New generation capacity should be developed;
- Environmental protection and security of supply are included;
- Fixing rules for the use of the interconnection capacity, supervision of network access tariffs, overseeing the level of transparency and competition.

The Directive 2003/54/EC, where Member States have properly implemented it – not only in form, but also in spirit, has significantly contributed to the creation of a common electricity market. According to these two documents, there is some experience in electricity market liberalization. The United Kingdom (UK) implemented reforms on market opening in the 1980s. Denmark was opening its energy markets along with measures for emissions trading and to ensure renewable energy. Germany opened its electricity market for this date, and Austria was scheduled shortly thereafter, though the market is currently open. France is beginning to open its markets, though EDF, the national French monopoly and largest generator in Europe, has been selling into other markets and investing in utilities.

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and applied to all users of the network. These tariffs are published. Under the ***single buyer model,*** eligible customer applies to a legal entity which is responsible for central electricity purchasing and selling.

3.1 Unbundling

One of the main changes introduced by the Directives is to unbundle the vertically integrated sector into four segments, i.e. generation, transmission, distribution and supply. The rationale is that, unlike generation and supply, transmission and distribution could stay as natural monopolies (with network externalities) because of security reasons. Consequently, since competitors in generation and supply need access to the networks, the electricity Directives have provided the separation of competitive from non-competitive segments, in order to avoid discriminatory access and conflicts of interest.

Many analysts are concerned that the introduction of competition in some segments (generation and supply) might create a downward pressure on prices, than the increased interaction and the need for coordination among participants from different segments could raise transaction costs. On the other side, the promoters of electricity deregulation implicitly assume that the downward pressure on prices resulting from competition (in generation and supply) will largely compensate for transaction costs, resulting from interactions between generation, transmission, distribution and supply.

European legislation requires network segments to be legally separated from competitive segments. While the principle of unbundling is simple in theory, it can assume a number of forms, allowing different degrees of independence between the unbundled segments. The Directive 96/92/EC essentially requested a separation of accounts. This was quickly considered to be insufficient, so that the Directive 2003/54/EC strengthened the requirements, imposing a legal separation and minimum criteria aimed at ensuring organization and decision making independence[4]. In most Member States, the Transmission System Operator (TSO) today is legally independent unit. In some cases (e.g. the Netherlands, UK, Scandinavian countries, Italy, Portugal and Spain), there even is a strict ownership separation between the TSO and the competitive players; in most of these cases this means that the TSO is state-owned.

For generation and supply segments, a strict separation between the two activities is not required by the Directive. The main development in past few years is the substantial wave of acquisition and mergers that took place throughout Europe. By reinforcing their position on both the generation and the supply markets, companies hope to be sheltered from market-risk exposure, credit risks and low market liquidity. Suppliers have to buy power at uncertain and volatile price. At the same time, they often have more or less fixed price contracts with their customers. One way to eliminate the associated price risk is by re-integrating with a power producer. Doing so provides the producer with a guaranteed output, implying mutual gains. These re-integration movements reduce risk, and as such might have a positive impact on costs and prices, and as consequence they are beneficial to consumers.

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[4] In terms of organization and decision making independence, the rules introduced by the Directive 2003/54/EC are as follows:

- those persons responsible for the management of the transmission system operator may not participate in company structures of the integrated electricity undertaking responsible, directly or indirectly, for the day-to-day operation of the generation, distribution, and supply of electricity;
- appropriate measures must be taken to ensure that the professional interests of the persons responsible for the management of the transmission system operator are taken into account in a manner that ensures that they are capable of acting independently;
- the Transmission System Operator shall have effective decision-making rights, independent from the integrated electricity undertaking, with respect to assets necessary to operate, maintain or develop the network.

3.2 Transmission

Transmission System Operators (TSOs) are responsible for the maintenance and development of their transmission networks as well as the interconnections with neighbouring networks, bur also for the operational management of their networks.

The electric power transport can not be compared to transport of other commodities. This is due to the fact that electricity has some very specific physical characteristics such as the occurrence of loop flows and transport losses. As a consequence, coordination of transport networks will be required but this will also have an impact on the geographical spread of the generation capacity. The operational management of the network requires close interaction with other market participants. In a deregulated market this interaction is supposed to take place through a market mechanism, and in most countries, the electricity exchange is a subsidiary of the TSO.

3.2.1 Market mechanisms

As rightly pointed out by Rosenburg (1998), the dynamics of current technological development is likely to greatly extend the present trend of rising electricity consumption well into the future. As electricity gains dominant status in the energy consumption profile, electricity pricing practices will play significant roles in economic development, technology development and energy consumption behaviour.

Different pricing practice in the electricity sector has been developed in accordance with changing industry structure. While natural monopolies are compatible with a usual cost-of-service pricing practice, deregulated markets require more complex pricing mechanisms. Since the extent to which markets are deregulated and unbundled could be different in each economy, the pricing mechanism may also differ.

Power exchanges

The liberalization of the electricity industry has created a need for organized markets at the wholesale level. Two mains kind of organized markets have emerged: power pools and power exchanges. The difference between two models can be explained by using two criteria: initiative and participation[5]. A power pool is the result of a public initiative (government wants to implement competition at wholesale level) and the participation is mandatory (no trade is allowed outside the pool). A typical example of this model was the England and Wales pool as it existed before NETA (the New Electricity Trading Arrangements). A power exchange is launched on a private initiative (for instance by a combination of generators, distributors and traders) and its participation is voluntary. This means that usually a bilateral market coexists together with the exchange. Nowadays the second model appears to be preferred by market players (e.g. Germany, Poland organized markets are based on the power exchange model).

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[5] Congestion management and power exchanges: their significance for a liberalized electricity market and their mutual dependence; Working Paper; Francois Boisseleau, Laurens de Vries.

As a private initiative, a power exchange aims to be financially profitable and therefore to attract a maximum of transactions. To achieve this it must deliver real added value to the market by providing a competitive marketplace. Firstly, it is efficient in economics terms by matching supply and demand at the lowest price without compromising the reliability of the system. Many buyers and sellers must be able to enter and act freely on the spot market. This assumes that there is a minimum level of liquidity so that no one can directly influence the market price.

Since most exchanges work on a day-ahead basis, this means that any participant wishing to supply electricity the next day has to send his supply curve for each hour of the next day to the exchange authority. Every participant wishing to buy electricity has to send his demand curve as well. The exchange authority aggregates all individual supply and demand curves and determines an equilibrium price for each hour of the following day. This is called the spot price.

Due to the specific characteristics of electric power, power exchanges usually consist of multiple submarkets. Depending on the maturity of the exchange, some of these submarkets may be lacking. There are markets for physical delivery, such as day-ahead market, fine-tuning market and balancing market, and financial markets, such as futures and options. Some of them will be explained below.

The ***day-ahead market*** mainly serves planning purposes. Before a certain closing hour each producer has to submit price/quantity pairs, indicating the amount of power he intends to inject into the network at a certain price. Likewise, buyers have to submit price/quantity pairs, indicating the amount of power they intend to buy at that price. After the closing hour, the power exchange aggregates all supply and demand curves and determines the equilibrium price. This yields one equilibrium price and quantity for each hour of the next day. All transactions are settled at the equilibrium price, called the system marginal price (SMP) or the market closing price (MCP).

Since the day-ahead equilibriums are based on one-day-ahead expectations, and because real-time consumption and production depend on a lot of unpredictable factors (e.g. weather conditions, plant breakdowns, etc.), some exchanges allow market players to fine-tune their expectations until a few hours before actual delivery. The same mechanism allows them to enter bids and offers, although their size should be relatively small. This market is called ***fine-tune market.***

In real time, during the hour of actual delivery, it is the TSO that is responsible for the overall balance between supply and demand. In the case of an imbalance, the TSO has to correct it. If there is excess demand, then the TSO must increase production or decrease demand. In order to do so, the TSO must use the ***balancing market*** to buy or sell last-minute power from power producers to keep a continuous balance of demand and supply. The TSO can delegate responsibility for this balance to so-called Balance Responsible Parties (BRPs). In that case, any producer or consumer having access to the transmission network must designate a BRP. Each BRP is responsible for its own overall balance, and the TSO regulates the network balance. BRPs and TSO have access to the balancing market, so if the TSO has to intervene, it will analyze which BRP caused the imbalance and ask for cost compensation. BRPs having their own production plants can use these in order to escape the very volatile balancing market price.

Congestion management

The cross-border exchanges have to be managed to maximize competition and to avoid system overload in existing interconnection conditions. Congestion is relatively prevalent on interconnectors because they were not built to facilitate the current large electricity flows between countries. Originally, their main purpose was to allow exchanges between countries for the purpose of system stability.

Many methods exist to handle congestion of power lines, but majority of already implemented methods have a problem that they are not economically efficient and the main goal of liberalization is just that. This problem is considered in the European Regulation 1228/2003 ("on conditions for access to the network for cross-border exchanges in electricity"), where it was stated that network congestion problems must be addressed with non-discriminatory and market-based solutions.

Consequently, it has been decided that the allocation of scarce interconnector capacity should be based upon some kind of market mechanism. In Europe the following methods are considered the most important options such as explicit auctioning, implicit auctioning and market splitting, counter trading, and redispatching. The first group (explicit and implicit auctioning and market splitting) of methods is called "congestion pricing methods", because they use a price mechanism to ration the scarce interconnector capacity. The rest of methods are called "remedial methods", as they do not affect the market transactions directly but leave it to the TSOs to find a solution to congestion[6].

Under ***explicit auctioning*****,** the TSOs of the systems between which congestion exists sell their interconnector capacity to the highest bidder. The explicit auctioning thus separates transactions in electricity from transactions in cross-border transmission capacity. ***Market splitting*** or ***implicit auctioning***, integrates electricity and transmission markets. The existence of power exchange on each side of the interconnector is a necessary condition. Market splitting is today generally regarded as the most efficient and transparent congestion management method.

While it can be shown that at least in theory all of the above five methods can achieve economic efficiency in the short run, their long term effects are quite different[7]. The congestion pricing methods send a price signal to market players indicating the cost of congestion, as a result of which market players have an incentive to relocate in a manner which reduces the congestion. The corrective methods do not send any price signal to market players, but provide the TSOs with an incentive to minimize congestion. Unfortunately, there is no workable solution available which combines the two types of incentives. Given the choice, the congestion pricing methods appear preferable, as it is more difficult to impact generators decisions about where to locate than it is to impact TSOs` development plans, as TSOs are already regulated monopolies.

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[6] Knops, H.P.A. , L.J. de Vries and R.A. Hakvoort, "Congestion management in the European electricity system: an evaluation of the alternatives", submitted for publication in the Journal of Network Industries, May 2001.

[7] De Vries, L.J. and R.A. Hakvoort, "An economic assessment of congestion management methods", submitted for publication in the Journal of Network Industries, May 2001.

3.2.2 Transmission losses

Since electricity generation and power consumption take seldom place at the same location, electrical power transport is required. Such transport makes use of high voltage lines because high voltages limit transport losses (Coppens F., D.Vivet 2004), but even in that case losses are huge[8]. For reasons of security of supply, transport networks are meshed giving rise to the problem of so-called "loop flows". Physical laws imply that electrical current follows the path of least resistance, so that power flowing through a meshed network follows a non-deterministic route. This implies that when a consumer and a generator contract for the delivery of a certain amount of power at a certain time of delivery, the consumer can never be sure that the power he consumes comes from the generator he contracted with. This is in strong contract to the transport of other commodities and has some complex side effects.

Assuming that a consumer from one country concludes a contract with a producer of the other country for some amount of power in particular hour. The consumer will extract the contracted amount, and producer will inject it during that specific hour. However, due to the meshed European grid and to the electricity laws, the consumer will not receive the injected power of contracted party, but part of it will come from neighbouring generators. Some power will also be lost due to heat dissipation underway and these losses will have to be compensated by different European TSOs by injecting additional power (bought on balancing market). This loss compensation however entails costs for these TSOs. These costs can not be charged to any individual consumer of producer, because the consumer/producer can not be identified, so that these costs will have to be compensated out of a common fund collected through compensation mechanisms, called Cross-Border Trade (CBT) mechanisms.

Cross-border trade (CBT) mechanism *-When a generator and a consumer, located in different regions, contract for the delivery of electrical power, the physical characteristics of electricity transport imply that transport costs can not be charged to the parties involved in the transaction. As a consequence, the intermediate TSOs incur costs which they should be compensated for. The financial compensation of these costs is organized through the cross-border trading (CBT) mechanism. While TSOs, where the generator and the customer are located, will have to contribute to a common fund, other TSOs, that have to compensate losses and to manage loop flows, will have to be compensated for the incurred costs. In order to finance the cross-border costs, every TSO that participates in the CBT-mechanism contributes to a compensation fund, proportionally to the size of its net imports or exports. (Daxhelet O., Y.Smeers 2005).*

The fact that each intermediate TSO compensates part of the losses implies that power is never transported over very long distance and losses are relatively limited. However these losses are only limited when there are neighbouring generators in order to limit the transport distance to be covered. It is also worth mentioning that power transport infrastructure is capital-intensive and is characterized by high construction lead times.

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[8] It can be easily computed that, typically, on a 380kV line the power lost is around 0.5% per 100km under normal circumstances (i.e. with a 50% load factor). Thus if 500MW is transported over a 1000MW line, every 100km around 2.5MW is dissipated as heat.

3.2.3 Interconnection infrastructure

For several years, numerous documents from the European Commission have been underlying the insufficiency of interconnection capacities between Member States, which is crippling the creation of an integrated European electricity market (Commission of the European Communities 2003). In particular, increased interaction capacity would correct the problems due to different national market structures, which are mostly concentrated. Than, this concentration could be solved by allowing competing imports from abroad.

Many analysts argue that one of reasons why EU market is not yet integrated could be found in poor interconnection between Member States. In fact, EU electricity market should rather be seen as consisting of a core area (Germany, France, Benelux, Austria and Switzerland) and satellites with limited interconnection capacity (Ireland, UK, Scandinavian countries and Iberian Peninsula).

The European Commission has taken a number of initiatives in order to improve this problematic situation. In particular, several critical bottlenecks have identified, where investments are a priority and are supported financially. In this respect, reference can be made to the interconnections between France, Germany and Benelux; between France and Spain; between Denmark and Germany; etc. (Commission of the European Communities 2005). The interconnector capacities have already improved, but it will take quite a long time to realize the necessary investments. Another notable initiative was launched at the European Council of Barcelona, which set the target for Member States to have a level of electricity interconnection equivalent at least 10% of installed production capacity.

The European Commission has recently emphasized the importance of developing regional markets as a necessary stage on the road to a European market (European Commission 2004; ERGEG press release PR-06-05). These regional markets would be organized of Member States at sufficient interconnection level. According to European Commission, these markets should include the Iberian market (Portugal and Spain), the West Europe market (Austria, Belgium, France, Germany, Suisse, and Netherlands), the Italian market and the Nordic market (Denmark, Finland, Norway and Sweden). These markets should develop a more harmonized approach to the degree of market opening, the setting of transmission tariffs or congestion management. For these purpose, the cooperation between institutions in neighbouring countries is needed (Jong J. 2004).

3.3 Security of supply and distributed generation in de-regulated market

The question of supply security has been much debated within economies undertaking electricity sector reform. Two issues are important, the securing of long-term supplies of generation fuels at favorable prices, and the reliability of the electricity system. The maintenance of adequate generation reserve capacity is a component of the system reliability concern.

The introduction of competition into electricity generation results in strong pressure to reduce investment and operating costs. The incentives to avoid over-building and over-designing power plants, and to reduce operation and maintenance costs, raises the possibility that reserve capacities could drop to levels well below what is prudent to manage contingency situation. So arguments about reserve capacity must be considered as a component of long-term reliability, which requires the planning and the construction of enough aggregate capacity (generating and network) to balance total demand and supply at prevailing prices at all times. Short-term reliability requires adequate reaction to load fluctuations over time scales ranging from microseconds to months.

Once markets are deregulated, competition in the power sector puts strong pressure on generators to lower overall costs, including those associated with fuel inputs. Although the choice of input fuel for existing facilities may be constrained, there still exists inter-fuel substitution potential. Another possibility for lowering costs and increasing competitiveness is to increase the capacity factor (utilization rate) of a particular plant or plants, usually those are already cost effective in a deregulated market.

Deregulated electricity markets, with the emphasis on cost structure, will tend to encourage investment in power generation plants that are least cost over the capital depreciation period. In most cases this will favour the lowest cost fuels, usually hydro where this is readily available, and gas because of new CCGT plants have relatively low capital cost, even if operating costs are somewhat higher. After majority of countries started renewable energy promotion, this became very attractive action for large industrials. Large industrials in fully competitive markets will invest in nuclear, because of the very high capital cost, and requirement for relatively large plant size. With respect to available technologies (hydro, gas, solar, wind) the future will likely see a large increase in smaller sized plants placed much closer to demand centers (encouraging the trend towards more highly distributed generation).

As observed elsewhere in this chapter, electricity sector reform has happened in parallel with some important technological developments. The emergence of the CCGT as well as other developments reinforced a trend towards smaller scale, distributed power systems. Additionally, there are advances in fuel cell technology, wind turbines, and other smaller scale, clean power sources.

4. DERREGULATION AND THE ENVIRONMENT

It can without doubt be stated that climate change is one of the major issues of the new millennium. Reflecting the worldwide acknowledgment of the dangers of global warming, the Kyoto protocol was adopted in 1997 by member countries of the United Nations Framework Convention on Climate Change (UNFCCC). The Protocol’s major feature is that it sets mandatory targets for greenhouse gas emissions for those of the world’s leading economies which have signed the Protocol. These targets are ranged from –8% to +10% of the countries individual 1990 emission levels. The ultimate goal is to reduce the overall emissions by at least 5% below 1990 levels in the commitment period 2008 to 2012. For almost all countries – even those set at +10%, of 1990 levels – the limits call for significant reductions in projected emissions. Future mandatory targets are expected to be set for commitment periods beyond 2012.

The European Commission launched its energy package in January 2007. The main aspect of the proposals is a binding target to slash the EU`s greenhouse gas emissions by 20% in 2020 compared with 1990 levels (EC, 2007a).

With respect to the Kyoto protocol the European Union is seen as one zone, its reduction target being -8%. This overall European reduction target was translated by the European Commission into national reduction targets for each member state ranging from -28% for Luxembourg to +7% for Portugal[9]. This common target is divided among 15 Member States under a burden sharing agreement.

Although there are noticeable variations from one country to another, due to the differences in production facilities, one could be noticed that electricity generation accounts for a significant share of greenhouse gas emission in the European Union, with an average of 26% of CO2 emissions in 2002[10]. This automatically makes electricity one of the sectors in which action has to be taken in order to meet the protocol target. In this respect, the European Union has adopted a Directive on the promotion of electricity produced from renewable energy sources[11]. To help reach its goal with least cost to society, the EU has chosen to make use of emission trading as complement to green electricity generation. These two approaches will be explained with more details in this section.

4.1 Electricity generation using renewables

Fossil fuels supply around 85% of the world's commercial primary energy needs. Natural gas provides about 25% of this, and its share is growing. Power plants represent by far the largest group of coal end users, consuming 60% of the total world coal production to produce heat and generate electricity. Electric power sector emissions of carbon dioxide are almost 10% of the world total (Asia Pacific Report).

Bernow et al (1998) argue that, "while there are potential environmental benefits from restructuring, the environmental threats appear larger". From one point of view, the future looks relatively bright if gas combined cycle plants and other renewable energy based technologies replace coal-fired generation, leading to lower CO2 emissions. However, it is argued that capital –intensive renewables and end-use efficiency (which tends to have a long pay back period), will suffer due to the higher cost of capital, reflecting greater levels of perceived risk in the marketplace.

The coal plants in some economies (especially pre-reform) suffer significant under-utilization, relative to their full availability. With relatively low coal prices, these plants have a significant competitive advantage in a wholesale electricity market. Increasing utilization of such plants would lead to significant increases in carbon emissions. Embedded technologies have an advantage over new and emerging ones – the physical stock and expertise are well entrenched, and investment risks are lower. These situations favour fossil fuels, especially in a situation where markets have systematically failed to account fully for the environmental costs.

A wholesale electricity market is driven by costs of production, and is a market where the lowest cost generators – regardless of fuel type – will invariably be called first. If the lowest cost plants happen to run on the least environmentally friendly fuels, than in the absence of any mechanisms to limit emissions, overall emissions of environmentally harmful substances are bound to increase.

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[9] The US`s reduction target is -7%, Japan's -6%, just as Canada's. The Russian Federation has to stabilize its emissions (0%) and Australia is allowed to emit more (+8%).

[10] International Energy Agency (2004a).

[11] See Directive 2001/77/EC. In addition to the goal of meeting Kyoto protocol commitments, the Drective also aims at guaranteeing security of electricity supply, as green electricity is not dependent on imports.

As mentioned before in this section, the electricity generation accounts for a significant share of greenhouse gas emissions in the EU, with an average of 26% of CO_2 emissions in 2002[12]. Due to this, the green electricity has to be encouraged and Renewable Energy Sources (RES) are undergoing important developments at all levels in the European Union. The EU adopted in October 2001 a directive on the promotion of electricity produced from renewable energy sources in the internal electricity market. The aim of this directive is to promote an increase in the contribution of renewable energy sources in the energy supply.

The directive seeks to increase the consumption of energy from renewables to 21% by 2010. Germany is one of the EU countries targeted with the 12.5% of use of RES, as well as UK whose target is about 10%, Spain, whose target for RES is 29.4% and Latvia with 49.3%; just to mention some of them. National indicative targets were set and, in order to achieve them, Member States have developed a variety of support schemes aiming to encourage green electricity generating plants.

Usually promoted market mechanisms to encourage green electricity generation are guaranteed prices, tradable green certificates or fiscal measures.

4.1.1 Market mechanisms for RES promotion

Generating electricity from renewables has a priority in the energy policy strategies. As *White Paper on Renewable Sources of Energy* and *Proposal on the promotion of electricity from RES*, published by European Commission, set challenging goals in the energy mix of European Union countries, a comprehensive range of measures is proposed to overcome barriers to the development of renewables.

Historically, dissemination strategies for commercial electricity from RES have included various rebate programmes as major incentives, whereby purchasers of renewable energy generating plant could claim back (i.e. be rebated for) part of the costs by a government grant or from a government legislated levy. The most influential programmes were (a) the wind promotion programme in Denmark, and (b) the German “1,000 Roofs Programme” for promoting photovoltaic (PV) power, and (c) the tendering program within the Non-Fossil Fuel Obligation (NFFO) in UK[13]. In the early 1980s financial incentives, in the form of capital grants, loans or reduced taxes, were also good complement to encourage installation of generating plant. The most successful examples were in Germany and Denmark, where for instance, it was possible to obtain preferential real estate loans for wind turbine.

In the mid-1990s, in various European countries, promotional programmes based on regulated tariff rates for the purchase of electricity from specified renewable sources become more common and were enhanced. The most important models in this context were enhanced Feed-In tariffs and rate-based incentives, as for all RES generators at fixed values in Denmark, Germany, Italy and Spain, and against competitive tendering in the UK[14].

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[12] International Energy Agency (2004).

[13] Reviewed Report on Promotion Strategies for Electricity from Renewable Energy Sources in EU countries”, Thomas Faber, John Green, Miguel Gual, Reinhard Haas, Claus Huber, Gustav Resch, Walter Ruijgrok, John Twidel; June 2001.

[14] The same as 8.

Perhaps the most significant opportunities for electricity from RES are coming with the increasing liberalization of electricity markets across Europe. Dissemination programmes for RES are being designed especially to fit within this liberalization. Table 1 presents a classification of the existing strategies for encouraging electricity generation from renewables. To be more understandable what the main differences between proposed mechanisms are, each of presented ones will be explained with more details below.

Voluntary approaches are based on the willingness to pay of private individuals or organizations, and commercial or industrial companies. Nowadays "Green tariffs" are the most common voluntary approach to promote electricity from RES. Consumers choose to either buy electricity at a utility green tariff, or from a Green Electricity supplier (if the customers are eligible). Usually the major feature of this type of financing program is that participants willingly pay a premium (i.e. surcharge) per kWh above regular tariff rates. The extra payments to the suppliers are passed to the renewable energy generators to meet the extra costs of generation, which are particularly associated with capital costs of the new plants. Green tariffs became popular in Germany, The Netherlands, the USA, but they are also offered in Austria, Finland, Sweden and the UK.

Table 1: Classification of the existing strategies for RES promotion.

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Direct</th><th rowspan="2">Indirect</th></tr>
<tr><td colspan="2">Price-driven
Capacity-driven</td></tr>
<tr><td rowspan="2">Regulatory</td><td>Investment focused</td><td>• Rebates
• Tax incentives</td><td rowspan="2">• Quota (RPS) / TGC
• Bidding</td><td rowspan="2">• Environmental taxes</td></tr>
<tr><td>Generation based</td><td>• Feed-in tariffs
• Rate-based incentives</td></tr>
<tr><td rowspan="2">Voluntary</td><td>Investment focused</td><td>• Shareholder programmes
• Contribution programmes</td><td rowspan="2"></td><td rowspan="2">• Voluntary agreements</td></tr>
<tr><td>Generation based</td><td>• Green tariffs</td></tr>
</table>

Participation/shareholder Programmes has attracted attention mainly in Germany. The idea is to sell shares of a RES plant to private customers, with the customer becoming a shareholder of the company owning the renewable part. An example is the "Bürger für Solastrom" programme of Bayernwerke utility.

Contribution programmes or donation programmes are organized in that way where subscribers contribute to a fund for renewable energy projects. It is an approach common for the promotion of PV systems in the public sector, e.g. schools. The projects developed are unrelated to the subscribers electricity usage.

Regulatory-price driven strategies, perhaps with financial incentives, aim to make investment in renewables more economically attractive. Fundamentally, there are two approaches to the provision of financial incentives: (i) investment in new capacity, and (ii) funding towards each unit of electricity produced.

Usually used investment focused strategies are “rebates” and “tax incentives”. Several different options have been used to promote the generation of electricity from RES with fiscal instruments such as lower VAT-rate applied for RES-E systems and dividends from RES-Investment made exempt from income taxes. Both options have similar impact, acting as new investment subsidies for new installations.

Generation based strategies usually used are “feed-in tariff” and “rate –based incentives”. A feed-in tariff is based on the price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators (also called producers). Thus, a government regulates the tariff rate. An intending producer is guaranteed the feed-in tariff for each unit of electricity exported to the grid if his form of generation meets the stated criteria; no bidding process or tendering is involved.

Regulatory –capacity driven strategies using obligated quotas to introduce a certain amount of green electricity fall into two categories such as (i) those based on competitive tendering and trading, and (ii) those without specified competitive trading.

The core principle of the tendering system is to invite developers to tender to construct a certain amount of renewable energy capacity. If the proposals are considered viable and competed successfully on price terms with other tenders within the same technology band, they are awarded a contract. A guaranteed surcharge per unit of output is guaranteed for the whole period of contract.

Tradable Green Certificates programmes work as follows: a quantified obligation (quota) is imposed on one category of electricity system “operators” (generators, producers, wholesalers, retailers, or consumers) to supply or consume a certain percentage of electricity from renewable energy sources (RES). On a settlement date, the operators must submit the required number of certificates to demonstrate compliance. Certificates can be obtained in one of the following ways. First, operators can own their RE generation, and each defined amount of energy produced by these would represent a certificate. Second, operators can purchase electricity and associated certificates from eligible RES-E generators. Third, operators can purchase certificates without purchasing the actual power from a generator or trader or via a broker, i.e. certificates that are traded independent from the power itself. Due to competition on supply side, this system of tradable certificates leads, under the assumption of perfect market conditions, to minimal generation costs from RES. Of course, this happens only if there is a surplus of renewables generation above the demand for certificates.

Aside from strategies which directly address the promotion of one or more specific renewable energy conversion technologies, there are other strategies which have an indirect impact on the dissemination of renewables such as taxes or permits on CO2 emission; fossil and nuclear subsidy reduction; eco-taxes on electricity produced with non-renewable sources, etc.

It can be seen that strategies for RES promotion shows that there is a wide range of possibilities to increase their dissemination. Yet, there are considerable differences in these strategies with respect to technical and economic efficiency, as well as with respect to their success in triggering a substantial number of new installations. Whichever strategy is chosen it should trigger and enhance competition between generators, as well as between manufacturers. It should encourage renewable electricity suppliers to improve operation performance and technology efficiency.

4.1.2 Emerging Technologies

From a purely technical perspective, commercially available technologies exist to mitigate almost entirely the adverse impacts of all pollutants that result from the combustion of carbon intensive fossil fuels to generate electricity. The most intensive fuel is coal, and in many cases the addition of these technologies can be achieved without making coal uncompetitive with alternatives, such as natural gas or renewables.

The importance of new and emerging technologies lie in the role of innovation as a means of increasing both economic and technical efficiency, and the growing requirement for cost-effective solutions to the greenhouse gas problem. This is where energy sector reform should have a very significant role to play. If, as expected, reform acts as a spur for technological innovation, we should see over the next few years significant advances with respect to improved goods and services, and in dealing with environmental impacts.

The firms thrive on innovation, especially if incentives exist to encourage the penetration of new technologies into the marketplace. Incentives could include customer preferences to pay extra for added value (e.g. green electricity), or incentives created by the Governments through market-based policies and measures. On the energy scene, a significant number of environmentally responsive innovations are reaching the marketplace such as large-scale wind turbines, natural-gas fired or coal fired combine cycle turbines, photovoltaic cells, etc.

4.2 Emission Trading Scheme

The idea of emission trading as a cost effective way of reducing emissions of pollutants dates back to the 1960s. It was presented by Dales (1968), and formal proof of equilibrium was provided a few years later by Montgomery (1972). The first sophisticated emissions trading scheme implemented was in the United States` Acid Rain Program, which aimed at reducing emissions of nitrous oxides (NOx) and sulphur dioxide (SO2). The program has been a success; emission targets were reached sooner than expected and with less costs than predicted (Ellerman et al., 2003).

The EU emissions trading scheme (EU ETS) began operation in 2005. The rules for the scheme are laid out in the emissions trading Directive 2003/87/EC, which came into force in October 2003. The Directive grouped the following industries under a cap-and-trade trading system: energy, metal, mineral, and pulp and paper. According to the Directive, these sectors must cover their yearly emissions of CO2 with a corresponding amount of allowances, of which one allowance equals one tone of carbon dioxide equivalent. From their issuance to the surrender date the allowances are transferable, and each transaction will be recorded in the national registries. The initial allocation of allowances is set out in the national allocation plans (NAP), in which each Member State declares the total amount of allowances to be allocated for each period and how this will be divided among the participating installations. According to the Directive, at least 95% of allowances shall be allocated free of charge for the period 2005-2007 (20003/87/EC). For the second period starting in January 2008 the amount is reduced to 90% free allowances.

The sector whose share is the largest in terms of total emissions covered under the first phase of the EU ETS is the power sector. This sector represents over 50% of the total CO2 emissions covered by the scheme. The power sector differs from the others in that markets are not global due to non-storability and transfer losses related to energy. Indeed, during times of congested transmission lines, electricity markets may be very local. Also, the emissions from energy production depend on the mix of generation technologies, which vary from country to country and provide differing possibilities for reducing emissions. These facts have raised the question of how emissions allowances and related cost could affect the price of electricity. Since the most EU-15[15] countries the electricity markets are liberalized; price formation is no longer controlled by an authority. Electricity intensive industries now fear rising productions costs, as electricity producers are assumed to pass on the additional cost of carbon to consumer prices.

The effect of emissions trading on the price of electricity is in principle rather simple. The introduction of emissions trading increases the cost of those production technologies that rely on carbon-based fuels. This affects the merit order; the ranking of producers by rising marginal production cost. A new merit order implies that the marginal, price setting technologies will change. It is therefore evident that there will be an impact on electricity prices.

Since the adoption of the EU Directive on emission trading, a number of studies have emerged concerning the interaction of electricity markets and the EU ETS. Some are country specific, such as Kara et al. (2006) concerning Finland, Linares et al. (2006) concerning Spain and IPA (2005) concerning UK. Other studies, for example Sijm et al. (2005), Ilex (2004), and ECON (2004), cover a larger market area. In general, the studies suggest that a comprehensive answer to the question can not be given. For example demand patterns, the technology mix and the structure of the electricity market influence the passing on of additional costs from carbon. These are conditions which are specific for each market area.

5. DIFFERENT MARKET STRUCTURE

5.1 Vertical Integration Monopoly Model

In this model there is no competition and no consumer choice. Typically this model is characterized by the existence of one vertically and horizontally integrated system. In some cases, a number of vertically –integrated monopolies may exist, but each has their own separate franchise area of operation – usually mandated in law. The monopoly utility owns and operates all generation plants, and transmission and distribution networks. It may be under an obligation to supply consumers, but consumers for their part are captive and have no choice of supplier. The service area may be national in coverage. The utility is usually also tightly regulated – usually through price control.

Historically, this model developed as a logical way of dealing efficiently with a number of the rather unique characteristics of the electricity supply industry at a time when rapid industrialization required rapid growth in supporting infrastructure.

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[15] EU-15: Austria, Belgium, Denmark, Finland, france, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden, UK.

Electricity is physically more complicated to deliver to final consumers than most other goods. Transmission requires split-second control to coordinate supply and demand at any moment. In the early days of development of an electricity structure, it was easy to imagine, and argue, that generation, transmission and distribution were intimately inter-related, were natural monopoly components of the overall supply system, and the best handled by a single monopoly structure. This approach also allowed for the construction of large-scale generation plants and transmission systems at a time when economies of scale were important in the industry.

With technological advances allowing for the construction and sitting of smaller-scale generation plants closer to demand centers, advances in information technology, the deregulation and development of competition in other infrastructural industries, and the realization that the sale of the product can be speared from the means of transport, it has become increasingly difficult to sustain the argument that a vertically-integrated monopoly structure is the only way of structuring the electricity sector.

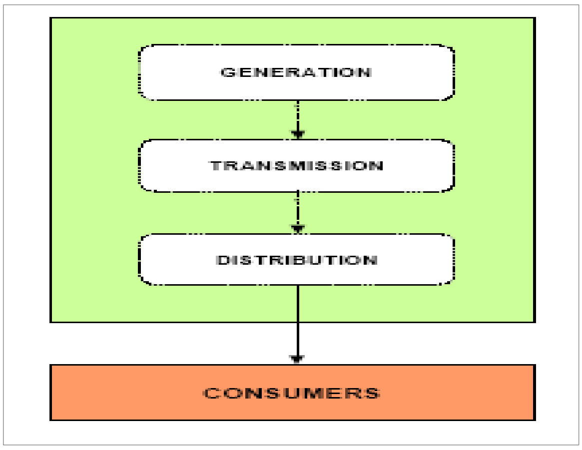

Figure 1.Vertical Integration Monopoly Model.

This model allows subsidies and cross-subsidies – as there is no competitive market – as well as investment in public goods such as rural electrification and distribution of power to poor communities.

The shortfalls of a vertically-integrated monopoly structure have really only become evident in recent years, and in economies with relatively large and mature electricity supply industries.

The major deficiencies of the vertical monopoly structure that have been identified include: a lack of incentives to improve services and lower costs; a lack of transparency; poor investment decision-making; and political interference.

Dismantling the above monopoly structure normally will involve separating out the potentially competitive generation, wholesaling and retailing elements from the natural monopoly elements of transmission and distribution. The difficulties in achieving this depends on who owns the assets to begin with, what regulatory regime will be instituted to deal with abuses market power, and what subsidies and cross-subsidies exist.

5.2 Wholesale market

This model may be considered as a first step towards deregulation. At the beginning of model existence, one or several vertically integrated companies still controlled the sector, but some private investment was made possible by licensing Independent power Producers (IPPs) to build generation capacity. These might be created from existing utilities by divestiture, or they might be new producers who entered the market when new plant is needed.

With this model it is possible to have competition in generation, but the vertically –integrated utility still has control over transmission and distribution. Retail consumers are still captive. The major advantage of this model is that it allows for direct inward investment by private investors, and allows investment risks to be shared. This model still allows governments to use the electricity industry to meet social policy obligations and create public goods, as there is no competitive market at the retailing level.

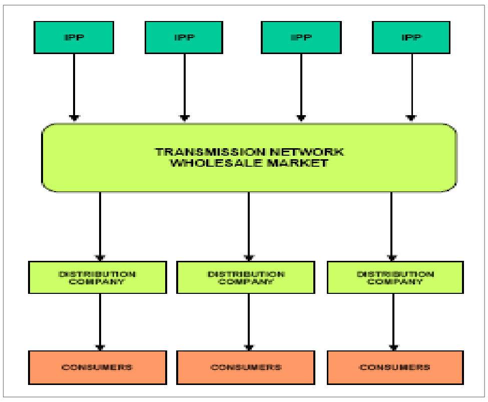

Figure 2. Wholesale Competitive Model.

As model progressed, distribution companies, that retail electricity to consumers, were allowed to choose their supplier. This brings competition into generation and wholesale supply. In this model, separate distribution companies purchase electricity from any competing IPP generator. The distribution companies maintain a monopoly over energy sales to the final customers. In this model an existing generation company has to compete against new entrants.

The ability of governments to direct the choice of new generation technology is, by and large, no longer desirable or necessary.

As there can now be a power pool or wholesale power market, it is possible to have a relatively competitive wholesale trading market, where the cost structure of generators is determined by the electricity wholesale price. It is still possible with this model, to have relatively few traders, and have "wheeling" contracts where distribution customers and generators make bilateral contracts to move power from one utilities` transmission system through that of its competitors.

There is still monopoly market power in the sector, as final consumers still have no choice of supplier. This allows for the delivery of certain public goods at the retail level, and some subsidies can be maintained, although it limits the form in which they can be imposed.

As the choice of generation assets is left to the market, economic efficiency can be improved, and risks transferred from government to private investors. Although investors may seek long-term contracts before building generation capacity, the existence of a wholesale electricity market (which normally includes a spot market) means that such contracts are not essential.

The importance of this model lies the fact that a decision to introduce wholesale electricity competition indicates that policy-makers have taken the important philosophical step of rejecting heavy handed regulation as an adequate tool to manage the sector, and have instead taken the leap of faith that competition can be introduced into the electricity supply industry, and that social and economic benefits will flow from this decision.

This model represents only a partial step towards the introduction of competition in the electricity supply industry. Consumers are still captive, and so the full economic benefits of a fully deregulated market are not achieved. However, once the introduction of competition at the wholesale level has been achieved it becomes easier to devise the means to introduce competition at the retail level, and this step usually follows after the introduction of a wholesale market.

5.3 Full Competitive Market

In this model, competition has been introduced into all levels of the industry, ideally from wholesaling down to individual domestic consumers. A key component of this model is direct (or third party) access to transmission and distribution networks. With the right regulatory structure in place, any electricity consumer should theoretically be able to purchase from any retail supplier, who in turn is purchasing electricity from a competitive wholesale market.

Ideally the network functions of transmission and distribution (natural monopolies) are completely separated from the functions of generation and retailing. Dispatch can be handled by the transmission network owner, but where more than one transmission networks exist, this is best handled by a TSO.

With this structure, there should be free entry by firms into the competitive functions of generation and retailing. There are no permitting or licensing requirements. This allows anyone, including householders, to build their own generation plants.

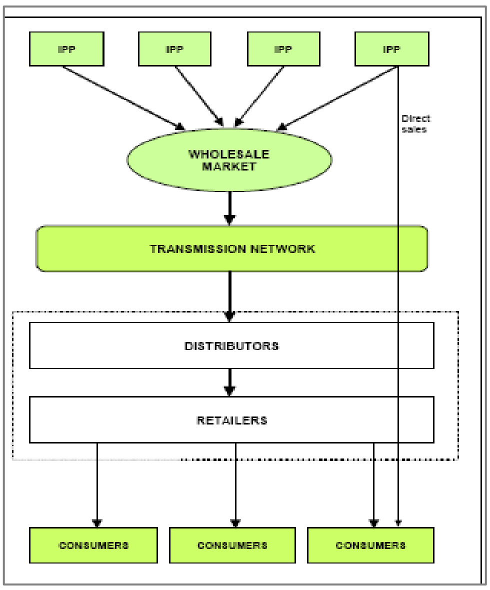

Figure 3. Full competitive market.

The advantage of this model is that it optimizes economic efficiency; at least once the regulatory regime has been optimized to minimize any market imperfections and control abuses of market power.

The experiences of economies where this model has been introduced suggest that a number of benefits become obvious. Firstly, costs in the generation sector are driven down substantially, and this usually is expressed in lower retail tariffs. At the retail level, competition is beginning to become evident, with the range of goods and services being offered by electricity retailers increasing in both quantity and quality.

The wholesale market operates as an auction, buyers and sellers meet and exchange goods on the basis of long-term (hedged) contracts and spot contracts. There is no single buyer. The operators of the market never own and never assume the market risk; they merely act as auctioneers, making their income from the transactions.

As disadvantage the transaction cost could be considered. It can be argued that the transaction costs involved with managing the contracting aspects of this model are not negligible. The response to this that advances in material and information technologies reduce such costs sufficiently to ensure that the overall benefits of full electricity market competition outweigh the disadvantages of increased transaction costs. With this model, firms in the industry are free to engage in joint venturing, acquisitions and other market activities.

6. CONCLUSION

Electricity liberalization in Europe is part of the trend towards the deregulation of network industries around the world. Whereas empirical evidence generally suggest that deregulation has had a positive impact on efficiency and consumer welfare in other sectors (e.g. telecommunications, air travel, etc.), the results expected for the electricity sector are much more relative so far. Since only a few countries have fully completed their deregulation process, the available evidence is not yet sufficient to build a comprehensive judgment.

For instance, increasing oil, gas and coal prices as well as the enforcement of the Kyoto protocol are responsible for much of the increase in bulk electricity prices, but, as that impact can not be quantified, it is also impossible to determine how prices would have moved otherwise, i.e. the real impact of deregulation.

The problems are more related to the unusual characteristics of electricity as a product, which make the industry very different from other network industries: electricity is not storable, demand and supply must be constantly balanced, and demand is both volatile and inelastic. As a consequence, the traditional, market clearing mechanisms, such as delivery delay or substitution of other goods, are not available for electricity (NBB Working Paper 2006). This implies price volatility on power exchanges and makes the security of the system more vulnerable to climatic conditions. It also creates the need for heterogeneous production park with sufficient reserve generation capacity.

Although there is an economic choice for heterogeneous generation technologies, today's heterogeneity in generation mix across European Union has been dictated by past national choices, based on a combination of economic, geographical, geopolitical and political consideration. The generation mix based on this has important consequence in deregulated markets: generators based in countries where the least costly techniques (i.e. nuclear and hydro power) are available enjoy a competitive advantage, which is strengthened when greenhouse gas emissions are internalized.

In order to avoid a system breakdown, efficient coordination and the exchange of information are required between the various segments of the sector (i.e. generation, transmission, distribution, and supply). The unbundling of these segments, which is one of the central measures in the deregulation process, has complicated the achievement of this crucial requirement and entails a new type of costs – transaction costs – that might reduce the potential gains from the introduction of competition in generation and supply.

As far as interconnection capacities between national markets are concerned, they are widely concerned as insufficient. This situation is retarding the creation of a single European market. More interconnection capacities would in many cases solve the problem of concentration on national markets. The European Commission has taken initiatives to improve this situation, such as financial support investments as well as promoting regional markets development as an interim stage on the road to a European market.

It should be mentioned that power transport over long distances requires high infrastructure investments and is characterized by high operational costs (congestion management, loop-flow management, etc.). Since the cost being the sum of generation and transport costs, power generation will probably always be dispersed across Europe.

The electricity industry is also at the crossroads of two important concerns, i.e. the enforcement of the Kyoto protocol and the security of supply. These two concerns were managed by governments through industry regulation and planning, the European policymakers tend to priorities the market as a way to solve them. For instance, the unequal national targets and use of different technologies, combined with the existence of entry barriers, might distort competition.

In order to overpass some concerns related to the process of liberalization, firstly the regulatory framework needs to be harmonized. This is precisely the case of electricity deregulation, which has been and still is particularly subject to controversy between Member States. This situation has resulted in extensive freedom in terms of national implementation. The lack of harmonization is particularly harmful to the economic design of the market, this is for the degree of competition introduced, the handling of market power problems, etc.

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