

Chapter 2

Restructuring of Electricity Markets

2.1 Liberalization, Deregulation, and Restructuring of the Electricity Markets

Governments have regarded the electricity industry as a leading industrial sector throughout history. Because of its strategic importance for industrial development, its impacts on social and environmental issues, and its natural monopoly characteristics, it has been seen necessary to regulate electricity industry effectively. Many countries have relied on public ownership of electricity supply assets instead of strict direct regulation. On the other hand, in countries with substantial private ownership since the early electrification, governments have typically subjected electric utilities to wide-ranging financial, health and safety, planning, and environmental control. These two approaches to the industry, public and private control, have ensued large-scale investments in costly technologies,¹ concentration on engineering excellence instead of cost minimization and high quality service, and lack of competition in the potentially competitive generation and supply businesses. Exceptions to these general rules can be found—for example the Scandinavian small-scale electricity distribution by municipally owned utilities.

Historically, the electricity industry has been characterized by economies of scale in the generation and necessity of an extensive transmission and distribution network in order to deliver the generated electricity to the final consumers. These primary components of electricity supply were integrated within individual electric utilities. However, in the mid-1980s it was realized in several countries that even though transmission and distribution networks are natural monopolies, the scale economies in electricity production at the generating unit level had exhausted at a unit size of about 500 MW (see e.g., [21, 24, 41]). This meant that the natural monopolistic characteristics of electricity supply and generation had vanished and thus they had become potentially competitive activities. As a consequence, it was

¹ Like, for example, nuclear power.

noted that a separation of network activities from generation and supply and the introduction of competition to the potentially competitive parts of the industry might increase the overall efficiency.

It is possible to organize the competitive wholesale trading by using many different systems from which the pool-based trade and bilateral trade have become the most common. However, a certain degree of central co-ordination is needed because competitive wholesale trading arrangements all share the same need to match supply and demand, and this matching process must be carried out instantaneously.² This is true regardless of whether the electricity industry consists of a single vertically integrated public sector utility or a multitude of competing generators and suppliers.

The objective of this chapter is to discuss the grounds and incentives of deregulation and restructuring processes in the electricity industry. Further, the success of already implemented deregulation processes is assessed by using the Nordic power market as an example. Also the crucial factors in improving efficiency are determined.

2.1.1 On Liberalization and Deregulation

During the past two decades we have seen comprehensive electricity sector liberalization and deregulation in all EU countries. The same is not true for the U.S. since it has not enacted mandatory federal restructuring and competition law. In the U.S. any significant restructuring reforms have been left under the decision of the individual states. In consequence, many states have introduced only some liberalization reforms concerning mostly the wholesale markets. Actually, some of those states that have introduced more comprehensive restructuring and reforms on the electricity sector are now planning to re-regulate the industry (see [24]).

When evaluating the degree of reforms in different countries it should be noted that the concept of liberalization or restructuring may take several different forms. It may mean permission for independent generators to enter the market, the creation of a power pool, or the horizontal separation of incumbent generators. In addition, it can refer to the vertical disintegration of state-owned monopolies into generation, transmission, and distribution businesses. In its most comprehensive form, liberalization usually culminates in the sale of the state-owned assets, either completely or at least partially, to the private sector (see [39]). Joskow [24] gives a comprehensive list of the desirable features for restructuring and regulatory reform.

It is often argued that liberalization, and as an endpoint of it, privatization, improves the economic efficiency. The reason why liberalization and privatization are assumed to improve economic efficiency and how significant improvements they create are explained in different ways, depending on the theoretical basis

² This is because power cannot be stored economically in significant quantities.

adopted. The property rights theory (following [1], see also [39]) argues that privatization assigns particular assets to those who can utilize these assets most efficiently. The supporters of this theory claim that state-owned electricity utilities are not run as efficiently as they could be run under private ownership. This is basically due to the fact that the state-owned firm is not supposed to minimize costs as would be the case as a result of privatization. Bureaucracy theories (see [36]) argue that managers in state-owned companies may be more interested in maximizing the budget of their department than in minimizing costs or maximizing profits. On the other hand, the theory of regulation and incentives does not support privatization as strongly as the two theories above. As a matter of fact, the famous Averch and Johnson study [4] argues that in industries where privatized activities are regulated, the regulation may introduce negative incentives, which may not be present in the public sector and which would reduce economic efficiency.³ More modern theories of regulation (see, e.g., [5, 30–32]) stress the importance of the information problems connected to the regulators' imperfect information about the true costs of the firm. The theory of influence activities asserts that ownership arrangements evidently change the relationships between groups and also their possibilities to influence within the company. These changes create some costs, which should be emphasized when planning privatization. Joskow [24] recognizes also many significant potential benefits, but also potential costs connected to the liberalization if the reforms are implemented incompletely or incorrectly. Green [15] emphasizes the importance of market power mitigation in order to reach significant efficiency gains as a result of liberalization. Concerning privatization the final effect can be positive since influence seeking is seen to be easier in private companies. However, as Newbery and Green [34] argue the relative performance of the industry does not depend strictly on whether the industry is under public or private ownership,⁴ but rather on the state of the development of the industry, on technology, and on the balance of political and economic forces shaping its development.

Although privatization may have a positive influence on the performance of a firm, it should be emphasized that it can also create some problems. The potential problems arising from privatization include the high cost of regulation,⁵ and the possibility of deadweight losses⁶ if the privatized company can exploit market power. Because of these contradictory conceptions of privatization, Pollitt [38]

³ Averch and Johnson [4] analyze the effect of rate-of-return regulation in the USA. They show how it creates incentives to over-invest in relation to the social optimum. They also argue that the rate-of-return regulation provides no incentive to reduce costs.

⁴ Public ownership may be preferable when we deal with issues, such as coordination and restructuring, while private ownership may have comparative advantages considering the competition and self-centered objectives of the firm.

⁵ The costs of regulation may include direct costs and also the costs resulting from poorer incentives for efficient performance.

⁶ Deadweight losses may be due to the high prices, the social waste of entry-deterring activities, or the excessive entry caused by the high profits of incumbents (see, e.g., [39]).

argues that it is more an empirical issue rather than a theoretical one, whether the privatization process ultimately means lower costs and improved efficiency.

It should be pointed out that deregulation and liberalization are not simply a matter of public versus private ownership. Liberalization of markets has been done in different ways in different countries. Some countries have deregulated the industry by introducing competition and “stopping” the regulation while others have at the same time privatized the industry. Thus, we can say that the debate on public versus private ownership is more like a matter of choosing the modes of control. Liberalization itself includes subjecting utilities to market forces, which can result in more changes in performance than privatization. Replacing the monopoly activities by competition can increase efficiency. However, it should be noted that at the same time liberalization also redistributes rents and raises new regulatory problems in managing the interface between the regulated and the competitive parts of the utility (see, e.g., [33]). As Joskow [26] argues market imperfections (and the costs it causes) should be always evaluated with the regulatory imperfections (and the costs which it causes) when deregulating, regulating, or restructuring the market.

As already stated above, a central issue in creating the new electricity industry structure has been the observation that even though regulation or public ownership is the only stable form of organization in natural monopolies, potentially competitive parts can be separated from network parts. However, before restructuring can be thought to be complete there is the crucial question of how to combine the necessary regulation of the network with the organization of competition in activities that use the network as an input and are potentially competitive (see [32]). The issue of practical implementation of efficient regulation is still an open question (see, e.g., [29] and Chap. 8 in this book). Although an increasing number of countries have moved toward a more incentive-based price regulation, in most countries the basis for regulation is still based on the cost of supplying electricity, including an appropriate level of return on capital investments. The problems continually faced by regulators are how to determine “proper” costs, what is the appropriate depreciation rate of capital, and whether it is permissible to allocate more costs to one group of customers than to another (see e.g., [22, 23]). A further issue that has been seen as a threat to the success of deregulation is the possibility of some companies to exploit market power.

As one can conclude from the discussion above the electricity market deregulation, liberalization, and restructuring are not easy tasks. In consequence, even though we have seen successes in the electricity sector restructuring in countries like UK, the Nordic countries, Argentina, Chile, Texas, and portions of Australia, in many countries electricity sector reforms are moving forward slowly with considerable resistance or in some cases even moving backward [24].

2.1.2 Different Grounds for Deregulation

There are at least two fundamental reasons acting as the impetus for deregulation. First, deregulation can be based on changes in the ideological atmosphere.

This kind of a basis for deregulation usually culminates in the privatization of public activities. This has been argued to be the driving force for the deregulation process, for example, in the United Kingdom, where during the term of Margaret Thatcher, many industries, including the electricity industry, commenced restructuring. The number of producers has not been seen politically as critical as the privatization in order to reach the target of efficiency improvements as a result of deregulation. However, economists in UK argued in the early stages of the restructuring process that the number of generators in electricity markets should be higher than it was in England and Wales (see [17, 19, 40]).

Another ground for deregulation is based on the pure target to improve efficiency. In restructuring processes based on the pure efficiency target the number of operators (buyers as well as sellers) in the market has been seen as a crucial element, and not the privatization, in order to reach the target. The Nordic Electricity market is an example of this kind of a restructuring process. For example, there were nearly 340 market participants in the Nord Pool Spot in 2010. Although privatization has taken place, significant amount of the generators have remained in public ownership even after deregulation. The crucial element, in addition to the number of operators, has been seen to be the actuality of the demand function used by the pool operator. In the Nordic Power Market the demand function is calculated on the basis of the real bids to the pool instead of estimation by the pool operator. The more efficient allocation of production capacity has also been one of the motives in deregulating the Nordic Power markets.

Generally speaking, even though the political forces behind the decision to change the market conditions have been strong and varied in many countries, it has been argued (see, e.g., [11]) that deregulation would not have occurred if economists had not supported it through their research. Recently, economists have developed a theoretical and empirical framework to predict the actual effects of deregulation and liberalization. Just to mention a few studies, Wolak [42] has pointed out through international experiences the importance of efficient market monitoring in order to reach the benefit of deregulation and Green [15, 16] has studied the main characteristics and potential problems of competition policy in the European electricity market.

Although the potential benefits from deregulation are well known (see [8, 24]), there is no worldwide agreement upon the set of market rules for guaranteeing a successful industry restructuring. However, economists generally agree that because technological changes have frequently lessened the presence of scale economies, the prevalence and importance of natural monopoly features of the industry are diminishing. Already in [6] Baumol et al. argued in their theory of contestable markets that deregulation may be superior to regulation even in industries with scale economies. The contradictory opinions are related to the questions of how the deregulation should be implemented, and which kind of market rules should be created. It is clear that in some industries, such as electricity distribution and transmission, characteristics of natural monopoly and scale economies are so evident that most of the countries still rely on some form of regulation. There are varieties of methods to regulate the firms from which the

so-called high-powered incentive regulation schemes are becoming more and more important. There is a lot of empirical evidence that the high-powered incentives created by competitive wholesale electricity networks will or have led to lower generator operating costs and also improved availability (see [10, 13, 23, 35]).

Although the major rationale for electricity industry restructuring is to provide stronger incentives for efficient production and delivery of electricity, it may not mean lower electricity prices if the firms possess market power and thus have the ability to raise output prices above the competitive levels. Consequently, it has to be decided which one of the two regimes will yield greater benefits to the final consumers: (1) a competitive market with strong incentives for least-cost production but limited incentives for cost-reflective output prices, or (2) a regulated market with limited incentives for least-cost production but potentially more cost-reflective output prices (see [8]).

The prevailing view is that the technologies for electricity generation and retailing are both such that competition is feasible. As discussed above, economies of scale in generation are exhausted at levels of production significantly below the current levels of industry output. However, the problem is how to guarantee that the price for electricity is set from the perspective of economic efficiency, i.e., such that it is set to mimic the market price in a competitive industry with many non-colluding firms and small barriers to entry.

2.2 Nordic Power Market as an Example of Restructuring

The Nordic power market, including Denmark, Finland, Norway, Sweden, and Estonia, provides a good example of restructuring and deregulating the electricity industry since 74% of all power in the region was traded in Nord Pool Spot in 2010. This makes the Nordic power market the world's largest market for buying and selling electric power.

The historical background of the electricity industry is fairly similar in all Scandinavian countries. Throughout the history of the industry there has been both public and private ownership of electricity companies. Another characteristic has been the relatively weak formal government-enforced regulation. Instead, there has been self-enforced club-regulation and yardstick competition. Also, the role of a publicly owned dominant firm has been extensive.⁷ In addition, the share of hydropower has been and is relatively large in all Scandinavian countries except for Denmark.

The first commercial, relatively large-scale private power companies were established in the late nineteenth century. After that many local co-operatives were built, but the real expansion of the retail distribution of electricity took place

⁷ At least in Norway, Sweden, and Finland.

shortly after the First World War. The next distinct stage of development in the electricity system was put forward after the Second World War. During the war, it had become clear that import and export of fuels were extremely difficult, which gave an incentive to further develop domestic hydropower in Scandinavia. As a result, hydropower capacity was increased rapidly in the 1940s and the 1950s. In the 1960s the expansion of hydropower slowed down, because the potential for unexploited hydro capacity was reduced. The increasing interest in environmental issues also changed the focus of future production and capacity exploitation from hydro to other alternatives (see [3, 18, 20]).

In Denmark, Finland, and Sweden several municipalities developed district-heating cogeneration systems based on oil, coal, biomass, or peat in the 1960s. Especially, Finland also built industrial cogeneration plants. The baseload production of electricity leaned on hydropower in Norway, coal, oil, and nuclear power in Finland, coal and oil in Denmark, and hydro and nuclear power in Sweden. The proportion of nuclear power was clearly increased in Sweden and Finland between the 1960s and the mid-1980s. In 1963, a co-operation organization, Nordel, was established. It enabled the collaboration between large generators in Denmark, Finland, Iceland, Norway, and Sweden. In practice, co-operation has been possible through high voltage direct current (HVDC) cables, which were constructed from Jutland to Sweden and Norway (see [18, 20]).

The retail distribution in urban areas was, already at the early stage of electrification, handled by utilities owned by towns or cities. In rural areas distribution co-operatives took the responsibility for retail distribution. As a result, there were numerous small and inefficient distributors in the mid-1940s. This problem was solved by regulation and nationalization, which resulted in a significant decline in the number of distributors, for example in Sweden from 2000 (in the mid-1950s) to 300 in 1996 (see [20]).

A common characteristic to Norway, Sweden, and Finland is that the population is concentrated in the south while the most of the hydro resources are in the north. As a result, transmission networks have been seen as very important since the first decades of the twentieth century.

2.2.1 Restructuring and Integration of the Nordic Power Markets

The deregulation of the Nordic electricity markets started in Norway on January 1991, as a new Energy Act was made effective. Originally, the Nord Pool was a national Norwegian power exchange, but it was expanded to cover also Sweden in 1996. It was extended further in 1998 when Finland joined the pool. In Finland the Nord Pool is represented by the Finnish power exchange EL-EX. Finally, in 2000 the Nordic market became fully integrated as Denmark joined the exchange. In 2010, Nord Pool Spot was again enlarged as it opened a new bidding area in Estonia.

Although the Nord Pool was built almost at the same time as the original Pool in England and Wales, they were built independently, and as a result they ended in quite different structures. The main differences of the Nord Pool and the original British Pool were (1) the mandatory versus voluntary role of the pool, (2) the way in which the balance between supply and demand is controlled, and (3) the incentive of the reform and ownership structure of the industry. Additional to these three issues the market structure is clearly different in the sense that while there are only a few active market participants in the British market, there are over 300 market participants in the integrated Nordic power market.

The basic characteristic of the Nord Pool is the voluntary participation since in the Nordic power market there is no obligation to buy or sell through the Pool. Instead, also bilateral contracts outside the Nord Pool are accepted. This means that in the Nordic model the real-time dispatch⁸ and the merit order⁹ dispatch have been strictly separated. The central grid operator determines the real-time dispatch,¹⁰ but the merit order dispatch is determined by the outcome of the hourly spot market.¹¹ Originally the main reason to create a different institutional framework in the Nordic power market is the fact that around two-third of the power is generated in hydropower plants. Thus, the trade at the spot market is primarily motivated by the need to adjust positions as there appear unexpected variations in supply and demand conditions (see [2]).

The Nord Pool closes everyday at noon when the supply and demand bids are cleared against each other and commitments are made for the delivery of the following day on an hourly basis. The interval between the times the bids are made and the actual trading takes place is at least 12 h. It is significant that both generators and consumers are required to plan to meet all the commitments they have made. Because of the time interval between the bids and the actual delivery, a certain amount of fluctuation in the actual supply and demand is unavoidable compared with the commitments made on the spot market. In order to control the balance a regulation system has been created (see [37]). The market participants can hedge their price through financial contracts and thus manage the possible price risks. Financial contracts are traded through Nasdaq OMX Commodities. There are different types of contracts covering daily, weekly, monthly, quarterly, and annual contracts. The reference price which is used in the financial market is based on the Nord Pool Spot price.

The main motivation in the restructuring of Nordic power markets was not privatization but rather the possibility to improve efficiency. Because the Nordic

⁸ The real-time dispatch refers to the real, implemented, sequence according to which different production units are utilized.

⁹ The merit order dispatch refers to the sequence, according to which different production units are utilized if cost minimization is used as a crucial argument. In other words, units are organized such that the unit that has the lowest marginal costs is utilized first, the unit that has the second lowest marginal costs is utilized next, and so on.

¹⁰ As in the British system.

¹¹ Operated by the independent Nord Pool.

countries provide the first multinational electricity markets, where it is possible for the seller and the buyer to trade between nations, the possibility of congestion in the transmission grid had to be carefully considered and distinctive rules had to be created. Transmission services are based on so-called point tariffs. Generally speaking, this means that at each location there is a given price per unit of power fed into or tapped from the transmission system. This price is independent of the location of the buyer or the generator of that power. The geographical distance between the seller and the buyer does not affect the price of the corresponding transmission service. However, whenever there is congestion in the network prices may vary between countries. Furthermore, Norway can be split into five different price areas, Sweden into four, and Denmark into two. Finland and Estonia are always treated as one price area. The Transmission System Operator (TSO) decides the number of bidding areas and Nord Pool Spot calculates a price for each bidding area for each hour of the following day (see [37]).

2.2.2 Current Structure of the Nordic Power Market

Currently, Nordic countries continue to run a common power exchange, the Nord Pool. The mix of production technologies in the Nordic power market is quite large and it has been argued that it would improve the efficiency of production if market participants could trade between countries.

Nord Pool Spot manages the capacity on the interconnectors between the Nordic countries and the cables that connect the bidding areas in Norway. A privileged place on a bottleneck could be abused by a commercial participant and it is therefore essential that the capacity is given to a neutral party (see, e.g., Nord Pool webpage for the discussion on bottlenecks).

The total net electricity production in the Nordic market was 367 TWh in 2009 (see [12]). Of the produced electricity 72.6 TWh was based on nuclear power, 205.1 TWh on hydropower, 61.7 TWh by using conventional thermal power plants, and 27.6 TWh was based on other renewables. The amount produced by hydropower can change much from year to year depending on precipitation. When the precipitation of the year is low, power is exported from Finland and Denmark to hydro-dominated regions and in the high precipitation years the opposite is true. Sometimes the precipitation is so high that some thermal capacity is idle during that period. There are five nuclear power plants currently operating in Nordic countries. Three of them (10 reactors) are located in Sweden whereas two of them (four reactors) are located in Finland. There is also one more 1,600 MW reactor under construction and permission to construct two more reactors in the near future in Finland. Characteristic to the Nordic energy markets is that a large part of the conventional thermal power is produced by combined heat and power (CHP) plants. The peak technology includes oil-fired condensing power plants as well as gas turbines. In our simulations below, we divide our technologies into five

representative technology groups based on the main characteristics of the Nordic power market.

Nordic power markets operate under the European Commission's internal emissions trading. At present, the emissions trading only concerns carbon dioxide emissions. The emissions trading scheme is meant to operate so that the emissions of the companies under the scheme keep the predefined total emissions quantity within the limits. For electricity markets, the Emissions Trading Act is applied to carbon dioxide emissions of such power stations for which the thermal input is more than 20 MW and also for the smaller combustion installations connected to the same district-heating network. Typically, the issuance of permits lies with the National Energy Market Authority. The amount of issued permits by power stations is less than their yearly emissions. Power producers can buy extra permits from the emission permit markets. This increases the costs of technologies under emission trade. As the new emission trade period starts at the beginning of 2013 the amount of issued permits per power station clearly reduces and more permits have to be bought from the emission permit market. The impact of this on the price of permits remains to be seen.

The aggregate demand for electricity in Nordic countries has been quite stable from year to year and the increase has been mainly due to economic growth. Some yearly variations happen along with variation in temperature. Price elasticity of demand has typically been very low because the price that final customers face is typically fixed for some period of time and prices do not follow the pattern of wholesale prices in the short run. Economists have argued that the absence of Real-Time Pricing is one of the most obvious shortcomings of the functioning of the electricity markets from an efficiency point of view. This is mainly because if demand is not responding to the prices we need too much reserve power capacity to meet the demand also in the highest peak hours (and this is of course very costly). The inelasticity of demand may also enhance the ability for producers to use market power (see, e.g., [27]).

2.3 Assessment of Deregulation Processes

Prior to the worldwide wave of deregulation, electricity was supplied by regional monopolies that owned both the power plants and the transmission lines for the distribution of power. Some form of regulation was used to set the rate of return of profit for the utilities in all nowadays restructured countries. Although it was recognized over 30 years ago that the character of electricity generation had removed from natural monopoly to the potentially competitive activity, there was no real pressure for the creation of a "deregulated generation market" until the 1990s. This was either because the political atmosphere supported it (as in the United Kingdom), or because large industrial customers did not want to pay vertically integrated traditional utilities for their expensive electricity (as in the U.S.). It is also possible, as argued in public discussion, that big generators started to

support restructuring of the electricity industry because they saw the possibility to increase their profits through a speculative market.

There are many observable differences in how the deregulated electricity supply industries can be organized. The interaction between created market rules and the prevalent market structure of the industry determines whether economically efficient prices can be set by these markets (see, e.g., [41, 42]). According to our view, the success of the deregulation process and the target to improve efficiency depends on six issues. First, the *number of active players* in the wholesale market seems to be important, not so much whether the wholesale is carried out through some kind of a spot market or a bilateral market. Second, the *rules of the bidding procedure in the wholesale market* clearly seem to affect the outcome of the market. Third, the *organization of the demand-side operation* in the wholesale market is much more important than has been recognized so far. Fourth, the *transmission grid should offer a neutral market place* for competitive activities. This requires that the access to the transmission grid is based on equality and furthermore that the transmission capacity is high enough to guarantee its efficient operation. Fifth, it seems that some *production technologies* make it easier for companies to use market power than others. And finally, the *ownership structure* may have some effect on the outcome of the market. Next, each of these six issues is discussed.

The first thing that clearly seems to affect the success of the restructuring process is the *number of active players* in the competitive markets. In some countries, such as the Nordic countries, the number of the market participants has been seen to be a crucial issue in order to achieve the target of deregulation, i.e., efficiency improvement. However, some other countries, such as the United Kingdom, have relied on the market performance even when there have been only few active companies in the market. This has been the case, even though already before deregulation Henney [19] argued that the British generating companies should be split at least into nine separate companies. Sykes and Robinson [40] also proposed that there should be at least five or six competing generating companies in the competing electricity market in order to reach the goal of lower prices. Green and Newbery [17] suggested that the generators using thermal power (in the United Kingdom) should be divided into five generators of equal size. Further, they argued that the scope of exercising market power has been considerably underestimated.

Thus, it was not a surprise that very soon after liberalization it became clear that the two major generators in the UK, National Power and PowerGen, had sufficient market power to raise prices in the Pool (see, e.g., [14, 44, 45]). This was possible because of two things, the *structure of bidding procedure* and the *determination of demand* when market price is calculated. The resulting price of the bidding procedure is called the system marginal price (SMP) and it is used in electricity spot markets worldwide. It is based on the bid of the most expensive set in normal use. The system is defined such that the lowest cost generating capacity is dispatched first, unless such dispatch will compromise the system integrity. According to this dispatching procedure “least-cost merit order” gives rise to an

upward sloping aggregate electricity supply function for each price period of the system. The SMP is determined combining the expected demand function to this supply function (see [41]).

In an electricity supply system where there are only few large companies they can manipulate the SMP by removing some of their capacity from the market. The generators thus are able to maximize their profits by keeping the industry's capacity at a lower level than would be efficient. It has also been claimed that large generators may bid some of their stations above their marginal costs. As a result these stations will be displaced in the merit order, sacrificing some market share, but in that way the infra-marginal stations can earn more because of the higher level of SMP (see [17]). In markets where there are many active players, as in the Nordic power market, the influence of one market participant on the outcome of the market is smaller than in the case of only few big suppliers, and thus price manipulation is more difficult.

The way in which the *demand function* is constituted has also great influence on the outcome of the market. Demand may be based on the estimation by the system operator or on the true bids of purchasers of electricity (as in the Nordic power market). If demand is based on the estimation, the operators' forecasts for demand can be readily available for generators prior to their submissions of bid prices and availability declarations for the next day. In this kind of a system generators can compute the forecast for demand for all load periods before they submit their bid prices and available generation capacity. Wolak and Patrick [43] argue that this market rule clearly improves the possibilities for generators to exercise market power. In the history, market power has been observed to be clearly a problem at least in the United Kingdom and in the state of California (see [8]). Another demand-side issue which has recently gained more and more importance is *real-time demand responses* to the changing marginal costs of production. Long before worldwide electricity deregulation and restructuring began, it was known that the marginal cost of producing electricity could change significantly according to the time of the day. This means that the true costs of consuming electricity also vary hour by hour. Consequently, economists have argued that retail electricity prices should also fluctuate hour by hour reflecting their true opportunity costs. The problem has been insufficient metering technology. Recently, however, new technology has enabled hour-by-hour measuring of electricity consumption and hence the technology constraint is disappearing (see, e.g., [7]).

A restraint that can significantly distract the operation of competitive markets is *the operation of the transmission grid* (see, e.g., [25]). Transmission grids have been a clear problem in some parts of the United States and also in New Zealand in the history. For example, there are areas in the United States, in which transmission lines become easily congested, which makes free competition difficult. For example, a significant amount of the generation units in California are so-called "must-run" units. This maintains local market power also in the case of free competition between different states. It is possible to diminish the problem of market power so that operators can ignore or cancel the bids made by generators that have been suspected of exercising local market power. However, the best way

to improve competitive conditions might be to increase the contestability of separate markets by improving the transmission infrastructure (see [9]).

The *diversity of generation technologies* seems to impact the outcome of the competitive market. It is interesting that, for example, market prices in the markets dominated by fossil fuel technology, for example, in the United Kingdom and in the state of Victoria (Australia), have been much more volatile¹² and also higher than the prices in the markets dominated by hydroelectric or nuclear power capacity, such as the Nordic power market and New Zealand. Possible explanations can be that it is more difficult to manipulate market prices when production is based on so-called must-run technologies. Also, the *ownership structure* may have an influence on the outcome of the market price, since the majority of the generating capacity in the United Kingdom and Victoria is privately owned and thus their objective may be pure profit maximization, whereas for example in the Nordic countries large state-owned generation companies have significant market share and thus their objective may be wider than just profit maximization. Consequently, some of the price volatility in the United Kingdom and Victoria may be explained as episodes of the successful and unsuccessful attempts to exercise market power (see [41]).

Is it, then, possible to draw conclusions about the success or failure of deregulation in general on the basis of the international experiences? Clearly, deregulation has offered some benefits, but it also has some weaknesses. Up to now, it seems that if the deregulation is carried out such that the “accurate” market structure is designed carefully and effective market rules can be created, the deregulation can result in increased efficiency and lower prices. However, it should be noted that we are still far away from a perfectly competitive industry. Thus we can conclude this chapter by the words of John Kay [28]: “the real benefits of competitive markets over central planning are that decisions are made on a smaller scale, and a diversity of views can be implemented. This makes the consequences of good and bad decisions more obvious. Errors can be more quickly corrected, and the expectation that individuals may be held responsible for the outcome helps judicious decision-making. Markets are not a perfect form of economic organization. They are just better than the alternatives.”

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¹² See Wolak [42] for evidence and more detailed discussion of volatile prices.

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Distribution

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2012, XII, 140 p., Hardcover

ISBN: 978-1-4471-2971-4