ENERGY POLICY

LIBERALISATION, COMPETITION AND WELFARE EFFECTS OF THE SWISS ELECTRICITY MARKET REFORM

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Fribourg, December 2012.

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ABSTRACT

Liberalization of the electricity market is a constantly evolving subject and must be built step-by-step. The process has started from the partial liberalization in 2008 and will end completely in the best case in 2014. At the moment 2018-2020 is debating.

Very few reports have been written in this area, this thesis aims to be one of the first that focuses on price trends and on consumer’s impact. In people’s mind, liberalization means lower prices. One conclusion of this thesis, based on the research of price trends shows an opposite tendency. Throughout the period preceding the liberalization, prices have decreased. While the first phase shows an increase in prices. Result entirely in contrast of consumers’ desire.

The first part describes the current structure of the Swiss electricity market and the integration through European interconnected project. It also illustrates the current legislation, which will frame all the work and will provide the foundation for all reflection. The second part aims to display fundamental contribution of economic theories of regulation in the analysis of the dynamics of deregulation in the electricity industry. Stiglitz (2006), Joskow and Tirole, (2006) effectively demonstrate the nature of electricity as private or public good. Moreover, recent additional developments complete this part to propose an overview on the new form of technical regulation that will occur probably in Switzerland the next years. Finally, the last part introduces empirical studies on the problem in modeling electricity prices before and after partial liberalization.
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INTRODUCTION

The Swiss electricity market is under a radical liberalization process. However, there seems to be no general comprehension about the effects of liberalization on future energy policy, capacity expansion, consumer prices and social welfare. The purpose of this thesis is to analyze the impact of nuclear phase-out policies and complete liberalization on the Swiss electricity market in terms of capacity expansion and international electricity exchanges (imports and exports). An emphasis is placed on price consequences for consumers.

The situation before the liberalization process was characterized by a monopoly. The electric monopolization has led to inefficiency present at all management levels. Many arguments have been created to justify this state control acquisition. Electricity has falsely received the designation of a public monopoly. However, the electricity market liberalization has strong arguments to challenge this theory. The change process has been motivated by the inefficiency of the monopolistic structure and to some extent by the changing in the perception of the public ownership role but also by the competition and the market. Technological progress has made possible the management of more and more complex energy systems and ipso facto the mechanisms implementation needed to support the effective electricity market liberalization.

At the beginning of the liberalization process, the Federal Council supported the liberalization because they expected a price decrease through a double effect: the market opening to competition and the integration, to offset the lost competitiveness in all businesses sectors. A first key question in this thesis is: Why do we liberalize the electricity market? The current debate is that the electricity market argument opening is an illusion and it is useless. This presupposes that a complete opening market is not really useful. It might seem a paradox as the basic objectives of liberalization according to the Swiss Federal Office of Energy (SFOE) is generated competition:

“A greater efficiency in business, more transparency and advantageous conditions for consumers through prices regulation” (SFOE)

This thesis shows that full liberalization is not desirable. We emphasize that even with liberalization; some sectors remain subject to monopoly because they are submitted to technological constraints or policies. Liberalization should fit into a partnership with the European Union. Furthermore, an avowed goal into the process is to break a dominant
vertically integrated public company not exposed to competition and protected by the State (SFOE).

In the European Union the internal market establishment in electricity, which results in the opening and increased market power, is assumed to counteract the negative effects of regional monopolies. This thesis shows how, according to the theory, the liberalization of the Swiss electricity market impacts the social welfare.

The first part presents issues related to monopolistic markets and the effects of liberalization. Theoretical studies are used to present the contribution of economic regulation theories in the analysis of the deregulation dynamics in the electricity industry. In contrast to the belief that an opened market necessarily requires a withdrawal of the state, the free markets operation requires a strong presence of the state, even if it is another kind of presence. According to Vogel (1996), more market also means more rules. The most important challenge for liberalization policies of energy markets is probably to ensure security of electricity supply in decentralized markets environment, at socially acceptable cost. Thus, the second part helps understanding these complex rules for this purpose.

Finally, the thesis examines the welfare impact after-liberalization on Swiss electricity market. Some models and forecasts explain the dynamic behavior of the Swiss electricity market, from a systemic point of view. The purpose is not only to forecast or quantify market response, but also to identify and understand possible scenarios for market behavior, having in mind that the energy infrastructures planned today in Europe must be compatible with the long term policy choices.
1. Economic Background

This chapter will describe the global energy policy. At the present time, transportation, telecommunications and energy represent the three most important factors to stimulate the economy. Since the last oil energy crisis in the seventies, governments and people became very conscious to preserve the energy autonomy and they appreciated comfort. Today societies are aware that energy sources are extinguished. Their retail prices are increasing without possible future drop.

Actually, it is obvious that the process of de- or, re-regulation, of a good reflects a willingness to lower or stabilize the retail prices, in order to keep regional economies flexible and dynamic. This goal is achieved today partially with the natural resources regulation, through state control, for water and gas or by lobbies for coal and uranium.

Primary energy is found in earth natural resources, sometimes called raw fuels. It can be a renewable or non-renewable source. The figure below shows the distribution of energy in the world. Better known renewable primary energies are: water, sun and wind. The non-renewable can be the coal, the crude oil and the uranium.

![Figure 1: Five primary energy agents in the world (2010)](image)

Source: BP Statistical Review of World Energy 2011

As a primary energy stands often far from the consumer centers, a conversion into secondary energy appears evident for carrying and distribution needs. In the energy field, these forms are called energy carriers. They correspond to the concept of secondary energy in energy
statistics. There are mainly defined as refined fuels or synthetic fuels such as hydrogen, heat or steam and electric energy like presented in the following figure.

Figure 2: Final energy consumption in Switzerland (2010)

The electric energy is transported by a complex infrastructure starting from generating units, transforming primary energies to supplying final consumers through bulk transmission and distribution power systems.

Within the electricity sector four vertically successive stages must be distinguished:

1. Power generation
2. Transmission grid (high voltage)
3. Distribution grid (low voltage)
4. Retail

Electric energy remains today the only secondary energy that cannot be stored. For a stable and efficient operation, the fundamental physical condition consists in the instantaneous balance between generated and consumed energy in the limits of a defined power system. If this condition is not fulfilled, severe dysfunction can affect the electric grid, the ultimate consequence is the total blackout.

Source: OFEN, Statistique globale suisse de l’énergie 2010
As a secondary energy, electricity can (in principle) be produced anywhere. It is predominantly generated in the country in which it is consumed. Both power stations location and transmission network design are selected to meet the needs of the domestic market.

The electric energy industry is seen as a conservative and reliable sector where the technology evolves slowly in time. The management of their assets has long life cycles lasting decades. In this sector, huge invested values are accounted in billions, even for a single mid-size electric company. Today electricity is considered by the society as an acquired good, a right, and is actually a conservative sector. Indeed electric energy was one of the last factors to be deregulated.
2. The Swiss Electricity Market

This chapter will describe the historical aspects of the electricity market and how the liberalization process is transforming the market structure. Furthermore it will deal with an enhanced European integration. The key is to know about the process of the European electricity market and the interactions that Switzerland can have with key partners. It will be completely wrong to think that Switzerland can only act alone on this market. A united effort which is centralized through a process of regional integration is the key to success. This chapter will go directly into the 2000s. For an overview of the foundations of European energy policy, see: Haaland (1997). To complete the part, the institutional aspect will be treated with the current legislation on the liberalization

In Switzerland, electricity supply is the responsibility of the private economy, the Confederation and the Cantons ensuring, by appropriate state framework conditions, that the energy economy is able to optimally fulfill this task in the interest of all. The objective is to ensure greater supply security in Switzerland. This shall be achieved if, at any time, the amount of energy required is available at the required quality and the appropriate price on the entire grid.

The Law introduction about the Electricity Supply (Electricity Supply Act\(^1\)) on April 1\(^{st}\) 2008 gave the start of the gradual liberalization of the electricity market in Switzerland. This law creates the framework conditions of competition in the electricity market. The new company “Swissgrid”, the national operator and owner of the network must guarantee an efficient national power grid. It is one of the prerequisites for supply security for Switzerland and a full liberalized market. In 2013, Swissgrid will be the only owner of the Swiss transmission grid (swissgrid.ch). Emergent liberalization is taking place. Nuclear dismantling is being debated (Swiss Federal Office of Energy: SFOE).

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\(^1\) “The Federal Electricity Supply Act, adopted by Parliament in 2007, foresee for an opening of the market in two stages. During the first five years (2009 to 2013), end users with an annual consumption of more than 100,000 kWh have access to the market. After this period, households and other small consumers will be able to freely choose their electricity supplier. Full market liberalization will be introduced on the basis of a federal resolution, which will be subject to an optional referendum. The high-voltage network has to be operated by a national operator (Swissgrid) with a majority Swiss holding” (Swiss Federal Office of Energy: SFOE).
The Swiss electricity market is partially liberalized since January 1st, 2009. Since then, production, transmission and distribution are separated. The national Society created for the operation of the network (Swissgrid) in line with liberalization, performs its task under the supervision of the regulatory authority: the Federal Electricity Commission (ElCom).

2.1. The Market as a Network

This section outlines the structure of the Swiss electricity grid. A special attention is placed on actors and network quality.

Any producer connected to the transmission system can inject electricity into the network. Switzerland has 850 companies frequently linked by cross-shareholdings. In addition, 80% of these companies are owned by Cantons and Communes and therefore are subject to strong political influences, including from governments and various organizations. There is strong political influence, not always convergent and high number of companies reporting to the regulator; the Federal Electricity Commission (ElCom) (Orzan, 2009).

With the liberalization and integration into the European market, we must expect a growth of electric companies in Switzerland. To strengthen the independence of Swissgrid in the long term, a change in ownership structure is essential. In other words, the owner, Swissgrid, must be from different economic sectors so that the capital is not found in one hand.

“Switzerland is no longer synchronized with other European countries. Our electricity market is not liberalized in fact. There is little change of suppliers.” (Orzan, 2009).

The Swiss electricity network with a grid of 6,700 kilometers at very high voltage is the longest infrastructure of Switzerland. In 2010 a volume of electricity equivalent to 80’100 Gig watt per hour (GWh) was transported. The Swiss electricity grid consists of seven distinct levels. Swissgrid is responsible for operating the network level - the transmission system - which ensures the transit, import and export and provides electricity to networks at lower levels. SBB (Swiss Federal Railways) is currently the only final consumer to be directly connected to the transmission system. All other final consumers receive the electricity through the distribution networks. We can compare the network to a grid road network (Swissgrid, 2011, p.30).
The network transmission is crucial to position the country as an electricity hub in Europe. In 2010, Switzerland totally imported 66’800 GWh and exported 66’300 GWh. It generated a profit of nearly 1.3 billion francs on the electricity market (Swissgrid, (2011), p.16).

A transportation system in good operating condition not only improves the economic framework in Switzerland with the neighboring countries but also increases the competitiveness of this country. Indeed, the profit in the electricity market is reinvested directly and indirectly to ensure security of cantonal supply. This reduces the local price of electricity. As to corporate taxes, benefits bring a significant contribution to the finance of the Cantons.
2.2. Supply and Demand on the Market

This subchapter will cover the supply and demand of the electricity market which is regulated, as it will be described few pages further, by special conditions relating to externalities. These externalities make the partnership and exchange with neighboring countries essential. Consequently this sub-chapter will conclude with a section dedicated to partnership.

The liberalization objective of the electricity market is the European internal market creation that offers customers the security of supply, as well as competitive prices and services. Within this market, companies increasingly diverse organize the production, trading, marketing, transportation and supply of electricity, in accordance with the appropriate regulations. Electricity producers compete to sell energy at the best possible price. Providers that deliver electricity to end consumers buy energy on the wholesale market to producers or trading companies.

Liberalization has led to the new markets and financial services emergence to facilitate trade, whose functions were before, integrated into the monopolistic organization. The market organization is based on the model «OTC: over the counter²».

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**Power exchange & OTC:**

The power exchanges offer a trading platform where members can enter orders to buy and sell energy. Their main objective is to provide a mechanism for price formation on the electricity market by matching supply and demand at a fair price and ensuring that transactions made on the exchange are finally delivered and paid.

*Source:* European Power Exchange

In European Union, the guidelines lack on markets organization of has led to different models creation in each state. Despite this diversity, we can distinguish a dominant model that combines bilateral transactions (wholesale market has over-counter or OTC) and multilateral organized markets: auction capacity interconnections and electricity (power) exchanges.


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² Reference model used for the construction of competitive market
Bilateral transactions are carried out on a confidential basis between two parties, but estimates for the price published by organizations such as *Platts* press (www.platts.com). With this, a retail price of electricity emerges on which line most actors. The contracts on the OTC market are long-term and large quantities and represent more than 90% of transactions between Switzerland and neighboring countries (SIA Conseil, 2007)).

Since 2007, electricity in the Swiss market is traded on the European Energy Exchange (EEX). The following figure gives an overview of the electricity wholesale prices. It is during the winter months that electricity traded in Switzerland is more expensive than in the Austro-German or French market. Indeed, the Swiss Hydroelectric production decreases during this period. Switzerland must import, resulting in the depletion of border capacities and requires auctions (Power exchange & OTC).

![Figure 3: Electricity wholesale prices (January-October 2007)](image)

*Source: Meister 2008 (Works based on EEX, Powernext, Mercatoelettrico)*
The need to constantly equalize demand by supply, as well as the non-storability of electricity and the demand inelasticity is responsible for highly volatile electricity prices. In times of capacity shortage or peak demand, electricity is available at a very high price, when demand decreases and that a surplus production capacity is reached, the price may fall to marginal cost. As an example, the next figure analyzes the price border capacities Germany-Switzerland (2007).

In the first half of 2007, using the coupling station to the Swiss-German border has cost an average of 6 euros / MWh; in January, the average price was 15 euros / MWh and dropped to almost zero in April. In the reverse (export to Germany), prices are almost never positive, because the transport capacity is sufficient. It turns out that the amount of auctions to Switzerland grew in parallel with the difference price between the two markets (Meister (2008), p.17-18).

**Figure 4: Price border capacities Germany-Switzerland (2007)**

Source: Meister 2008 (Works based on EEX, Powernext, Mercatoelectrico)
The explanation is simple. The interest of the broker is to export electric power from Germany to Switzerland as long as the Swiss market price is higher than the German market price, respectively: Figure 3: October until April. By adding the price border capacities demand exceeds supply until the auction price is less than the difference in market rates (Respectively, Figure 4: January, March, September, October and November). In equilibrium, the auction price is equal to the difference in market prices.

Considering the price differentials during base and peak periods, electricity is a particular good and distinct during each day phase.
2.2.1. Demand

Supply and demand specificities in network industries make the access to the market, the key issue of the liberalization process. Demand for electricity will continue to grow in the coming years, for several reasons: around the world, large markets like China, India and Brazil will gain in importance. In Switzerland too, according to the Federal Statistical Office (FSO), the Swiss population will count 8.8 million people in 2035 against 8 million today, a demographic growth of 12.5%. In addition directly linked to this increase, several other reasons explain this rise in demand:

“The gradual replacement of fossil fuels by electricity
The current automation of production processes
The electromobility” (FSO 2010)

The increase in demand for electricity cannot be explained only by economic or demographic reasons, but also by two significant externalities related to this sector.

On one hand, demand is characterized by significant network externalities. For an unchanged service, consumer satisfaction increases with the number of users that the network has. There is a positive externality because the network connection of new customers increases the value of existing services, improving customer satisfaction which does not pass through the pricing system. Furthermore, a growing number of users encourage the network operator to diversify and to improve the quality of its services, making the network more attractive. There is a virtuous cycle that strengthens the competitive advantage of the leading operator on the market (Pénard, (2002)).

On another hand electricity demand increases also network congestion. Demand cannot grow indefinitely. We must take the network capacity into account. Expected growth consumption of electricity in Switzerland is 2 percent per year. In 2010, an increase of 4 percent was recorded, twice what was expected (Swissgrid, (2011), p.8).

The latest forecasts predict that the energy consumption will exceed production capacity in 2020. An "energy scarcity" is currently taking shape (www.alpiq.ch).
2.2.2. Supply

Supply offer is also characterized by very specific conditions and externalities in electricity sector. The demand characteristic would push companies to concentration.

Firstly, increasing returns on scale economies are observed. Design and construction of a network involve very large investments. Fixed costs are very high and the variable costs are often close to zero. The marginal cost of providing these services is decreasing, making it impossible for new competitors to enter into the market. They would face higher costs and their activities would not be profitable. This is known as a natural monopoly. Secondly, the supply and demand interact according to a principle that strengthens the trend towards concentration. The operator which dominates the market is twice advantaged. Its potential customers benefit from both the maximum externalities, by the number of users and lowest prices through economies of scale. The operator will attract new customers and will further strengthen its attractiveness. The network industries create a dynamic of monopolization (Pénard, 2002).

Dealing with obstacles to liberalization, we can wonder why and how the European Commission initiated an extensive process of liberalization. The liberalization process means more competition, so more players on the market. The opening to competition in network industries, in addition to being constantly threatened and challenged by the trend towards concentration, remains largely incomplete. Eventually, with increased competition, companies will be encouraged or forced to merge with others, or will go bankrupt. The most successful companies will become even more important and will be able to offer even lower prices.

3 The natural Monopoly is only for the network
2.3. Towards European Integration

The liberalization of European electricity markets has increased the international trade importance. The exchange power increases border competition. In practice, it is difficult for new independent producers to enter into the market, due to lack of sites to build new plants. However, it would be possible to enter into the market with an international supply strategy. The distance between the production place and the end customer is not necessarily an obstacle; tariffs are not related to distance anymore. The import, export and transit taxes were abolished in Europe during the "Florence process."\(^4\) In practice, the exploitation of cross border transmission capacities, called "border capacities," continues to generate costs associated with distance. For historical reasons, these capacities have been under-evaluated between most countries (Meister, (2008)).

All stakeholders benefit from free trade in raw materials, to process goods and services. Its advantages are obvious especially for a small country, where there is "unavailability trade". At the regional level, this is also correct for electric power. In this field, the possibilities and production costs can change with location and make necessary the exchange capacity (gas prices and coal site-specific availability of hydropower, solar, wind, etc...). In addition, electricity trade can compensate the production difficulties and can contribute to the supply stability. It does not mean that imports can replace current domestic production. If the production capacity is missing in the country, the supply security can only be guaranteed with great difficulties. For example, in case of temporary disruption (in the international network), the necessity of domestic production is justified.

As the exchange energy is global, market prices are calculated on the international markets. It is clear that energy prices could show regional differences, especially because the costs may vary depending on production sites and transport costs, etc... Nevertheless, due to the negotiability between different energies, prices tend to move together. As an example, it is interesting to note in this respect, that the growing gas extraction in the U.S. tends to influence the European market through international trade in liquefied natural gas (LNG), which has led to lower prices even in Europe (Meister 2010) due to cross-elasticity. The decline in gas

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4 “Florence process was set up to discuss the creation of the internal electricity market. It is currently addressing cross-border trade of electricity, in particular the tarification of cross-border electricity exchanges and the management of scarce interconnection capacity” (http://europa.eu)
prices also lowers the price of electricity. Due to cross-border exchanges of electricity, these developments are transmitted to Switzerland, while in Switzerland there is no gas plant; gas prices on international markets also ultimately affect the electricity price on the Swiss market.

As we saw in the previous chapter, during 2007 summer, (Figure: Electricity wholesale price), the market price of the Swiss electricity is at the same low level as practiced in Germany. In contrast, in winter, when Switzerland must import, the price climbs at the same level as in Italy, where the electricity price is higher because of higher gas prices in this region (Meister, (2010)). Due to the international market and interdependence between energy sources, a small open economy has a very marginal impact on market prices: construction on new large power plants have virtually no change in prices on the electricity market.

2.3.1. International trade and market integration

Far from being alone in electricity business, Switzerland plays an important role in the European interconnected network (11% of European electricity flows through Switzerland). Favorable conditions framework and sufficient transmission capacity are essential for security of supply in the country. These are signals that national electricity markets liberalization is now closer to the long-term objective of a single European energy market (www.swissgrid.ch).

Switzerland depends on more than 80% for energy imports, (Figure 5: Use and total final energy: consumption in Switzerland) particularly oil, natural gas and uranium. The only indigenous energy sources are hydroelectric power, solid fuels (waste wood) and another called new renewable such as solar, wind or geothermal energy. That is why Switzerland promotes an adequate energy supply.

Article 89 of the Federal Constitution reads as follow:

1 Dans les limites de leurs compétences respectives, la Confédération et les cantons s'emploient à promouvoir un approvisionnement énergétique suffisant, diversifié, sûr, économiquement optimal et respectueux de l'environnement, ainsi qu'une consommation économique et rationnelle de l'énergie (CH Constitution).

This sustainable energy policy also reduces the dependency on external sources, including improving energy efficiency and increasing the proportion of domestic renewable energy. Therefore, the legislation does not make a priority of energy production on the territory, but promotes clean energy sources.
Another example (Conseil fédéral (2008), p.18) illustrating the importance of integration on the Swiss market shows that the balance of electricity cross-border trade reached around 1 billion francs per year. It results from dams and the commercialization of surplus capacity in the liberalized environment. A significant barrier to cross border electricity trade lies in the shortcomings of the network related to the insufficiency of transmission capacity.

At present, European electricity market liberalization represents the world’s most extensive cross-jurisdiction electricity sector reform involving integration of distinct state-level or national electricity markets.
Energy is in the heart of European integration, since the beginning of the process and the adoption of the ECSC and EURATOM Treaties. Both treaties remain to this day unique as they define a common energy policy. They are based on supranational powers delegation belonging to one exclusive central authority. The subsequent treaties: the EEC Treaty and successive amending treaties (Single European Act (1986), Maastricht (1992), Amsterdam (1997) and Nice (2001)) - did not offer comprehensive legal basis for the EU to address the question of energy (Andoura, Hancher, and Van der Woude, (2010)).

With the expiry of the ECSC Treaty in 2002, the EURATOM Treaty remains the only legal basis for a real common energy policy, but it only covers the nuclear industry. Within the general framework of the EC Treaty, measures relating the energy policy must necessarily be based on the Treaty general provisions; subject to the principle of subsidiarity and on the rules governing the internal market. The insertion of a section devoted to the energy in the Treaty of Lisbon (2007) does not fundamentally change the situation. (Andoura, Hancher, and Van der Woude, (2010)).

The three goals future approach in the energy policy that the European Council has approved in summer 2007 is based on three pillars. According to De Jong, Glachnant, Hafner (2010): it was a basis for a variety of policy, regulatory proposals and actions, which are known under

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5 The European Coal and Steel Community (ECSC) was a six-nation international organization serving to unify Western Europe during the Cold War and create the foundation for the modern-day developments of the European Union. It was formally established by the Treaty of Paris (1951), signed by France, West Germany, Italy and the three Benelux states: Belgium, the Netherlands and Luxembourg. Between these states the ECSC would create a common market for coal and steel.

6 The European Atomic Energy Community (EAEC or EURATOM) is an international organization which is legally distinct from the European Union (EU). It is governed by the EU’s institution. It was established on 25 March 1957.

7 Under the principle of subsidiarity, in areas which do not fall within its exclusive competence, the Union shall act only if and so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States. Either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level. A more descriptive analysis of the principle can be found in Official Journal of the European Union, Protocol 2 on the application of the principles of subsidiarity and proportionality.
the names of three mantras: “Kyoto, Lisbon and Moscow”. It covers the issues of climate change, competitiveness and supply security:

1. «Lisbon, market issue»: guarantee the competitiveness of European economies in a competitive internal market with no internal barriers to trade.
2. «Kyoto, the green issue»: promotes environmental sustainability and the fight against climate change.
3. «Moscow, supplies security»: Russian energy (gas) supplies have played an increasingly important role for the EU since the early 1980’s.

The main problem, pointed by De Jong shows that these three policies frequently are in conflict. The European Directive RES\(^8\) (Renewable Energy Sources) which intends to develop electricity from renewable sources is implemented according to strict national lines. Another argument of De Jong is to say that the competitive market offers insufficient guarantees for long-term investment in alternative energy sources on a large scale, such as nuclear, wind farms offshore and projects CCS (carbon capture and storage).

Europe is now liberalizing electricity in accordance with the European Commission’s Electricity Directives\(^9\). Different countries have responded differently, notably in the extent of restructuring, treatment of mergers, market power and vertical unbundling. While Britain and Norway have achieved effective competition, others like Germany, Spain and France are still struggling to deal with dominant and sometimes vertically integrated companies (Newbery, (2005)). The lack of energy policy overview is clear. The objective of competitiveness and access to energy at affordable prices is largely left to the market liberalization process, which seems almost considered as a goal. This approach can have negative repercussions for energy consumers, producers and suppliers, who may prefer the stability of prices in the long term period rather than a short-term volatility.


2.3.2. Interconnected project network and vision in Europe

Today, some voices rise and argue in favor of a more ambitious policy to guarantee the effectiveness of a common energy policy especially in the field of the network grid. Europe is full of one-sided strong social and political interest groups. These groups argue that:

“What are lacking is smart ideas and open pragmatic debate. What heretofore has not existed at the EU level is a neutral, open-minded and intentionally pro-scientific approach and knowledge exchange platform. We must act quickly if we want to address the challenges raised by the energy and climate crises and also solve problems of external dependence, while trying to ensure the transition to a European low-carbon. Such efforts must be made collectively at European level, and be oriented specifically on the energy challenges” (De Jong, Glachant, Hafner, 2010)

The avowed purpose is to move towards a European community of energy. An innovative project is being discussed to create a mega interconnected network in Europe: the Supergrid. This network is defined as "a pan-European transmission network" facilitating the integration of large-scale renewable energy and the balancing and transportation of electricity.

“There are now no technical barriers to the delivery of a European Supergrid. What is now required is the regulatory and investment framework to enable the construction of the first legs, to bring sustainable and clean energy from the North and South of Europe to cities and communities across the continent.” (De Jong, Glachant, Hafner, 2010)

“Europe’s vast renewable energy reserves are a continental resource to be traded in a single electricity market. An interconnected Europe will deliver affordable and secure sources of low carbon electricity to consumers who are today penalized by barriers to trade and exposed to volatile fossil fuel prices.” (De Jong, Glachant, Hafner, 2010)

United Nation (2007) showed the Grid interconnections benefits and highlights the fact that it can offer both direct and indirect economic and financial costs and benefits. The “E7”

10 For example: VaasaETT Global Energy Think-Tank (One of the World’s top centers for expertise in energy markets.

11 The E7 is a group of seven countries with emerging economies including: China, India, Brazil, Mexico, Russia, Indonesia and Turkey
Utilities group describes some of the economic benefits of interconnection. We can imagine that it will be also appropriate for the European Supergrid.

“The pooling of resources and the interconnection of isolated electric power systems allow optimum use of available resources. They will be instrumental in achieving reductions in the operating cost of the generation mix, increasing the generation capacity margin and, conversely, reducing the need for investment in peak capacity. Lower production costs and/or lower investments in generation, achieved through the interconnection of electric power systems, and should have an impact on rates to the customers’ advantage. Improved electric power systems reliability will foster an increase in quality of service and a reduction in power interruptions that too often lead to productivity losses in the commercial and industrial sectors, affecting average regional manufacturing costs and, finally, the national gross domestic product (GDP). Pooling electricity resources is crucial if the electric power systems are to fully contribute to sustainable development.”

The idea of a fundamental reflection on the future of European energy policy has opened a European wingspan debate about the various stakeholders: public, private, voluntary, local, national and European as we have seen it before. Therefore, a proposal was put forward to create a "European Energy Community." On a proposal by Jacques Delors, a report on the future of European energy policy was created in April 2010 entitled "Towards a European Energy Community: a policy proposal" According to M. Delors, president and founder of Notre Europe, and M. Nilsson, despite the progress made in recent years, the policy of the EU’s energy has failed to achieve its main objectives:

12 Quote is from Section 5 of the “Guidelines” volume of Regional Electricity Cooperation and Integration (RECI), E7 Guidelines for the pooling of resources and the interconnection of electric power systems, prepared by the E7 Network of Expertise for the Global Environment, (2000).

13 For more information, see: “Vers une Communauté européenne de l’énergie "Sur une proposition de Jacques Delors

14 The association hopes to think as “a united Europe” in other words to contribute to a closer union of European people. Notre Europe participates in current debates, with declared positions through detailed policy analysis and concrete policy proposals.
“To ensure access to energy at a reasonable stable price to maintain the competitiveness of European industry.

To ensure the energy security supply for all Europeans, wherever they live.

To promote a sustainable model of production, transmission, distribution, storage and consumption of energy that makes a decisive step towards a low carbon.”

(Orzan, (2009))

These objectives gather a general acceptance among both politicians and civil society. However, their perspectives differ greatly. The collective action is primarily an objective obligation. No Member State has adequate resources to meet the challenges alone. Research programs involve collective international efforts. Moreover, the necessity of providing a common response is also a legal requirement. If Member States wish to maintain the current level of integration, they must develop a common policy compatible with internal market rules. National energy policies have shown their limits. There is still no common European energy program to overcome them. The project is still under discussion (European Commission, (2005)).

Member States of the EU have developed so close interdependencies that going alone is now an impractical choice for them, as we have seen before for example with the release of nuclear energy. Such unilateral decisions increase the risk of divergences and can lead to tariff increases in production and energy consumption at the regional level. Today, no European country is able to provide its only reliable energy supplies at affordable rate for its citizens.

The lack of political will is obviously a problem, but not the only one. According to Delors and Nilsson:

- Member countries have not fully taken an advantage from the promise and potential of the single market to strengthen energy security and add value for its citizens.
- Solidarity between Member States is expressly requested by the Lisbon Treaty but has not been applied in the present institutional framework.
- EU does not have the resources required to finance large-scale actions or impose choices regarding energy sources.
- The annual EU budget available in this sector is restricted and severely limits funding allocated to joint interconnection of electricity and gas networks or collaborative research on energy production to low-carbon.” (Orzan, (2009))
Delors and Nilsson would be in favor of a more ambitious promising project with the aim to develop a European energy covering all economic, political and strategic aspects of the issue. This would include integrating Europe's energy markets, coordinate research policies, investment decisions and mechanisms of solidarity. Issues that are particularly noteworthy to relate, with respect to external relations, are regional energy cooperation, international energy trade, and development cooperation. An important contribution to improve technical competence in the EU and internationally is the Strategic Energy Technology plan (COM 2007). There has been considerable progress in regional cooperation in Europe through the Energy Community Treaty\textsuperscript{15} (European Commission, (2005)).

At present, the goal of the energy market liberalization process in Europe is increasingly focused on electricity market integration and related cross border issues. The current legislation and regulation is more complex than it has ever been before. The next chapter (2.4 Swiss Institutional Aspects) will further describe this information. The Community had to deal also with the challenge of absorbing 12 new Member States having joined the past four years. The opening market is now entering in its last phase. Integrated approaches are becoming the norm. Essential elements of the European Union Energy Policy, with special emphasis on recently enacted or proposed legislation as well as the implications to reach fundamental objectives should be the goal for secure, competitive and sustainable for the future Europe energy (Eurostat, (2009)).

\textbf{2.3.3. Gains from partnership: with whom?}

The economic integration theory explains that scale economies are related to the market size. According to Krugman’s model (economies of scale, (1992)), in the case of a capital intensive industry, with economies of scale and consequences composed of several oligopolistic companies, the increased market will lead to lower prices. The Krugman’s model can be well applied to the electrical industry. Even if economies of scale are not applicable to whole electricity production sector, the current situation in the European market and the Swiss

\textsuperscript{15} This treaty foresees the rules for the creation of an integrated market for natural gas and electricity in Europe, with a stable regulatory and market framework that is capable of attracting investment in gas networks, power generation and transmission networks. The Energy Community Treaty also aims to enhance the security supply by extending access and allowing mutual assistance in the event of a service disruption.
market is close to the oligopoly with several big actors. The idea is therefore to benefit from this market while taking advantage of the partnership.

Switzerland is interested in benefits of regional integration. Switzerland covers approximately 55% of its energy consumption by fossil fuels (around 45% of crude oil and about 10% of natural gas) and 25% by the nuclear fuel. The remaining 20% comes from domestic energy sources, one-half for hydropower; the other half for solid fuels (waste wood) and other renewable energies (Conseil fédéral (2008), p.5).

The integration of Switzerland in the European electricity market creates a new situation. Transmission capacities to Italy will be adjudicated by auction to the highest bidder in the bilateral negotiations. For the Swiss electricity suppliers, the abolition of the exclusive use of border capacities reduces potentials sales and brokerage; henceforth, the German producers could export electricity to Italy even without any intermediary. However, the central hub of Switzerland in the European electricity trade could change. For examples following the construction of additional power plants enforced in Italy. Switzerland could therefore gradually lose its role as a transit country. The potential return of brokerage would decrease but imports for domestic consumption could also become more favorable due to the reduction of bottlenecks in the north (Meister, (2008), p.19).

At the network transmission and distribution level, the physical reality is that networks are already connected, management between Switzerland and different parts of Europe being different. Switzerland is a hub between different intensity sectors in Europe. In contrast, the integration of the Swiss transmission grid in the European transport network may result in additional costs (due to the oversize of infrastructure in particular). The question will be how to allocate costs to cross-border trade and the needs of the Swiss consumers. This will be a key issue to achieve this integration (Groupe E Interview with energy consultant).

A new situation occurs also in Europe because of the physical interconnections which now link formerly separated markets. An example: the submarine cable of 580 km between the Netherlands and Norway. The development of physical interconnections also increases the economic interpenetration of markets. The Management of bottlenecks is improving. It simplifies and integrates trade and electricity transport capacity. In the medium term, Switzerland will have to think how it intends to participate in this development and about the consequences on the planning of new development or large power transmission capacity (Meister, (2008), p.19).
Moreover there are several other integration benefits:

1. “There has been considerable progress in regional cooperation in Europe through the Energy Community Treaty with Albania, Bulgaria, Bosnia-Herzegovina, Croatia, Macedonia, Montenegro, Serbia and the Kosovo region. This treaty provides for the creation of an integrated market in natural gas and electricity in South-East Europe, with a stable regulatory and market framework that is capable of attracting investment in gas networks, power generation and transmission networks. ...Regional cooperation along the lines of the EU model is promoted so that smaller countries can benefit from more competitive markets, cross-border investment opportunities, and the standardization of energy technologies and products.” (Eurostat, (2009), p.7)

For structural reasons, Swiss economy currently has a power consumption of oil and low intensity (absence of heavy industry, no fossil power generation). However, the consumption of oil per capita in Switzerland is 13% higher than the EU average. The main reason is the low taxation of oil in the European comparison. For a long time, oil in Switzerland has been one of the cheapest and most widespread sources of energy for heating. Even increased of a CO2 tax of 9 cents per liter, the price of oil remains very low in Switzerland compared with EU (Conseil fédéral (2008), p.11).

2. Assuming the increase of worldwide energy consumption and depletion of fossil fuels resulting, Switzerland will actively contribute to secure its long-term supply in the future. Helvetic strategy is to improve the supply security by diversifying as much as possible the fossil fuels sources and transport channels. Switzerland therefore intends to develop energy partnerships not only with its neighbors but also with third countries selected from those who produce fossil fuels or enable transit. In this context, Turkey, Azerbaijan, Algeria and Norway are some priority prospective partners (Conseil fédéral (2008), p.8).

In the coming year, Switzerland will continue to pursue a high level energy security. The Swiss Federal Office of Energy (SFOE) intends to introduce the Energy Strategy for 2050 to “continue safeguarding Switzerland’s high level of energy security even without nuclear energy in the medium term. This decision has been taken at his special meeting on May 25, 2011. Existing nuclear power plants should be decommissioned at the end of their operational lifespan and not be replaced by new nuclear power plants. In order to ensure the security of supply, the Federal Council, as part of its new Energy Strategy 2050, is placing emphasis on
increased energy savings (energy efficiency), the expansion of hydropower and new renewable energies, and, if necessary, on fossil fuel-based on electricity production (cogeneration facilities, gas-fired combined-cycle power plants) and imports. Furthermore, Switzerland's power grid should be expanded without delay and energy research strengthened.”
2.4. Swiss Institutional Aspects

The institutional part frames all the work and provides the foundation for all reflection. Furthermore this chapter provides an overview and explains in some aspects the electricity price’s trend.

The legislation strongly influences the economic organization based in one of the most important branches of the economy. It directly addresses over 800 companies and many more are indirectly concerned. In addition, each person living in Switzerland is also affected by the new legislation.

Each country has its specificities. Switzerland develops sometimes specific regulations which are not always compatible with the European system. This section will have a look at the purely legislative situation in the field of Swiss parties involved and the Swiss legal framework. Moreover, external relationships concerning the electricity supply are being forged primarily on the basis of private law. Knowledge of the legal environment allows a systematic analysis of the trends and risks.

The Swiss electricity market legal bases are\(^\text{16}\):

- The Swiss Electricity Market Law (LME),
- The Law on Electricity Supply (Electricity Supply Act, (LApEl, RS 734.7),
- The Ordinance on Electricity Supply (Electricity Supply Ordinance (OApEl, RS 734.71)),
- The Energy Act (LEne, RS 730.0),
- The Ordinance on energy (energy Ordinance, OEnE, RS 730.01)

Legislation allows the market liberalization and creates new conditions. It improved transparency and basic network access without creating discrimination. Furthermore, the LApEL is Euro compatible, which is of great importance due to the geographical situation of Switzerland in the European transport network and to the bilateral negotiations with EU in the electricity field.

\(^{16}\) See Appendices : Hierarchy of legislation
2.4.1. Electricity Market Law

In December 1999 the Swiss Parliament has adopted the new Swiss Electricity Market Law (LME\textsuperscript{17}). LME refers only the production of electricity and not its trade, transportation or distribution. The LME laid the foundations to reform the Swiss electricity industry by moving from regulation to deregulation (liberalization of some parts of the industry).

Art. 1. LME: But

\begin{footnote}{1} La présente loi vise à créer les conditions d’un marché de l’électricité axé sur la concurrence.\end{footnote}

This change will be phased gradually during a transitional period of seven years. Today in Switzerland there are some fears. We have heard in the newspapers that this reform will adversely affect the economic and financial situation of the hydropower plants.

At the end of the process, all customers will have the option to choose their energy supplier.

The main characteristics of the LME include the following:

- A system to regulate third-party access to the networks and therefore wholesale and retail competition
- The high voltage transmission grid will be disinvested as part of the regulatory reform by the five firms (Ueberlandwerke\textsuperscript{18}) currently in control of the national grid. The national grid will be organized as a private company with the function of an independent system operator (ISO).
- The separation of accounting for generation, distribution/retail supply and non-electricity related activities will be effective.
- The creation of a new institution, the Arbitration Commission, to act as an independent agency with responsibility to supervise transmission and distribution tariffs.
- The system is based on bilateral contracts freely negotiated between buyers and sellers. Therefore a system without an independent system operator (ISO) is necessary in a centralized spot market.

\textsuperscript{17} Loi sur le marché de l’électricité
\textsuperscript{18} Atel/EOS (today Alpiq). // CKW/EGL/NOK (today Axpo). // FMB, EWZ and Rätia Energie.
The 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 liberalized electricity markets.

2.4.2. LApEl and OApEl
The law on electricity supply is the legal framework of the Swiss electricity market liberalization. It provides an open market in two stages: the first five years (2009-2013), only the final consumers whose annual consumption exceeds 100 MWh have free market access. After five years, households and small consumers can also choose their electricity supplier. End consumers whose consumption exceeds 100 MWh will also be legally admitted on the open market. The full market opening will be done by federal decree which is subject to an optional referendum (OFEN (2011), p.6).

According to the Electricity Supply Act, the network transportation (extra high voltage) is operated by a National System Operator (Swissgrid). This network transportation should remain mostly under Swiss control. Not later than five years after the law has been put into force, the extra high voltage must also pass into the hands of the national network society.

The Electricity Supply Act implementation is controled by an independent regulator: the Federal Electricity Commission (ElCom) which monitors compliance with the law. This controller monitors the remuneration of the network usage and energy prices for customers. It resolves disputes concerning free access to the electricity grid. In addition, Elcom addresses issues of transportation and international trading of electricity (OFEN (2011), p.6).

The Ordinance on electricity supply rule the first phase of market electricity opening during which the captive consumers do not have access to the network (Article 1, OapEl, Le Conseil federal, (2008)).

Are considered captive consumers, the household and other final consumers whose annual consumption is less than 100 MWh (megawatt hours) per site of consumption (Article 1, OapEl).

2.4.3. Overview of what a consumer pays
In the current understanding of the law, taxes and license fees to local authorities do not touch the water license fee, but license fee for the land use or other charges. There are various taxes, whether local, cantonal or federal. From 1 January 2008, Swiss consumers must pay the following taxes depending in which cantons they live.
Federal

The national grid company (Swissgrid) will receive an additional transport costs; limited to 0.6 ct/kWh (Nouvel art. 15 b de la Loi sur l’énergie modifiée par la LApEl). This tax will be especially designed to supply the national fund for renewable energy. This fee will vary from year to year and all consumers must pay it.

Cantonal

The more "imaginative" taxes in western Switzerland are in the canton of Vaud. They have the ability to levy up to five municipal taxes (described later) and two Cantonal taxes (currently). In the Canton of Fribourg, this kind of taxes does not exist. In Neuchâtel, these charges are discussing (Interview with Energy Consultant Groupe E).

There was also a "story" in the Canton of Ticino: The canton wanted to introduce the possibility of a land use fee for the benefit of communes. An appealed has been made against the law at the Federal Court. The Court overturned the law saying that such a tax was not correct\(^1\). The future of these land taxes is therefore not really clear (Interview with Energy Consultant Groupe E).

The Canton of Vaud will set an example for the following description, cantonal and communal. The Canton collects two types of taxes\(^2\)

1. Tax functioning of the monitoring commission: 0.025 ct/kWh
2. Fund for Sustainable Development: 0.18 ct/kWh

On the legal basis: **Art. 19 Emoluments cantonaux** (LSecEl\(^2\))

\(^1\) *Les concessions octroyées dans le cadre de la loi sont soumises à émoluments cantonaux, afin de permettre le fonctionnement de la Commission cantonale et de contribuer aux tâches de l’Etat liées à l’application de la présente loi. Le Conseil d’Etat peut décider d’autres attributions en relation avec l’approvisionnement en électricité.*

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\(^2\) See Appendices : Example of cantonal and communal taxes

\(^2\) LOI 730.11 sur le secteur électrique
2. Ces perceptions doivent être justifiées et transparentes. Le Conseil d’État en fixe la quotité qui restera inférieure à 0.025 centimes par kWh distribué au client final.

**Communal**

The commune of Chavannes-près-Renens collects two types of taxes

1. Indemnity for land use: 0.7 ct/kWh
2. Communal fund for sustainable development: 0.1 ct/kWh

The municipality has the right to collect other taxes according to their needs while respecting the law. Two new taxes could be created, namely, a tax for the renewal of street lighting and another for the renewable energy promotion.

On the legal basis: **Art. 20 Redevances communales** (LSecEl)


2. *Les communes sont également habilitées à prélever des taxes communales spécifiques, transparentes et clairement déterminées permettant de soutenir les énergies renouvelables, l’éclairage public, l’efficacité énergétique et le développement durable.*

The decree on the electricity sector: **19 Art. 23 al. 2 (LSecEl)** authorizes municipalities to collect specific, transparent and clearly defined local taxes, to support renewable energy, public lighting, energy efficiency and sustainable development. It should be noted that these taxes can be charged either through the billing of electricity transmission and distribution, either directly by the municipality.

The institutional part must always be on the reader’s mind to understand the law entanglements in the field of electricity. This is merely a preview, for further information, the reader will refer directly to the law texts. The EU now sets standards of the electricity market. The Swiss legislation takes most of the EU legislation.

\(^{22}\) [Loi fédérale du 23 mars 2007 sur l’approvisionnement en électricité]
3. The Liberalization Effects

As the reader can see from the preceding chapters, the Swiss electricity market is in transition from monopoly to liberalized market. This theoretical part will provide an overview of the contribution of economic regulation theories in the analysis of the deregulation dynamics in the electricity industry.

The political decision to liberalize the electricity industry can be interpreted in different ways. In a first approach, the deregulation of the production activities and marketing is related to an evolution in the production costs structure. The good network development and the progress made in production technologies or the developments in economic theory (theory of contestable markets\textsuperscript{23}) lead to a questioning of the monopolistic status previously recognized in all activities. Respectively; transmission grid (high voltage), distribution grid (low voltage) and retail (Fontanel (2008), p.39).

A second approach tends to describe the deregulation process as the result of pressure from consumers to the political authorities. Liberalization of the electricity industry would be the result of a desire to transfer the annuity earned by incumbent operators to the benefit of end customers (Fontanel (2008), p.39). Transportation and electricity distribution are the only activities recognized as naturally monopolistic aspects.

A relevant question to be asked is undoubtedly one of the bases of liberalization:

**Does liberalisation imply more competition?**

The market opening is intended to bring down a monopoly (synonymous in the minds of too high price and lack of effectiveness) and thus reduce prices. As shown in the next chapter, it is not the case. The main problem in relation to this question is that electricity is necessary linked to "tense" market when supply is always exactly the same as demand (Groupe E, Interview).

The Swiss electricity market liberalization requires an appropriate market structure within which effective competition can be encouraged. However, this generally means that

\textsuperscript{23} In economics, the theory of contestable markets holds that there exist markets served by a small number of firms, which are nevertheless characterized by competitive equilibrium (and therefore desirable welfare outcome) because of the existence of potential short-term entrants.
restructuring energy sector is decoupled in vertically integrated operations. Thus, they must reduce their horizontal concentration (Jamasb and Pollitt (2008), pp. 4584-4589). To emphasize the purpose of vertical separation is "to separate the potentially competitive generation and supply of natural monopoly activities of transmission and distribution. The purpose of horizontal separation is sufficient to create effective competition in generating and retailing where economies of scale favor competition."\(^2^4\)

A second element is that Mr. Price already controlled several years to avoid the abuse of power prices and imposed on reality (no real constraint, but with some persuasive power of media) a limited cost. Therefore, the expected prices fall has not really taken place. The upward trend which was discussed 2009/2010 is not true, especially due to uncertainties related to production facilities (Groupe E, Interview).

The next chapter will focus therefore on the monopoly nature in the electricity sector, and try to show a theoretical point of view: Does liberalization brings more competition?

We will see that market is not fully liberalized and some areas still have monopolies. This is why the power sector is so difficult to identify, cannot be fully liberalized and therefore totally in competition

\(^{2^4}\) In some circumstances competition and/or efficiency may be promoted by increased horizontal concentration in retailing or distribution. This may be the case where large numbers of small distribution companies sell electricity (as was the case in the Netherlands until recently).
3.1. On Competition

Electricity is a sector in which liberalization and re-regulation triggered by European legislation has put an end to public monopolies in most European countries (OECD 2008). In the Swiss case too, the EU was the most important impulse for domestic reforms. However, changes have been ambivalent:

“On the one hand, the market has been accompanied by re-regulation and the establishment of regulatory agencies in charge of ensuring compliance with the rules. On the other hand, the former monopoly of the big electricity firms continues to dominate the market. Nevertheless, the transformation extend of the sector is comparable to the situation in neighboring countries such as France, Germany and Austria, with the exception of new entry regulated companies in the electricity market” (OECD 2008).

When we are describing the regulation and the natural monopoly in the sector of electricity, it is necessary to distinguish different stages:

1. Power generation
2. Transmission grid (high voltage)
3. Distribution grid (low voltage)
4. Retail

Competition introduction is possible in the four functions of the electricity sector. In case of transmission and distribution, the technological constraints do not allow, the free trade establishment yet. Due to the increasing returns associated to the development of power grids, transportation and distribution approach well the theoretical model of natural monopoly. Since electricity is not storable in nature, it is necessary to balance the instantaneous production and consumption. This can be achieved by a market mechanism.

This function has traditionally been assumed by the major generation and transmission companies that had specialized services capable of managing this balance in real time. The sudden emergence of deregulation has led identification and separation of function. Competitive activities of power market could be given to traditional operators (knowledge production capacity at all times, right to impose the operation or non-functioning of any equipment for safety reasons...). In the various processes of deregulation this function was entrusted to an entity called transport network manager, Swissgrid in Switzerland.
An indication to identify the natural monopoly is the existence of scale economies accompanying the capital-intensive sectors. The traditional argument of scale economies confounds coordination of generation capacity with the control of energy actually produced (De Vany (1997)). De Vany argues that this confusion arises from a conviction that there must be a sole owner of the outputs to achieve coordination.

“Without regulation, the industrial organization of electricity generation might well have resembled the organizational form found in housing markets. Each facility would have many owners, each of whom controlled a part of the electricity output similar to the way large owners control separate condominiums in a large apartment building. The owners would appoint someone, often one of the larger owners with generating capacity, as coordinator of the electric generation facility. But each owner would individually sell the electricity output they control, the same way condominium owners might sell their unit without checking with the other owners. Without regulation, the pricing and allocation of electricity generation would be decentralized; no single entity would decide how much output to put on the market.” (De Vany (1997))

The model wanted by the Confederation is exactly the same as De Vany advocated in 1997, namely multiple electricity producer injecting the current in the network.

“The economies-of-scale argument becomes a self-fulfilling prophecy. By equating the simple managerial job of coordinating use with the power to control the amount of output going onto the market (the only source of monopoly power when entry is also blocked, as in a regulated natural monopoly) the standard model becomes a blueprint for creating monopoly. A blueprint of virtually every regulated, large scale activity follows.” (De Vany (1997))

In the Swiss market, the basis for regulation has shifted to the transmission grid. The concerns are two-fold. The transmission grid is a natural monopoly and the physics of electricity transmission require central coordination. According to De Vany (1997) these arguments are false theoretically and empirically.

“The arguments are wrong theoretically because of confusion over how complex systems coordinate. In a complex system, many simple components interact to produce aggregate behavior that cannot be comprehended by simply understanding the simple components. There is order in complex systems; it emerges from the components’
interactions. Think of how a crowd leaves a football stadium after the game. The flow is not centrally planned yet the stadium empties very efficiently. It is as though the crowd had instructions to minimize the total time it takes to empty the stadium. An overhead observer would witness what F.A. Hayek called spontaneous order: social order emerges from the decentralized decisions of many agents interacting in simple ways and whose aggregate behavior exhibits emergent, dynamically organized behavior.” (De Vany (1997))

The goal of the next table is to analyze or to know what will be the liberalization result of the electricity market on some electricity companies in Switzerland. Density of firms is a hypothesis to identify indicator of competition. Therefore, this table provides an update on the current situation.

<table>
<thead>
<tr>
<th>Types of businesses</th>
<th>Before Liberalization</th>
<th>After partial Liberalization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject to competition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Generation</td>
<td></td>
<td></td>
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<tr>
<td>Retail</td>
<td></td>
<td></td>
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<tr>
<td><strong>No - Subject to competition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission Grid</td>
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<tr>
<td>Distribution Grid</td>
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</table>

The first assessment to be drawn is that, a priori, an increase of firms’ number in the market should lead to more competition. Therefore more competition ultimately leads to lower prices in the four sectors, especially for end consumers (See in the next chapters).

The key question raised by many politicians is whether in the future, it would be wise to drop the last monopole into the two remaining sectors to be fully competitive. To do this, it is useful to define if electricity is private property. In which case, it should be fully liberalized. Or, if it is a public good, in this case it should be partly regulated.

25 No available data
26 In my opinion rather a concentration in organizations, but not necessarily a decrease in the "primary" actors number
27 According to which protection will be left to the consumer protection with "historical" pricing model
28 It will depend on the regulation model: incentive model? More regulation will be stronger, more it will decrease… (companies)
3.1.1. Electricity: Public or Private Provision?

This section is based largely on Stiglitz (2006), Cornes and Sandler (1996). For more details, the reader can refer to Cowen (1992) that reproduces the seminal paper by Samuelson (1954) on public property. On pure public goods, Musgrave (1969) is an essential reference.

Electricity supply organizes itself increasingly around decentralized markets supervised by the competition rules. The failure occurring on power grids, in parts of the world in recent years, suggest that these rules are not compatible with the position suggesting that electricity supply is a public good.

This subchapter purpose is to show that several specific questions arise. These questions have significant difficulties to define the best industrial practice in the electrical industry. We should question the nature of electricity to determine the role and its place in the market. We should question the methods of regulation efficient to ensure electricity supply security in the long term. The first question concerns the public good security character of electricity supply, which justifies in principle, the government intervention.

The electricity supply is a composite good, both public and private. The public good character explains why some companies prefer others investments to maintain a level of security. The private property character refers to the existence of differentiated preferences for this security. The electric supply composition has implications on the security supply policy in the electric power sector.

The standard economic theory of public property has limitation to be applied to electricity supply. According to this theory, Samuelson, (1954), “public goods are goods or services that can be consumed by several individuals simultaneously without diminishing the value of consumption to any one of the individuals”. This key characteristic of public goods, that multiple individuals can consume the same good without diminishing its value, is termed as non-rivalry, “No rivalry is what most strongly distinguishes public goods from private goods. A pure public good also has the characteristic of non-excludability, that is, an individual cannot be prevented from consuming the good whether or not the individual pays for it. It should be emphasized the practical implications of theoretical and possibly private good character of the security of supply. For example when there is congestion, network access can enter into competition.”
The economic literature is still confused about the public good nature of supply security. Houldin (2004) and Abbott (2001) consider as a public good, not only the security but also the network, the electricity on the wholesale markets and other elements of the electricity supply. The existence of localized failures showed that the security is a local public good. Electricity is a good which consumption can cause congestion "congestive good". Such property is only partially non-rival. Rivalries appear as soon as the consumption level approaches a ceiling. Any good circulating on a limited transport network is subject to be congested. For example, the electricity produced by thermal peak and passing on an undersized transmission lines, when many have stopped working. A pure public good, once somehow produced, is available for all; it inevitably has external effects on others. These effects are positive in case of security supply (Stiglitz, 2006).

However, some authors tend to exclude one of two characters and put the other forward. Joskow and Tirole (2006) seem to consider reserves capacity as a public good. When the model deals with the situation of producers in competition, it results an under-investment in capacity reserving and therefore an insufficient reliability level. A solution proposed by the authors is that marketers will endow reserves. Chao and Wilson (1987) propose a market security model depending on choices, where buyers whose willingness is to pay a higher price can ensure a first served basis in the event of unexpected rationing of aggregated demand. In neither of these models all consumers can receive the same amount of public good. The electricity supply has at any time a public good character. Other studies Houldin (2004) and Abbott (2001) emphasize nevertheless the public good nature of supply security and other elements of the electricity supply. This is, for example, electricity "produced on the wholesale markets" in limited capacity. We must therefore admit that electricity supply would have both characteristics of a public and private good or a private good under the constraint that aggregated demand is satisfied. In the latter case, it would be a private good which supply is guaranteed by the public service constraint.

As shown before, once a pure public good has been produced, it is available for all. It inevitably has external effects on others. According to Pigou (1920), an externality occurs when the action of an agent affects the value function from another agent, positively or negatively. The concepts of externality and public goods are closely linked. When the transmission system operator (TSO) has constructed several lines, the supply security for all users is maintained. Therefore we can think that an additional network infrastructure is a public good. Nevertheless the existence of public goods creates allocation problems on the
markets, particularly when a producer or a consumer of the good has an interest to behave like a free-rider. The situation of a marketer who would realize no investment to maintain network reliability, but would count on the contributions of others, is an example of such behavior in the electrical network case.

The theoretical framework mentioned can be used to search, more precisely, for the public good nature of electricity supply. However this wish should not hide the character of private goods such as electricity consumed.

The Swiss government seems to be moving rapidly to compromise with effective monopoly unbundling networks. In recent decades, the regulation of natural monopolies integrates more incentive mechanisms.
3.1.2. Monopolistic aspects in the Swiss electrical industry: towards a regulated monopoly

The dynamics of competition sought by the liberalization has so far hardly developed, particularly hampered by:

Art. 4: Tarifs d’électricité et comptabilité par unité d’imputation pour la fourniture d’énergie\textsuperscript{29}.

\textsuperscript{1} La composante tarifaire due pour la fourniture d’énergie aux consommateurs finaux avec approvisionnement de base se fonde sur les coûts de production d’une exploitation efficace et sur les contrats d’achat à long terme du gestionnaire du réseau de distribution. Si les coûts de production dépassent les prix du marché, la composante tarifaire s’appuie sur les prix du marché.

The art 11: Final choice of eligibility of the Electricity Supply Ordinance (OApEl).

In the medium term, it is possible that the revision of the ordinance under the Electricity Supply Act 2014, removes some barriers to competition. It could as well provide free market access to all customers, incl. the current residential captives. The increase in suppliers will necessarily multiply and greatly increase the administrative work of the GRD\textsuperscript{30}. Moreover, in such a dynamic, it is necessary to actively keep its customers through enhanced commercial presence.

At the horizon 2015-17, the Swiss electricity market will be moving clearly towards incentive regulation, according to all markets in the European Union. This new regulation form will lead to a better reward of GRD’s according to their effectiveness.

\textsuperscript{29} The art 4: Supply base of the Electricity Supply Ordinance (OApEl).
\textsuperscript{30} Network managers Distribution (GRD)
Incentive regulation theory

The incentive regulation theory fits into the general framework of natural monopolies regulations. Literature on natural monopolies regulations distinguishes two problems facing the regulator:

(i) Define the structure of tariffs ("Optimal pricing") in order to ensure a balanced budget of natural monopoly
(ii) Limit the effects of the information asymmetry between the regulator and the regulated company.

Source: author’s elaboration, (Microeconomix (2008), p.10)

The literature on optimal pricing of natural monopolies evokes the assumption of a perfectly informed regulator. In other words, the regulator knows the cost of the regulated company and the demand addressed to it. This allows the regulator to define the optimal tariffs. In reality, it is clear that the regulator is facing severe information asymmetries which the regulated company can benefit from (Laffont and Tirole (1993)).

The mechanisms:

The incentive mechanism should cover all costs over which the company may be regulated. It is therefore appropriate to exclude from the price cap all uncontrollable costs for the regulated company. As these costs are not known ex ante at the time of determining the price cap, it should compensate ex post all the differences between the estimates and uncontrollable costs found by adjustment mechanisms precisely defined and known in advance of the regulated company. It is important to include any adjustment mechanism on controllable costs because the incentive regulation precisely due to the possibility for the regulated company to retain the gains to differences between the estimated costs and the costs proved.

Source: author’s elaboration, (Microeconomix (2008), p.10)

31 Price cap regulation: the principle is to set ex ante the remuneration of the regulated company to give a maximum incentives to reduce the costs but at the end the company can keep all the profits = the annuity.
The economic theory of incentive regulation is very advanced and offers optimal control solutions. However, the implementation of these theoretical solutions faces many difficulties, so that the solutions implemented differ gradually from the theorists’ recommendations.

Even if the incentive regulation will only intervene in a few years in Switzerland, it will profoundly change the role of manager’s distribution (GRD) towards greater competition. The energy sector professionals (Group E interview) believe that the situation will change considerably:

The upper limit costs are set individually by the regulator (Elcom). The assessment of the effectiveness plays a decisive role in this regard. This will result in:

1. Lower costs for the industry network
2. Individual efficiency factor
3. Decoupling of costs and revenues (prices) over a certain period
4. Incitement: with lower costs, the company (managers’ distribution networks) may retain profits.

The pressure on network costs will increase dramatically and require from GRDs to better control the financial and operational charges. There will be a growing pressure of Elcom (in 2016, 2020 and 2025) to reduce the cost of GRD:

Indeed, it is planned to create an equalization fund in 2012:

1. “The GRD which operating costs are above the accepted (costs) must pay the cost difference compared to the national average
2. The GRD which costs are below this average will receive the difference.” (Elcom)

The goal is therefore an incentive system; put everyone on an equal base with a national comparative "Benchmarking". The regulator measures the efficiency of each company (managers’ distribution networks) to determine the performance of the "product" electricity transport.

Costs imputable to transport are frequently used as Inputs, while features relating to the supply are taken into consideration for the Output. Several simulations are performed on the basis of mathematical models. The next table provides some examples:
Table 2: Mathematical models to measure the efficiency of each company

<table>
<thead>
<tr>
<th></th>
<th>Determinist</th>
<th>Stochastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonparametric</td>
<td>Data Envelopment Analysis (DEA)</td>
<td>Stochastic Data Envelopment Analysis (CRS)</td>
</tr>
<tr>
<td>Parametric</td>
<td>Corrected or Modified Ordinary Least Squares (COLS or MOLS)</td>
<td>Stochastic Frontier Analysis (SFA)</td>
</tr>
</tbody>
</table>

Source: author’s elaboration, Pool Energie Suisse SA

The most used models by companies are: DEA (Data Envelopment Analysis) and MOLS (Modified Ordinary Least Squares). The two calculations efficiency results are compared. To do this, the efficiency values are analyzed in a cross-comparison.

DEA: Determination efficiency frontier

- The efficiency frontier is directly determined by the key figures of productivity. Axes are defined by the values that we want to analyze.
- The business efficiency value is calculated as a function of their distance against this limit.

MOLS : Determination efficiency frontier

- The MOLS efficiency frontier is based on OLS estimation which determines the influence of the outputs on the costs (Inputs). The OLS line is moved downwardly to determine the efficiency frontier MOLS.
- The displacement magnitude corresponds to the value of expected residues (E [û]), respectively, the expected value between actual costs (c) and the OLS line.
- The business efficiency is determined by the relationship between the estimated costs of the model (ĉMOLS) and actual costs (c).
In conclusion, I would say that the comparative benchmark allows a comparison based only on actual figures and data. Furthermore, it helps to stimulate companies (managers of distribution networks) between them. However, the benchmark does not take into account all the specificities of the sector. This incentive system does not correspond strictly to an ideal integrated theoretical model. It has proven in UK (Incentive regulation in electricity distribution networks). It has provided adequate regulatory tools to target specific activities of the operators.

A major problem is: may the regulator, without all the specificities of the sector, allow optimal simulation between them? In economic theory; the asymmetry constraining information of the regulator causes two problems:

<table>
<thead>
<tr>
<th>Adverse selection &amp; Moral hazard problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the one hand, the regulator does not know exactly the costs of the regulated firm. However, since the regulation of a natural monopoly should enable it to cover its costs, the regulated firm has an interest in overestimating and pretending to be less effective than it is to retrieve a pension from the regulator. In economic terms, it is a problem of adverse selection.</td>
</tr>
<tr>
<td>On the other hand, the regulator does not recognize the effort made by the regulated company. From the economic efficiency point of view, the regulated company must provide a certain effort level - the optimum level - but the effort is costly. It is an incentive to provide less. In economic terms, it is a moral hazard problem.</td>
</tr>
</tbody>
</table>

Source: author’s elaboration
3.1.3. Effects of liberalization
This chapter should provide an understanding and analysis of the liberalization potential effects in the electrical field. A large part of this chapter is built on Gaffard and Salies (2007).

The current liberalization in the energy sector in Europe raises two questions which are interdependent. The first question is related to the form that will take the organization of the industry with entry or exit of new players, mergers or acquisitions. The second question concerns the problem of energy supply security in the short and long term, dependent on projected investments.

Concerning the new industrial organization, the question is whether competition on businesses will lead to oligopolistic market structure established at European level, and what will be the characteristics of an effective structure? What will the implications be for end customers? The emergence of an effective structure depends on the ability to realize investments into new production capacities and network infrastructure. It should fulfill the evolution of demand in price conditions in favor of the consumer interest.

“The difficulty is naturally the identification of this effective structure. From an economic analysis point of view, it should result in a competition leading to a stabilization of market structure. Such structure cannot be defined a priori because the fundamentals are neither immediately neither directly observable. What is important, are the appropriate environmental conditions which help companies in competition to coordinate and to capture the returns of their investments. These conditions are not fully competitive conditions. They enable the firms to implement coherent investment allowing market equilibrium. These conditions are known under the term of friction or market imperfections. The problem for the authorities in charge of competition and regulation is to know the balance between the friction and imperfections, necessary and/or harmful in terms of social welfare.” (Jamasb and Pollitt, (2005), p.6)

Basic microeconomic textbook theory suggests that competition and profit motivate the result in internal (production) and external (market) efficiency. Benefits are passed on to customers and economy benefits in the form of lower prices and costs. The electricity supply industry (ESI) has important physical characteristics shaping its optimal regulatory design.
It involves:

(i) “large sunk costs which limit entry possibilities,
(ii) vertical stages (generation, transmission, distribution and retailing) of production with different optimal scales,
(iii) non-storable good delivered via network which requires instantaneous physical balance of supply and demand at all nodes. Liberalization of such an industry involves the creation of a combination of competitive energy, retail markets, regulated transmission and distribution activities (like described at the last chapter). Successful liberalization requires well-organized energy, associated auxiliary services and transmission capacity markets to achieve competition with physical balancing and appropriate regulation of monopoly power.” (Jamasb and Pollitt, 2005, p.6)

Experience from electricity liberalization around the world has produced a measure of consensus over some generic measures achieving a well-functioning market-oriented industry. The Table 3 described an overview of the main steps in electricity reform and how the market should look like after the reform implementation.

<table>
<thead>
<tr>
<th>Restructuring</th>
<th>Vertical unbundling of generation, transmission, distribution and supply activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal splitting of generation and supply</td>
</tr>
<tr>
<td>Competition and Markets</td>
<td>Wholesale market and retail competition</td>
</tr>
<tr>
<td></td>
<td>Allowing new entry into generation and supply</td>
</tr>
<tr>
<td>Regulation</td>
<td>Establishing an independent regulator</td>
</tr>
<tr>
<td></td>
<td>Provision of third-party network access</td>
</tr>
<tr>
<td></td>
<td>Incentives regulation of transmission and distribution networks</td>
</tr>
<tr>
<td>Ownership</td>
<td>Allowing new private actors</td>
</tr>
<tr>
<td></td>
<td>Privatizing the existing publicly owned businesses</td>
</tr>
</tbody>
</table>

Source: author’s elaboration, (Jamasb and Pollitt (2005), p.2)

Liberalization generally requires implementation of one or more of the following inter-related steps: sector restructuring, introduction of competition in wholesale generation and retail
supply, incentive regulation of transmission and distribution networks, establishing an independent regulator, and privatization (Joskow (2006)).

3.1.4. Potential positive and negative effects

It is difficult to predict what the level of prices after liberalization will be. After an initial steep decline, prices should stabilize at a level between "before" and "after" market opening (Press announced 2011). Taking the example of the United Kingdom, the decline for individuals stood at around 10%. It was 20 and 30% for companies. In Germany, the decline was 25%, which represented a decrease of 10% of the total production costs for big companies (Jeunesse et Economie, (2001)).

In Switzerland, electricity prices are cheaper than in European neighboring countries. The next figure shows clearly the electricity prices for households in Europe in 2011 (tax included). Compared to the European average, the Swiss pay around 3 cents (or 12%) less per kWh. With the market opening, will it be the same? Only the use of the network rates is a little bit more expensive abroad. This is because of the Swiss topographic conditions (electricitepourdemain.ch).

![Electricity prices for households in Europe in 2011 (tax included)](image)

*Figure 6: Electricity prices for households in Europe in 2011 (tax included)*

*Source: AES, exchange rate 1.23*
The domestic capacity to generate enough electricity is a factor which influences the price. Switzerland achieved a good domestic capacity during the last 50 years, by expanding its hydro and nuclear capacity\(^{32}\). Switzerland was able to protect itself against expensive imports and bottlenecks on international markets, thus maintained electricity tariffs at a relatively low level. To maintain as well this status in the future, significant investments in production, in maintaining and expanding the transportation infrastructure of the Swiss electricity is needed in the coming years (electricitepourdemain.ch).

The Problems related to electricity trade are very specific. The electricity storage is not economically achievable. At any time, the production (resp. injection of electricity on the network) must be equal to the demand (resp. consumption). Additional consumption implies an increase of electricity drawn from the network. Inversely, an unexpected decrease in production implies a reduction of the total quantity of electricity injected. However, it is impossible to predict a priori (before real time) what will be exactly the quantities produced and consumed at every moment of the day (Fontanel (2008), p.52). Such a constraint can pose different problems:

**Risk price**

Price volatility is very important. The variations in real time between supply and demand are likely to cause important price peaks on the markets. In case of temporary deficit capacity, the equilibrium price of the wholesale market can reach extremely high levels. The magnitudes of such imbalances will be more important than short term inelasticity if the production price is high (time required to start new plants) (Fontanel (2008), p.54).

The activities separation required by industry liberalization questioned the coordination mode between generation, transmission, distribution and consumption. A vertically integrated monopoly had informational and technical necessary resources to ensure real-time balance of supply and demand (Fontanel (2008), p.54).

The regulator (Swissgrid) must ensure that institutional mechanisms (responsibility of both parties ...) and economic (compensation of network services ...) newly established are able to maintain the network security and the continuity of the service. These two characteristics

\(^{32}\) The Federal Council has decided for the future not to replace existing power plants. The most probable scenario for the moment over the medium term is to focus on gas power plants
combined imply that, for reasons of network security, coordination of production and consumption cannot be achieved in real time by the network manager (Fontanel (2008), p.54).

**Risk volume**

The transportation system must be able to "react" to the slightest imbalances of supply and demand. In particular, for safety reasons, the frequency must be maintained at a constant level (50 MHz in Europe) on the whole network. However, many variables may alter this balance (constant changes in real supply and real demand, incidents on the network).

**Risk congestion**

The cross border transmission capacities also known as "border capacities" between most countries have been under estimated. For historical reasons, there are often bottlenecks. Sale of capacity is then available for auction. In other words, in case of shortages, the power-brokers have to purchase border capacities and for import or export transaction (Fontanel (2008), p.54).

If Switzerland gradually stops its nuclear power plants, it will depend largely on imports as from 2020 mainly from France which is the biggest exporter in Europe. From an economic point of view on the other hand, to depend unilaterally on French imports would have negatives effects. Electricité de France (EDF) benefits today from a virtual monopoly position on the French market. If countries like Switzerland, Germany and Italy are more dependent on imports, EDF's position will continue to strengthen in international trade (Meister, (2008), p.19).
3.2. **Empirical Findings**

This chapter is based on the report of the Swiss Federal Office of Energy SFOE, OFEN (2011). It will refer to the modeling of electricity for electricity supply companies (EAE) in Switzerland. Emphasis is placed on the periods before and after the partial liberalization of the electricity market, i.e. 2004 to 2008 and from 2008 to 2009.

Liberalized markets are generally characterized by greater competitiveness resulting initially in lower prices. In Switzerland, it is expected on the contrary to a significant increase in electricity prices, immediately after liberalization. Was it the truth? Why?

3.2.1. **The effects on electricity prices**

June 4, 2008, the State Councillor Philipp Staehelin submitted the postulate 08.3280 "Evolution of electricity prices" below:

«Divers éléments indiquent aujourd’hui que les prix de l’électricité vont augmenter en Suisse au cours des prochaines années. Toutefois, on n’est pas en mesure de se faire une idée générale de la façon dont la situation évoluera. Si la perspective d’une hausse venait à se confirmer, les répercussions sur notre économie seraient considérables. Elles pourraient notamment toucher des secteurs clés du domaine des services ou de la chimie. L’approvisionnement en électricité dépend également en grande partie des conditions-cadres fixées par l’Etat. C’est pourquoi il est nécessaire d’examiner sans tarder les scénarios et les solutions de rechange possibles.» (OFEN (2011))

To develop forecasts for electricity prices in Switzerland is a complex operation that depends on a variety of endogenous and exogenous factors. Basically, economic theory suggests that the price of electricity is moving according to the law of supply and demand and the marginal costs of the last unit produced determine the price.

The report OFEN (2011) is based on the Energy perspectives 2035. The DETEC has also updated the Energy perspectives in expanding the prospects for 2050.

In order to analyze the impact of changing electricity prices in Switzerland, it is necessary to know the components of electricity prices (OFEN (2011), p.6):
1. **Remuneration of network usage**: it reflects the costs for the delivery of electricity from the plant to final customers. The revenues include the ability to finance the maintenance and development of the power system (e.g. Airlines, pylons and transformers).

2. **Energy prices**: it is the price of the supplied electrical energy. The electricity supply companies produce their own electricity or buy from other energy producers (upstream suppliers).

3. **Dues and payments to public institutions**: include taxes and fees, Federal, Cantonal and Communal, concession fees or energy royalties and municipal services to public authorities (e.g. Free energy or lighting).

4. **Charges designed to promote renewable energy**: the "cost-covering remuneration of the injected current" (CPP) is a federal levy to promote renewable energy. It amounts identically throughout Switzerland and is set annually by the SFOE. It did not change for 2011 and amounts to 0.45 ct. / kWh.

The following illustration (Figure: Tariffs composition) provides an overview from the four components in the price of electricity in 2010 for the categories of: (OFEN (2011), p.8)

- **Households (H4; annual consumption of 4,500 kWh)**
- **Handcraft sector (C2; small business with annual consumption of 30,000 kWh)**
- **Industrial (C5; large company with an annual consumption of 500,000 kWh)**

Basically, letter H is for Household category, C for Handcraft sector. Initially, the Association of Swiss Electricity Companies (AES) and the SFO have defined fourteen consumers’ categories characterized by a predefined consumption. However, in this work, I have chosen three categories to synthesize the data. Because of the partial liberalization of the electricity market, it is common for large consumers to negotiate tariffs with the Swiss Electricity Companies.

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33 H4: apartment with a family of two adults and two children, heated by gas or oil fuel (Source: Interview Groupe E, Energy consultant).
34 C2: small restaurant, small bank, hair salon (Source: Interview Groupe E, Energy consultant).
36: (SPR (2010), p. 3-4)
Therefore, for a Swiss household, the remuneration of the network utilization accounts for almost 47%, energy prices 40%, royalties and benefits to local authorities at the final distribution 11% and 2% of the CPP electricity prices. The annual cost of electricity is approximately 960 francs for a Swiss household type (category of consumer H4), about 5,700 francs for a company of handicraft sector (C2) and 72,000 francs for an industrial operation (C5) (OFEN (2011), p.8).

**Evolution of electricity prices in Switzerland from 1995 to 2008**

Since the mid-nineties, the economy and households have benefited from a continued decline in electricity prices (in nominal and real terms), which reached a low point in 2007 (Figure: Evolution of nominal price (A) and real price (B)).

Thus, according to Swiss Statistics of electricity published annually by the SFOE, the average nominal price paid by final consumers for electricity declined by 16% between 1996 and 2007 (OFEN (2011), p.18). This trend caused the opening of the electricity market within the European area and the progress of international trade which have significantly improved the system efficiency. Therefore, and because of the electricity oversupply in Europe, prices have fallen in Switzerland between 1996 and 2007.
Since 2007, electricity tariffs have again slightly raised, mainly because of increased investment in branch lines and power plants as well as higher charges levied by public authorities. Statistics of Federal Statistical Office (FSO), on electricity prices and the Association of Swiss Electricity Companies (AES) as well as those contained in the report on the price change between 2004 and 2009 published by the price regulator give a similar picture.
Figure 8: Evolution of nominal price (A) and real price (B)

(Adjusted on inflation based on electricity paid in 2010 by the end consumers in ct./KWh)

Sources: l’OFS, l’OFEN, l’AES, Elcom
The most relevant part to analyze is probably the evolution of prices before the partial liberalization (comparison between 2004 and 2008). Different end consumers represented consumption range from 1'600 kWh / a (H1: House with 2 pieces) to 13'000 kWh / a (H7: House with 5 pieces). The illustration below (diagram boxplot: Evolution of electricity prices, 2004-2008 EAE) was performed on this table data.

Table 4: Reference values, boxplots 2004-2008

<table>
<thead>
<tr>
<th></th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>H6</th>
<th>H7</th>
<th>B</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>133.33%</td>
<td>89.17%</td>
<td>66.84%</td>
<td>56.74%</td>
<td>56.21%</td>
<td>72.59%</td>
<td>61.05%</td>
<td>63.15%</td>
<td>78.46%</td>
<td>64.90%</td>
</tr>
<tr>
<td>9 decile</td>
<td>7.68%</td>
<td>5.90%</td>
<td>6.23%</td>
<td>4.67%</td>
<td>4.76%</td>
<td>6.17%</td>
<td>4.43%</td>
<td>4.71%</td>
<td>4.07%</td>
<td>4.36%</td>
</tr>
<tr>
<td>Median</td>
<td>-6.58%</td>
<td>-8.61%</td>
<td>-8.00%</td>
<td>-9.24%</td>
<td>-8.27%</td>
<td>-8.52%</td>
<td>-9.87%</td>
<td>-5.72%</td>
<td>-3.43%</td>
<td>-9.48%</td>
</tr>
<tr>
<td>1 decile</td>
<td>-18.24%</td>
<td>-19.32%</td>
<td>-18.52%</td>
<td>-20.49%</td>
<td>-20.66%</td>
<td>-19.62%</td>
<td>-22.22%</td>
<td>-22.51%</td>
<td>-23.09%</td>
<td>-21.18%</td>
</tr>
<tr>
<td>Min</td>
<td>-62.66%</td>
<td>-58.33%</td>
<td>-47.57%</td>
<td>-46.40%</td>
<td>-47.90%</td>
<td>-49.31%</td>
<td>-48.29%</td>
<td>-56.10%</td>
<td>-66.34%</td>
<td>-60.95%</td>
</tr>
<tr>
<td>Average</td>
<td>-4.53%</td>
<td>-6.13%</td>
<td>-6.30%</td>
<td>-6.45%</td>
<td>-8.12%</td>
<td>-7.37%</td>
<td>-8.62%</td>
<td>-6.24%</td>
<td>-6.36%</td>
<td>-8.66%</td>
</tr>
</tbody>
</table>

*Source: SPR (2010), p. 8*

It shows the average and median values and extreme values (lower and higher price variation). The diagram boxplots shows in the rectangle, the range of price changes if we exclude the 10% variation of the most important prices (9th decile) and the 10% variation of less important prices (1st decile). The rectangle shows the variations in price of 80% of EAE (Electricity Supply Company).

The difference between the smallest (- Min) and the largest (- Max) variation in the different categories is very important. Under H1 category for example, the average price charged by EAE increased by 133.33%. The median value and the average value are both represented in order to allow observation of the average price movements. The median value (- median) indicates the value at which 50% of the variation is greater, and 50% of the variation is lower. This is the price variation of EAE which is exactly in the middle of the price variations of all EAE. For H1 category, this means that half of the variation is less than -6.58% and therefore, half of EAE decreased their average prices of at least 6.58% during this period.
Figure 9: Evolution of electricity prices, 2004-2008 EAE

The vertical rectangle represents the percentage changes, without 10% highest variations and 10% lowest variations. The lower edge of the rectangle represents the first decile, meaning that 10% of all the variations are below this value (-18.24% for Class H1). The top edge of the rectangle represents the 9th decile, meaning that 90% of all variations are below this value (7.68% for Class H1).

In summary for the category H1, we can see that 80% of all percentage changes in electricity prices ranged from -18.24% to 7.68% ie 80% of EAE conducting to an adaptation of prices between -18.24% and 7.68% during the period 2004 to 2008. We observe that during the years preceding the opening of the electricity market (2004 to 2008), the EAE have reduced their average prices in all categories.

Source: SPR (2010), p. 6
Tariffs evolution of during partial liberalization (comparison between 2008 and 2009)

The following analysis is crucial because it will show the consequences of the partial liberalization on prices just after the opening market. Like before, we will use boxplots diagram. This boxplots shows the Evolution of electricity prices, 2008-2009 EAE. It based on Table 5: Reference values, boxplots 2008-2009.

![Figure 10: Evolution of electricity prices, 2008-2009 EAE](image)

Source: SPR (2010), p. 11

Most rectangles for the period 2008 to 2009 are above the axis of 0%. For household categories H3, H5 and H6, rectangles are even entirely above the axis of 0%. Compared to other categories, the category H6 appears also as the largest first decile (2.23%), as the highest median value (15.58%) and finally as the highest mean value (16.24%)
In household categories, it is clear that the percentage changes are mainly in the positive. This makes it possible to conclude that a significant increase in average prices between 2008 and 2009 has occurred.


The beginning of the first opening stage of the electricity market in January 2009 put an end to the downward trend of electricity prices. Thus, the electricity prices announced by the electricity supply companies for 2009 were on average 10% to 20% above the values of the previous year (OFEN (2011), p.20).

According to the study of price surveillance: (SPR 2010\(^{37}\)), electricity prices increased in 2009 from 2 to 12% depending on the class of consumers. The next figure and tables will analyze this trend.

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\(^{37}\) Price surveillance (SPR): the Price Supervisor has published a report in 2010 on the evolution of electricity prices in Switzerland between 2004 and 2009. The study shows how the price of Swiss electricity supply and in the municipalities have changed during this period with special emphasis on evolution before (2004-2008) and after (2008-2009) the partial liberalization of electricity market. Recounts and representations are based on data that the monitoring of prices gathered between 2003 and 2009 in the tariffs of all Swiss companies of supply electricity.
Figure 11: Average value of electricity prices applied in 2004, 2008 and 2009

The three different colors sticks (Figure 11: Average value of electricity prices applied in 2004, 2008 and 2009) show that the average prices for 2004 (blue) fell to the partial liberalization in 2008 (red) before climbing again in 2009 (green) for each type of consumers after market opening. Different end consumers represented consumption range from 1'600 kWh / a (H1: House with 2 bedrooms) to 13'000 kWh / a (H7: House with 5 bedrooms). The illustration above (histogram diagram) was performed on the following table data\(^{38}\).

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|c|}
\hline
 & H1 & H2 & H3 & H4 & H5 & H6 & H7 & B & C1 & C2 \\
\hline
2008 & 23.44 & 20.57 & 15.84 & 18.05 & 14.84 & 11.49 & 14.35 & 15.84 & 19.92 & 18.35 \\
\hline
\end{array}
\]

\(\text{Source: SPR (2010), p. 7}\)

\(^{38}\) In appendix, the reader can find more information about the data table construction. Appendix 5: Average price evolution of electricity in ct. / KWh / per category. Appendix 6: Average price evolution of electricity in % by category.
One of the first consequences resulting of partial liberalization is an increased remuneration of network utilization. The following reason is:

**Costs of market opening:** the market opening requires network operators to adapt their structures and procedures, which generates one-time costs, primarily integrated in network costs. Adaptation costs are higher in small companies of electricity supply as they affect a smaller number of customers.

A comparison published last year by the AES and the SFOE with numbers from a 2007 study shows that contributions to local authorities had increased 13% primarily due to the introduction of the compensatory feed-(RPC: tax promoting the renewable energy). This tax stimulates the following technologies: Hydropower (up to 10 megawatts), Photovoltaic Energy, Wind Energy, Geothermal, Energy Biomass and waste biomass (OFEN (2011), p.20).

**Electricity prices in 2010**

In 2010, electricity prices have remained stable or declined slightly compared to 2009. The Figure: Comparison of electricity prices paid by households in 2010 shows this trend at the next page. ElCom reached this conclusion after studying data from electricity supply companies. However the regulator notes that in certain Communes, the electricity price has continued to increase up to 10% (OFEN (2011), p.20).

ElCom has also found that electricity prices are still varying quite a lot between regions. The gap between Western Switzerland and Eastern Switzerland still exists. Thus, as illustrated below, electricity is generally more expensive in Western Switzerland, in the Mittelland region and in Northeast Switzerland, where the cost advantages of native plants are further passed on to end customers.
Electricity prices in 2011

End of August 2010, the electricity supply companies have published their electricity prices for 2011. The prices increased on average by 2% for households and 3 to 4% for the handcraft companies. According ElCom, the increases are in most cases due to higher prices of energy, which recorded an increase of 5 to 8% on average. By cons, the remuneration of network utilization remained generally unchanged, like the fees and the services to local authorities (OFEN (2011), p.21).

3.2.2. Estimation of future price changes

To know the evolution of prices in the future, we must look at the different influences of the four electricity prices components in order to get an idea of the future possible evolution.

1. Compensation for the network use

Investments in network infrastructure: during the next ten years, between 23 and 28 billion Euros will be invested to expend Europe’s network. Current data provided by Swissgrid required that the investment for the renewal and extension of the Swiss transmission grid should amount to 3.2 billion Swiss francs at least for the next ten years. Electric companies can reward their investments at a rate set in the Electricity Supply Ordinance and affect this remuneration on end customers (OFEN (2011), p.24).

Increase of requirements for network construction: first, these requirements are based on the people opposition for the overhead lines. Indeed, the burial of new power systems is
required in many areas and communes. The requirements for the electrical supply security grid also increased. A better protection against future blackouts requires further complicating network architecture (OFEN (2011), p.24).

**European context:** the current negotiations with the EU on electricity have a direct impact on the remuneration of network utilization, specially transit and charges for congestion management. If no agreement is reached, the remuneration of network utilization in Switzerland could tend to increase (OFEN (2011), p.24).

**The revision works on the electric supply law** tend to reduce the costs of network utilization. The revision priority is to create legal conditions to introduce an incentive regulation in Switzerland, to encourage the network operators to increase the productivity and to reduce the costs. The incentive regulation is designed in such a way that network operators continue to be encouraged to invest in expansion and in the quality of the network infrastructure (OFEN (2011), p.24).

2. **Energy price**

The energy price includes: the cost of production, supply and distribution of electricity to final customers. An electricity supply company provides electricity sold to the final customers from its own production, purchased to upstream suppliers or purchased on the market (including power exchanges). These three ways to provide electricity have different cost factors.

A. **Own production:** Experts are expecting that the own corporate electricity power will have a tendency to increase in the coming years for the following reasons:

**New construction or renovation of power plants:** Without new energy efficiency measures, electricity consumption will increase every year by 2 to 3%. In Switzerland, the economy plans to increase its electric power production by 30% until 2018 (source: AES). New power plants will be more expensive than those built 50 years ago and already depreciated. This means that production costs of the Swiss power plants park will increase.

**New rules for environmental protection:** an increase of future hydro Swiss production costs is expected due to residual flows of stricter requirements on and
revitalization of the waters. A decrease in production due to residual flow requirements will be between 0.25 and 0.50 ct. / KWh. (LEaux\textsuperscript{39}).

B. **Purchase of electricity from upstream suppliers.** The electricity supply companies usually conclude long term contracts with upstream suppliers. Acquisition costs are therefore less volatile than during the purchase of exchanges power. The following factor will influence the future acquisition costs:

**Expired electricity contracts:** during the next ten to fifteen years, the electricity contracts concluded in long-term with French producers of electricity will gradually expire. These contracts allowed for nearly 20 years to provide cheap electricity in Switzerland produced in the French nuclear power plants. Purchase of electricity on the market could lead to higher prices (OFEN (2011), p.27).

C. **Purchase of electricity on the international market.** The costs of electricity purchasing on electricity for international stock exchanges are influenced by the following factors:

**Supply / Demand:** It is expected that electricity demand will continue to increase or, in the best, case will stagnate in Europe and Switzerland whereas the power plant park should be expanded respectively replaced in the European Union. An excess of demand could form if new power plants are commissioned on time. This excess demand would increase the market price (OFEN (2011), p.27).

**Fossil electricity production:** in Europe, almost half of the electricity is produced from fossil fuels like coal, gas or oil. Thus, the electricity prices in the international market depends heavily on the prices of those raw materials which are now relatively stable but may rise notably because of taxes and certificates on the CO2 (OFEN (2011), p.27).

\textsuperscript{39} Loi fédérale sur la protection des eaux
3. **Dues and payments to local authorities**

In the coming years there will be an upward trend mainly because of the increase in the maximum hydraulic fee since 2011 and other measures adopted by Parliament to reduce the negative effects of hydraulic power use (Parliamentary initiative "Protection and Use of water")\(^{40}\).

4. **Promotion of renewable energy (CPP)**

If the Federal Council decided fully utilizes the maximum possible charge of 0.9 ct. / KWh from 2013, we should expect in the coming years a doubling of charge. (This charge was announced before the 2050 Strategy. The Federal Council plans now to increase the CPP at 1.9 ct / kWh in its 2050 strategy (OFEN, 2012)). In total, it could increase from 0.45 ct / kWh today to 2 ct / kWh in a few years... As we can see that this tax is constantly evolving.

The evaluation made on all electricity prices in Switzerland confirms that electricity prices declined slightly before the market opening between 2004 and 2008. Prices have increased with the market opening. For households, we observe by category, higher prices ranging from 1.31 to 9.62% between 2004 and 2009 (SPR 2010). Price variations are therefore more or less pronounced depending on the category of consumers. It is also clear from the study that between 2008 and 2009, electricity companies providing a large number of customers, have increased their prices more than others. Price changes observed are compared with the values of the investigation by the Federal Office of Statistics (FOS). Both studies show a similar trend.

In Switzerland, the electricity industry must invest massively in the coming decades if Swiss people will continue to benefit the security of supply. These major investments will also influence the electricity prices. Concerning the future development of electricity prices and its effects on economy, the factors of price energy and network utilization are most important as they represent all over 80% of the total electricity price paid by households and by the industries (OFEN (2011), p.31).

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\(^{40}\) 07.492 – Initiative parlementaire Protection et utilisation des eaux
With these two factors, we rather expect that prices will tend to rise as it is necessary to invest in new capacity. Today a large part of the Swiss electricity is produced with nuclear and hydro power plants. These plants are already amortized. The production costs will be higher in the future due to the need to build new facilities. Those should replace power plants that will be shut down or to satisfy the likely increase in electricity demand or even allow renovating hydropower plants even if the market is fully liberalized (OFEN (2011), p.31).
3.3. Modeling welfare effects of Swiss electricity market liberalization

Liberalization of the electricity market will not only have an effect on prices but also on organization and structure of the electricity companies in general. Furthermore, consumers will be free to choose their electricity suppliers. Companies will then be in need to implement appropriate marketing strategies to retain customers.

Regarding Swiss companies in general, the second subchapter will show that electricity prices are still competitive after the first stage opening, compared to prices in neighboring countries. The economic impact is considered moderate.

3.3.1. Effects on firms, commerce and households

A study on the future of electric companies was directed by PwC. The goal was to see how these companies see their future after the full liberalization (2014) and in which sectors they think they can grow.

The Swiss energy distributors see an opportunity in the market changes. The surveyed companies\(^ {41}\) (PricewaterhouseCoopers (2008)) are preparing to expand and diversify their basic services. The goals most frequently reported are described in the next figure.

\[\text{Figure 13: Activities diversification}\]

\begin{center}
\includegraphics[width=0.8\textwidth]{activities_diversification.png}
\end{center}

\[\text{Source: PricewaterhouseCoopers (2008), p.22}\]

\(^{41}\) PricewaterhouseCoopers invited supply energy companies to take part in a national study. A total of 102 companies were surveyed.
The availability of data networks and the entry into differentiated markets (gas, heat, etc.) are among the objectives most frequently reported. If such is the case, electricity companies will be present in a variety of fields. This diversification seemed unthinkable in recent years. However, it is impossible to predict whether this will be the case in 2014.

Market liberalization allows the consumer to choose its Swiss electricity supplier among a number of companies. A key point in their strategy is to prevent or minimize customer defections. Therefore, the customer loyalty appears to be more important than acquiring new customers, especially for small companies whose turnover is relatively modest.

Switzerland is well situated as regard to the prices of electricity in an international comparison. The figure 14 is a ranking with the average electricity prices for households in the EU (2010). The horizontal red lines show the range of typical prices paid by households in Switzerland (13 to 25 ct. / KWh approx.). However, it should be emphasized to the price determination (Different methods in Europe and Switzerland).

![Figure 14: Average electricity prices for households in the EU (2010)](image)

*Source: Eurostat resp. ElCom*
As we saw earlier, a demand increase for electricity in Switzerland is expected. However the electricity price does not necessarily rise with an increase in demand. Even in case of decrease or stagnation of electricity prices, increased demand may raise costs of electricity at the macroeconomic level. As shown in the illustration below, since 1996 the costs of electricity to final consumers have increased despite the decline in electricity prices due to increased consumption.

![Figure 15: Temporal evolution of the total final consumption in Switzerland - Average price for final consumers - Electricity expenditures for final consumers.](image)

Higher electricity prices generally represent a challenge for the competitiveness of Swiss companies particularly when these prices rise faster abroad. The increase in electricity prices in Switzerland, from the first stage of the market opening, has played a role in the competitiveness of the national economy. The electricity prices are still competitive compared to prices in neighboring countries. It is expected that electricity prices will harmonize across Europe, also in Switzerland. This harmonization will be due partly to the stronger integration of the electricity markets (electricity trading) which basically benefits Switzerland and partly to the increase in import requirements of Switzerland. The economic impact of an adaptation is considered moderate as Switzerland is now slightly above the average for the prices charged to the companies (OFEN (2011), p.32).
The increase in electricity prices (and energy in general) can weigh during recessions, on the companies that are energy intensive. Companies that exports are also confronted with currency risks i.e. the weakness of the euro or the dollar (OFEN (2011), p.33).

The increase in electricity costs can be reduced at the macroeconomic level (lower demand) but also at the microeconomic level (declining share of electricity costs) with efficiency measures on the condition that the increases are predictable and that the investments can be incorporated into the planning (OFEN (2011), p.33).
3.4. Dynamic Simulations

This last subchapter will be devoted to the latest modeling and simulation in the Swiss electric sector. To do this, the analysis comes from Ochoa and van Ackere’s working paper (2005).

The authors of this paper use the dynamics of systems to model the current structure of the Swiss electricity market. The model is based on causal loop diagrams\(^{42}\). The authors analyze the market behavior in response to fundamental changes in the market structure such as the withdrawal of nuclear plants and the effects of liberalization of international trade. This paper was written in 2005, but the analysis and the significant values of the result are still relevant.

“This approach we adopt to analyze various aspects of security of supply in Switzerland differs from the traditional economic methodology which focuses on equilibrium of outcomes as opposed to on how the new situation is reached.” (Ochoa, van Ackere, (2005), p. 1)

An overview of their model is presented in this section. First, there is a description of the main model structures. It is followed by an analysis of several scenarios. We will choose the nuclear phase-out scenario and avoiding imports dependence, relevant for this thesis.

3.4.1. Nuclear phase-out scenario

The simulations run over 20 years, from 2004 to 2024, with a monthly step. Initially, the paper foresaw a scenario based on the 2003 referendum for the total nuclear phase-out of Swiss nuclear power. After this federal referendum May 18, 2003, Swiss people voted against the two initiatives proposed, aiming to stop nuclear power in their countries\(^{43}\). The analysis of this model has therefore fallen into desuetude until the famous June 8, 2011 when the Swiss parliament decided the total nuclear phase-out. The monthly step enables the reader to observe seasonal variations of demand and supply. The model is composed of five main sectors:

1. Local and export demand,
2. available capacity,

\(^{42}\) Causal loop diagrams (CLDs) are a kind of systems thinking tool. These diagrams consist of arrows connecting variables (things that change over time) in a way that shows how one variable affects another. (www.mindtools.com)

\(^{43}\) The results of the "voting" were (KKW Gösgen web site):
   - 66.3% against the stop of nuclear power plants before 2014
   - 58.4% against a new moratorium
3. price comparison,
4. dispatch,
5. capacity and investment.

The model proposes a nuclear phase-out. In 2005 (two years after the referendum), 34% of nuclear capacity will be shut down, respectively 30% in 2009, the remaining 36% in 2014. As a first case considered by the authors, the main hypothesis is that political relations with neighboring countries remain stable so that it is possible to increase international trade until the capacity limits are reached. The second hypothesis is that electricity generation industry in Switzerland remains a public monopoly.

Figure 16: Simulation results with and without nuclear capacity

Source: (Ochoa, van Ackere, (2005) p.19)

The model (Simulation results with and without nuclear capacity) compares the situation without nuclear power plants (No Nuclear: Pink line) and the 2003 situation with initial capacity of five nuclear power plants (Base Case: Blue line).

The first figure shows the behavior of exports in both nuclear phased-out and base case. As expected, export contracts are lower in the nuclear phase-out case than in the base case, since the technology used for the nuclear capacity replacement - thermal power generation, has a marginal production cost higher, than nuclear energy. This observation was made by the authors in 2003, but it can be argued that the data are the
same when gas plants will replace nuclear power plants. Indeed, gas plants are faster to build.

The graph of long-term import contracts are increasing rapidly in both scenarios. This is explained when the installed capacity is sufficient to match local demand, Swiss generators will prefer to increase imports rather than significantly expand capacity because imports are a cheaper source of electricity. A first observation is that this statement is partially valid. Indeed, see Appendix: The Swiss electricity record. Empirically in 2010, after three years completed with a balance of 2.1 TWh in 2007, 1.1 TWh in 2008 and 2.2 TWh in 2009 exported, Switzerland again became an importer of electricity in 2010 with a balance of 0.5 billion imported (Ochoa, van Ackere, (2005), p. 19).

As one can expect, capacity expansion (Additional capacity graph) is faster in the nuclear phase-out scenario, as the lost capacity needs to be replaced. One can also see that capacity expansion starts to grow faster after year 3 in the nuclear phase-out scenario, in order to compensate the withdrawal of nuclear power. This extra capacity will permit exports to increase, yet exports in the benchmark scenario remain higher than those in the nuclear phase-out scenario (Ochoa, van Ackere, (2005), p. 19).

The graph: Total Capacity/Total Demand shows the ratio Total Capacity/Total Demand for the two scenarios. We can observe under-capacity stages (when Total Capacity/Total Demand < 1) during some periods (after year 1 in the graph), which means that companies will have to import last minute electricity in order to ensure exports during that period. In any case, capacity at those points will still be sufficient to match internal demand, thus avoiding blackouts (Ochoa, van Ackere, (2005), p. 19).
“In case of a nuclear phase-out new capacity is installed as nuclear replacement and demand growth is met by the increase of long term imports. Some excess capacity could lead to exports but, as the cheaper source of electricity - nuclear power - is no longer available, the exportable electricity is expensive, thus exports are lower in this scenario.” (Ochoa, van Ackere, (2005), p. 19)

Figure 17: Average capacity and consumption at year 2005

Figure: *Average capacity and consumption at year 2005* shows the comparison between installed capacity and consumption (local consumption plus exports) by generation technology in both the benchmark case (graph a and b) and the nuclear phase-out scenario (graphs c and d). In the benchmark case with constant nuclear power over the 20 years simulation, even though new thermal capacity has been installed, imports are used for exporting and for supplying internal demand with low cost electricity. Thus, even though new thermal capacity is available (20.6% of installed capacity), Switzerland prefers to import electricity because it is less expensive. Net imports at the last year simulation represent about 9% of local consumption (Ochoa, van Ackere, (2005), p. 20).
In the second scenario, with the withdrawal of nuclear power, both the new capacity and the import contracts are necessary to cover demand (graph d), thus, exports of electricity are lower because of the higher marginal generation cost. Net imports in this case reach 19% of local consumption (Ochoa, van Ackere, (2005), p. 20).

Imports are an important source of electricity for Switzerland. In the case of a nuclear phase-out there is an important risk of import dependency. Simulation of the nuclear phase-out scenario shows that imports may rise to 32% of total consumption (local demand + export) by the end of the simulation. In the base case, with constant nuclear capacity, imports represent 29.3% of the final consumption, in a period where 29.7% of the electricity is produced by nuclear plants (Ochoa, van Ackere, (2005), p. 20).

Imports may certainly help lower the cost of electricity, but, as mentioned before, it is not politically desirable to create a dependence on European relationships to supply local electricity demand. Switzerland may introduce policies to avoid import dependency (Ochoa, van Ackere, (2005), p. 20).

“International exchanges represent an important source of profits for the Swiss electricity industry. Imports from France are exported to Italy, and they are also used for domestic consumption in order to keep hydro capacity for peak load demand and thus lower the cost of electricity in Switzerland. But this successful policy of international exchanges will no longer be possible in the absence of clear and reliable market rules. Uncertainty about the future of nuclear generation as well as the lack of regulation and emergent liberalization may prevent capacity expansion from taking place. Furthermore, as regional markets evolve, Switzerland might no longer be able to continue to arbitrate; the contracts might be negotiated directly between Italy and France and Switzerland might only be able to wheel electricity through - a situation that would be much less profitable for Switzerland” (Ochoa, van Ackere, (2005), p. 24)
3.4.2. Avoiding imports dependence

In the avoiding imports dependence scenario presented by Ochoa and van Ackere (2005), imports are no longer considered as an alternative for capacity expansion, this means that Switzerland will only increase long term import contracts when it is economically desirable - when the prices in Europe are lower than generation costs in Switzerland. Local capacity construction becomes unavoidable whenever expansion is needed (Ochoa, van Ackere, (2005), p. 21).

Figure 18: Simulation results, scenario avoiding import dependence

Source: (Ochoa, van Ackere, (2005) p.22)

Figure: Simulation results for the avoiding import dependence scenario shows simulation results for the case where nuclear capacity remains constant during the 20 years of the simulation with the avoiding imports dependence policy. The authors again use for comparison the benchmark scenario - the base case where nuclear power is constant and imports are considered as a source for capacity expansion.

In graph: exports contracts, Ochoa and Ackere (2005) analyze: “one can see that if plant construction cannot be avoided, this leads to a stronger increase of exports after 4 years of simulation. One can also observe that variations during the year are stronger in the base case, which is due to the more strategic use of hydro generation - the fact that there is a large amount of available imports allows companies to keep the water into the reservoirs in order
to produce in peak load periods, thus hydro power generation follows a seasonal pattern, while in the case where imports are limited, hydro generation is mandatory during certain periods, thus water cannot be stored and the maximum generation is reduced, which implies a decrease of the excess of capacity having as a consequence a more constant level of exports (Ochoa, van Ackere, 2005, p. 21).”

The fact that long term imports cannot be increased to solve under-capacity problems encourages capacity building (Graph: additional capacity). Once capacity has been expanded and supply is guaranteed, then exports may be increased without endangering internal supply. Average cost of electricity (Graph: Average costs) seems slightly higher when capacity building cannot be avoided but this is explained by the increase in demand as a consequence of export increase (Ochoa, van Ackere, 2005, p. 24).

Figure 19: Simulation results, scenario avoiding import dependence in nuclear phase-out

Source: (Ochoa, van Ackere, 2005 p.23)

The authors run the model with both the avoiding imports dependence policy and the scenario of gradual nuclear dismantling. They obtain similar results (Figure: Simulation results for the avoiding import dependence in nuclear phase-out scenario). Obviously, exports (graph: export contracts) are not growing at the same pace because generation costs are higher -as we use thermal generation to replace nuclear power (Ochoa, van Ackere, 2005, p. 23).
The scenario of avoiding import dependence presented in Ochoa and van Ackere (2005) paper may seem unrealistic, but actually the liberalization that is taking place in the Swiss market may produce the same results. In this unregulated situation, competitors from the European Union (or from other Swiss cantons) may sell electricity to Swiss consumers; this will lower local prices on the one hand, and distort under-capacity signals on the other hand. Demand for local producers will be lower, reducing incentives for building new capacity (Ochoa, van Ackere, 2005, p. 23).
CONCLUSION

The first chapter synthesis sets out the importance of partnership in Europe because Switzerland depends on more than 80% of energy imports. This tendency is confirmed in the empirical part. *Table: Simulation results with and without nuclear capacity* reveals that interaction between European countries is essential. The European neighbor countries are mostly ahead of liberalization process.

The second chapter presents a legislation overview. With the market liberalization introduced by law on electricity supply, the Swiss electricity market is gradually opening up to competition and gaining transparency. Furthermore, the law on electricity supply strongly influences the economic organization. This legal framework expressly defines the liberalization context, namely the agenda, the role of companies which empowers of a supreme entity to oversee everything (Swissgrid/Elcom).

The last part of this thesis aims to introduce empirical studies. The first subchapter has a look on evolution prices. In the European Union, the electricity market liberalization initially caused a sharp decline in prices (Eurostat (2010)) and was followed by an increase. However, liberalization was not the trigger for further increase in electricity prices. It was rather due to increase in international consumption of energy, soaring prices of primary energy (oil, gas, coal) and economic growth in recent years (until summer 2008). Indeed, a variable plant cost is defined especially by the price of the energy it uses. As the Swiss electricity is primarily generated by hydropower and nuclear, it does not depend so heavily on energy prices. In Switzerland, the electricity sector will invest heavily in the coming decades to continue ensuring supply security. These major investments will also influence the price of electricity. In comparison with the international level, electricity prices are quite competitive in Switzerland. They are in the average for European households but above in the handcraft sector. The empirical part confirms that electricity prices declined slightly before the market opening between 2004 and 2008 and, prices have increased with the market opening. A conclusion appearing like a paradox as most people expected the opposite result. Moreover, prices observed have been compared with the values of the investigation by the Federal Office of Statistics (FOS). Both studies show a similar trend. Price variations are therefore more or less pronounced depending on the category of consumers (SPR (2010)). The future development of electricity prices and its effects on economy will be influenced by several factors. It is also very tricky to make predictions; both models are subject to numerous uncertainties. The prices factors of energy and network utilization are most important as they
represent over 80% of the total electricity price paid by the households and the industries (OFEN (2011)).

Ochoa and van Ackere’ models (2005) presented in the second subchapter help to understand the logic and dynamic of the Swiss electricity market. The implementation simulation of different policies (several hypotheses tested) - nuclear phase-out – avoiding imports dependence helps to anticipate and analyze possible market responses to these policies in a transition period between different market structures. The authors run the model with both the avoiding imports dependence policy and the scenario of gradual nuclear dismantling but they obtain similar results. Ochoa and van Ackere assume that in this unregulated situation, competitors from the European Union may sell electricity to Swiss consumers; this will lower local prices, on the one hand, and distort under-capacity signals, on the other hand. Demand for local producers will be lower, reducing incentives for building new capacity. This may lead to lower prices from abroad but at the same time, to larger dependence on European markets. It is regrettable that there is a lack of studies on the potential prices after full liberalization. The lack of study on this topic is understandable by the fact that the sector is subject to constant mutations. It is hardly possible to analyze without making any coarse assumptions.

However, as a Master’s student, I will do these recommendations. Future research should analyze the liberalization evolution process with a constantly law adaptation. For instance, it could be interesting to assess the efficiency of liberalization market process in 2014-2015. Therefore, it would be relevant to investigate which kind of companies would have survived and what would have been the structure and the price in Switzerland after/over this time. However at this stage, if the initial goal of liberalization was to reduce prices, empirical analyses present worrying results. Switzerland is not able at the moment to keep prices stable for the electricity market. Furthermore, European integration of the Swiss market is inescapable and we cannot stop it. In the future, politicians should place more emphasis on limiting production costs despite the exit of nuclear energy. In the end, the last remark concerns the lack of information and studies on the subject. A variety of documents describing coarsely the market opening are available, but no case studies are currently publicly available based on detailed reports. This is a paradox for a sector relating to the whole population and preponderant in the household budget.
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1. **Hierarchy of legislation**

Source: Romande Energie
2. **Example of cantonal taxes in the canton of Vaud**

<table>
<thead>
<tr>
<th>Taxe cantonale</th>
<th>Émolument destiné à financer la Commission cantonale de surveillance du secteur électrique et contribuer aux tâches de l’État en matière d’approvisionnement électrique (DSecEl, art. 22)</th>
<th>0.025</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fonds affecté à la promotion du développement durable en matière énergétique (LVLene, art. 40)</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Source: RSV-VD 730.11 11 5.6: Règlement sur l’émolument cantonal lié à la distribution et la fourniture en électricité

3. **Example of communal taxes in the canton of Vaud**

<table>
<thead>
<tr>
<th>Taxe communale</th>
<th>Indemnité communale pour usage du sol</th>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fonds communal pour l'utilisation rationnelle de l'électricité et la promotion des énergies renouvelables</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Éclairage public communal</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fonds communal pour le développement durable</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Source: Conseil communal de Chavannes-près-Renens, PREAVIS N° 32/2008
4. Swiss electricity record

<table>
<thead>
<tr>
<th>Year</th>
<th>Landesverzepung - Produktion nationaler Wasserkraftwerke</th>
<th>Konventi-</th>
<th>Konventi-</th>
<th>Verbrauch der Speicherpumpen</th>
<th>Nettoerzeugung</th>
<th>Einhuft Import</th>
<th>Ausfuhr Export</th>
<th>Landesverbrauch</th>
<th>Verbrauch des</th>
<th>Neuthe Fert.</th>
<th>Enderverbrauch - Consommation finale</th>
<th>Ausfuhr:</th>
<th>Enderverbrauch - Consommation finale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wasserkraftwerke</td>
<td>Konventielle Strommärkte</td>
<td>Konventielle Strommärkte</td>
<td>Total</td>
<td>Nettoerzeugung</td>
<td>Produktion</td>
<td>Einfuhr Import</td>
<td>Ausfuhr Export</td>
<td>Landesverbrauch</td>
<td>Consommation des</td>
<td>Neuthe Fert.</td>
<td>Total</td>
<td>Enderverbrauch - Consommation finale</td>
</tr>
</tbody>
</table>

Source: OFEN, Statistique suisse de l'électricité 2010, p. 11.
5. **Average price evolution of electricity in ct. / KWh / per category**

<table>
<thead>
<tr>
<th></th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>H6</th>
<th>H7</th>
<th>B</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2008</td>
<td>-1.68</td>
<td>-1.74</td>
<td>-1.33</td>
<td>-2.06</td>
<td>-1.59</td>
<td>-1.11</td>
<td>-1.62</td>
<td>-1.27</td>
<td>-1.80</td>
<td>-2.17</td>
</tr>
<tr>
<td>2006-2009</td>
<td>1.00</td>
<td>1.00</td>
<td>1.49</td>
<td>1.16</td>
<td>1.49</td>
<td>1.70</td>
<td>1.26</td>
<td>0.95</td>
<td>0.04</td>
<td>0.26</td>
</tr>
<tr>
<td>2004-2009</td>
<td>-0.69</td>
<td>-0.74</td>
<td>0.16</td>
<td>-0.90</td>
<td>-1.10</td>
<td>0.59</td>
<td>-0.25</td>
<td>-0.32</td>
<td>-1.64</td>
<td>-1.91</td>
</tr>
</tbody>
</table>

Source: (SPR (2010), p. 7)

6. **Average price evolution of electricity in % by category**

<table>
<thead>
<tr>
<th></th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>H6</th>
<th>H7</th>
<th>B</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2008</td>
<td>-6.65%</td>
<td>-7.80%</td>
<td>-7.75%</td>
<td>-10.24%</td>
<td>-9.88%</td>
<td>-8.81%</td>
<td>-10.14%</td>
<td>-7.42%</td>
<td>-8.20%</td>
<td>-10.58%</td>
</tr>
<tr>
<td>2006-2009</td>
<td>4.27%</td>
<td>4.66%</td>
<td>9.41%</td>
<td>6.43%</td>
<td>10.64%</td>
<td>14.50%</td>
<td>5.45%</td>
<td>6.00%</td>
<td>-3.20%</td>
<td>1.42%</td>
</tr>
<tr>
<td>2004-2009</td>
<td>-2.71%</td>
<td>-3.32%</td>
<td>0.53%</td>
<td>-4.46%</td>
<td>-0.91%</td>
<td>4.68%</td>
<td>-1.63%</td>
<td>-1.87%</td>
<td>-6.47%</td>
<td>-3.31%</td>
</tr>
</tbody>
</table>

Source: (SPR (2010), p. 7)