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Deregulation of the Swiss Electricity Industry: Implication for the Hydropower Sector

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Content

Abstract

Although Switzerland is not a EU-member country, in December 1999 the Swiss Parliament adopted the new Swiss Electricity Market Law (EML). The EML laid the foundations for reforming the Swiss electricity industry by moving from regulation to deregulation. The Swiss population will vote on this issue in September 2002. If accepted, the deregulation process will be phased in gradually during a transitional period of seven years. This paper describes the Swiss electricity industry and shows how the federal structure leads to different regulation frameworks in each canton and municipality. Moreover, the paper sets out the most important characteristics of the law.

In a second part, the paper focuses on the cost structure of the hydropower sector and gives an overview on the development of the production costs over the last decade. The paper shows that the cost structure of the producers has changed in the run-up to market deregulation. Further, the paper analyses the actual cost structure of the hydropower sector in Switzerland and shows the expected impact of the EML on the hydropower firms, especially on the competitiveness of the hydropower sector and on chances and dangers related to the deregulation of the electricity market.

1 Introduction

In the last two decades many EU-member countries have implemented a full or, at least, a gradual opening of their markets into national legislation. This process has been generated by the obligation of the member countries to implement the European Electricity Directive (96/92/EC) by February 1998. Although Switzerland is not a EU-member country, the Swiss Parliament adopted the new Swiss Electricity Market Law (EML) in December 1999. However, this law has been submitted to a referendum.[1] Therefore, the Swiss population will vote on this issue in September 2002, and, in case of approval of the EML, the Swiss electricity market will be deregulated on January 2003. Of course, one of the most important arguments for the Swiss parliament to adopt the EML was to make Switzerland compatible with the EU-member countries which are, due to the geographical location of Switzerland, very important commercial partners in the electricity sector. In fact, Switzerland has always been a relevant partner in the European exchange of electric power.

The EML laid the foundations for reforming the Swiss electricity industry by moving from regulation to deregulation. This change will be phased in gradually during a transitional period of seven years.

This paper briefly describes the Swiss electricity industry and details the reform plans set out in the law. It also offers an overview on the competitiveness of the hydropower sector in the deregulated market.

[1] Federal laws, generally binding decisions of the Confederation and State treaties concluded for an indefinite duration are subject to an optional referendum: in this case, a popular ballot is held if **50,000 citizens** request so.

The referendum is similar to a veto and has the effect of delaying and safeguarding the political process by blocking amendments adopted by Parliament or the Government or delaying their effect.

2 The Swiss electricity industry

Switzerland is a modern federal state composed of 26 cantons and approximately 3000 municipalities.[2] It has a population of about 7 million persons and is characterized by a high degree of decentralization in the provision of public services. Article 3 of the Federal Constitution grants large autonomy to the single cantons and the municipalities in the sectors, which are not regulated directly by the constitution itself, among others schooling, roads, hospitals, taxation systems, and electric utilities. For instance, in the electric power sector each municipality has the autonomy to decide how to organize the electricity distribution on the own service territory. The typical solutions adopted by the Swiss municipalities in the electricity distribution are the following: distribution through a own public electric utility, distribution through a public utility owned by another municipality or distribution by a private utility. In the last two cases the electric utilities operate as franchised monopolies.

2.1 Market structure

The Swiss electric power industry is composed of about 1,100 public and private firms that are engaged in the generation, transmission and/or distribution of electric power. There is great divergence in size and activity among these companies. Generally, we can distinguish three types of electric companies. The first type is characterized by companies, which generate and transmit electricity. The second type is represented by electric companies, which primarily distribute electricity. Finally, there are companies, which are vertically integrated and thus perform all three electric power system functions. Table 1 presents an overview of the composition of the Swiss electricity industry.

Table 1: Number of electricity companies in Switzerland

Generation and/or Transmission	90
Generation, Transmission and Distribution	140
Transmission and/or Distribution	940

Source: VSE, The Swiss Electricity Supply Industry Development and Structure, 1997.

In the first group of companies we find also the so-called partner company, where shareholders can claim electricity production in proportion to their share capital. These partner companies are hydropower plants (storage) located in the Alps.

In terms of numbers, utilities exclusively engaged in the distribution of electric power are dominant, accounting for 74% of the total. The majority of these 900 or so companies are municipal and provide power to their communities exclusively. The remaining utilities operate within urban or regional areas. Part of this group of firms is involved in generation, transmission and distribution, but generally the amount of generated power is small and is determined by the ability to exploit favourable hydroelectric power generation possibilities. There are few vertically integrated utilities, which generate a large amount of power. The municipal and regional electric utilities purchase power mainly from the 9 largest overland companies, which form the backbone of the industry. These larger vertically integrated

[2] 23 cantons, 3 of which are divided into 2 semi-cantons for historical reasons. The most populated canton is Zurich with approximately 1.2 million inhabitants; the smallest is Appenzell Innerrhoden with little more than 15,000 inhabitants.

companies provide most of the generated electricity and are also involved in the transmission and distribution of electricity to final consumers and municipal utilities. Moreover, these dominant companies own and control the transregional and the international grids that are planned and used in close cooperation. These companies are thus the relevant international actors in the exchange of electric power with neighbouring countries.

The characteristics of the Swiss sector of electric energy generation are best illustrated with the aid of table 2.

Table 2: Swiss electricity generation characteristics (2000)

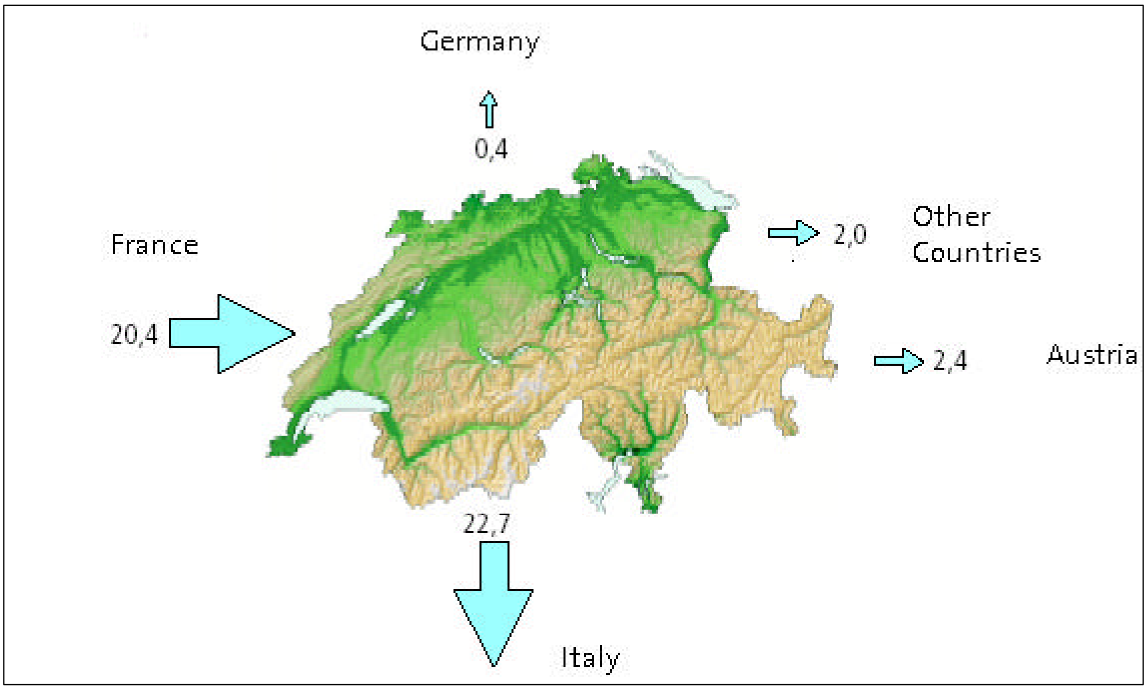
Type of power plant	**Installed capacity MW**	**Installed capacity in %**	**Annual electricity production million of kWh**	**Annual electricity production in %**
Hydro (Run-of-river)	3'570	20.8	17'566	26.9
Hydro (Storage)	9'600	55.9	20'285	31.0
Nuclear	3'200	18.6	24'949	38.2
Thermal power plants and others	790	4.7	2'548	3.9
Total	**17'160**	**100**	**65'348**	**100**

Source: Schweizerische Elektrizitätsstatistik, 2000, Swiss Federal Office of Energy, Bern.

The Swiss electricity sector is mostly based on hydropower generation (~58%) and on nuclear power generation (~38%). The production of electric power using thermal power plants or using wind or photovoltaic energy is yet limited (~4%). The run-of-river hydro power plants and the nuclear power plants are principally utilized to satisfy the electricity demand at the national level during the medium and low load periods, whereas the storage and the pumped storage power plants are employed to satisfy the electricity demand during the high load periods.

Around 80 of the largest power plants (hydro and nuclear) are organised as joint ventures ("Partnerwerke") of the seven overland companies and some of the largest utilities owned by the cantons. This form of co-ownership was a successful way to share the risk of the long-run investments, which characterise the hydropower sector.

The Swiss overland companies are very active in the exchange of electric energy with other countries. This exchange is shown in Figure 1. The figure illustrates a large net import of electricity from France and a subsequent large net export to Italy. Moreover, thanks to the relevance of the Hydro production capacity (storage and pumped-storage) in Switzerland, electricity can be imported at a favourable price from France at off-load periods by night and exported abroad, mainly to Italy, at peak load times. In Figure 2 we present the typical Swiss load curves over the course of a day for the national generation and consumption.

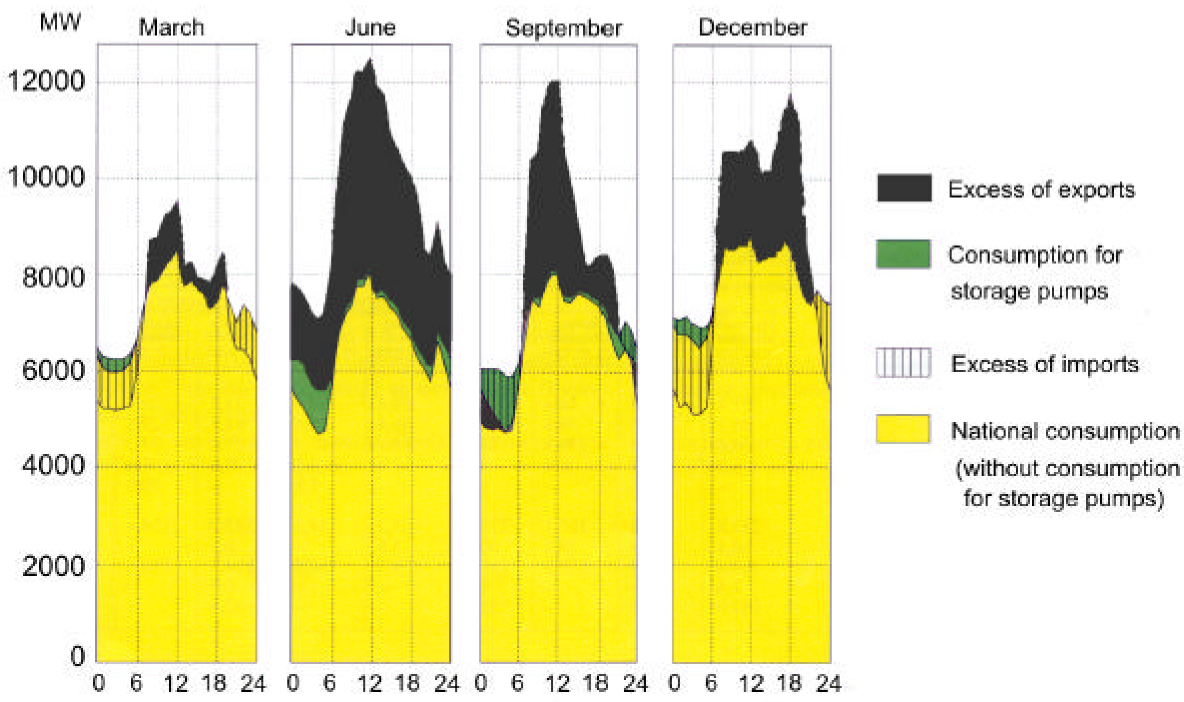


Source: Schweizerische Elektrizitätsstatistik, 2000, Swiss Federal Office of Energy, Bern.

Fig. 1. Exchange in 2000 of electric energy (net import and export) with neighbouring countries in TWh.

The difference between these two variables gives us the amount of the Swiss net electricity export. This exchange of electricity with neighbouring countries over the day contributes significantly to the economic and financial results of the largest Swiss electricity companies. Therefore, during the last 20 years Switzerland has consolidated a position as European electricity peak producer and trader. Due to the advantageous geographical position between Italy, France, Germany and Austria, Switzerland is an active player in the European electricity markets. In total, the electricity trade volume corresponds to almost 170 percent of domestic consumption.

The overland companies have established a market for exchange of surplus power based on short-term bilateral contracts. This is basically an inter-utility market for surplus production open only to a few companies. Since 1998, prices of this short-term trade are published in the Swiss Electricity Price Index (SWEP). The SWEP indicates prices in the short-term Swiss-European electricity spot market. It is calculated on working days for working days and applies to the peak hour (11 am to 12 am).

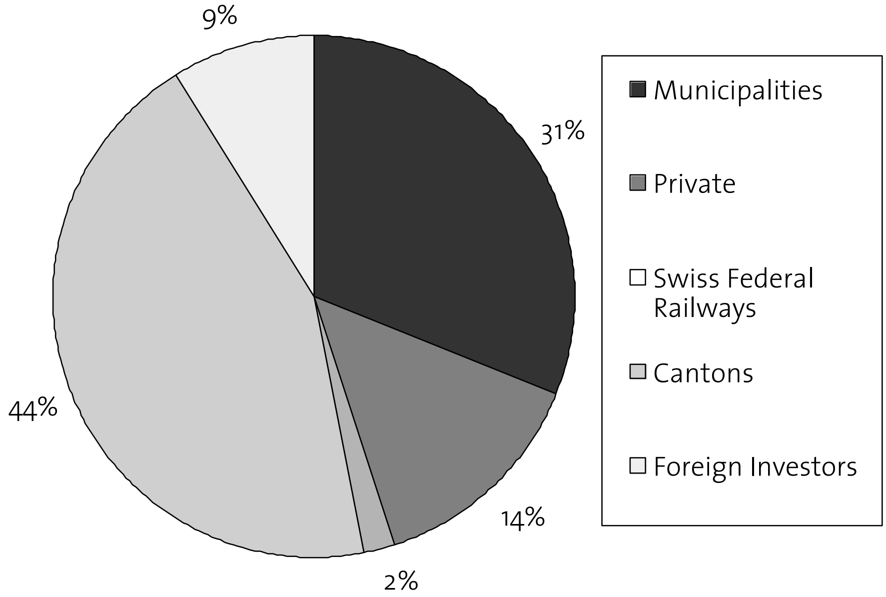


Source: Schweizerische Elektrizitätsstatistik, 2000, Swiss Federal Office of Energy, Bern.

Fig. 2. Typical Swiss load curves over the course of a day

The structure of the electricity distribution sector is characterised by a great heterogeneity: The size of the Swiss electric utilities varies from very small municipal utilities selling 100,000 kWh (Kilowatt-hours) to large utilities selling more than 10,000,000 kWh. The 15 largest utilities account for approximately 50 percent of total electricity sales to end-users, the 100 largest utilities for 80 percent and about 1000 utilities for the remaining 20 percent. The average number of persons served by an electric utility is circa 6000. The Swiss electricity industry is, therefore, characterized by a small number of large electric utilities, which generate and distribute a high percentage of total sales of electricity and a large number of small public electric utilities, which essentially distribute electric power to their communities.

Figure 3 illustrates the ownership structure of the Swiss electricity market. Private investors hold about 30 percent of the total capital invested in the electric power industry, whereas the cantons and the municipalities own 70 percent.

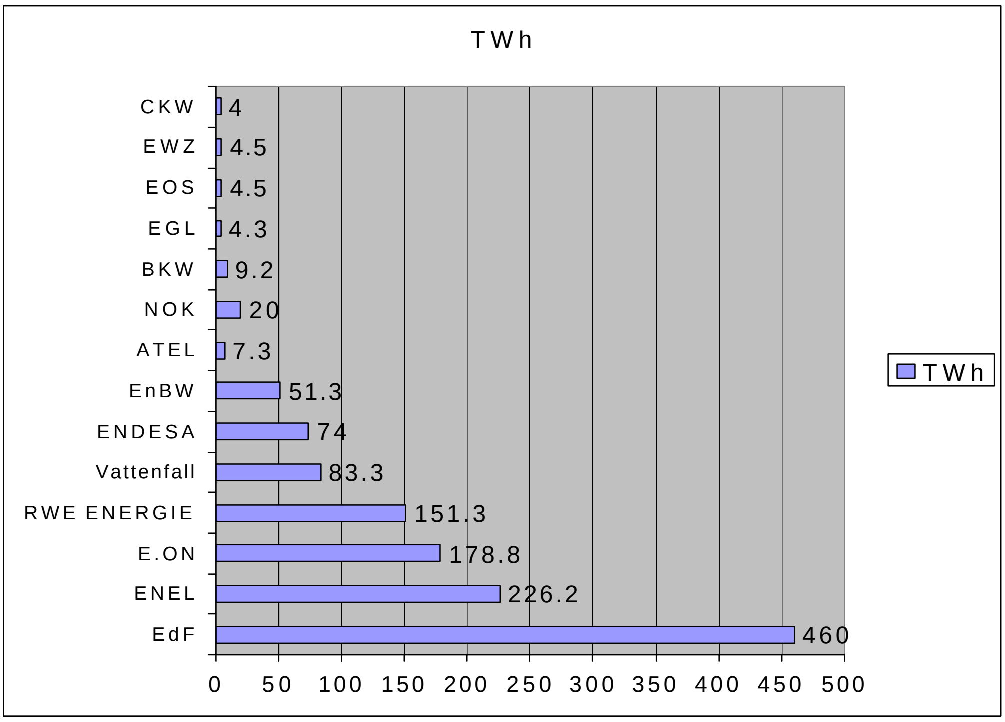


Source: Schweizerische Elektrizitätsstatistik, 2000, Swiss Federal Office of Energy, Bern.

Fig. 3. Base capital structure of the Swiss electricity utilities.

Switzerland's electricity sector has experienced in recent years a slow, ongoing process of mergers and takeovers and therefore shows a higher concentration today. For instance, during the last years several private and public utilities created three large sale companies: Axpo (company created in eastern Switzerland), Swiss Citypower (company created by the most important electric utilities operating in the Swiss cities) and Avenis (company created in western Switzerland).

As can be seen from figure 4 the largest Swiss generators (the seven overland companies EOS, ATEL, BKW, NOK, CKW, EGL, EWZ) are very small in comparison to the largest European generators. This picture allows us to make two remarks: First, the Swiss generators will not have the capability to influence the prices on the European electricity market. Second, the current merger phenomenon and the high concentration in the generation of electric power at the European level may lead to a handful of dominant and potentially mischievous oligopolies. To contrast such an undesired situation the Swiss overland companies have created two co-operations and commercial alliances groups: the West group composed by EOS, ATEL, BKW and the East group composed by NOK, CKW, EGL, EWZ. Moreover, some of these overland companies have some projects of alliances and potential mergers with foreign partners in their agenda.



Source: Company reports, 2000.

Fig. 4. Comparison of the largest Swiss and a sample of European generators.

Of course, if you consider also the sale activities of these overland companies the figures would be higher: ATEL (33 TWh), EGL (14 TWh), BKW (12 TWh), EOS (9TWh), EWZ (5 TWh), NOK (22 TWh). However, these dimensions are still very small in comparison to the largest European companies.

2.2 Regulation structure

In Switzerland, the federal government, the cantons and the municipalities exercise legislation on the activities of the electric power industry. The federal government has the authority to license and regulate the construction and operation of all nuclear power plants, the construction of trans-regional grids and the exploitation of water resources for hydroelectric power generation. The cantons and municipalities regulate the activities of regional private and public electricity utilities. Only rough generalizations about their operations can be made because the federal structure leads to different ways of regulation. Some cantons regulate all utilities, while others limit jurisdiction to private utilities and leave regulation of public or private utilities to the municipal authority. Regulation on the canton and municipal levels governs entry, quality and conditions of service, including the obligation to serve all customers in the assigned service area. Furthermore, electricity price changes by private electric utilities have to be approved by the Federal Price Surveillance Authority, whereas either the cantonal or the municipal public utility commission must approve electricity price changes by public electric utilities. In the latter cases, the intervention of the Federal Price Surveillance Authority is not always required.

Concerning electricity distribution, the main policy options employed on the cantonal and municipal level are: the provision of electricity by a regulated public monopoly respectively by a privately owned but regulated monopoly. In exchange for a guaranteed service to all customers, public and private electric utilities receive an exclusive territorial franchise. Thus, these utilities operate as local monopolies in their legally defined service territories and are protected from competition from other utilities offering the same service elsewhere. Of course, with the introduction of the new Swiss electricity market law, this situation will partially change.

In practice the municipalities have the following two options when deciding how to provide their communities with electrical power. The first option consists of the attribution of the exclusive territorial franchise to a private utility, while the second one involves the attribution to a local or cantonal public utility. This self-governing process in the organisation of the distribution of electricity at the municipal level can explain the high number of municipal electric utilities in Switzerland. With the introduction of the new electricity market law the municipalities will still have the possibility to decide which utility will have the right to operate the distribution network on their territory.

3 The Swiss Electricity Market Law (EML)

With the introduction of the Electricity Market Law, the electricity sector of Switzerland will be reformed by moving from regulation to liberalisation of some parts of this industry. At the end of this process, all customers will be able to choose their energy supplier freely. The Swiss Electricity Market Law rewrites the rules that have traditionally governed all electricity-related activities in Switzerland. The basic principles of this law involve turning generation and retailing into competitive activities and allowing free access to the transmission and distribution grids, which will remain regulated activities. The general deregulation model adopted in the EML is a model of retail competition based on bilateral contracting. Under retail bilateral contracting, the actual distribution companies will be replaced by grid companies, which provide local distribution, and marketing companies, which purchase power from generators and sell it to customers. Marketing companies may or may not bundle their activities with distribution. Therefore, the Swiss proposal contains a system without an independent system operator (ISO) that operates a centralized spot market.

The main characteristics of the EML include:

1. The abrogation of the local monopolies of supply. Consumer they will have the possibility to purchase electricity from a wide range of producers located in all parts of Switzerland as well in other EU-member countries using bilateral contracts. The local distributors will not have any more the monopoly of both retail sale and distribution activities, but only the monopoly of the distribution activities. Transmission and distribution are thus defined as local natural monopolies and, therefore, not subject to competition, whereas generation, wholesale and retail sale activities (trading activities) they are.

2. The principle of a regulated Third Party Access for all parties is the core element of the regulation of all transmission grids: national, regional and local. This is obtained through a mechanism in the law, granting so-called area concessions to grid owners. If technically possible, the concessionaires are obliged to allow access of other parties to the grid without discrimination. The access to the transmission and distribution network will be organised subject to a regulated third party access (TPA) model with point-of-connection (“postage stamp”) network prices. All transmission and distribution network owners will have the obligation to provide non-discriminatory access to the network.

3. Tariffs for transmission and distribution are regulated and based on a model of point-of-connection ("postage stamp") network prices. These "postage stamp" network prices will vary among regions depending on the cost structure of the regional and local owner of the transmission and distribution grids.

4. As part of the regulatory reform, the high voltage transmission grid will be disinvested by the seven firms (Überlandwerke), which today control the national grid. The national grid will be organized as a private company with the function of an independent system operator (ISO). This company will also be responsible for balancing electricity demand and supply on the integrated transmission grid.

5. Separation accounting for generation, distribution/retail supply and non-electricity activities. This will make easier to regulate the distributors and to avoid cross-subsidization between the different activities of an electric company.

6. The creation of a new institution, the Arbitration Commission, as an independent agency with regulating and controlling activities of the transmission and distribution tariffs. Article 6 of the EML states that transmission and distribution tariffs should reflect costs of an efficiently operated network company. The actual discussions on the political level show a tendency to introduce during the first years of the reform a rate-of-return regulation. This means that utilities are allowed to set tariffs that cover their operating and capital costs as well as a return on capital. However, Therefore, due to the fact that article 6 of the law contains also the idea of a benchmarking between the utilities, it is not excluded that in the mid term a yardstick regulation approach will be implemented.

7. With respect to the universal service obligation, the EML states that at the electric distribution utilities are obliged in their service territory to provide all users with a connection to the electricity grid and to apply uniform distribution tariff and ensure a good quality of the services. Thus, uniform distribution tariffs are not imposed at the national level. Moreover, public service obligations, which may relate to security, including security of supply and regularity are not included in the EML. Therefore, the determination of the electricity price, the security of supply, including the provision of reserve capacity is principally delegated to the market forces of the free competition.

8. To promote the development of part of the renewable energy sources (power plants with a capacity less than 1 MW; in the case of hydropower plants less than 500 kW) the EML states that this kind of energy sources can benefit from an exemption of network charges for a ten-year transition period. Moreover, in exceptional situations to deal with the problem of stranded investments, the hydro power plants can benefit from special financial loan conditions by the Swiss government. Therefore, the Swiss parliament did not decide to promote the development of renewable energy sources, either the small hydropower plants or the wind power plants, using the portfolio approach (in which a certain market share is reserved for renewables) or the approach characterized by a fixed subsidy for electricity fed back to the electricity grid.

9. The EML does not include privatisation processes as element of the regulatory reform. Therefore, the reform will not particularly affect ownership structure. However, at the local level there is a tendency to develop commercial entities through the transformation of the local utilities from companies organized within the domain of public authorities to stock company.

10. The EML includes liberalization of international electricity exchanges. Therefore, market players will be free to accomplish international electricity transactions trough bilateral short or long-term contracts. However, a safeguard clause in the law ensures that

access to the grid can be refused to foreign suppliers if the Swiss agents in the exporting country do not have the same capacity to enter contracts, as do their counterparts in Switzerland. In other words, the principle of reciprocity applies.

11. The EML allows qualified consumers to choose their electricity supplier. This element of the reform will be phased in. Table 3 shows how the retail market will be opened to competition, starting from 2003 a possible year of the introduction of the EML. The distribution companies will have in the first phase of the introduction of the reform the possibility to choose their electricity supplier for 20% of their supplies. Whereas in the second phase of the reform this share go up to 40%. After six years, the electricity market will be fully open to competition, which goes beyond the requirements of the EU electricity market directive.

Table 3: A timetable for supplier choice in the Swiss electricity sector

Size of qualified consumers	**Year for supplier choice**	**Number of qualified consumers**
Consumption > 20 GWh	first 3 years	114
Consumption > 10 GWh	4^{th} to 6^{th} year	250
Consumption > 0 GWh	2009-………	all consumers

Source: Swiss Federal Office of Energy, Bern.

4 The cost structure of the Swiss hydropower industry

Although at the moment it is uncertain when the new electricity market law will be in force, some fear that power prices in the next years will decrease and that this decrease could have a negative impact on the financial situation of the hydropower producers. In order to analyse this impact, the Swiss government and the Swiss Electricity Supply Association have commissioned some studies on the issue of stranded investments due to the deregulation process.[3]

In this paper, we employ another approach to analyse the impact of the EML on the competitiveness of hydropower firms. Our study is based on the comparison of the actual cost structure of a sample of hydropower firms with the expected market prices for the next ten years. In our analysis a firm is competitive in the short-run, and therefore, does not shut down, if the market price is equal to or higher than the minimum of its average variable costs.[4] This definition, considering that the majority of the Swiss hydropower firms will renovate their plants only after 2020, seems, from the economic point of view, appropriate.

Our analysis is based on the assumption that the cost structure of enterprises will not change significantly over the next decade. This seems quite reasonable since in recent years - in view of market liberalisation - important improvements in cost efficiency have been achieved. Operational costs (wages and maintenance) especially have been lowered.

[3] Estimates of stranded investment of the electricity sector in Switzerland have been carried out for example by econcept (1997) and CSFB (1997)

[4] In this analysis, due to the very long run character of the hydropower investments, short-run means 5 to 10 years

In addition, the potentials for capital cost reduction have been, as far as possible, exploited. Producers have carried out extraordinary depreciations, since they fear that in a liberalised market power prices will not be high enough to allow for an amortization of plants. Enterprises are largely unable to reduce interests' payments on debt capital, since the capital market fixes interest rates. Consequently, it can be observed that interest payments vary according the development of interest rates, increasing during periods with high interest rates and decreasing when the interest rates fall.

4.1 Dataset

The analysis of the cost structure is based on a dataset containing technical and economic information for a sample of **46 producers**[5]. The dataset contains economic information derived from the annual reports of the producers for four years (1990, 1995, 1997, 1999), whereas the technical data are available for the year 1999. One major difficulty was to find meaningful criteria to allocate enterprises that generate electricity from several different types of plants to one specific hydropower category.

For the analysis the following categories of hydropower plants were defined and allocation criteria used:

1. Run-of-river hydropower producers (exploitable drop below 25 m): This category includes all firms that produce more than 50% of their power with run-of-river plants having an exploitable drop below 25 meters. These plants have no storage capacity and therefore have to produce continuously according to the river's seasonal and annual flows. Run-of-river plants with a small difference in elevation (less than 25 m) between water catchment and turbines are usually located along the large rivers in the flat parts of the country. Further, they generate power constantly over the year.

2. Run-of-river hydropower producers (exploitable drop above 25 m): This category includes all firms that produce more than 50% of their power with run-of-river plants having an exploitable drop above 25 meters. This category contains mostly the run-of-river plants located in the mountainous regions of the country. Usually, these plants exploit the large altitude differences between the water catchment and the location of turbines. The water is usually led into pressure conduit systems. These producers often have problems with minimal flow requirements in the downstream reaches (between the point of water catchment and the release of the used water into the river). Their power generation is larger during the summer period (higher flows of the mountain's rivers).

3. Producers using storage plants without pumps: This category contains all firms that produce more than 50% of the power with "pure" seasonal storage plants. They are usually located in the alpine regions of the country. Their investment costs (costs per installed kW) are significantly higher than those of run-of-river plants. These additional costs are compensated for by focusing production on peak demand hours.

4. Producers using storage plants with pumps: Firms assigned to this category use pumps whose capacity reaches more than 8% of the capacity of the turbines. The presence of pumps has an impact on investment costs (costs per installed kW). On the other hand, the water pumped in the reservoir during the off-peak period can be used to generate electricity during the peak-load periods, increasing the enterprise's revenues.

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[5] From the original dataset we had to eliminate all those enterprises that are producers and distributors. At the moment it is not possible to discern the share of the costs of each activity.

Table 4. Characteristics of the sample (data for the year 1999)

Categories	# of firms	# of plants	Æ Installed capacity MW	Æ output in GWh
Run-of river (drop <25 m)	8	9	52	308
Run-of river (drop >25 m)	14	30	73	273
Storage without pump	12	28	199	400
Storage with pump	12	58	553	885
Total sample	**46**	**125**	**227**	**472**
Total Switzerland	311	525	45	110

The sample includes 46 firms with 125 power plants. Considering that in Switzerland there are 525 hydropower plants with a capacity of more than 1 MW, our sample includes about one fourth of all these plants.

The figures in table 4 show that the average size of the plants considered (227 MW) is much higher than the Swiss average (45 MW, only plants above 1 MW capacity). Consequently, the average power generation of the plants is much higher than the Swiss average (sample: 472 GWh; Swiss average: 110 GWh). In total, the sample plants generate more than 60% of power produced in Switzerland. Looking at the different plants' categories, storage plants with pumps have the largest average capacity (553 MW) and annual generation (885 GWh). By contrast, the storage plants without pumps considered in the sample are considerably smaller (in average around 200 MW) and produce about half as much power as storage plants with pumps. The two categories of run-of-river plants have similar output levels, although some differences in their average capacity can be observed.

4.2 Actual cost structure

Fig. 5 shows the costs structure for the five categories of hydropower plants. The hydropower plants with a capacity between 1 and 10 MW have the lowest costs per kWh. Further, the run-of-river plants have below-average costs. In contrast, the production costs of hydropower plants with storage possibilities are above average.

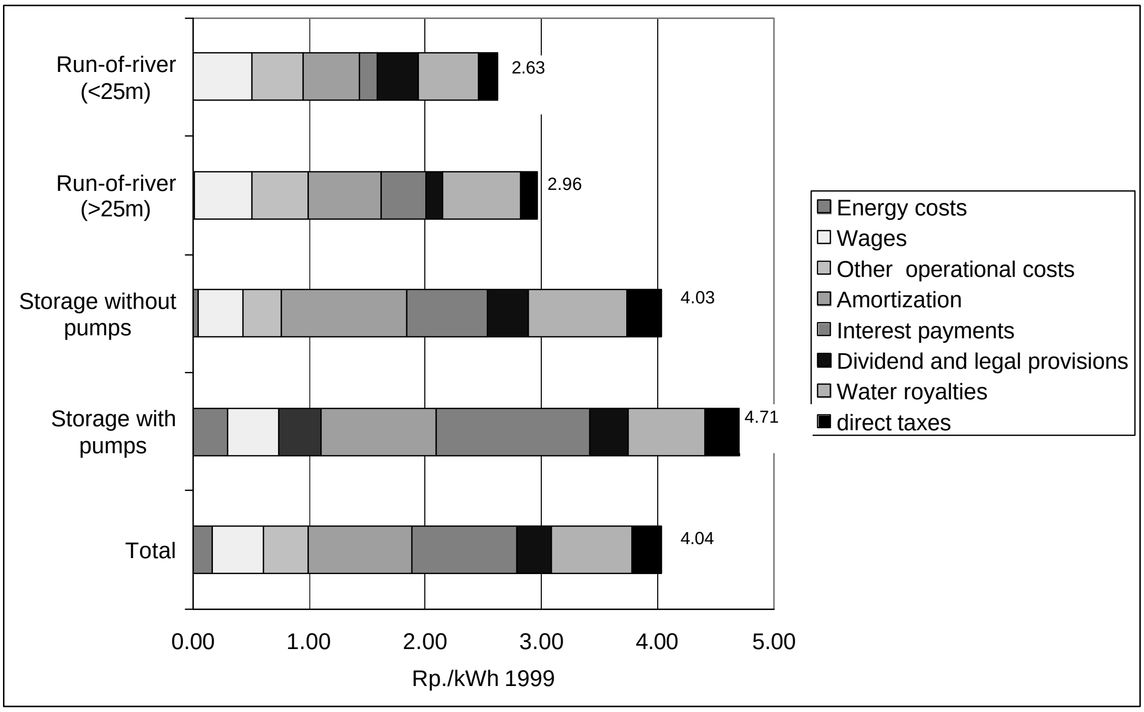

Fig. 5. Production costs for different categories of hydropower plants (1 CHF = 0.67 €)

Over all categories, the variable costs of power generation – wages, energy and other operational costs – amount to 27% of total production costs, while 46% are related to capital costs (interest payments, amortizations, and legal provisions). This share is higher for the high capital-intensive hydropower plants with storage, where this costs' category is responsible for more than 50% of total production costs. Finally, 27% of overall production costs are related to water royalties and taxes. This share is higher for those plants with low operational and capital costs (i.e. plants with a capacity between 1 and 10 MW and run-of-river plants).

4.3 Variable costs and output level

In order to identify the factors decisive for the level of production cost of firms, it seems reasonable to look at the variable and the fixed production costs separately. We assume that different elements affect the level of these two cost categories.

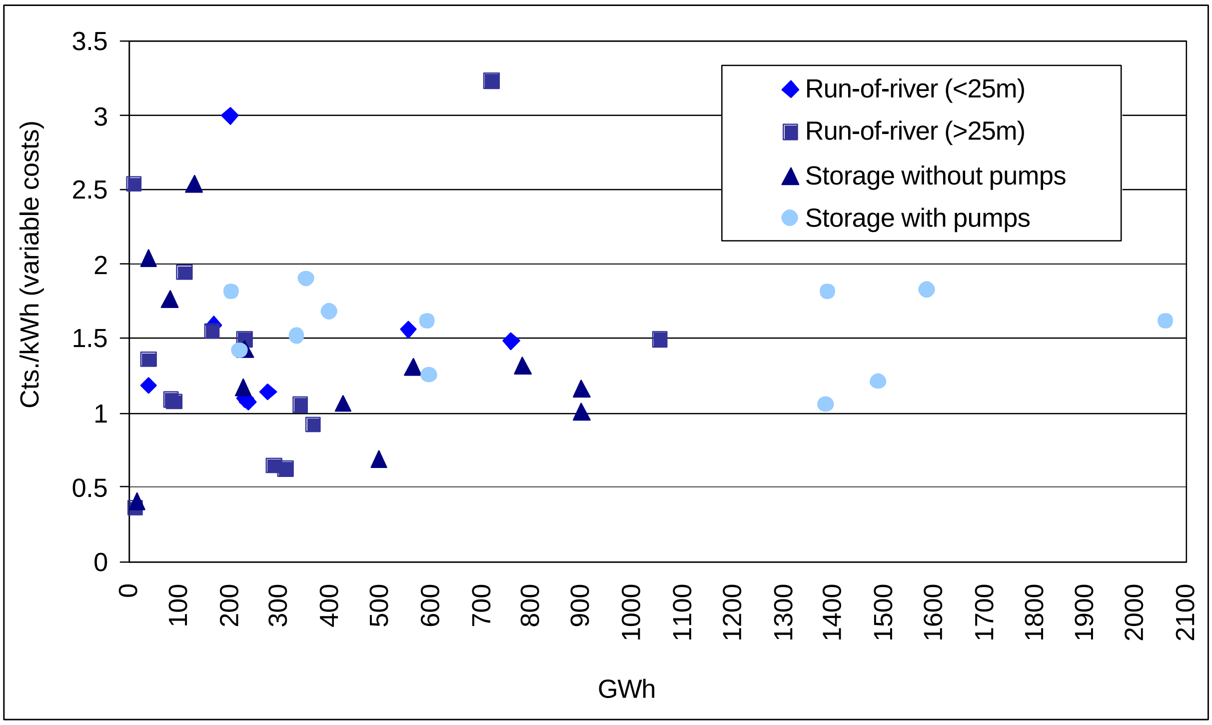

Fig. 6. Relationship between output and specific variable costs of production (labour, energy and other operational costs, 1 CHF = 0.67 €)

Fig. 6 illustrates the relationship between the variable production costs and the annual power generation (in GWh) for the five categories of hydropower plants. The level of variable costs varies considerably, between categories as well as between plants of the same category and with similar levels of production (see for example the variable production costs of storage plants with pumps). Within the same category of power plants variable production costs vary by a factor of two or more. These differences can be explained either by site-specific characteristics - and thus differences in the maintenance of the plants - or by different efficiency levels.

Storage plants with pumps show decreasing variable costs with an increase in output level. For the other categories this relationship seems to be weaker.

Given the small number of enterprises considered in each category, these results are to be interpreted carefully. In the next step of analysis we plan to carry out econometric analysis with a larger sample in order to identify more definitively the presence of economies of scale in production.

4.4 Capital costs

Investments in new storage plants or in enlargement of existing plants imply considerable investment costs (costs per installed kW). These can be compensated for either by an increase in the output level or by a change in the production pattern i.e. an increase in peak load generation (an increase in the average market price).

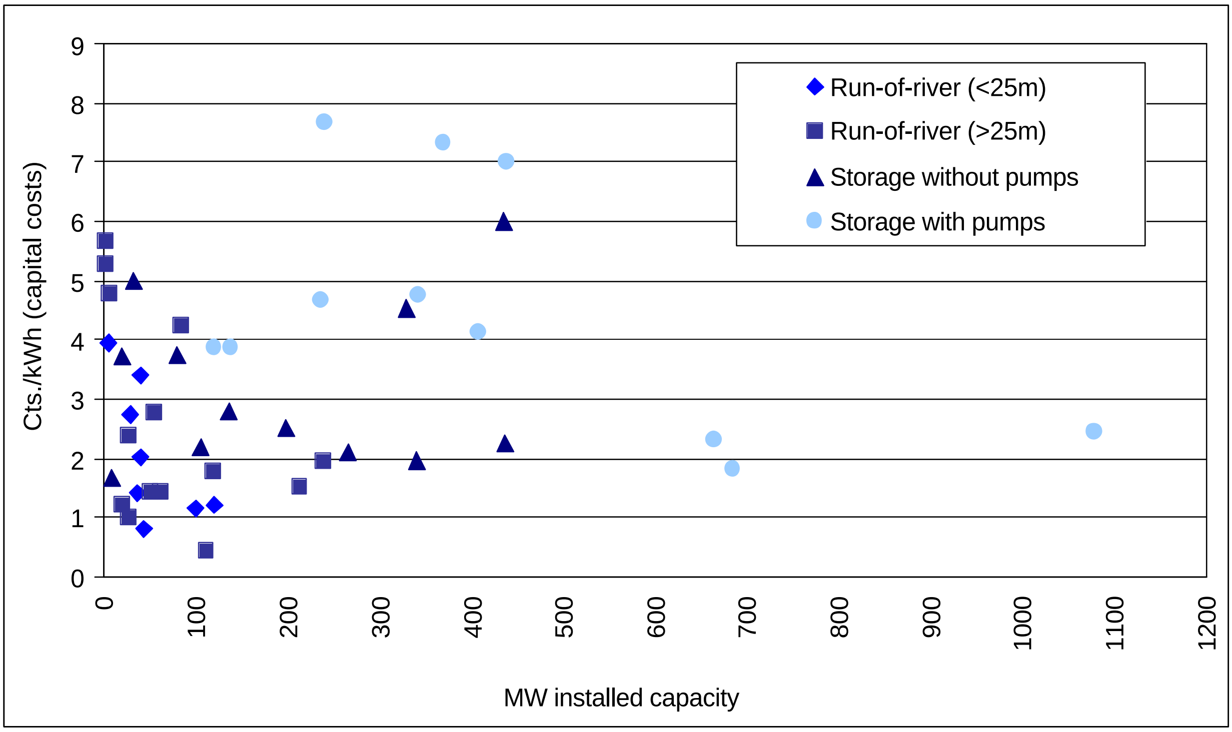

Fig. 7. Relationship between capacity installed and specific capital costs (amortization, interest payments, dividends, legal provisions, 1 CHF = 0.67 €)

Fig. 7 shows the relationship between specific capital costs (sum of amortizations, interest payments, dividends and legal provision) and installed capacity.

On the one hand, increasing capacity implies higher capital costs: investment costs (costs per installed kW), and therefore amortizations and interest payments, are positively related to the capacity installed. On the other hand, this cost-increasing effect can be partly offset by an increase in the production level.[6] Probably because of the small sample, it is difficult to identify clearly how capital costs vary with the capacity installed.

Fig. 8 illustrates the development of specific capital costs according to the age of the plant (years since plant construction). As expected, specific capital costs are lower for older plants. This can be explained by the fact that a larger share of the value of the plant has already been depreciated.

[6] One objective of an increase in the capacity installed can be an increase in production in peak load periods, leaving the total annual production unchanged.

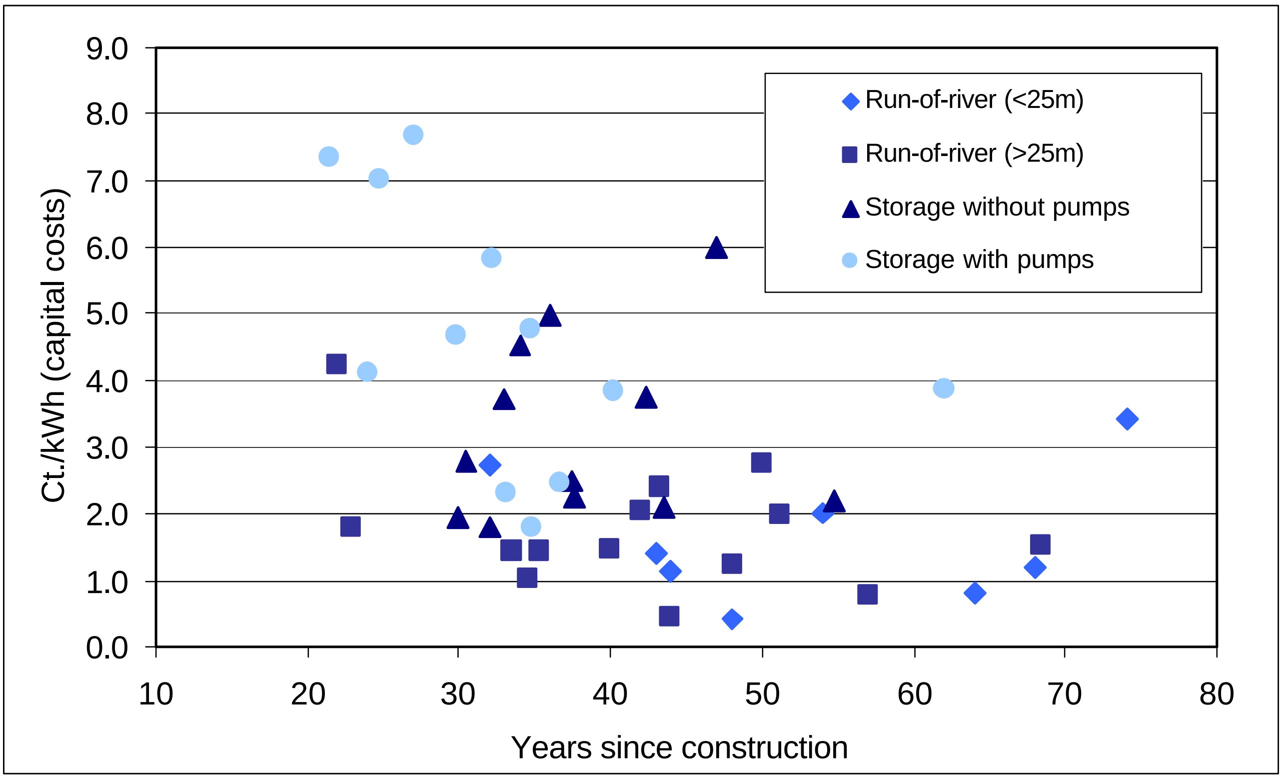

Fig. 8. Relationship between year of construction and specific capital cost (amortization, interest payments, dividends, legal provisions, 1 CHF = 0.67 €)

4.5 Comparison of the production costs with the expected prices

In this part of the paper we compare the specific actual costs of the hydropower firms in our sample with the expected power prices for the next years (table 5, prices expected by Swiss producers). This comparison will show whether or not some firms from our sample will be able to cover their variable costs. From the theory we know that in the short run, hydropower plants will operate as long as electricity market prices cover at least the variable costs of production.

Table 5. Forecast of electricity market prices (1 CHF = 0.67 €)

Period	Peak (cts./kWh)	Off-peak (cts./kWh)
2003-7	5-6	3-4

Source: Econcept (1997) and information of Swiss electricity producers

On the basis of our sample of 46 enterprises, it is possible to look in more detail at the production costs and average prices of each enterprise.

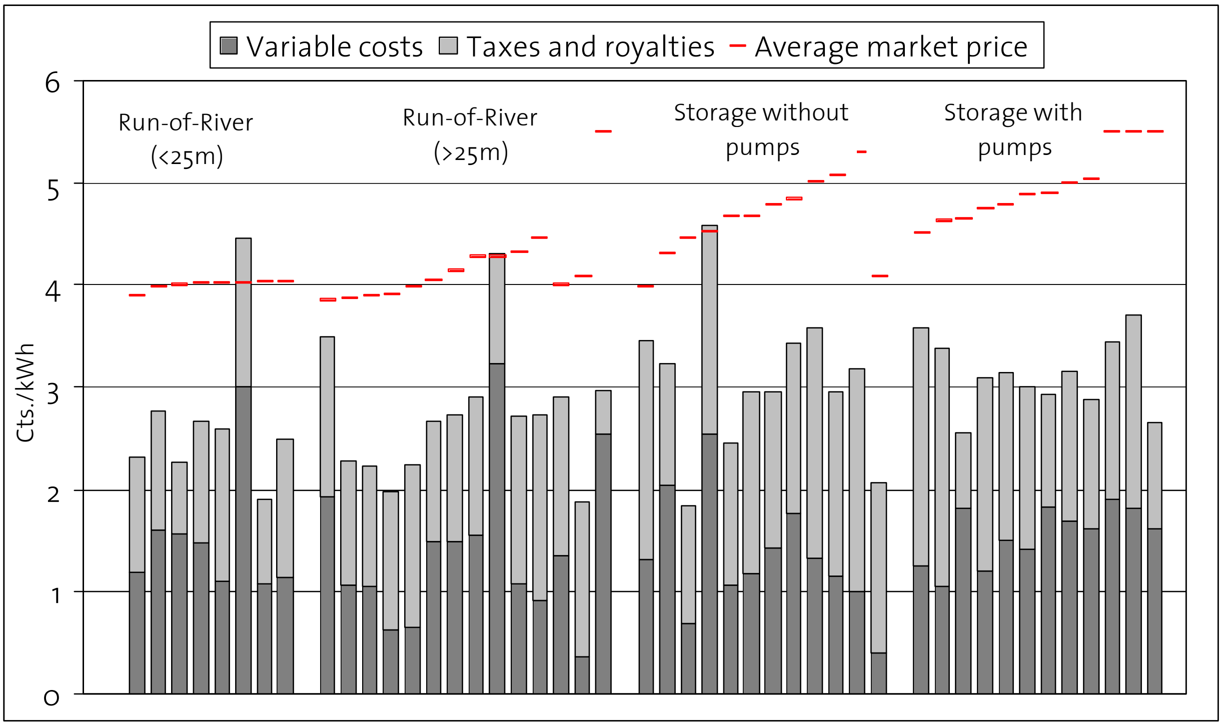

Fig. 9. Variable specific production costs and average market prices of the enterprises in the sample (N=46), peak market price: 5.5 Ct./kWh; off-peak price = 3.5 Ct./kWh (1 CHF = 0.67 €)

Fig. 9 shows the variable production costs as well as the costs of taxes and water royalties and, as indicated by a thin line, the average market price of enterprises. We calculate the average price taking into consideration the production structure of enterprises. For storage plants we have assumed that production takes place primarily in peak periods and only secondarily in off-peak periods. Run-of-river plants are not able to adapt production to the different load periods. Therefore we assume a constant production pattern across the day and the year[7]. The output in each load period is priced according to its corresponding market prices (table 5).

If we compare the expected short-run prices with the variable production costs (including taxes and royalties) we see that the great majority of enterprises will be able to cover at least their variable costs. Only those producers with the highest specific operational costs will have difficulty covering them.

Since small plants (with capacities between 1 and 10 MW) have low operational costs they do not seem to incur such problems in the short run. The same holds for the storage plants with pumps. Although they have higher average operational costs, the prices they achieve are also higher than those of run-of-river plants. The other categories have only a few enterprises with variable costs above or near average prices. For a majority of enterprises, the difference between specific variable costs and prices is high enough to allow for small variations in price level or costs without having an impact on the short-run decision of whether or not to generate.

[7] We consider the differences between hibernal and summer production levels.

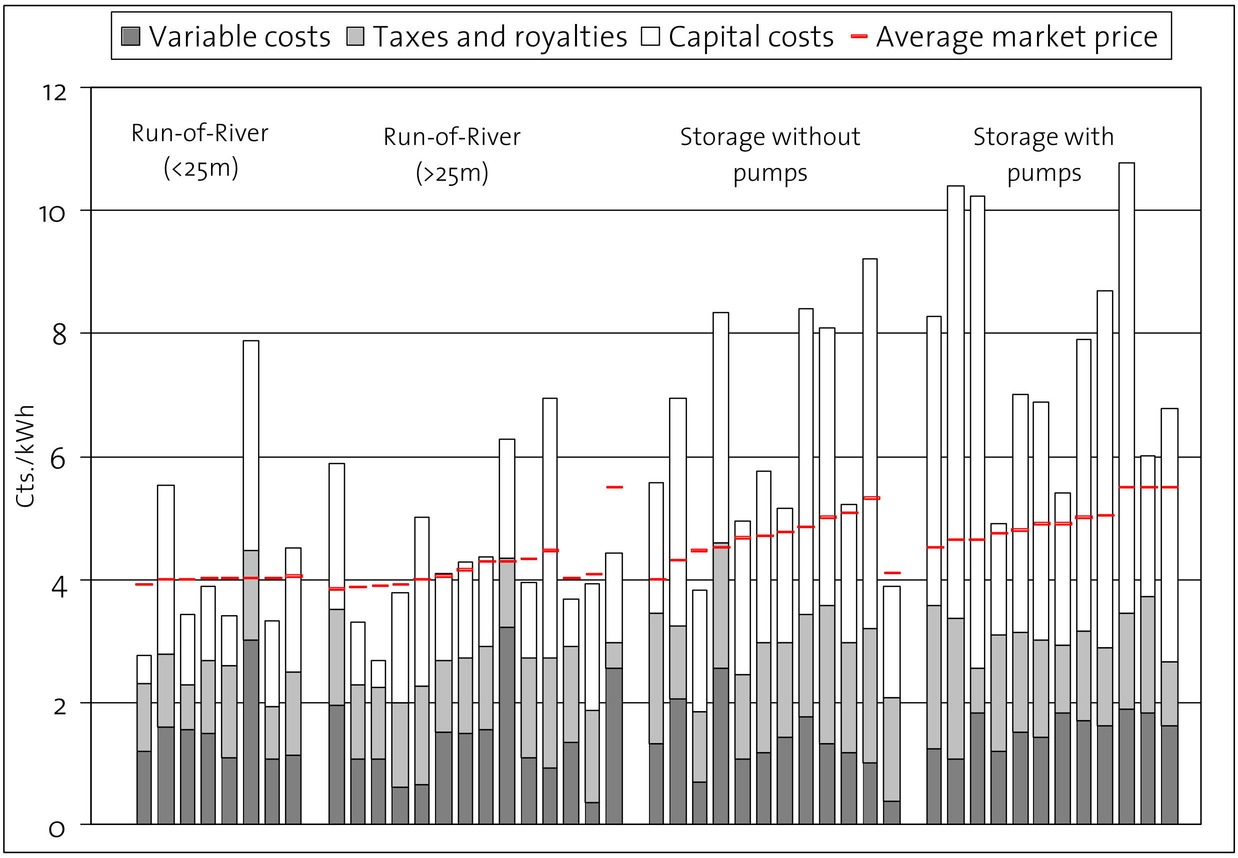

Fig. 10. Total specific production costs and average market prices of the enterprises in the sample (N=46), peak market price: 5.5 Ct./kWh; off-peak price = 3.5 Ct./kWh

Including the capital costs obviously dramatically changes the situation concerning the economic performance of enterprises.

Although the specific costs in Fig. 10 could represent an upper limit of effective capital costs (due to extraordinary amortization carried out in view of market liberalization), several enterprises will not be able to cover their capital costs. Particularly among the capital-intensive storage plants with pumps, the forecasted market prices could imply important stranded investments.

5 Conclusion

The new Electricity Market Law will bring about a liberalization of some parts of this industry. It is expected that in the short term, in a European market situation characterised by over-capacities, power market prices will fall. As a result, some fear that Swiss hydropower plants will encounter economic and financial problems and, in the worst case, could be obliged to shut down.

An analysis of the cost structure of hydropower plants and a comparison of the expected specific revenues with production costs yields the following conclusions:

In the short run only a few producers will have financial difficulties covering operational (variable) costs. Therefore, the majority of the Swiss hydropower firms will not shut down their activities.

Some firms of our sample present very high variable costs. We believe that these firms have the potential for optimisation and efficiency increases.

In the short run several power plants will be unable to cover the full production costs. Capital-intensive hydropower plants (plants with storage) will be particularly affected.

In the long run, the competitiveness of the hydropower sector will be determined by the capability of the producers to renovate, and therefore to re-invest in, their plants. The expected long-run market prices will be decisive for these investment decisions.

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