Term Paper

ELECTRICITY MARKET REFORM:

WHAT'S THE PRICE FOR LIBERALISATION?

Energy Economics and Policy

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1 Introduction

The electricity infrastructure is one of the most complicated networks, as it is very fine meshed. In Europe most of the homes and buildings are connected to it, due to the fact that electricity is crucial to the functioning of modern society. Thanks to electricity we have such a high standard of living and would the supply fail, it would become impossible to perform most economic activities (security of supply is an important keyword here). The electricity infrastructure undergoes fast and substantial changes at the moment, there are two trends observable: liberalisation and internationalisation. Both trends have a significant influence on the recent policy developments concerning the European electricity supply system.

This paper takes a closer look at policy developments concerning deregulation of electricity markets in Switzerland and the EU. A simplified OLS-regression model gives some information about electricity price developments after liberalising an electricity market. This is then applied to draw conclusions on the further development of the electricity prices in Switzerland.

1.1 The Swiss electricity market

The supply of electricity in Switzerland is mostly provided through hydro power stations and nuclear power stations. Figure 1 shows monthly figures from 2008 about the different production types and their magnitude. In summer months the production exceeds the demand (indicated by the black line), while in winter the demand cannot be covered by the domestic production. Furthermore, the hydro production is dependant on the season, in spring and summer the water inflows are higher than in summer, while the production from nuclear power plants is constant during the year beside the maintenance outages during the summer month.

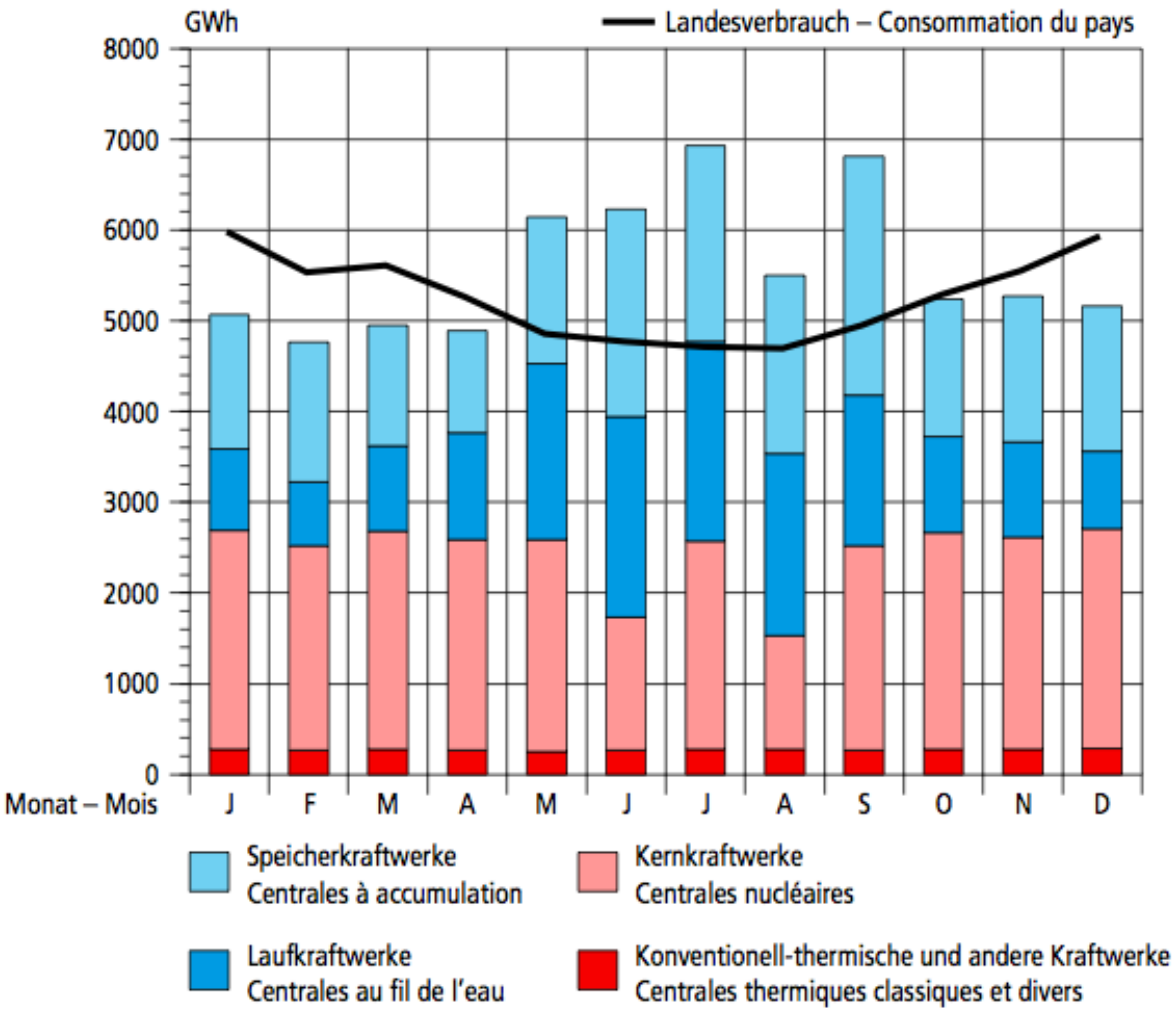

Figure 1: Monthly production shares and total demand in Switzerland in 2008 [Swiss Federal Office of Energy. 2008].

Since 1960 the electricity production in Switzerland has more than tripled (see Figure 2). At that time the whole production consisted of hydro power plants, while later in 1969 and 1070 the first two Swiss nuclear plants were built. Since 1990 the share of hydro power from the total production has been quite constant (50-60%).

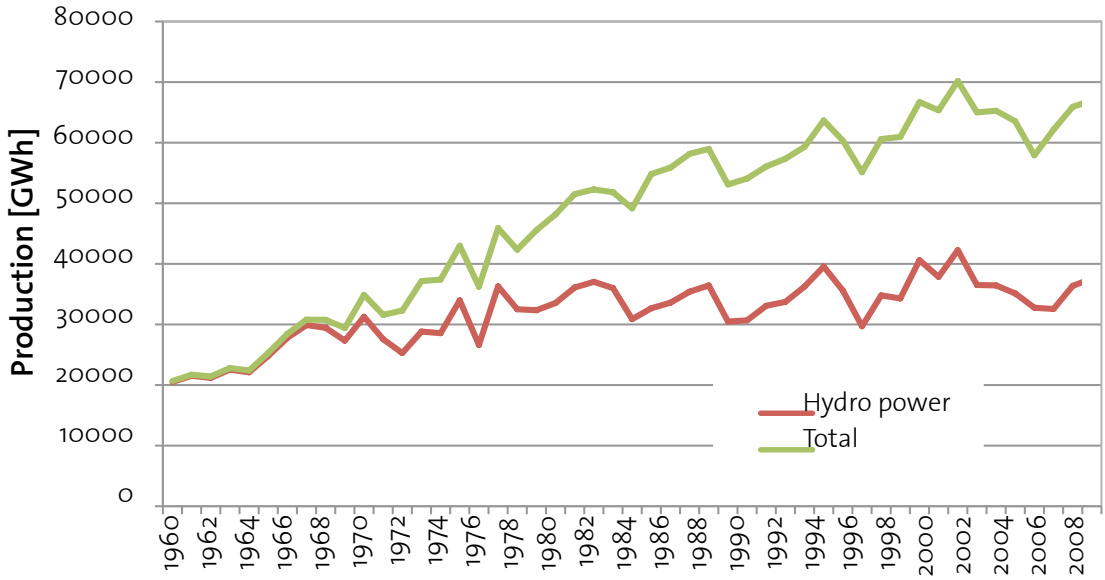

Figure 2: Yearly production of electricity in Switzerland from 1960 – 2008 [Swiss Federal Office of Energy. 2008].

According to Swissgrid, about 900 companies are involved in the production, distribution and supply of electricity in Switzerland at the moment. These companies supply electricity in Switzerland to around 7.4 million citizens and to customers in industry and trade as well. There are different sizes of companies working in this field, from small municipal utilities supplying single communities to international working companies [www.swissgrid.ch]. In Europe, Switzerland assumes a key role as the electricity hub of Europe (In 2008 the Export was 51.4 TWh and Import was 50.3 TWh [Swiss Federal Office of Energy. 2008].

1.2 International comparison

The hydro power sector in Switzerland is rather large compared to other countries (see Figure 3), because of the large potential in the Alps. The total hydro production in 2009 was

38.2 TWh (Total electricity production: 67.5 TWh) [Swiss Federal Office of Energy. 2009]. Figure 3 shows a comparison of the electricity mix in different companies (Norway, Austria, Switzerland, Sweden, Italy, France, Germany and EU-15). Norway, for example, produces electricity almost exclusively out of hydro power. Compared to that, France uses manly nuclear power to generate their electricity, which is exported to Italy through Switzerland as well. Germany, in contrast, produced two thirds of its electricity in conventional thermal power plants, while also producing a relatively large fraction with wind turbines. Sweden seems to have a quite similar electricity production mix to Switzerland, however it produces double as much electricity in thermal power plants.

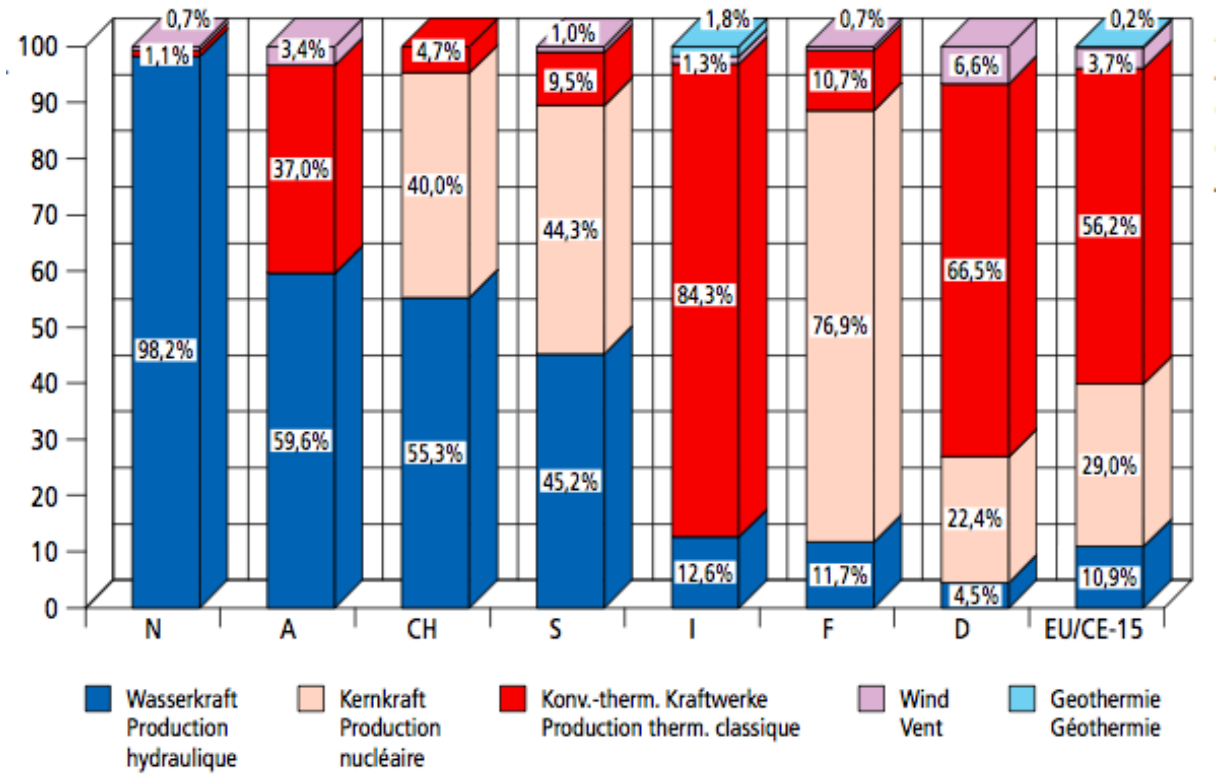

Figure 3: International production composition in 2007 [Swiss Federal Office of Energy. 2008].

These different production conditions are also reflected in the particular prices for electricity in the different European countries. This has to be kept in mind when comparing electricity price developments in different countries later on.

1.3 Economic situation

In March 1998 the *Aare-Tessin AG für Elektrizität (ATEL)* and the *Elektrizitäts-Gesellschaft Laufenburg AG (EGL)* started to publish the Swiss Electricity Price Index (SWEP). The SWEP represents the electricity transactions performed over a day's trading on the spot market and was the first wholesale price index for electricity in Europe. In Figure 4 the development of the SWEP from 2007 to 2010 is shown. As it is an index for the spot market it shows a quite high volatility trough the last three years. Figure 5 displays the price for base load power at the EEX (European Energy Exchange in Leipzig, Germany) in quarterly steps. This shows a long-term price development.

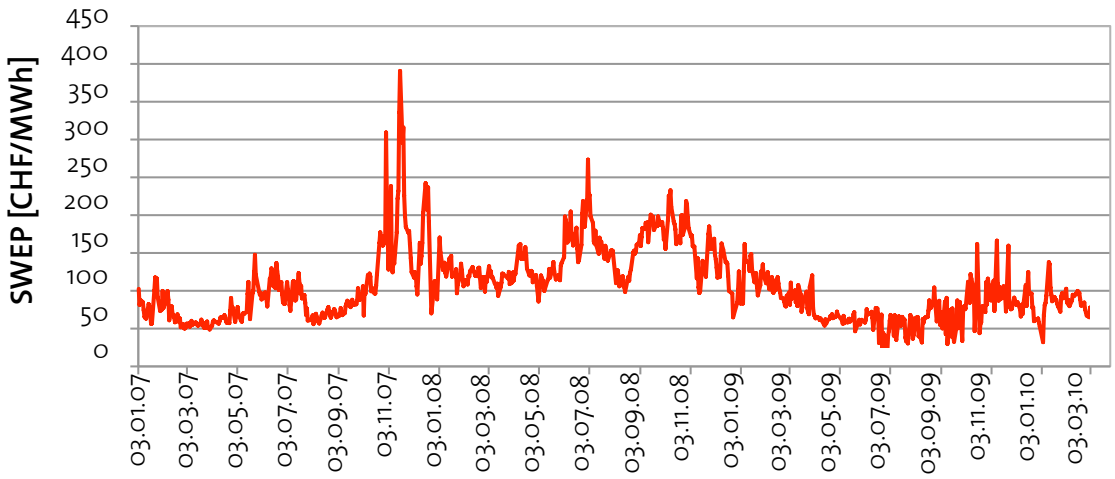

Figure 4: Development of the Swiss Electricity Price Index (SWEP) from 2007 to 2010 [www.caleniaenergia.com].

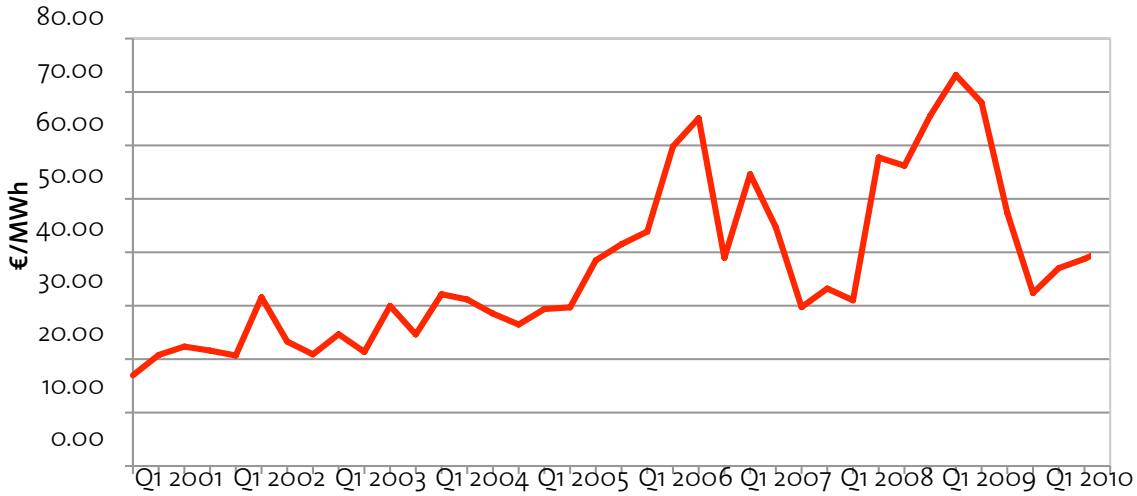

Figure 5: Price for base load power at EPEX Spot per Quarter from 2000-2010 [www.eex.com].

2 Electricity market liberalisation

2.1 In Switzerland

According to the Swiss Federal Office of Energy (SFOE), the Swiss electorate rejected the proposed Electricity Market Act by a majority of 52.5% on 22 September 2002, and thus demanded that the Federal Council and the Federal Administration should reconsider the pace and methodology for the liberalisation of Switzerland's electricity market and the regulation of cross-border transmission. From spring 2003 to summer 2004 a committee of experts appointed by the Federal Department of the Environment, Transport, Energy and Communications (DETEC) set out to redefine the legislation governing the Swiss electricity supply structure, while taking account of the reasons for the rejection of the proposed Electricity Market Act. The three other main considerations on which the formulation of the draft legislation is based include:

1. The ruling by the Federal Tribunal in May 2003 (Entreprises Electriques Fribourgeoises versus Watt/Migros) to the effect that the liberalisation of the market is fundamentally possible on the basis of the Cartels Act
2. The fact that the electricity market in the EU is to be fully liberalised as of 1 July 2007
3. The blackout of 28 September 2003 in Italy [www.bfe.admin.ch].

The new Act (StromVG, into force since 1 January 2008) regulates the basis for a reliable (security of supply) and sustainable electricity supply. It plans an opening of the market in two stages: In the first five years, end-consumers with an annual consumption of more than 100 MWh are allowed to choose their supplier (as of 1.1.2009). After five years, all end-consumers have free access to the market, but the full liberalisation of the market is subject to an optional referendum. The high-voltage transmission network (220/380 kV) has to be operated

by a national network operator with Swiss majority ownership. For this purpose, transmission companies have already established *Swissgrid* as a corporation. Ownership of the high-voltage transmission networks has to be transferred to this network operator within five years after the Act enters into force. Hence, *Swissgrid* is responsible for coordination and monitoring in the European Network of Transmission System Operators for Electricity (ENTSO-E/UCTE). Meanwhile, the federal authority *ElCom* supervises legal compliance, the security of supply and the consumer prices.

2.2 In the EU and Norway

In the European Union the first electricity (and gas) directive was adopted in 1996 (96/92/EG), with the objective of opening up the electricity and gas markets by introducing competition step by step. The second electricity directive, adopted in June 2003 (2003/54/EG), include 'unbundling', whereby energy transmission networks have to be run independently from the production and supply side. According to the directives, markets for all non-household electricity customers are to be liberalised by July 2004. For private households, the deadline is July 2007. After this deadline everybody would have been able to choose their electricity supplier freely in a competitive marketplace. But this was not fully the case; there were some serious malfunctions in the market for industrial consumers. According to the EurActive Network therefore corrective action was promised by the EU executive, which tabled a further package of proposals in September 2007. After long negotiations a compromise deal on the legislative package on 23 March 2009 could be made. The most important objective was the introduction of an *Independent Transmission Operator* (ITO) [www.euractiv.com].

Furthermore, it is important to mention the example of Norway at this point. Norway was the first Scandinavian country that started liberalisation of the electricity market through

the establishment of the Norwegian Energy Act in 1990, which came into force in January 1991. The main goals of the Energy Act were economic efficiency, security of supply and national equalisation of electricity prices [Welfens, Kaufmann and Keim 2004]. In the first phase from 1992 until 1996 Norway used a cost-based regulation, while in 1997 the state introduced an incentive-based regulation (see chapter 3.2).

In Norway about 340 companies are engaged in electricity production, transmission, grid management and operations and trading, of which about 200 are engaged in distribution. The state-run Statnett SF owns 87 % of the central transmission grid, and is also the operator of the entire central grid. Municipalities and the counties own the regional and local grids. Statnett is also the Norwegian transmission system operator and therefore co-ordinates the operation of the entire Norwegian power supply system. It is also responsible for the Norwegian balance system [Wild and Vaterlaus 2002].

2.3 Problems associated with liberalising the electricity markets

General economic theories show that converting a public owned market to a free and liberalised leads on one hand to lower prices (through more competition and less market power for each existing firm) for the consumer and on the other hand to less market imperfections like monopolies which in turn leads to smaller deadweight losses. But liberalising is not always the perfect solution; some goods may not be prone to the free market. For example for natural monopolies (e.g. railway infrastructure) it is not possible to transform these into free markets. In 2005 Steve Thomas wrote in the Energy Policy Journal [Thomas 2006] about the situation and problems with deregulating the electricity markets internationally. He named three main reasons why liberalisation of the electricity markets may fail:

1. Companies need a regulatory bargain to deal with the risks inherent in the electricity industry.
2. Competition is not a free lunch. Building up a market needs investments.
3. Electricity is different from other commodities, because:
    - Power is not storable
    - There is a need for supply and demand to match at all times
    - There is a lack of substitutes
    - Electricity plays a vital role in modern society (security of supply)
    - Electricity is a standard product (no different qualities available)
    - Environmental impacts of electricity production are huge

3 Modelling electricity prices before and after liberalisation

3.1 Price dependencies on interconnection capacities

A simple example from Jacques Percebois (2008) illustrates the price mechanism when interconnections for electricity distribution between two countries are implemented. In terms of surplus some consumers are winners and others are losers; it is the same for producers. It shows that in the situation of liberalising a market, the above-mentioned simple economic model is not always applicable alone.

1. Two countries, Home (H) and Abroad (A), face the same electricity demand D = 100 MWh for a given period t (i.e. instantaneous demand at the given hour). Country H benefits from a comparative advantage in terms of generation cost compared with country A, due to a large proportion of nuclear power stations. The supply function is p=aQ in country H and p=bQ in country A with a=1/4 and b =1/2. The equilibrium price p is thus 25€ per MWh in country H and 50 € per MWh in country A. In the absence of any cross-border exchanges, the consumers have to pay 2500 € to the national electricity producers in country H whereas those of country A have to pay 5000€ for an identical quantity.
2. Let us assume now that there is a unique competitive market uniting the two countries, without any bottlenecks in the interconnections. At price p, the Home and Abroad producers supplies are 4p and 2p respectively. The total supply is thus 6p for a total demand of 200 MWh, which gives an equilibrium price p = 33.33€ per MWh. At that price, the supplies of the Home and Abroad producers are 133.33 MWh and 66.66 MWh respectively, a quantity of 33.33 MWh being exported from Home country to country A.

3. Let us assume that the interconnection between the two countries is now limited to 10 MWh (per hour) i.e. 10% of the total demand of a country (this 10% figure was the target of the European Commission for the year 2005 and we observe that many European countries have benefited from a lower rate until now). The Home producers will now supply 110 MWh, the foreign ones only 90 MWh and 10 MWh will be exported from country H to country A. In country H the equilibrium price will be p = 110/4 =27.5€ per MWh whereas in country A it will be p = 90/2 = 45€ per MWh. The Home exporters will obtain windfall over-profits equal to 175€ (10 MWH sold at 450€ in country A instead of 275€ in country H) [Percebois 2008].

3.2 Regulation of natural monopolies

Electricity transmission and distribution, like all other network industries, are usually a natural monopoly. Due to the element of economies of scale associated with network and infrastructure, they are often regulated. The traditional textbook theories of optimal pricing for regulated enterprises are characterised by subadditive costs and a budget constraint assumes that regulators are completely informed about technology, costs and demand. Different methods for price regulation are for example: Marginal cost pricing, Ramsey-Boiteaux pricing, Two-part tariffs and Peak-load pricing. However, the modern textbook theories assume that fully informed regulators clearly do not exist. Two different methods can be distinguished here: cost-based methods and incentive-based methods. In the case of cost-based methods, regulated firms can earn revenues equal to their historical costs including a return on investment corresponding to cost of capital [Al-Sunaidy and Green 2006]. The best example for cost-based regulation is the rate of return regulation. The regulator here sets a cap with an incentive factor X, to induce lower costs, for a specified period of time. The complexity of such regulation relies in determining the value of X over interval periods of time [Al-Sunaidy and Green 2006]. For incentive-based regulation different methods can be ap-

plied like price-cap regulation, revenue cap regulation and Yardstick competition (for country examples see Table 1).

Table 1: Examples for different regulation schemes in different countries.

Country	Regulation Method	Explicit use of benchmarking
Netherlands	Yardstick	Yes
United Kingdom	Price-cap	Yes
Norway	Revenue-cap	Yes
Sweden	Yardstick	No
Finland	Expenditure-cap & Rate of Return	No

As a central milestone of the liberalisation process the transition from cost-based to incentive-based regulation methods can be expected. While the focus of the liberalisation efforts in the beginning mostly is on cost- and revenue-parameters, the emphasis in the further liberalisation process often shifts towards a more incentive as well as benchmarking based regulation scheme. For instance Norway had a cost-based rate of return scheme from 1992 until 1996, while since 1997 an incentive based revenue-cap regulation is in force. As well other countries like the Netherlands, UK or Sweden established an incentive based regulation scheme (see Table 1).

3.3 Modelling with historical Data

With the empirical prices of electricity for industry customers from the European Union [epp.eurostat.ec.europa.eu] in the period from 1998 until 2009 can be made a simple statistical model to make a statement about the price development in the electricity market and how it changed after the opening of the market. This is done in the following five steps: The first step contains a first sight on the data to find some time trends. While the second step includes a calculation of the regression before the liberalisation (1998-2003), accordingly the third step calculates the regression after liberalisation (2004-2009). The forth step analyses

the results from the two regressions done in the previous two steps, whereas the fifth and last step deals with the application of the model to Switzerland.

1. Step: First sight of data and finding rough trends

Figure 6 shows the electricity prices (in €/MWh) for industries of 13 different European countries. According to the EU Directive from 2003 (2003/54/EG) the electricity market for industry customers should be liberalised at by 1st of July 2004. The price developments in Figure 6 clearly show a rough horizontal trend until 2003, while showing another trend after 2003 indicated by the arrow. This leads to the conclusion that it is important to have a closer look on these time trends.

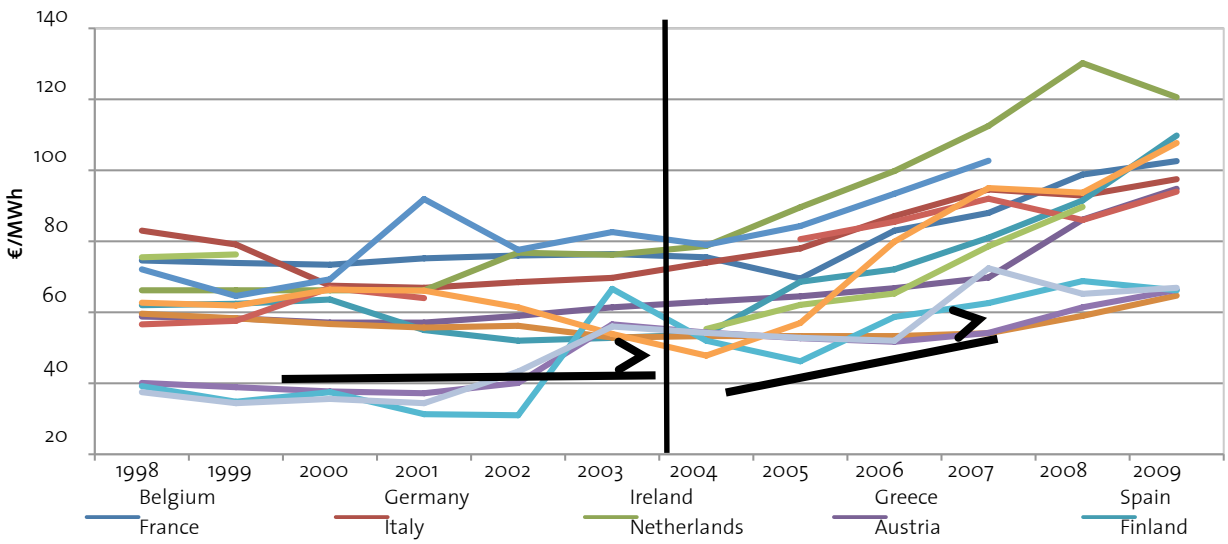

Figure 6: Price development for industries in the European Union [epp.eurostat.ec.europa.eu].

2. Step: Calculation of the regression before liberalisation (1998-2003). Error! Reference source not found. Firstly the empirical price development was calculated with a simple linear OLS-regression in Excel. Where Price P in €/MWh is the dependant variable and a yearly time step t is the independent variable. This regression includes time as explaining variable, in an advanced model it should also include other variables (see chapter 3.4). However, the usage of the second functional form (log-linear) may make the model more robust and easier to draw conclusions. The two models are defined as follows:

Linear Model:	$P = \beta_0 + \beta_1 \cdot t$
Log-linear Model:	$\ln(P) = \beta_0 + \beta_1 \cdot t$

Figure 7 (linear model) and Figure 8 (log-linear model) show only the years before opening the electricity market to industrial customers. In comparison to step 1 only selected countries, on which it seems worth to have a closer look at, are used for the regression (Germany, France, Belgium, Spain, UK and Norway). Table 2 (linear model) and Table 3 (log-linear model) show the summarised results.

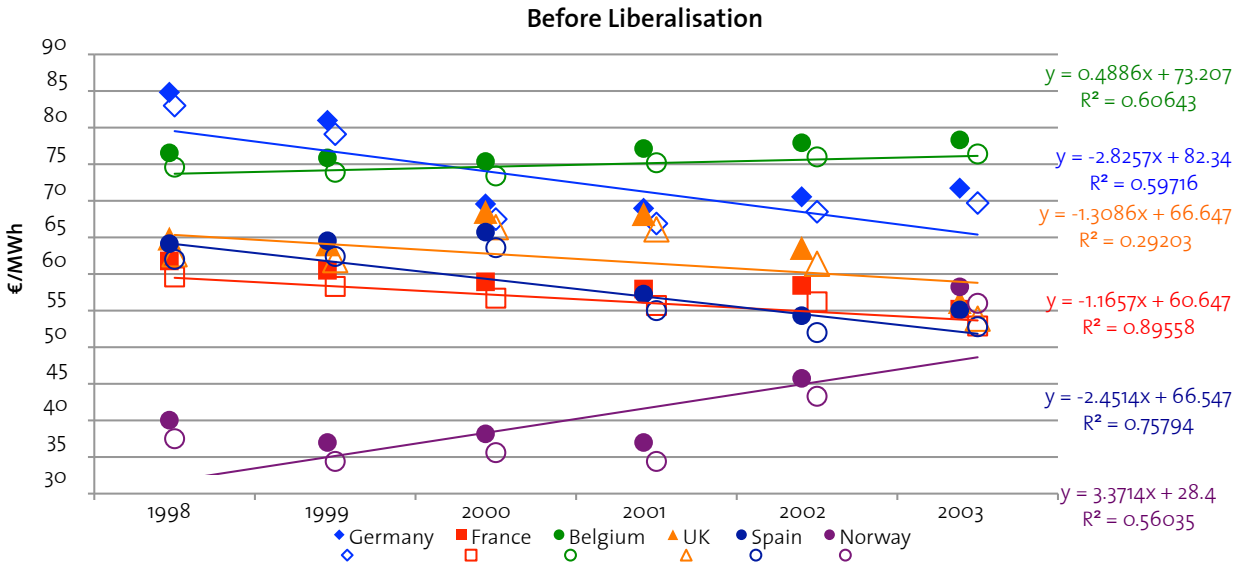

Figure 7: Electricity prices in different EU countries from 1998-2003, regressed with the linear Model.

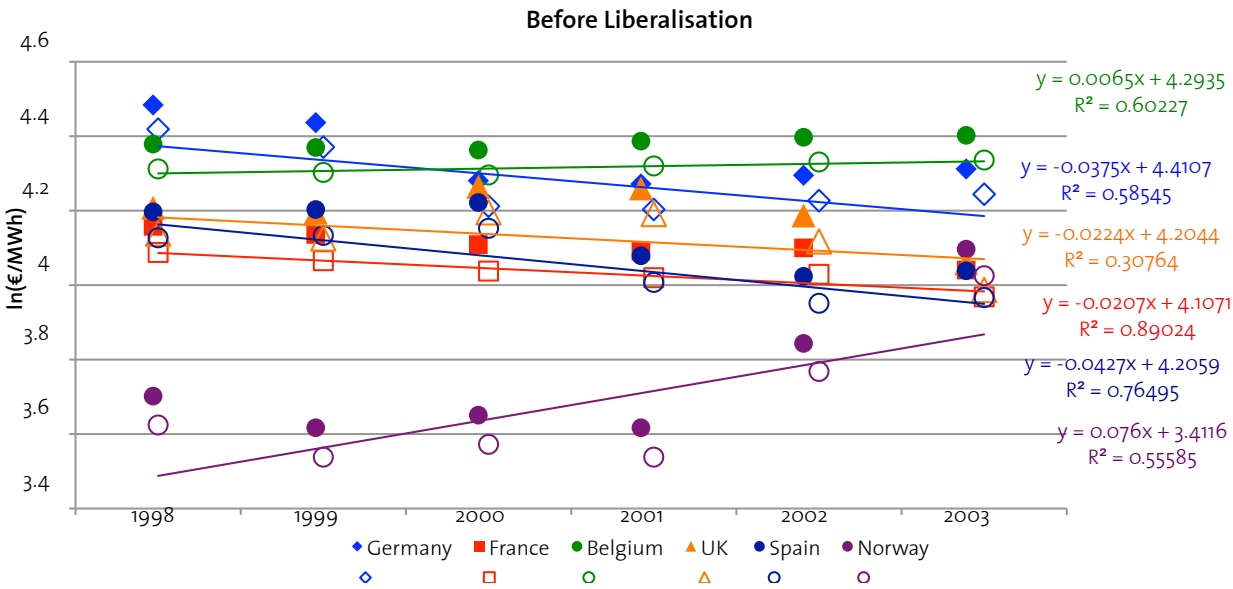

Figure 8: Electricity prices in different EU countries from 1998-2003, regressed with the log-linear Model.

3. Step: Calculation of the regression after liberalisation (2004-2009).

According to step 2 Figure 9 (linear model) and Figure 10 (log-linear model) show the results from the same procedure as in the previous step, though with the years after opening up the electricity market for industrial consumers. These results are tabulated in Table 2 (linear model) and Table 3 (log-linear model) as well.

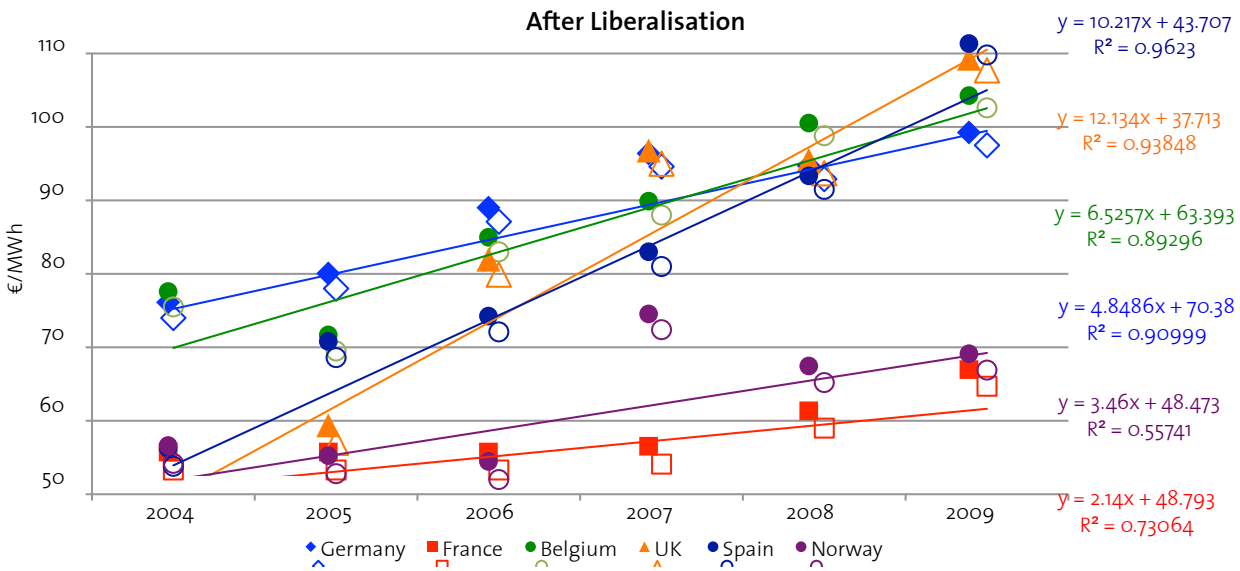

Figure 9: Electricity prices in different EU countries from 2004-2009, regressed with the linear Model.

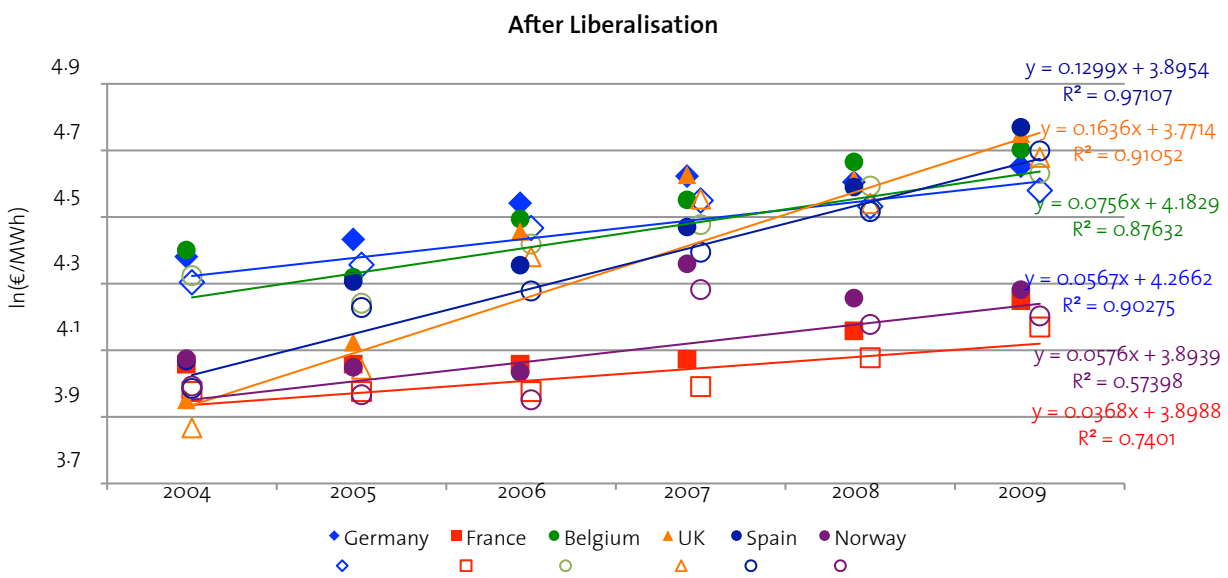

Figure 10: Electricity prices in different EU countries from 2004-2009, regressed with the log-linear Model.

4. Step: Analyse the results.

Having made these calculations, the results from Table 2 and Table 3 need to be compared in detail. The most interesting thing to look at, are the estimated slopes, since it can clearly be showed that the slope is always much higher after liberalisation except in Norway.

Table 2: Overview on the different results from the linear model

Country	1998-2003			2004-2009		
	Slope (β_1)	Intercept(β_0)	R-Squared	Slope (β_1)	Intercept(β_0)	R-Squared
Germany	-2.8257	+ 82.34	0.59716	4.85	+ 70.38	0.90999
France	-1.166	+ 60.65	0.89558	2.14	+ 48.793	0.73064
Belgium	0.489	+ 73.207	0.6064	6.53	+ 63.39	0.89296
UK	-1.309	+ 66.65	0.29203	12.134	+ 37.71	0.93848
Spain	-2.4514	+ 66.55	0.75794	10.217	+ 43.71	0.9623
Norway	3.3714	+ 28.4	0.56035	3.46	+ 48.473	0.55741

Table 3: Overview on the different results from the log-linear model. Changes are given in percent per year.

Country	1998-2003				2004-2009			
	Slope (β_1)	Inter-cept(β_0)	R^2	Change	Slope (β_1)	Inter-cept(β_0)	R^2	Change
Germany	-0.0375	+ 4.4107	0.58545	**-3.75 %**	0.0567	+ 4.2662	0.903	**5.67 %**
France	-0.0207	+ 4.1071	0.8902	**-2.07 %**	0.0368	+ 3.8988	0.7401	**3.68 %**
Belgium	0.0065	+ 4.2935	0.60227	**0.65 %**	0.0756	+ 4.1829	0.8763	**7.56 %**
UK	-0.0224	+ 4.2044	0.30764	**-2.24 %**	0.1636	+ 3.7714	0.9105	**16.36 %**
Spain	-0.0427	+ 4.2059	0.76495	**-4.27 %**	0.1299	+ 3.8954	0.9711	**12.99 %**
Norway	0.076	+ 3.4116	0.55585	**7.6 %**	0.0576	+ 3.8939	0.574	**5.76 %**

Figure 7 and Figure 8 show as well clearly that Norway seems to have different price trends compared to other countries. In the first phase form 1998-2003 Norway had a yearly increase in price of 7.6 %, whereas in the second phase (2004-2009) the increase was only 5.76% per year. This difference is not surprising, considering that Norway was the first Scandinavian country to start the liberalisation of the electricity markets in the early 1990s (see chapter 2.2). When comparing the level of the electricity price before the actual date of the liberalisation to the price in 2007, as done in the study from PriceWaterhouseCoopers (2009), the price increased by +147 %.

All other countries included in the model had falling or just slightly increasing electricity prices before 2003 (ranging from -4.27% to 0.64%). In contrast all of the countries had rising prices from 2004-2009. France and Germany experienced only a slight increase (3.68 and 5.67 % per year) compared to Spain and the UK (12.99 and 16.36 % per year). Belgium had a slightly higher increase than Germany (7.56 % per year), but this is just about half compared to the UK. Especially remarkable is the moderate increase of the French electricity prices and the still low price level. The reason for this is the regulation of the prices to keep them artificially low for all industry customers. This regulation, which subsidises medium and large companies, is already subject to an inquiry by the European commission. If France can keep their prices that low in the future, remains to be seen [PriceWaterhouseCoopers 2009].

5. Step: Applying the model to Switzerland

Figure 11 displays the past Swiss prices from 1996-2007, to predict the future electricity price in Switzerland after full liberalisation. But in comparison to the data in the previous model here the prices are for a mix of all user groups including households. This must be considered when drawing conclusions from the model.

The mean end-user price (in CHF/MWh) decreased by -1.5 % per year in the last ten years, while the end use demand was always increasing. This number derives from Figure 11, where similar to step 2 and 3 a log-linear OLS-regression results in an estimation with an R-squared of 0.98. The slight price decrease is comparable to the values of the phase before the liberalisation in Table 3.

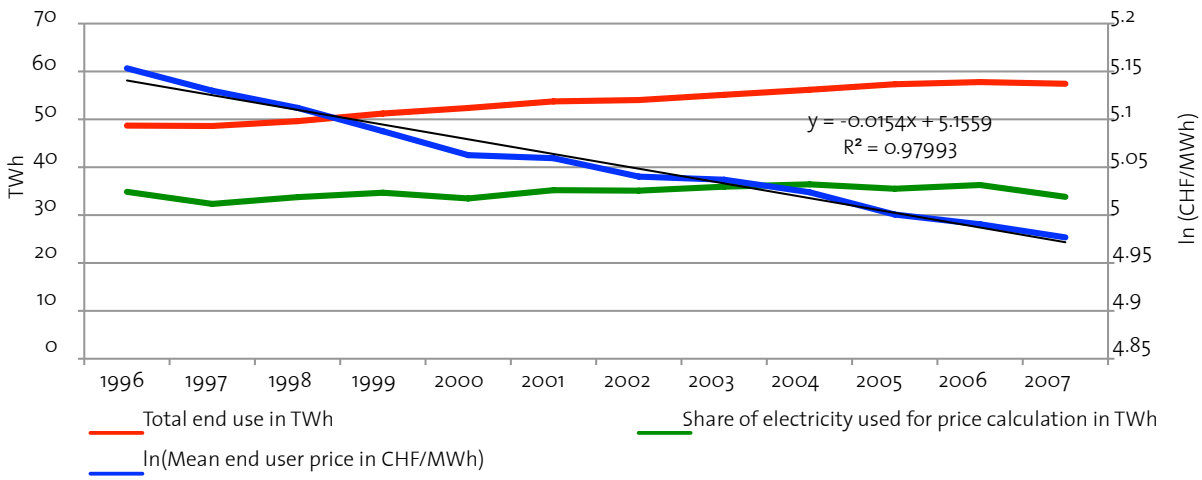

Figure 11: Swiss Price Index calculated from more than 100 electricity distributors across all user groups [Swiss Federal Office of Energy. 2001, 2005 and 2008].

If Switzerland follows the trends revealed in chapter 3.3, the constant decreasing of the prices will not continue in the future as is already indicated by the price supervisor (Stefan Meierhans) in his Newsletter from 29 March 2010 [Federal Department of Economic Affairs 2010]. There, Meierhans calculates an increase of about 3% for small companies and about 7-12% for households between 2008 and 2009.

Through estimations according to the model from step 2 and 3 the Swiss electricity price will increase by 5-7 % per year in the next five years, which is about 7.25-10 CHF/MWh per year in absolute. This rough numbers only apply for industry customers, as the model is calculated with prices for industrial electricity supply only. However, Switzerland's electricity production is mainly out of hydro power, therefore the price increase will be more intense than in other

countries like France (mostly nuclear) and Germany (mostly coal). Norway is among all the other countries examined in the previous model the most suitable as comparing country for Switzerland due to several reasons [Wild and Vaterlaus 2002]:

- The electricity production is based almost solely on hydro power
- Most of the companies engaged in the electricity market are public owned
- There are a large number of regional and local distribution companies
- The electricity market reform was introduced already in the 1990ties and is generally seen as a successful process. Therefore Norway is suitable as role model.

Therefore, Norway should play the role of a good example for Switzerland. However, not all the circumstances are comparable, for example the climate and the relief of the countryside is not the same, one should be aware of that when drawing more precise conclusions. Furthermore, the microeconomic example from Percebois (2008) in chapter 3.1 shows that with a full opening of the Swiss electricity market the prices will increase, as the surrounding countries Italy and Germany have quite high electricity prices compared to Switzerland due to their production mix. If the transmission capacities to these countries will be large enough, the prices will equal each other in the future.

3.4 Limitations of the model

The previous model just looks at the price development in countries, where the liberalisation process is already well advanced, over time trajectories. However, in electricity network reforms there are more types of factors, which could influence the price development for the end consumer. Some of these factors may not be easy to measure, yet they include:

- Share of hydro/nuclear/fossil electricity generation in the pre-reform market (see chapter 1.1 and 1.2) can influence the overall price level.

- The exposure of the deregulated market to international trade, interconnection capacities (see chapter 3.1)
- The type of regulation scheme imposed prior to the reform (see chapter 3.2 for different regulation forms)
- The number of generating firms in the deregulated market plays also a role in the price developments. Norway as well as Switzerland has many regional and local companies engaged in distribution, which makes it more complicate to regulate.
- The interconnection of the electricity spot price to the oil price (which also depends on the electricity mix), and the oil price itself.

These factors should be in mind at all times, when considering the results from the model above. Therefore the results from the model cannot be applied to the Swiss circumstances without adjustments. In further research the focus should lie on capturing data on these variables mentioned above. This will result in a better statistical model.

4 Conclusions

Generally it can be said, that the model shows obviously a clear empirical trend for increasing electricity prices after opening the domestic electricity market. It shows a reversal of the economic trend after 2003 from mostly decreasing electricity prices before (from -4 to +0.65 % per year) to slightly or highly increasing prices afterwards (from 5 to 16 % per year). Applied to Switzerland there will be a clear trend of about 5 to 7 % price increase in the next five years.

In a bigger context two other exogenous factors may also play a role in the future electricity price level: If transmission capacities between countries are not large enough, the prices of the different countries can not equalise, therefore the Swiss prices will increase less. Secondly the increase may be even higher since the future electricity mix in Switzerland is insecure. Around 2020 at least three of the five nuclear power plants need to be shut down due to concession expiration. How these existing power plants will be replaced, depends on several political decisions. Consequently, this results in a supply gap, the demand may not be covered by domestic supply.

Furthermore it must be said, that deregulation of markets, as an ultimate solution for more economic efficiency, may not always be unproblematic. In the case of electricity markets it is even more challenging to achieve a well functioning free market, as electricity is not storable and hence not a standard commodity. Though the well functioning of the electricity network is crucial for the economic welfare of modern societies.

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