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Impact of the new Swiss electricity law on the competitiveness of hydropower

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Content

1 Introduction 1
2 The Swiss electric power industry 1
3 The Swiss Electricity Market Law (EML) 3
4 The cost structure of the Swiss hydropower industry 3
4.1 Dataset 4
4.2 Actual cost structure 6
4.3 Variable costs and output level 6
4.4 Capital costs 7
4.5 Comparison of the production costs with the expected prices 9
5 Conclusion 11

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 late 2002. 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 analyses the impact of EML on the hydropower firms and offers an overview on the competitiveness of the hydropower sector in the deregulated market.

1 Introduction

Over the past two decades many EU-member countries have legislated either a gradual or full opening of their electricity markets. This process was begun in accordance with member countries' obligations to implement the European Electricity Directive (96/92/EC) by February 1998. Although Switzerland is not an EU-member country, in December 1999 the Swiss Parliament adopted the new Swiss Electricity Market Law (EML). However, this Law has since been submitted to popular referendum.[1] Therefore, the Swiss population will vote on this issue in late 2002, and, if the EML is approved, the Swiss electricity market will be deregulated on January 2003.

The EML lays 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. Today in Switzerland some fear that this reform will adversely affect the economic and financial situation of the hydropower plants.

The purpose of this paper is to detail the reforms plans set out in the EML and to offer a first overview on the possible impacts of the reform on the competitiveness of the hydropower sector.

The article is organized as follows. In the next section we briefly present the Swiss electric power industry. After that the main elements of the Swiss Electricity Market Law are discussed. The possible economic effects of the introduction of this Law on hydropower sector follow in section 3. Section 4 concludes.

2 The Swiss electric power industry

The Swiss electric power industry is composed of about 1,170 firms, public and private, that are engaged in the generation, transmission and/or distribution of electric power. There is great diversity of size and activity among these companies. Generally, we can distinguish three types of electric companies. The first type is characterized by companies that generate and transmit electricity. The second type is represented by electric companies that primarily distribute electricity. Finally, the third type of company performs all three electric power system functions and is vertically integrated. Table 1 presents an overview of the composition of the Swiss electricity industry.

[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 it.

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.

Table 1. Number of electricity companies in Switzerland (1997)

Generation and/or Transmission	90
Generation, Transmission and Distribution	140
Transmission and/or Distribution	940
Total	1170

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

In the first group of companies we also find the so-called partner company, where shareholders can claim electricity production in proportion to their share of 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, comprising 74% of the total. The majority of these 900 or so companies are municipals 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 favorable hydroelectric power generation possibilities. There are few vertical integrated utilities that generate a large amount of power. The municipal and regional electric utilities purchase power mainly from the nine largest overland companies, which form the backbone of the industry. These larger vertically integrated 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 trans-regional and the international grids, which are planned and used in close cooperation. This means that these companies are the relevant international actors for the exchange of electric power with neighboring countries.

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

Table 2. Characteristics of Swiss power generation sector (2000)

Type of power plant	Installed capacity in MW	Installed capacity in %	Annual electricity production in Gwh	Annual electricity production in %
Hydro (Run-of-river)	3570	20.8	17566	26.9
Hydro (Storage)	9600	55.9	20285	31
Nuclear	3200	18.6	24949	38.2
Thermal power plants and others	790	4.7	2548	3.9
Total	17160	100	65348	100

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

The Swiss electricity sector is almost exclusively based on hydropower generation (~58%) and on nuclear power generation (~38%). The production of electric power using thermal power plants or wind or photovoltaic energy is still limited (~4%). Run-of-river hydro power plants and 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.

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 liberalization of some parts of the industry. At the end of the process, all customers will have the option to choose their energy supplier. 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 main characteristics of the EML include the following:

1. A system of regulated third-party access to the networks and therefore wholesale and retail competition.

2. Organisational unbundling of electricity transmission at the extra high voltage level and other activities. As part of the regulatory reform, the high voltage transmission grid will be disinvested by the seven firms (*Ueberlandwerke*) currently in control of the national grid. The national grid will be organised as a private company with the function of an independent system operator (ISO).

3. Separation of accounting for generation, distribution/retail supply and non-electricity related activities.

4. The creation of a new institution, the Arbitration Commission, to act as an independent agency with responsibility for supervising transmission and distribution tariffs.

5. A system based on bilateral contracts freely negotiated between buyers and sellers; therefore, a system without an independent system operator (ISO) that operates a centralized spot market.

6. Power exchange with other countries based on the adoption of a reciprocity clause. However, a safeguard clause in the law ensures that access to the grid can be refused to suppliers from countries with less liberalised electricity markets.

The EML allows qualified consumers to choose their electricity supplier. This element of the reform will phased in. In the first phase (first 3 years) of the introduction of the reform the distribution companies will have the possibility to choose their electricity supplier for 20% of their supplies. Whereas in the second phase (second 3 years) of the reform this share increases 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.

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.[2]

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.[3] 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 liberalization - important improvements in cost efficiency have been achieved. Operational costs (wages and maintenance) especially have been lowered.

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**[4]. 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. **Hydropower producers with an installed capacity between 1 and 10 MW**: This category includes all firms producing more than 50% of their power with plants that have an installed capacity between 1 and 10 MW. This category usually has higher specific investment costs (costs per installed kW) and is therefore analyzed separately.[5]

2. **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

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

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

[4] 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.

[5] Elektrowatt 1998

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 catchment area and turbines are usually located along the large rivers in the flat parts of the country. Further, they generate power constantly over the year.

3. **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 catchment area 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 catchment and the release of water into the river). Their power generation is larger during the summer period (higher flows of the mountain's rivers).

4. **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.

5. **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.

Table 2. Characteristics of the sample (data for the year 1999)

Categories	# of firms	# of plants	∅ Installed capacity MW	∅ output in GWh
1-10 MW	5	8	5	24
Run-of river (drop <25 m)	7	8	59	346
Run-of river (drop >25 m)	11	27	91	342
Storage without pump	11	27	217	434
Storage with pump	12	58	553	884
Total sample	46	125	185	406
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 2 show that the average size of the plants considered (185 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: 406 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 (884 GWh). By contrast, the storage plants without pumps considered in the sample are considerably smaller and produce about half as much power as storage plants with pumps. The two categories of run-of-river plants have very similar output levels, although some differences in their average capacity can be observed. Finally, the average installed capacity as well as the average output level of plants between 1 and 10 MW is very low, according to the definition of this category.

4.2 Actual cost structure

Fig. 1 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.

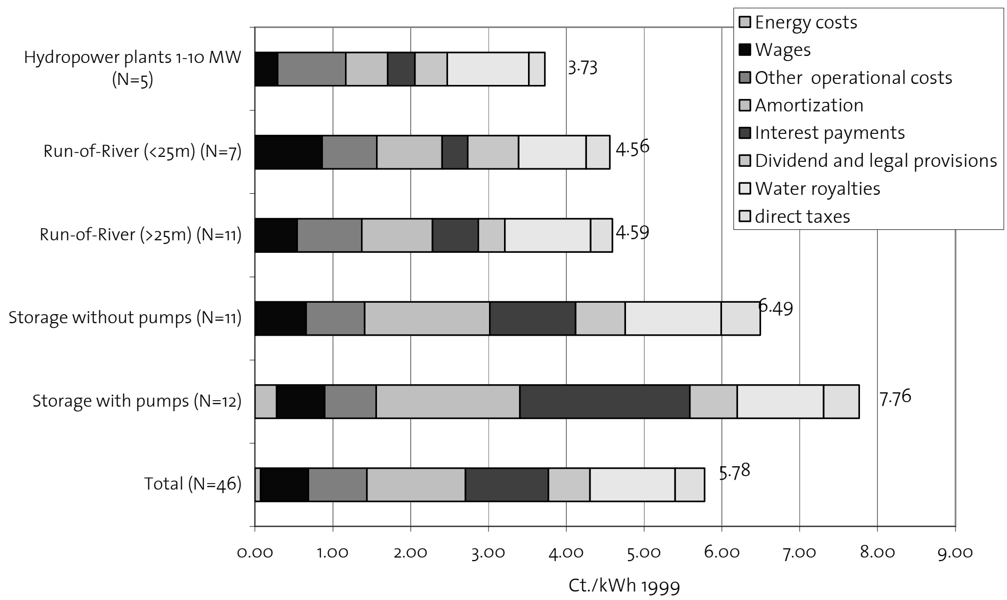

Fig. 1. Production costs for different categories of hydropower plants (1 CHF = 0.67 €)

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.

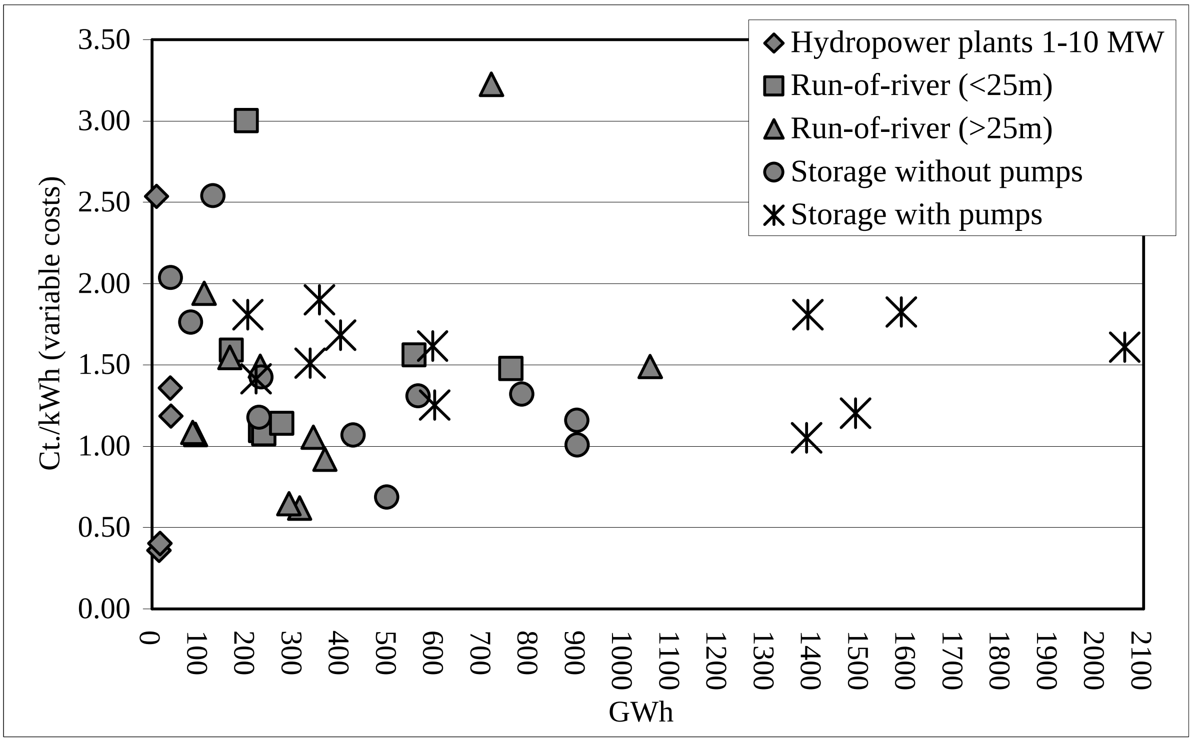

Fig. 2. Relationship between output and specific variable costs of production (labour, energy and other operational costs, 1 CHF = 0.67 €)

Fig. 2 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).

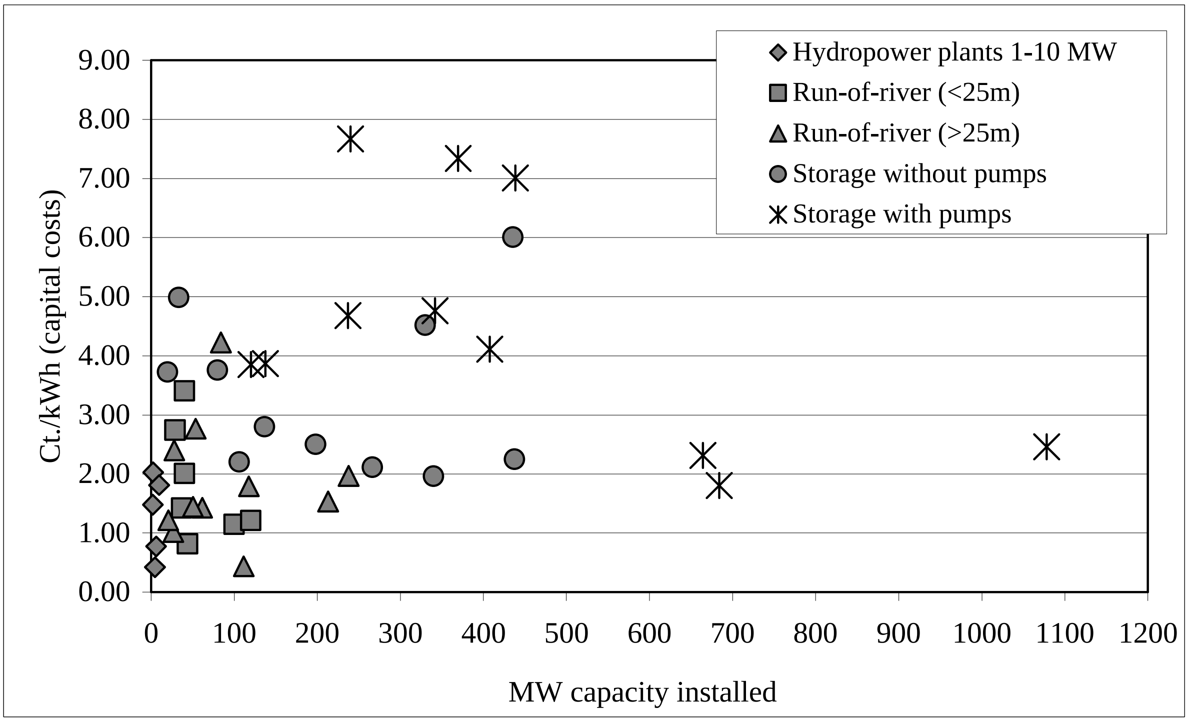

Fig. 3. Relationship between capacity installed and specific capital costs (amortization, interest payments, dividends, legal provisions, 1 CHF = 0.67 €)

Fig. 3 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. 4 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.

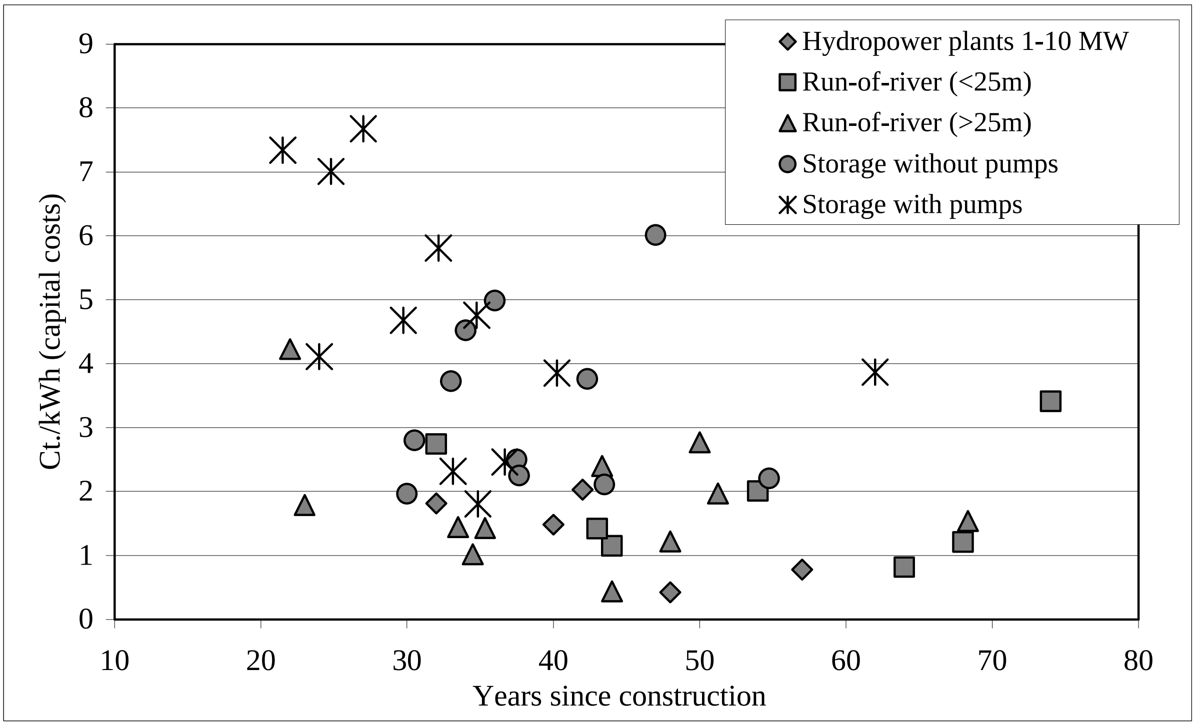

Fig. 4. Relationship between year of construction and specific capital cost (amortization, interest payments, dividends, legal provisions, 1 CHF = 0.67 €)

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 3, 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 3. 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.

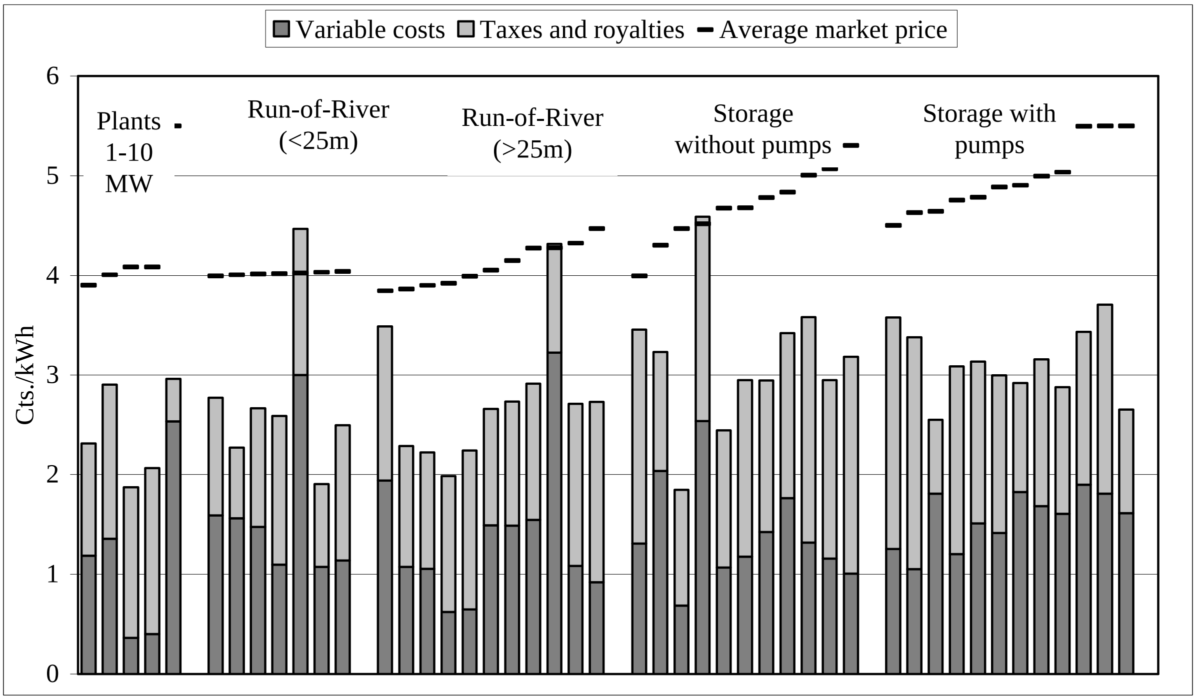

Fig. 5. Variable specific production costs and average market prices of the enterprises in the sample (N=46), peak market price: 5.5 Ct./kWh; off-peak price = 3.5 Ct./kWh (1 CHF = 0.67 €)

Fig. 5 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 3).

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.

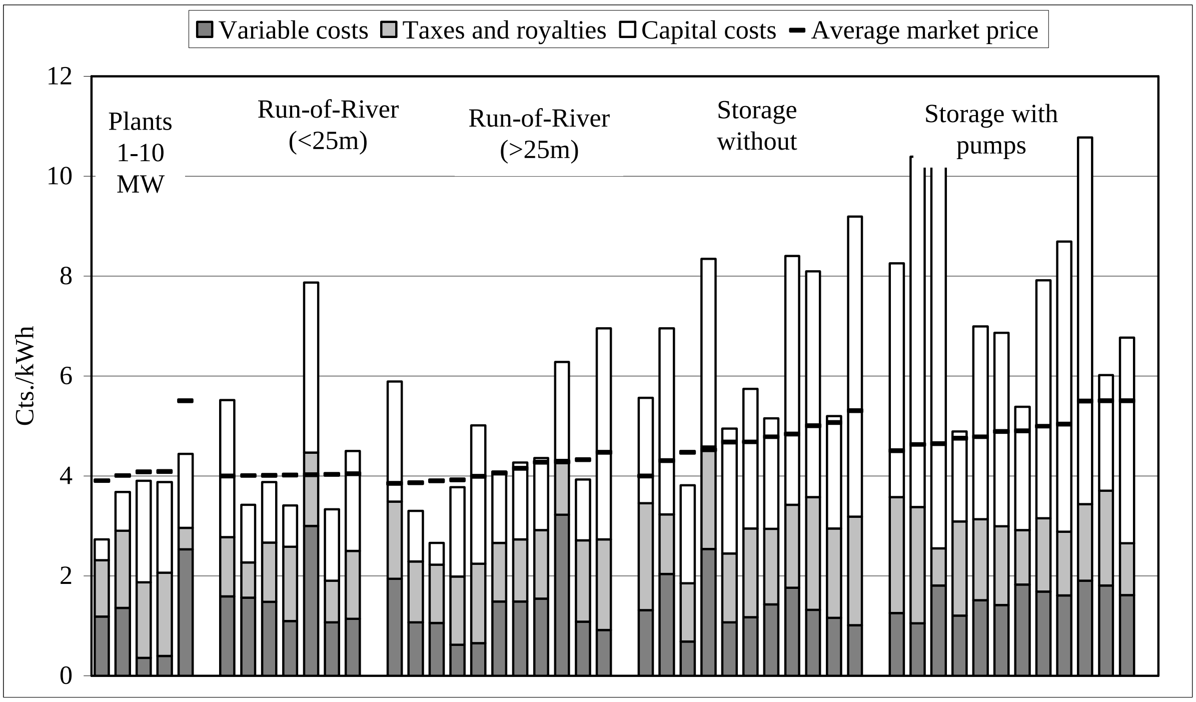

Fig. 6. Total specific production costs and average market prices of the enterprises in the sample (N=46), peak market price: 5.5 Ct./kWh; off-peak price = 3.5 Ct./kWh

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

Although the specific costs in Fig. 6 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:

1. 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.

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

3. 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.

4. 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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