Electricity market interactions between Hungary and the Balkan region

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EXECUTIVE SUMMARY

In this study we examine the situation of the Balkans' electricity market and its effects on the Hungarian (henceforth also called domestic) market price[1], because it is widely considered that the recent substantial increase in the domestic electricity price is due to the Balkanian situation. Our purpose is to reveal the background of the developments of the South-East European electricity market and to describe the actual relationship between the Hungarian and the Balkanian electricity market. In our study we try to paint a clearer picture of the Balkanian electricity market than what has appeared recently in our, sometimes chaotic, policy debates.

The questions examined in our study are answered either by simple statistical analyses or by a simulated equilibrium model of the Central and South-East European electricity markets. With this model we can consistently examine the demand-supply situation of 14 countries[2] from the Central and South-East European (CSEE) region, the constraints of the regional networks, the prevailing national wholesale electricity prices, keeping in mind all these constraints and supposing perfect competition, and the typical commercial flows. Changing the model's basic assumptions makes it possible to check the validity of several real world scenarios (i.e. fluctuations of cross-border capacities, fluctuations of water yield, assumptions considering the prices in countries adjacent to the region). By comparing and evaluating the results of these different model settings we try to reveal the real character of the relationship between the Hungarian and Balkanian electricity markets.

We kept in mind throughout our calculations that the Bulgarian Kozloduy 3-4 nuclear blocks now are out of order and that the Romanian Cernavoda 2 nuclear block is operating. We would like to emphasize that we always calculated supposing peak demand, so this model reflects a pessimistic point of view (regarding market price levels).

Our most important results are based on our modeling and can be summarized as follows:

The cross-border capacity on Hungary's southern borders and the trade which goes on there play a crucial role in the case of the observed problem, as this border **connects the Central European market (Poland-Czech Republic-Slovakia-Hungary) with favorable producing cost and prices and the South-East European markets**.

The prices of the Central European region never exceed the German price zone's (Germany-Austria-Switzerland-sometime Slovenia) **market prices, under the assumptions of realistic technical circumstances and of perfect competition**. **As Hungary is part of the Central European price zone in competitive circumstances, its prices cannot/could not deviate substantially upwards from the Czech and Slovakian prices**. Even though the

[1] Prices which are not under a price setting regime.

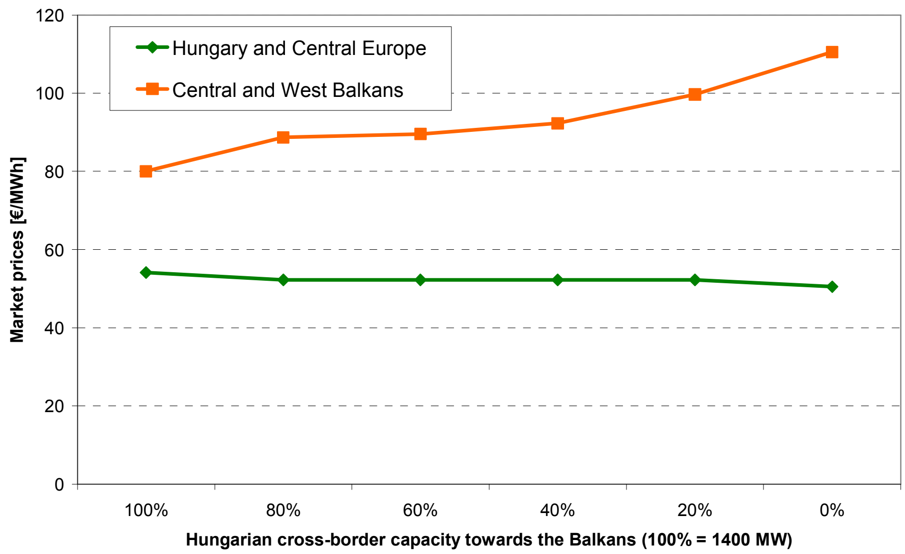
[2] In the graphic presenting the basic assumptions of modeling, the data and the results we use only the UCTE abbreviations of the countries (to save space). In the case of the explicitly modeled countries these are the following: Albania(AL), Austria(AT), Bosnia and Herzegovina(BA), Bulgaria(BG), Czech Republic(CZ), Croatia(HR), Poland(PL), Macedonia(MK), Hungary(HU), Montenegro(ME), Romania(RO), Serbia(RS), Slovakia(SK), Slovenia(SI). Apart from these countries we cite the electricity market parameters of Greece(GR), Germany(DE), Italy(IT), Switzerland(CH), Sweden(SE) and West-Ukraine(UA_W).

export towards the Balkans is important, that never takes Hungary out of the Central European price zone, as the southern cross-border transmission capacity is not strong enough.

Regarding the relation of **Hungary's and the Balkan region's electricity market**, **our modeling shows an asymmetric dependency**. According to this, **export from Hungary (Central Europe) significantly decreases the Balkanian prices, but the Balkans' import demand raises only slightly the Hungarian prices**.

In this context **our modeling does not support the hypothesis,** which has become a commonplace in Hungarian policy debate**s, that high Hungarian prices are due to high Balkanian prices**. **Our results remained valid even after running the model with extreme input values**. Figure 1 explains this phenomenon: the gradual narrowing of our southern cross-border capacities (restriction on exports) does not decrease significantly domestic prices, but at the same time it can push up Central and Western Balkan prices to the level of Italian prices or even higher.

Figure 1: The effects of restrictions on southern Hungarian cross-border capacities, assuming high Balkanian prices at the same time



The results above raise the following dilemma: **if we consider that competing market conditions are still valid in the Central European region, we cannot explain how high prices could be present in Hungary and in the Balkans at the same time**.

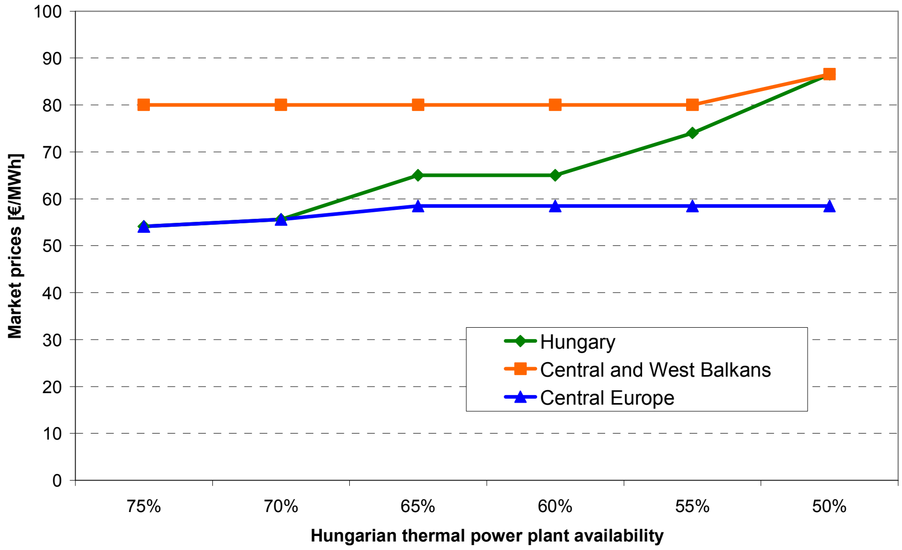
In our opinion the most probable reason behind the high Hungarian prices – which are orienting towards the Balkanian level – is capacity withholding on the domestic generator market.[3]

Figure 2 illustrates how the electricity prices of the Central European and Hungarian markets changes, starting from the high Balkanian prices, if we gradually decrease the capacity of the Hungarian thermal power plants. The gradual withholding of the Hungarian generator

[3] The MVM can do this strategy by the means of long term power purchase agreements and proprietary control. There are too many direct and indirect signs of such a strategy to ignore it.

capacity leads first to the secession of Hungary from the Central European price zone, and with increasing prices it leads to joining it to the Balkanian price zone.[4]

Figure 2: The effects on market prices of the Hungarian capacity restrictions



To sum it up, **our modeling supports the alternative hypothesis, that the withholding of domestic generation capacity fuels the convergence of domestic and Balkanian electricity prices**. However to evaluate precisely this result, further investigations are needed.

Next we summarize other important observations of our investigations.

<u>The general market situation</u>

1. **In general the demand and supply conditions of the Balkanian electricity markets show that the markets are more balanced than what we might think according to recent professional debates**. In the region there are many important electricity exporters with significant capacity surplus (Romania, Bosnia and Herzegovina), and at the same time Serbia and Bulgaria have balanced demand and supply conditions as well. **Whilst the installed capacity is 1.6 times the peak demand quantity in the Central European region, the same value in the Balkan region is 1.9, and in Hungary it is 1.4. The extremely high value in the Balkan region can be explained by the high capacity of hydroelectric units**, whose actual capacity is significantly less than those of other generators.
2. The average age and capacity of the Balkan region's power plants are not significantly different from the Central European market[5]. The utilization of the hydroelectric power plants is less than of the thermal power plants in the whole CSEE region. The

[4] László PAIZS's (2008) modeling results do not contradict this result. He has modeled – with a different approach – the relations of Hungarian and Balkanian electricity markets, supposing an oligopolistic domestic market. The more concentrated domestic market leads to a capacity withholding here as well, which results in the convergence of domestic and Balkanian prices.
[5] Austria, Czech Republic, Poland, Hungary and Slovakia

average capacity utilization is 31% while in the case of thermal power plant it is 47.1%.

3. If we do not take into consideration the foreign trade possibilities, and we focus only on the question that to which extent local installed capacities can fulfill local demand, we find that **in the case of autarky we can group the countries with security of supply problems and high local prices in two blocks: in the west Slovenia and Croatia, and in the south Macedonia, Montenegro and Albania** (see Figure 3). In our opinion, in the case of autarky high prices in these countries are due to high percentage of hydroelectric power plants, as these are only operating at a relatively low level. **These capacity constrained and high priced countries represent only 10 percent of the CSEE region's overall consumption**, and we presume that decent network reliance and intensive foreign trade could solve these problems.

4. **The former Yugoslavian states can be described by a very strong network connection** (Slovenia and Macedonia are partly exemptions), so the Serbian, Bosnian, Croatian and Montenegrin markets can be considered to be one market (price zone).

5. **In 2006, the Central European and the Balkan regions were net exporters**. Looking at the details in the Balkan region, we can see that its eastern part (Romania and Bulgaria) were net exporters, the situation of the Central Balkans[6] is more balanced, and the rest is net importer. The Central European region exports mainly towards Germany, Sweden and Hungary, while the Balkan region towards Italy and Greece.

6. **As it is widely known, Hungary is in a net import position**. Hungary's consumption adds up 60 percent of the Central Balkan region and 22 percent of the whole Balkan region.

7. If we take into consideration foreign trade conditions, **only Macedonia, Albania and Slovenia remain in the group of countries who suffer from high prices** and security of supply problems. The most exposed country to supply security problems is Macedonia.

8. **The domestic markets of the Balkan region – except in Romania – are dominated by vertically integrated incumbents, if not by ownership, then by long term power purchase agreements**. So we cannot talk about domestic trading competition, we can rather mention artificially lowered prices, which are either financed directly by the state (Albania) or the incumbent cross-subsidizes it from its export revenues (Bulgaria).

9. **The biggest participants of international trade are each countries' incumbents** as well. They often purchase or sell electricity in public tenders. These international tenders, through their openness and frequency, help to signal better the relation of demand and supply than domestic prices.

[6] Bosnia and Herzegovina, Serbia and Montenegro

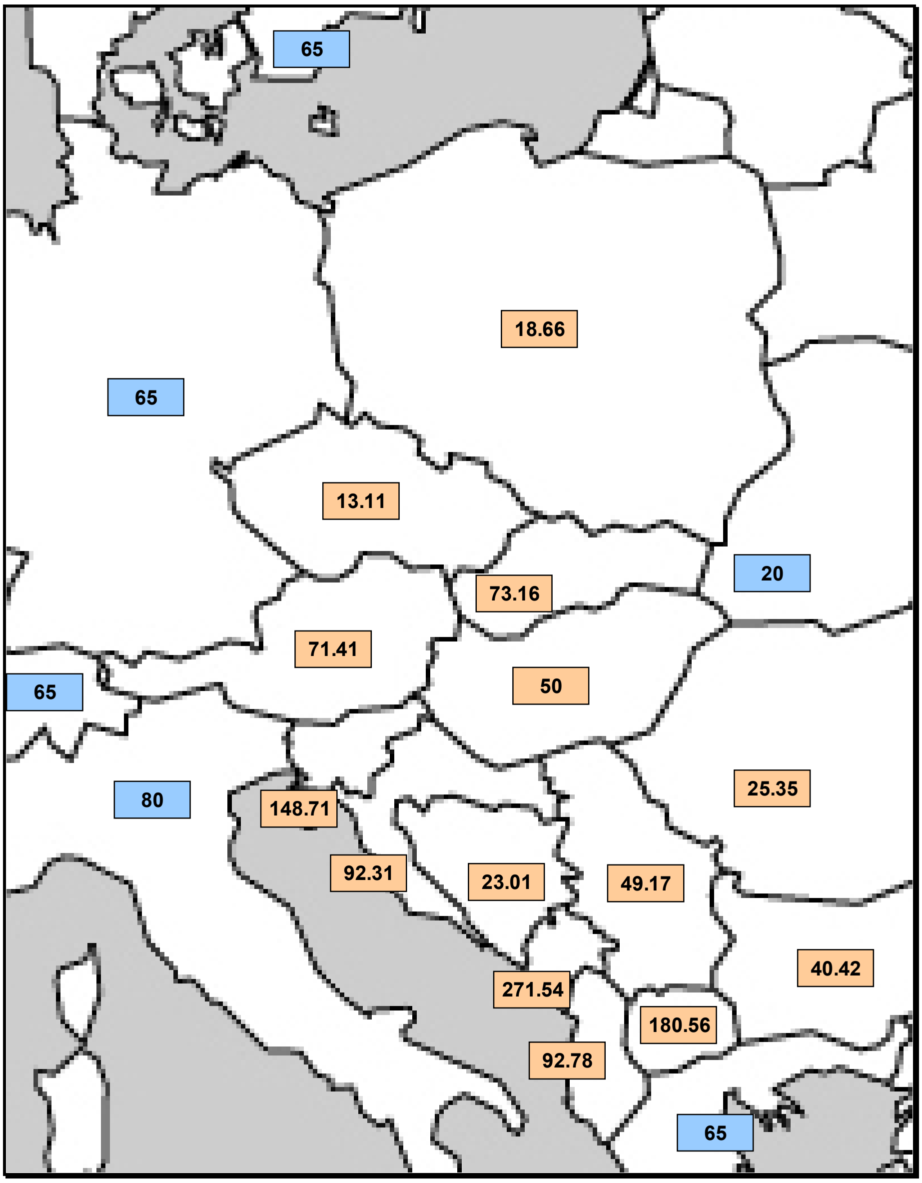
10. **System operators, who allocate cross-border capacities, are not independent from the incumbents** – except in Romania and in Bosnia and Herzegovina. The allocation of cross-border capacities are not everywhere based on market mechanisms or accessible to everyone. What is more, import and export fees distort commercial relations. In many countries the external trade of regional electricity is distorted by discriminative local regulation as well (Bulgaria for example).

11. Regarding **the region's future commercial situation**, the planned power plant investments allow at least for the replacement of all the old existing power plants. Furthermore, in Romania and in Bosnia the investment plans even exceed the level of today's capacity. Besides, the improvement of network capacities will ameliorate the supply situation as well. Important cross-border capacities are under construction, i.e. between Serbia-Romania and Montenegro-Albania, which will help the regional prices to converge. Romania, by revitalizing the Russian and Ukrainian commercial connections, can import from a cheaper region to the Balkan region. On the whole, regarding the plans, the region's net commercial position and its prices will not deteriorate, and in function of the consumption's growth they can even improve.

Further modeling results

12. **Assuming autarky, Hungary would be among countries which can be described by average electricity prices in the CSEE region**.

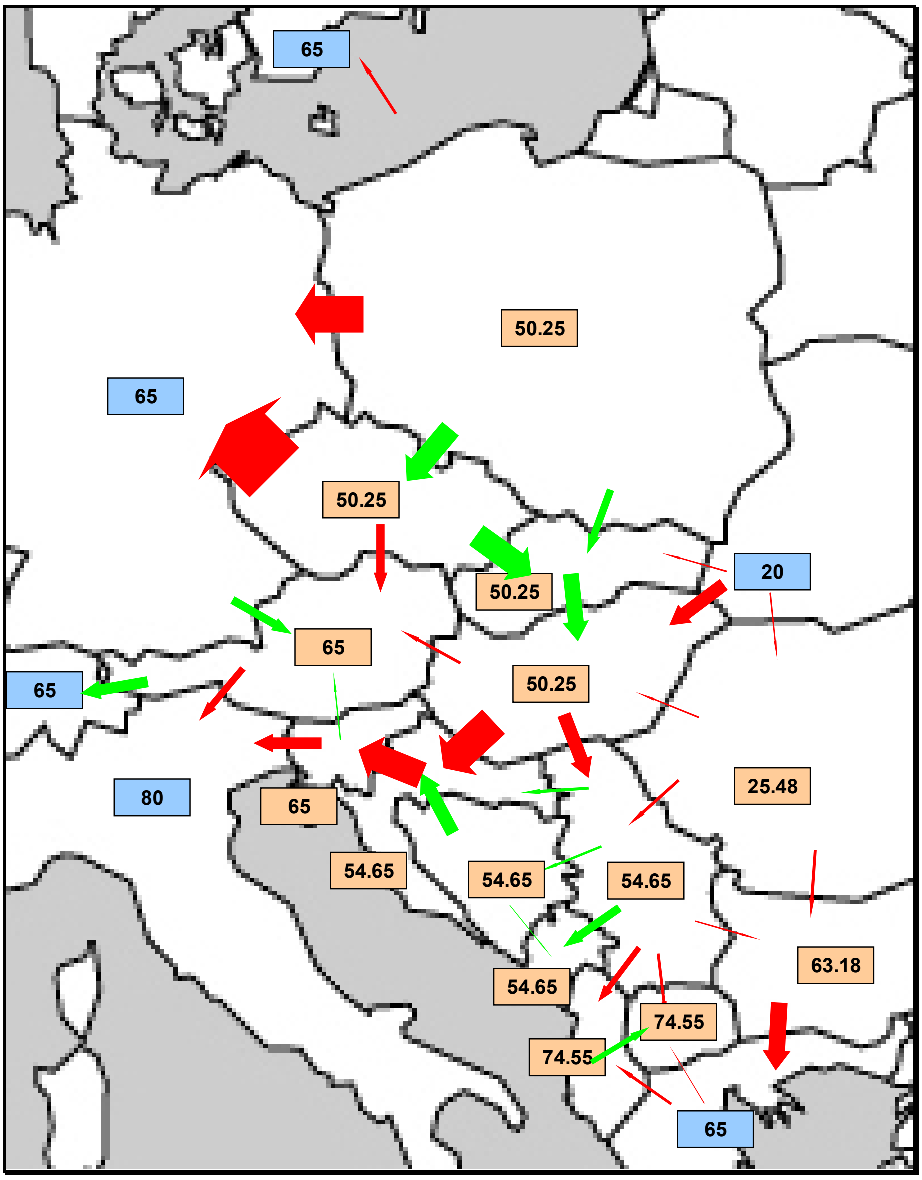
Figure 3: Equilibrium prices in case of autarky[7]



13. According to scenarios based on publicly available NTC data, **Hungary is part of the Central European region, its prices cannot/could not significantly diverge from Czech and Slovakian prices**. Even though there is an important export in the direction of the Balkans, this never takes Hungary out of the Central European price zone.

[7] The small rectangles put to the countries represent respectively the model's equilibrium prices. The rectangles with a blue background represent the prices of the neighboring countries, so they are not modeling results, they are input parameters. On the other hand, the yellow colored rectangles (of 14 countries) represent modeling results.

Figure 4: Basic modeling results[8]



14. **Demand and production conditions of the Balkanian countries play an important role in the formulation of the regional prices**. It is important to know that the **network connections between Romania and the former Yugoslavian countries are very weak** (according to the publicly available NTC values). Another important local factor is the **exposure to hydro power**. And finally **the import coming from the north (from the direction of Hungary) has a big influence on regional prices**.

15. **The northern import and the fluctuation of water yield are substitutes in influencing the Balkanian prices**: a decrease in water yield causes higher prices, which can be reduced by an increase in import, and a restriction on northern import causes higher prices, which can be offset by a good water yield. A low water yield and

[8] The arrows on the figure represent the direction and the size of export-import electricity flow (the width of the arrows is proportionate to the traded quantity on that border.) The colors represent the intensity: on red borders all the possible transfer capacity is used, in the case of green ones, there is still room for trading.

import restriction at the same time drastically raise Balkanian prices and cause them to converge to the Italian price level.

16. **There is a remaining question about the effects on regional prices of Balkan regions' exports towards Italy and Greece**. Italy is only connected to the Balkans through Slovenia, which means only 330 MW cross-border capacities. This is simply too low to mark up the prices in the South-East or in the Central European region. The export towards Greece puts pressure mainly on Bulgarian prices.

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I. INTRODUCTION

Recently an intensive (and sometimes emotional) policy debate has developed about the causes of the drastic increase in domestic wholesale (and final consumer) electricity prices. A great majority of price increase explanations are about fundamental causes. On the one hand it is rooted back in the increase in world market price of fuel (this makes supply more expensive), on the other hand an export demand is cited, which is due to high Balkanian prices (this pushes up demand). However other analysis suggests that cost side reasoning is not sufficient to explain the extent of the price increase, because it is partly due to the too concentrated domestic electricity market and so to the market dominance of generators and to their capacity withholding[9].

In this study we examine the most cited reason of domestic electricity price increase: the electricity market situation in the Balkans and its effects on domestic electricity market. According to the common reasoning, there is an electricity shortage on the Balkan recently, which is partly due to the fast increase in demand, partly due to the ageing of generator's capacity, the lack of investment, and the shutdown of the Bulgarian Kozloduy nuclear station's block 3 and 4[10]. This results in high wholesale prices in the Balkans, which causes a sizeable import need in the region and a significant demand increase in the Hungarian electricity market, which without intervention – *ceteris paribus* – causes price increase.

[9] László Paizs (2008): *The effect of Balkanian price increase on Hungarian electricity prices*. Study prepared for the Hungarian Energy Office by REKK, Corvinus University of Budapest [available only in Hungarian].

[10] It is 800 MW of nuclear capacity, and its shut-down was requested by the EU as an accession condition.

Figure 1: Wholesale electricity prices in neighboring countries

Source: EON

In parallel with this logic, in October 2007 an export duty was introduced for 2008 in accordance with the date of the 2008 MVM auction. The 85/2007. (X.21.) GKM decree put extra burden on those who wanted to transport abroad electricity produced in Hungary[11].

Figure 1, which was prepared by E.ON in October 2007, about the regional wholesale electricity price predictions, illustrates well the expectations of Hungarian and Balkanian (at least Croatian) price convergence. Moreover, it also shows that Hungarian and South-East European prices were expected to rise beyond the German wholesale price level.

It is undeniable that the electricity markets of Central-East European and South-East European countries have gone through important changes in the past one to one and a half year. From the point of view of Hungary, one of the most important regional market change is the important price increase in the Balkanian electricity markets. The price information of some markets' import tenders show that there is a possibility of wholesale transactions, whose prices are even 10-15 EUR/MWh higher than the German price level. Because there are no further thorough analyses, we cannot reject that the high Italian and Greek electricity prices, the neighboring countries of the region, contribute to the persistence of high prices.

The primary goals of our study are to discover the background of the events on the South-East European electricity markets, and to describe the factual relations among the Balkanian and the Hungarian electricity market. In other words, the goal of our study is to discover the true reasons behind the price convergence shown in Figure 1.

[11] However the decree was soon overruled – to avoid the EU's countermeasures.

In our study we try to paint a clearer picture of the Balkan electricity market than what has appeared recently in, sometimes chaotic, policy debates. We try to demonstrate that many countries of the Balkans electricity market (Albania, Bulgaria, Romania and former Yugoslavian countries) are important electricity exporters and they have significant extra capacities (Romania, Bosnia and Herzegovina), but at least they have balanced demand and supply conditions (Serbia and Bulgaria). Most of the generator capacities of these countries were built before the transition to market economy, just as the majority of Hungarian and Central European capacities, so it is not surprising that in age, in efficiency and in the utilization we find fairly similar conditions as in Central Europe (of course there are some exemptions).

We present the region's network connection capacities and their constraints imposed to the regional electricity trade. It seems to be obvious that the former Yugoslavian countries can be described by strong network connections (Slovenia and Macedonia are partly exceptions), so the Serbian, Bosnian, Croatian and Montenegrin markets are generally considered to be one market (one price zone). We examine especially the importance of the trade and the state of network capacities on the southern Hungarian cross-border capacities, as this border connects the Central European (Polish-Czech-Slovakian-Hungarian) and the South-East European markets. And at the same time we prove the fallacy of the hypothesis that the high priced Italian and Greek markets take out an important quantity of electricity from the Central European (including the Hungarian) market through the Balkans.

The questions examined in our study are answered either by simple statistical analyses or by a simulated equilibrium model of the Central and South European electricity markets. With this model we consistently examine the demand-supply situation of 14 countries from the Central and South-East European (CSEE) region, the constraints of the regional networks, the prevailing national wholesale electricity prices with all these constraints and then supposing perfect competition, and the typical commercial flows. Based on the results of this model, we try to discover the real nature of the relation between the Hungarian and the Balkanian electricity markets.[12]

The equilibrium model has numerous advantages – beside its drawbacks. Firstly, it can be consistently estimated, on the basis of the available data, what we could achieve if the region's markets have worked in an integrated and perfectly competitive way. This idealized state can help to learn what results could have been achieved, within the actual technical set, with adequate market regulation. This modeling is based on the simplest economic assumptions (unlike in the case of more sophisticated model, which assumes strategic behavior), so it can be easily reproduced and verified. This holds to the database used for modeling: its verification, specification can be done at any time, and the model running can be easily done again.

[12] This modeling can be regarded as an extension of the REKK's market modeling, prepared as a part of the South-East European electricity market monitoring pilot project for the Athens Forum. See: *Report on South East Europe Market Monitoring For the Period June – August, 2007*. Prepared by Potomac Economics & REKK. http://www.naruc.org/see_monitoring/reports.html.

The structure of the study is the following. First we present the important parameters of the Balkanian electricity markets and compare them to the Central European region, which is a determinant for the Hungarian market. The fuel compound, the ratio of generation capacities and demand, the parameters of the regional hydroelectric power plants and thermal power plants and network capacity (these are the key factors of local market events and security of supply) are in the center of the analysis. Parts of our results are used in the calibration of the modeling, which is presented later on. After this we summarize briefly the situation of each Balkanian electricity market. In the end we present the key features of the equilibrium model of the CSEE region and the main results of the model specifications.

II. COMPARISON OF THE BALKANIAN AND THE CENTRAL EUROPEAN REGIONS' ELECTRICITY MARKETS

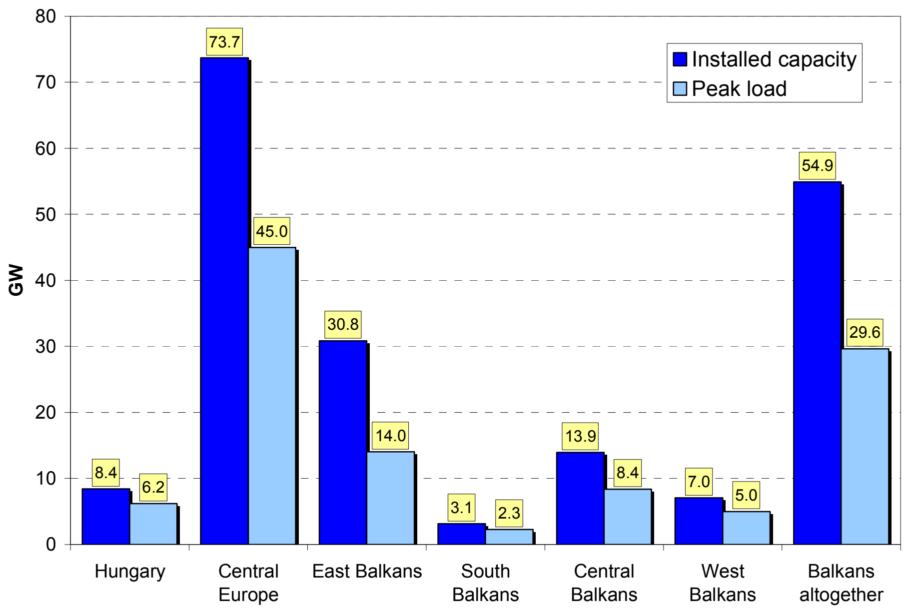
In this part we discuss and compare the main characteristics of the Balkan and the Central European regions' electricity markets. In the first part of the chapter we show the main parameters of the Central and South-European region's electricity sector. After we analyze the situation of power plants in each country, and finally we briefly discuss security of supply questions.

II.1. General presentation of the Balkan region's electricity sector

In the analysis we could divide the countries in two groups: one of them is the Central European which includes Poland, Czech Republic, Slovakia, Hungary and Austria, the other one is the Balkan region, which includes all the remaining countries. We divided the latter in further subgroups such as the South Balkan region (Albania and Macedonia), the East Balkan region (Romania and Bulgaria), the West Balkan region (Croatia and Slovenia), and the Central Balkan region (Bosnia-Herzegovina, Montenegro, Serbia).

In the following figure we present the size of the regional electricity sectors. Hungary is an exception, it is taken out from the Central European region and represented separately.

Figure 2: Regional installed capacities and peak demands in 2006



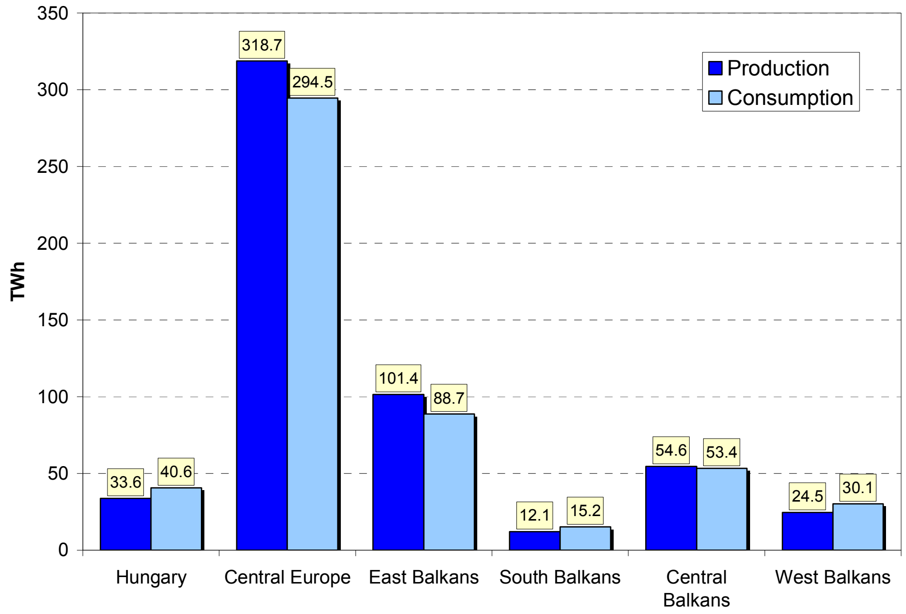
Source: UCTE and own computations

The total installed capacity in the examined countries is 136 GW, while the peak load is 81 GW. More than half of the total installed capacity is in the Central European region (73.7 GW). The installed capacity in the Balkan region is significantly less, about 55 GW while in Hungary it is 8.4 GW. Analyzing the demand-supply equilibrium in the simplest way, we find that the installed capacity in the Central European region reaches 1.6 fold of the peak periods demand, the same value is 1.9 in the Balkan region, while in Hungary it is 1.4. As we point out in our further analysis, the outlying value in the Balkan region is mainly due to the high proportion of hydropower capacities, whose available capacity significantly smaller than in the case of other power plants.

It is worth to compare the Hungarian and the Central Balkan region's parameters. Even though the latter includes three countries, its capacity is only 1.6 fold of the Hungarian, while this ratio in the case of peak demand is only 1.4.

In the following figure we represented regional production and consumption, in similar grouping.

Figure 3: Regional generation and consumption in 2006

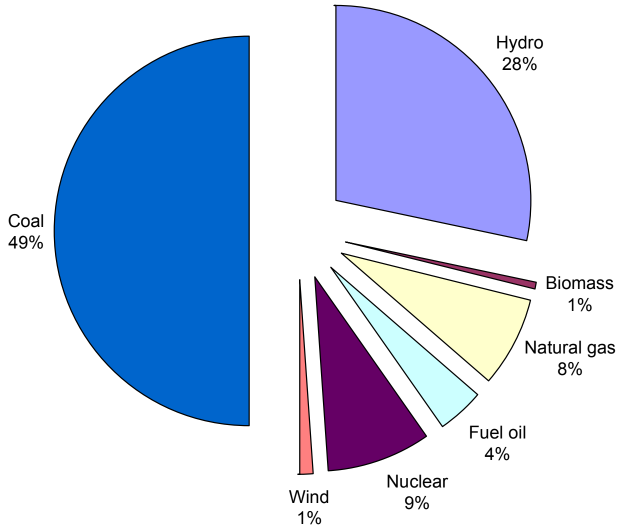


Source: UCTE

It can be seen that in overall the Central European and the Balkan region were net exporters in 2006. Analyzing the Balkan region in details, it can be seen that her eastern part (Romania and Bulgaria) was net exporter, the situation of Central Balkan is balanced, the rest is net importer. The Central European region exports mainly towards Germany, Sweden and Hungary, while the Balkan region towards Italy and Greece. Hungary, as it is widely known, is in important net importer position. The consumption of Hungary is equivalent of 60% of the the Central Balkan region, and to 22 % of the whole Balkan region.

Examining the compound of the fuel, it can be seen that almost the half of the total installed capacity (136GW) is generated by coal fired plants. Hydropower is significant as well, it is about 28 %, so these two types of power plants make out more than two thirds of the installed capacity. Natural gas is 8 %, nuclear energy is 9 %, while heating oil, biomass and wind energy are less than 5 %.

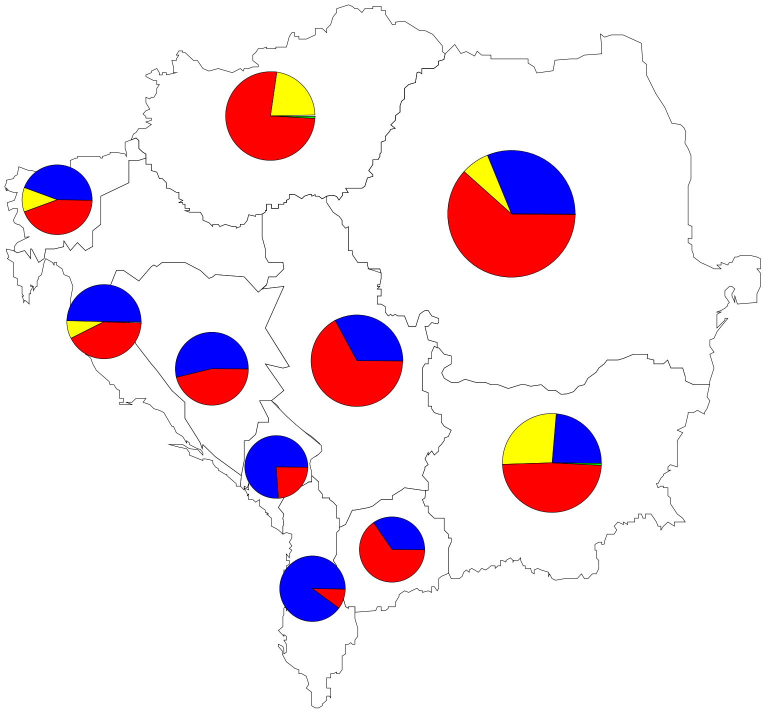
Figure 4: The distribution of installed capacities in the whole Central European and Balkan region



Source: own computations

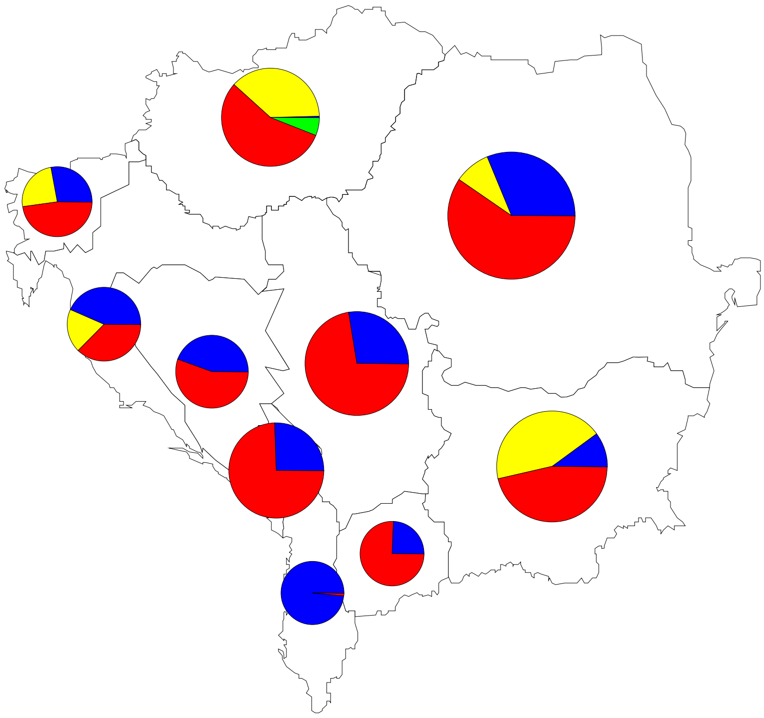
The next two figures show the fuel compound in each Balkanian country and in Hungary. The exposure to hydropower of each country can be seen in the case of installed capacity (figure 5.) and in the case of production as well (figure 6.). This is especially true in the case of Albania, Bosnia and Herzegovina and Croatia. Slovenia, Hungary, Bulgaria and Romania have the most diversified power plant portfolio.

Figure 5: Distribution of primary energy sources
among installed generation capacities



Source: UCTE (blue: hydro power, yellow: nuclear energy, red: fossil fuels, green: renewables)

Figure 6: The distribution of primary energy sources
among energy generation

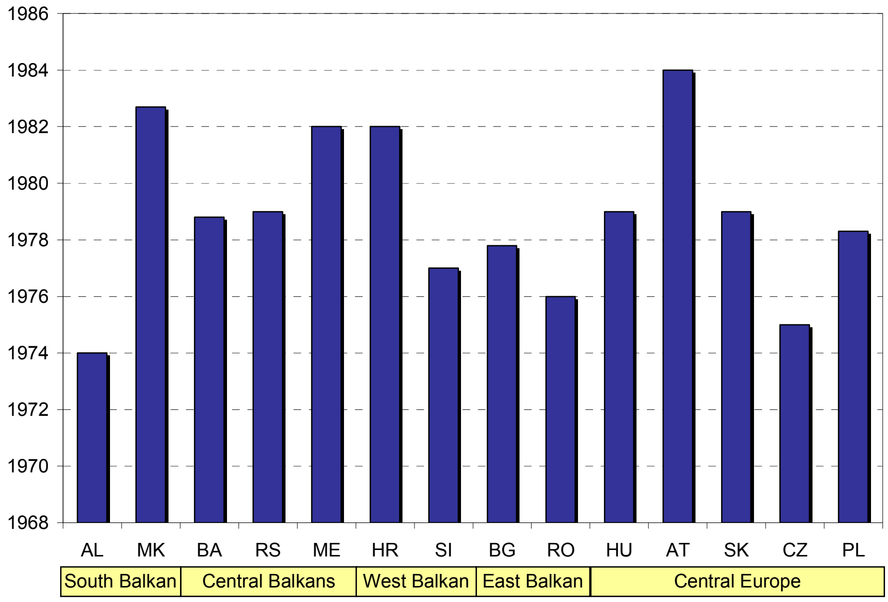


Source: UCTE (blue: hydro power, yellow: nuclear energy, red: fossil fuels, green: renewables)

II.2. The situation of power plants in the countries

The explanations of high South European electricity prices often cite that the average age of Balkanian electricity generating capacities is high, the capacities are dated, and therefore they can only be operated at a lower utilization capacity. All this contribute to a scarce supply. Thereafter we investigate this statement. We examine the state of installed capacities in each country, and the average utilization rate of operating power plants.

Figure 7: Average construction year of thermal power plants in each country



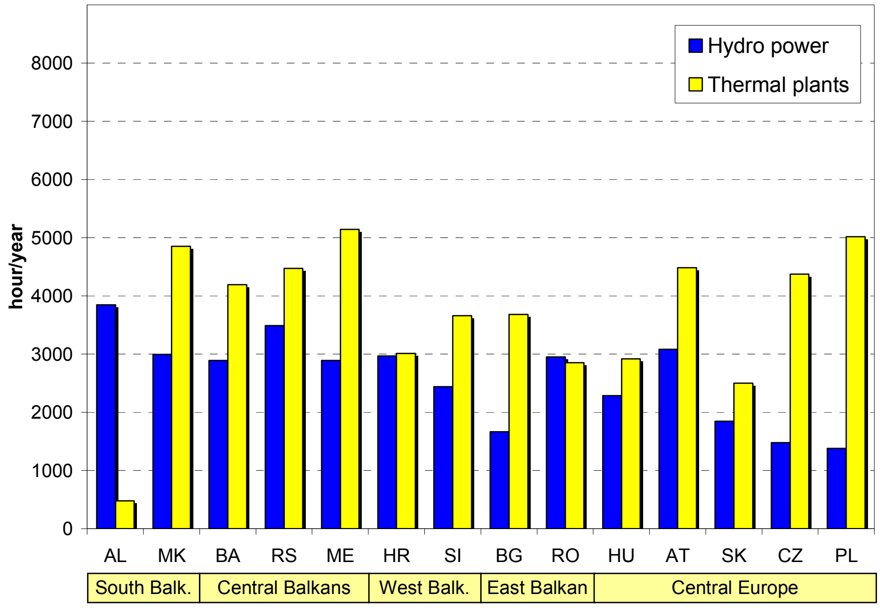
Source: own computations

In the figure above, the average construction year of the power plants can be seen. Albania has the oldest power plant set, she is followed by the Czech Republic and Romania. By the years of the construction years we can say that the power plants on the Balkans are not older than in the Central European region. However, we have data only about the construction years, we do not know about the actual renewals and so on, therefore it cannot be stated that the older power plants are less efficient.[13]

Thereafter we study what annual average utilization of hydroelectric power plants and thermal power plants are in each country.

[13] As it is widely known, the CEZ has carried out a big reconstruction program

Figure 8: Annual average utilization of hydroelectric power plants and thermal power plants in 2006



Source: UCTE, own computations

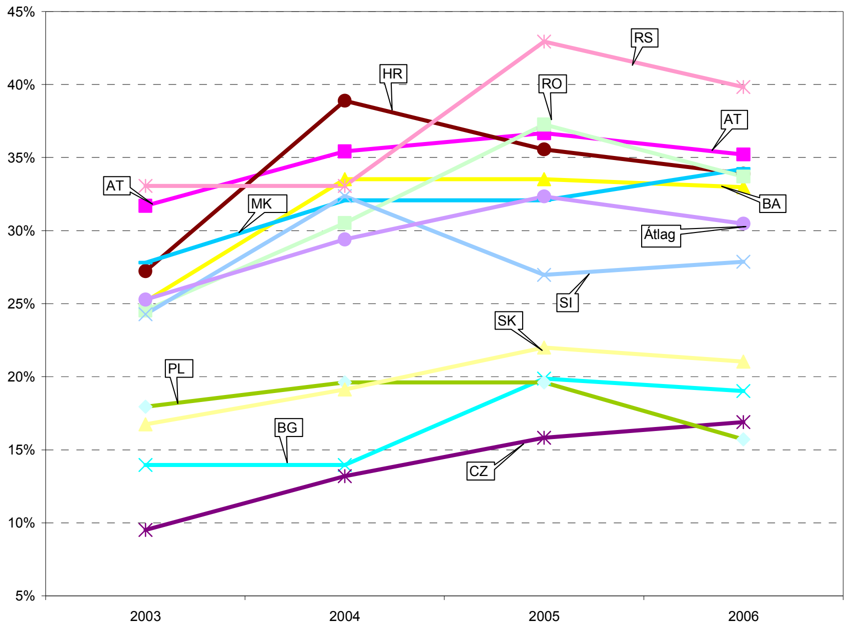
Studying all the countries, the average utilization ratio of thermal power plants is around 40-45 percent. The utilization of the Albanian thermal power station is especially low, which is mainly due to its bad state. Unlike in Poland, in Montenegro and in Macedonia where average utilization is far higher than the overall average. Hungary, just like Slovakia and Romania, has a low rate of average utilization, which is either due to the bad state of power plants or to extra capacities.

The average utilization of thermal power plants is 30-35% in the Balkans (Bulgaria is excluded), while in the Central European region it is significantly lower, 20-25% (Hungary and Austria are excluded). As we take in consideration only one year's data, the results are not surprising, because the Balkanian countries formulate one catchment area, and Hungary can be added to this as well, because the bigger hydroelectric power plants get water from the Eastern Carpathians. Therefore later on we analyze the utilization on a longer time series. Furthermore the generation of hydroelectric power plants is relatively negligible in the Central European countries (except for Austria), in 2006 these countries generated 10.4 TWh, while in the Balkan it was 57.2 TWh, in Austria it was 34.1 TWh. So the importance of hydropower in the Balkan region is obvious, as 30% of the generation comes from such power plants, so their utilization is crucial from the viewpoint of supply security.

In overall, the utilization of hydroelectric power plant is less than thermal power plants' almost in every case. While the previous' average utilization is 31%, that of the thermal power plants is 47.1%.

In the following, we present the average utilization of hydroelectric power plants in the last 4 years.

Figure 9: Average yearly utilization of hydroelectric power plants between 2003 and 2006



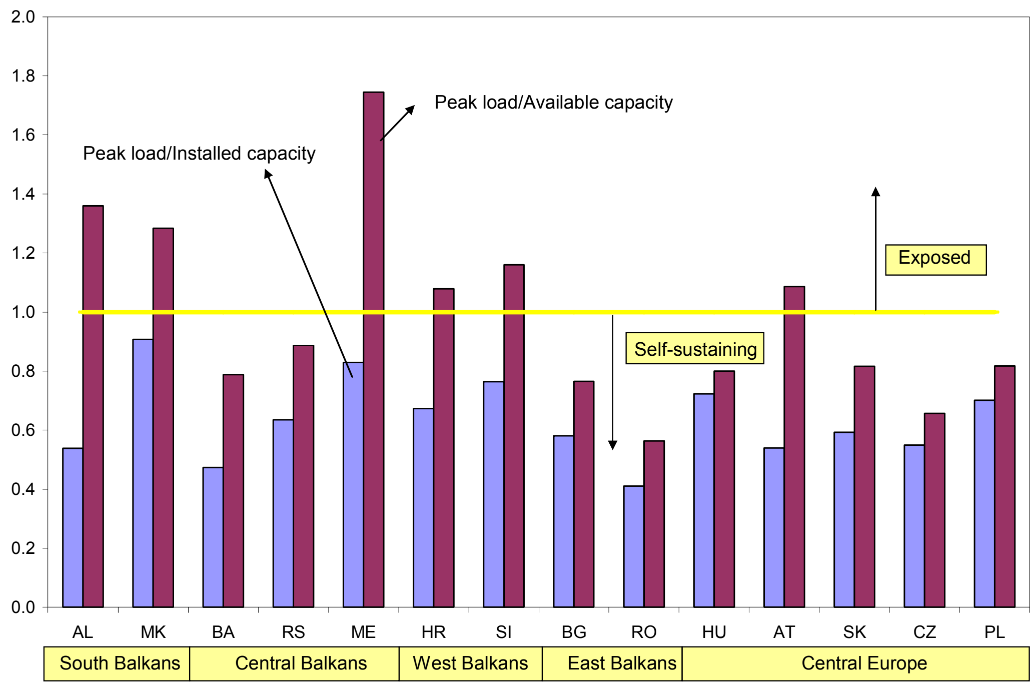
Source: UCTE

In the figure above we can see that the utilization of hydroelectric power plants importantly was increased between 2003-2005, and then there was a little drop. The average utilization was around 25-30 %. We can divide the countries in 2 groups: the first group consists of the Czech Republic, Slovakia, Poland and Bulgaria. In these countries the power plants operate at a low level of utilization. The rate of utilization is 10-15 % higher in the units of the Balkanian countries and in Austria. Apart from Bulgaria, we can say that this is due to the different catchment area.

II.3. Security of supply questions

Now we have a closer look on countries' potential of self-sufficiency and to what extent import capacities help to provide security of electricity supply.

Figure 10: Each countries' self-sufficiency potential



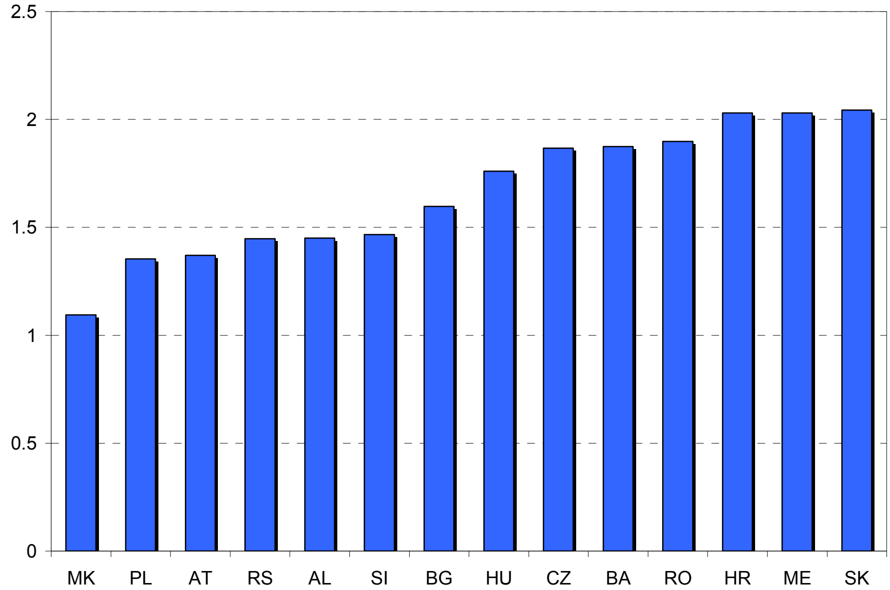
Source: UCTE, ETSO, own computations

In the figure above we can see the ratio of peak demand and installed capacity and the ratio of peak demand and available capacity. If in a country the peak demand exceeds the capacity, there is an import dependency, otherwise she can self sustain. In the figure we made 2 different columns. First we compared peak demand to installed capacities (Column 1), second to the available capacity (column 2). In latter case we supposed that hydroelectric power plants are only available 34 % of the time compared to installed capacities, while heat power stations 90% and nuclear stations 95%.

If we examine the installed capacities, every country could self supply in peak demand period. In this case the most exposed country is Macedonia, which is quite close to not to be able to self-supply. Bosnia and Romania have the biggest ratio if idle capacity, even in peak period they use 40-50% of their capacities. However in the case of available capacity, many countries need import in peak period. Albania, Macedonia, Croatia, Montenegro, Slovenia and Austria cannot self sustain because of the high proportion of hydroelectric power plants. This demonstrates that the high proportion of hydroelectric power plants is an important question of supply security. Analyzing Hungary, it can be seen that in both cases there are important capacity reserves.

In the figure below we added the import possibilities to the countries' domestic capacities, and compared it to the peak demand of 2006.

Figure 11: The ratio of the sum of installed and import capacity and peak demand



Source: ETSO, own computations

It can be seen that Macedonia is in a dire situation from a viewpoint of supply security, as she hardly can supply the peak demand even with import capacities. The safest countries are Croatia, Montenegro and Slovakia, these countries have twice as much capacity as the peak demand. Hungary is in the middle zone, compared to these countries.

III. A SHORT ANALYSIS OF THE ELECTRICITY MARKETS OF THE BALKAN COUNTRIES[14]

In this chapter we provide brief summaries of the electricity markets of the countries of the Balkan region, focusing on the structure of the domestic power sector, its owners, the investment plans, and – to the extent allowed by the availability of data – the characteristics of international trade.

III.1. Croatia

Croatia is positioned in the middle of the range of the Balkan countries (fourth position) in terms of its 2006 consumption (16.7 TWh), installed capacities (4157 MW) and production (14 TWh). At the same time, considering its net trading position, it imports the largest absolute volume of electricity within the Balkan, with 2.7 TWh in 2006. In comparison with its neighbors, Croatia has a well diversified fuel base, its portfolio consists of coal, gas, oil and nuclear[15] as well. Still, like in all other Balkan countries, Croatian power supplies heavily depend on hydropower (43% in 2006). At the moment there are no known major plans for power plant investments in Croatia, only construction of a new gas turbine, and 30-50 MW of biomass capacities are planned by the incumbent.

The Croatian electricity sector is dominated by a vertically integrated holding company called HEP. Production, transmission, system operation, distribution and service activities are all carried out by subsidiaries of the holding company. Almost 100% of the power plants are owned fully or partially by HEP. Based on an Act adopted in 2002 before Croatia joins the EU, at least 51% of HEP shares must be owned by the Croatian state, while some shares are handed to employees of HEP and retired soldiers, and the rest is distributed among Croatian citizens and private investors.

In 2006 only 6% of the final consumers decided to enter the competitive market, the rest was served in the public utility market by HEP. Since the country considerably depends on imports, in order to supply the public utility segment, HEP also controls most of the international trade. This dominance is further augmented by the ownership of the transmission system operator which decides over the availability of the cross-border capacities. HEP's main import partner is one of the Bosnian incumbents, EPBiH, with which it has a 5-year import contract that will expire this year. As part of this contract, in 2008 the Bosnian partner will deliver 1.126 TWh of energy, equivalent to 41% of the 2006 net import of Croatia. Other

[14] The main sources of data used for this summary are as follows:
Platts: Energy in East Europe. 2007 and (partial) 2008 publications.
ETSO (2007): Overview of transmission capacity allocation methods in SEE.
UCTE website: production and consumption data.
Websites of the national regulators and TSOs.
Interviews with regulators and system operators as part of the **South East Europe Electricity Market Monitoring Project** organized by Naruc in 2007.

[15] The Krsko nuclear power plant (with total installed capacity of 650 MW), located in Slovenia, is owned by Croatia and Slovenia together, and its output is equally shared between the two countries.

than Bosnia and Herzegovina, Croatia has cross-border capacities on the Slovenian, Serbian and Hungarian borders. Croatia imports from Hungary to supply domestic consumption and also to transit electricity to other countries. Trading companies supplying the consumers on the public utility market, and also those who export the power produced domestically have a priority over the use of all cross-border capacities. These traders do not have to pay for the use of these capacities while the rest of the capacity is auctioned. Power transit [passing through Croatia] is subject to a tax of 2.8 €/MWh. Apparently, international transfers are rather distorted, and domestic traders are favored, partly through the priority applied at the borders, and partly through the transit fee. Thus, the relatively cheap import stays within the country, while the somewhat more expensive domestic production is exported to the rest of the Balkan countries, the difference is enjoyed by Croatia.

III.2. Serbia

Based on its 2006 consumption (37.6 TWh) Serbia ranked as the second largest in the region, while production (38.32 TWh) and installed capacities (9234 MW) qualified it for the third place. In terms of its foreign trade balance, the country is in a moderate net importer or net exporter position, depending on the weather which has an influence on production of hydro power. The majority of electricity production is coal based (72%), and in addition to negligible amounts of gas based production, hydro power is the other major source of electricity (28%). Serbia plans to replace much of its ageing generating capacity, with the four oldest coal fired plants to be replaced by 2015, and a new 700 MW coal fired unit and modern gas fired plants are to be built.

The sector is dominated by the old, vertically integrated incumbent, EPS, owned 100% by the state. EPS controls 94% of the generating capacity, the network operator EMS, and all five distributors and retailers as well. There is a multi-level price regulation in the sector, the production, wholesale and retail prices are all regulated. While hypothetically there could be a competitive market, due to the low public utility prices at the moment there isn't any consumer who would purchase outside of the public utility segment. Therefore Serbia is not yet a target country for new entrant suppliers. Traders currently either sell their power to EPS at the border, or transit / export electricity.

Regarding foreign trade, Serbia has a central role in the Balkan region, connecting net importer countries with net exporters. Since domestic consumers are served solely by EPS, the company also dominates export and import activities. 95% of its import is procured through annual tenders, while 5% is obtained through spot trade. At the same time, transit has a great international relevance. Distribution of the capacities is done by the EPS owned EMS, which organizes auctions on all borders and not a single participant enjoys a preferential position. Due to its central location and the taxes imposed on export and import, 25-30% of EMS revenues are received from those traders which use the Serbian transmission network for transit purposes. EMS plans to expand its transmission network, including a new Serbian-Romanian crossborder line, which is expected to have a great influence on international trade.

III.3. Montenegro

Montenegro is the smallest country of the region, in terms of consumption (4.68 TWh)[16], installed capacity (868 MW) as well as production (2.8 TWh). Nevertheless, this country is the second largest importer (tied for the title with Macedonia), with 2006 net import of 1.88 TWh. The electricity network of Montenegro is closely linked to the Serbian system, separation having started only recently. 60-70% of the production is hydro power based (depending on the weather), the rest is coal based. The pool of Montenegrin power plants has not been refurbished for 25 years. In the national energy strategy a new coal fired plant and additional hydro power plants are provisioned.

The electricity sector is dominated by the vertically integrated incumbent, EPCG, which is also listed on the stock exchange. 67.65% of the stocks are owned by the state, 11.81% by private individuals, while the rest is owned by privatization and investment funds. At the moment EPCG owns all domestic production capacities, but privatization of the sole thermal power plant and the related lignite mine is on the agenda, possibly triggering private investments, and thus expansion of capacities in Montenegro. The rest of the sector activities, namely system operation, transmission, distribution and supply are all carried out by EPCG. Final consumer prices are regulated. There is only one consumer on the competitive market, the KAP aluminum manufacturer, which secures part of its consumption through its own import.

The net importer Montenegro has cross-border capacities with Albania, which is also a net importer, Bosnia and Herzegovina, which is a net exporter, and Serbia, which has a balanced foreign trade position. Cross-border capacities are auctioned by EPCG without providing preference to anyone. Concerning foreign trade activities, Montenegro has an agreement with Serbia, according to which until 2016 EPCG supplies EPS with 360 MW of peak energy daily from the Piva hydro power plant, in exchange for 2.5 GWh of base load power[17]. On top of this international agreement, in 2006 EPCG purchased significant amounts from two traders, called EFT and Energy Holding, in the form of annual contracts. while EPCG bought smaller amounts from several traders and state owned incumbents through short term contracts. Besides EPCG, only the KAP aluminum manufacturer imports power, its 2006 import was 705.6 GWh. Regarding network development, EPCG plans to expand its cross-border capacities at the Albanian border, which investment may well be finished by 2009. This expansion may further integrate the internal market of the region.

III.4. Albania

Based on its 2006 consumption (6.76 TWh) and production (5.58 TWh), Albania is the second smallest in the region, while its installed capacities qualify it for the sixth place – out of eight. Albania, nevertheless, relies on substantial volumes of import, 1.18 TWh in 2006. Electricity production in Albania heavily depends on the weather, as 99% of its 2006

[16] 42.55% of the 2006 gross consumption of 4.68 TWh is attributed to the KAP aluminum manufacturer.
[17] This is equivalent to an exchange rate of 1:1.425, while the same rate at the Leipzig Energy Exchange is 1:1.7.

production came from hydro power. Regarding coal fired plants, 89 MW is functional out of the total installed capacity of 150 MW. Concerning future capacities, there are plans for several new hydro power plants, but these will, nonetheless, not provide a remedy to Albania's extreme dependence on weather.

The Albanian electricity sector is dominated by the vertically integrated incumbent, KESH, which is fully owned by the state. The company controls all production capacities, and also OST, the legally separated transmission system operator. By now a distributor-supplier company was established, as a subsidiary of KESH, and plans about its privatization were announced in March 2008. Final consumer prices are set by regulation at a drastically low level, consequently KESH requires constant financial support from the state. Even the World Bank has suggested on several occasions that electricity prices should be raised to cost reflecting levels. Due to the low prices in the public utility segment, Albania also lacks an operating competitive market.

The net importer Albania has cross-border capacities with Greece (also a net importer), Montenegro and Serbia (Kosovo), all of which are distributed through auctions.[18] As a result of the Albanian market structure, all power import is carried out by KESH, but this is done in a rather transparent fashion, through public tenders covering a year or longer periods.

On top of the auction fees, both exports and imports are subject to additional fees, distorting commercial flows. As far as network investments are concerned, a noteworthy investment is the already mentioned expansion of cross-border capacities at the Montenegrin border.

III.5. Bosnia and Herzegovina

Bosnia and Herzegovina is in the middle of the region – fifth largest -, in terms of its 2006 consumption (11.5 TWh), production (13.6 TWh) and installed capacity (3808 MW). When we look at its international position, however, it is a major exporting country of the region (2.1 TWh). Production in Bosnia and Herzegovina also depends on the weather, but domestic coal based generation is also significant. Regarding the future, despite ample production capacities, there are plans to construct several new power plants: seven coal based plants with a total capacity of 3200 MW, and several hydro power plants, small and large alike.

On the territory of Bosnia and Herzegovina the transmission network is separately owned from the rest of the sector activities, being supervised by two state owned companies, one of which operates the network, the other is responsible for system operation. Both companies are supervised by the state regulatory agency (SERC), which also sets the fees theirtariffs. Production, distribution and supply within the three administrative entities (the Bosnian, Serbian, and Croatian regions) are separately managed by three vertically integrated regional companies; Elektroprivreda BiH, Elektroprivreda HZ, and Elektroprivreda RS. Functional unbundling of all three companies is on-going at the moment. The corporations have their own regulatory bodies, in all three areas production and final consumer prices are regulated.

[18] Regarding the border of Greece and Albania, at this time the Greeks do not allow power to be exported to Albania, in order to keep domestically produced and imported electricity within the country.

90% of the shares of the companies are still owned by the state, but further privatization is planned with the goal of reducing state ownership to 50%. Outside of the three companies, in District Brčko distribution and supply is carried out by a company of the local government. Concerning the adequacy of production, Elektroprivreda BiH (EPBih) and Elektroprivreda RS have surplus capacities (2.2 TWh and 2.1 TWh, respectively), while Elektroprivreda HZ (-1.4 TWh) depends on substantial import, which is satisfied by EPBiH through an annual contract.

International trade takes place at the Montenegrin, Serbian and Croatian borders, and in spite of the fact that outside of Romania Bosnia is the only country where the system operator is ownership unbundled allocation of the capacity is not market based, but is done on a *pro rata* basis. International trade is performed by the incumbents, most information is available on the trade activity of Elektroprivreda BiH. In 2007 EPBiH issued a tender for sale of the surplus 2008 energy (724.54 GWh). Atel from Switzerland (637 GWh) and the Energy Financing Team from Britain (88 GWh) won the bid at an average price of 75 €/MWh, equivalent to 54 million euros.[19] Moreover, as part of an already mentioned 5 year contract, which will expire in 2008, the EPBiH sells 1.126 TWh of energy to the Croatian incumbent.

III.6. Macedonia

Concerning its consumption (8.4 TWh) and production (6.5 TWh) Macedonia takes sixth place in the region, while its installed capacities (1543 MW), slightly below Albania's, surpass only that of Montenegro. The net import of Macedonia (1.9 TWh) ranks it as the second largest importer of the region (together with Montenegro). The usual Balkan pattern of substantial hydro power (25%) and coal (60%) is supplemented with oil based production (15%). Concerning the future, the country plans to invest mainly in gas based production and hydro power generation, partially expected to be functional by 2009. The scale of these investments, nonetheless, is not too large, the net import position of the country is likely to stay.

Separation of the activities has already taken place in Macedonia, production and distribution is also unbundled from the transmission network. The majority of production is done by three state owned companies, the coal based AD Elem, generating 60% of domestic power, the oil fired TPP Negotino and JP Strezevo, which operates small hydro plants. MEPSO is also a state owned company, which, besides performing the tasks of transmission and system operation, is also the public utility wholesaler responsible for purchasing energy to satisfy the needs of tariff based consumers. At a regulated price MEPSO buys all of the output of AD Elem and TPP Negotino, and through tenders it also secures the import to serve the needs of tariff based consumers. Distribution and retail supply of the tariff based consumers is done by the AD ESM company, 90% owned by the Austrian EVN AG, while the last 10% is owned by the state. The output of JP Strezevo is directly purchased by AD ESM, also at a regulated price. Moreover, the company also operates 11 small hydro power plants, and it has the freedom to sell the generated power without regulation. To sum up, while the activities are

[19] The Government wanted to attack the results of the tender and remove the managers of EPBiH, but this effort finally did not prove successful.

separated for the most part, the Macedonian market is characterized by state ownership and the dominance of regulated prices.

International trade takes place at the Bulgarian, Serbian and Greek borders. Concerning the allocation of the cross-border capacities by MEPSO – which is also the public utility wholesaler -, the capacities at the Bulgarian-Macedonian border are not available to third parties, since for the time being these lines are used to transport power from Bulgaria to Macedonia, as some sort of a payment in exchange for constructing another 400 kV network of the Chervena Mogila. Capacities at the Greek border are allocated through a shared auction, while *pro rata* is used at the Serbian border. There is a substantial difference between the price of the import purchase of MEPSO and the regulated price at which it buys domestic production, at 70 and 21 €/MWh in 2006, respectively. A large increase in imports is forecasted for 2008, with the import need expected to be 3917 GWh.

III.7. Romania

In 2006 Romania took the first place in the Balkan region in terms of consumption (58.1 TWh), production (62.4 TWh) and installed capacity (19500 MW), and by now, having passed Bulgaria, it also became the largest net exporter of the region. Concerning the structure of production, Romanian power generation is one of the most diversified and balanced in the region, in addition to the usual hydro power (31%) and coal based production (39%), it also has gas (5%) and oil (18%) fired plants, and nuclear generation (7%).[20] Regarding future investments, the 2007 energy strategy of the Romanian government declared, among other plans, construction of additional coal fired, nuclear and renewable power plants, enabling Romania to produce 100 TWh, and export 15 TWh of electricity by 2020.[21]

Restructuring of the Romanian power sector has already taken place, the system operator is independently owned, 10% of its stocks are listed on the stock exchange. 70-80% of production capacities are owned by the state,[22] and more than half of these capacities are also reserved at the regulated price through contracts between the producers and the public utility suppliers. The other half of the market (50%) is competitive - this is an exceptionally high degree in the Balkan region -, 11% of which (equivalent to 5% of the total market) participates on the Romanian power exchange. Concerning the retail segment, out of the eight supplier-distributor companies, five have already been privatized. Nevertheless, the already mentioned Governmental energy strategy seeks to create a vertically integrated “national champion” company, and this may slow down further privatization.

[20] The percentages here refer to the fuel structure based on installed capacities, while in the previous country descriptions they indicated the 2006 production data.

[21] In addition to the envisioned 2014 or 2015 completion of generating units 3 and 4 of the Cernavoda nuclear power plant, each with 700 MW of capacity, the Government plans to build an additional nuclear power plant. Iberdola has just purchased a 1600 MW wind power portfolio, the first projects of which will start operation in 2009. Moreover, there are plans for two hydro power plants on the Danube in cooperation with Bulgaria.

[22] Privatization of these state owned power plants is also on the agenda. On 3 March 2008, for example, 16 small hydro power plants were sold to private investors. By the end of 2008 some of the lignite fuelled power plants are also planned to be sold.

Within the UCTE region Romania has cross-border capacities at the Bulgarian, Serbian, Western-Ukrainian and Hungarian borders. With the exception of Ukraine, allocation of these capacities is done through auctions, no one has privileges. Since July 2007, for the first time in 20 years, Romania has also been importing electricity from Russia, or – to be more precise – from the Moldayskaya thermal power plant located in Transnistria, which legally belongs to Moldova, but has essentially broken away from it. A subsidiary of RAO UES, the company executing the Russian foreign trade of electricity, has a 50% control over the power produced at this plant. According to the one year contract, which prompted the delivery of power in July 2007, Romania will import at least 613 GWh of electricity from Transnistria.[23] Another piece of recent news is that the Romanian import from Ukraine is also under expansion. In summary, from the perspective of the region, Romania is not only a major net exporter with low-cost production, but it is also a trader with the capacity to channel even cheaper sources into the region, which – based on its plans of investments and network development[24] – can reinforce its leading net export position in the region, while also contributing to lower regional prices.

III.8. Bulgaria

The 2006 consumption (37.4 TWh) of Bulgaria qualifies it for the second place in the region (together with Serbia), while its 2006 production (45.7 TWh) and presently installed capacities (10336 MW) are also below those of Romania. While in 2006 Bulgaria used to be the largest net exporter in the Balkan (8.3 TWh), following the shut down of two generating units (number 3 and 4) of the Kozloduy nuclear power plant, it is now only the second largest net exporter. Similarly to Romania, the structure of production in Bulgaria is well diversified, in addition to hydro power (26%), coal (50%) and natural gas (4%) there is also nuclear power generation (19%).[25] The age of the thermal power plants is a cause for concern, some of them were built in the 1950s, and 80% of all thermal plants are older than 20 years. To circumvent this problem, the Bulgarian investment plans include 3600 MW of new capacities by 2014.

Regarding the structure of the sector and ownership characteristics, almost all of the hydro power plants of the country are owned by NEK, the 100% state owned, vertically integrated incumbent. Several thermal power plants, and the Kozloduy nuclear power plant are also state owned. Private ownership within the power generating sector is at around 42% of installed capacities, and this ratio will likely further grow partly because of further privatization, and partly in connection with new investments. Even though many power plants are privately owned, the wholesale market is considerably concentrated partly due to the long term power purchase agreements between NEK, which is also the public utility wholesaler and the power plants, and partly due to the contracts between NEK and the public utility service providers (distributors and suppliers). The transmission network is operated by ESO, which is a

[23] The price is 38 €/MWh according to unofficial sources (Platts: Energy in East Europe, July 2007)
[24] In addition to expanding its already existing cross-border capacities, Romania also plans to build new lines, such as the planned sub-sea cable linking it with Turkey.
[25] The fuel structure is again based on installed capacities.

subsidiary of NEK. Concerning distribution and supply, the seven distributor-supplier companies were privatized in three packages to E.ON, CEZ and the Austrian EVN. Based on the structure of the market, it is obvious that there are regulated prices both in the wholesale and the retail markets. Even though any consumer can select its own supplier since July 2007, since regulated prices are very low, Bulgarian consumers choose not to enter the more expensive competitive market. The low regulated prices are cross-financed by NEK's export revenues.

The Bulgarian Government, just like the Romanian, would like to create a national champion company in the energy sector. The Bulgarian Energy Holding (BEH) would own the Maritza Iztok coal mines, which satisfy the domestic coal demand, the lignite fired Maritza Iztok thermal power plant, the Kozloduy nuclear power plant, the NEK and the Bulgargaz Holding.

Regarding international trade, Bulgaria has cross-border capacities at the Greek, Serbian, Macedonian and Romanian borders. Until 2007 NEK had a monopolistic position in international trade, therefore allocation was not an issue. Even though these monopolistic rights were suspended by law as of January 2007, the first cross-border capacity auction took place only in September 2007. Significant interest, corresponding to a price greater than zero, was observed only at the border between Bulgaria and Greece, and most capacities were taken by NEK itself.[26] This incidence shows that the option to export in itself is not enough, since NEK controls most of the production capacities, others do not have access to the sources. Another reason for the observed indifference is that producers can receive an export permit only if they already supply at least 25% of the domestic consumers. Besides the incumbent NEK, there is no such producer. Furthermore, traders cannot directly trade with each other. When a trader would like to export, it has to purchase the power from NEK at the border, and then it can resell it, hence the Government can completely stop trading, and there is no room for back and forth trading.

Lastly, the decline in export potential due to the suspension of the two generating units of the nuclear power plant is well characterized by the fact that on 14 January 2008 the Government banned all electricity export due to a radical increase in domestic consumption, and this prohibition stayed in force until 1 March.

III.9. Summary

With the exception of Romania, the domestic markets of the Balkan region are dominated by vertically integrated incumbents, either as owners, or through long term power purchase agreements. Therefore domestic market competition does not really exist, while prices are often artificially kept at a low level, frequently supplemented by the state (Albania), or cross financed from the export revenues of the incumbent (Bulgaria). Regarding international trade, the biggest participants are the national incumbents, which usually use annual tenders to purchase or sell electricity. Multi-year contracts may also exist, such as the five year contract

[26] At the Greek border besides NEK, capacities were allocated to traders Vivid power, Arcadia and Enemona, while at the other borders CEZ and EFT participated in the auction.

between Croatia and Bosnia, but the duration of most contracts is one year or less. Part of the purchases are arranged through publicly announced tenders. The publicity and frequency of the tenders help to assure that foreign trade prices, as opposed to domestic prices, indeed reflect the interrelation of supply and demand. There are, however, several factors which distort the commercial nature of the market, specifically: the system operators allocating cross-border capacities, with the exception of Romania and Bosnia and Herzegovina, are not independent from the incumbents; allocation of cross-border capacities is not market based in all countries, or it is not available to every participant; and the existence of export and import fees.

Concerning the future trade position of the region, the volume of the planned power plant investments in all countries is sufficient to at least replace the obsolete plants, while the investment plans of Romania and Bosnia and Herzegovina clearly surpass the simple replacement level. In addition, supply will get better as a result of the improvement of network capacities, among other things important cross-border capacities are created, such as the ones between Serbia and Romania, and Montenegro and Albania, and these will also contribute to equalizing regional prices. Through restoring Russian and Ukrainian connections, Romania imports additional power from a cheaper region. Generally speaking, based on these plans, the net trading position and the prices of the region will certainly not get worse, and depending on the rate at which consumption grows, they may even moderately improve.

After having reviewed the attributes of the South-East European power market, now let us proceed to the description of the methodology and results of our one-sector equilibrium model covering the Central European and South-East European region (including Hungary).

IV. CENTRAL AND SOUTH-EAST EUROPEAN ELECTRICITY MARKET MODEL

The prime question of our study can be easily phrased: can it be confirmed that the recent increase in the price of wholesale electricity in Hungary is attributable mainly to the shortage of electricity in the South-East European countries?

Which mechanism raises the price of power in Hungary to, e.g. the Croatian level? Obviously, it can only be international trade. When power traders observe that electricity bought in Hungary can be sold at a higher price in Croatia, then they will buy more in Hungary, and sell more to the South of the border, realizing the difference in prices as their surplus.

Since the cost of transporting electricity is negligible, having no other obstacle it is worthwhile to continue to export from Hungary to Croatia as long as the price level in the two countries become equal. Nevertheless, there are other obstacles, mainly the magnitude of cross-border capacities between the two countries.

Once the export to Croatia reaches the highest possible volume at the cross-border profile, and a difference in price between the two markets still exists, then we can be certain about two issues. First, the prices cannot get any closer to each other, since there is no more unused trading capacity. Secondly, the surplus profit that can be earned on the export-import trade will not be realized by the traders themselves. The right to use the cross-border capacity can be obtained through an auction, at which participants will be willing to drive up the price of cross-border capacity almost to the level of the expected difference between the power prices of the two countries. This is simply a consequence of the competitive nature of power trade.

The profit derived from trading at full capacity utilization will thus, without doubt, be realized by the state owned system operator which is responsible for selling the cross-border capacities. Therefore, in an economic sense the statement that the net revenue of trading will "leave the country" is certainly not true.[27]

Continuing the example of the two countries, let's assume that the full export capacity has been utilized and there is still a price difference between the two countries. For the sake of the example, let's assume a Hungarian price of 60 €/MWh and a Croatian price of 70 €/MWh. What would happen to the price in Hungary, if the price in Croatia further increased to 80 €/MWh (due, for instance, to exacerbating shortage of southern capacities)? The answer is "nothing", since there is no room for additional export. The system operator, and thus, indirectly, the country would nevertheless clearly benefit from the increased difference in prices, since instead of 10 €/MWh, twice as much, 20 €/MWh would be realized as revenue from the auction at the border.

[27] This statement should be refined in as much as the full available capacity is usually equally shared and sold between the system operators of the neighboring countries. Therefore regardless of the direction of the trade, the system operators of both countries can be expected to receive identical returns.

IV.1. Modeling of multilateral trade

We know that market prices are shaped by domestic demand and supply, and also by the characteristics of export and import. The latter depend on the prices of neighboring countries in comparison with our domestic prices, and these foreign prices depend on local demand and supply, and export and import. It is easy to recognize that very soon we face a circular pattern of reasoning.

There is an obvious resolution to this problem, however: in countries which have direct or indirect commercial relation with each other, the level of prices, export and import flows, and the utilization of cross-border capacities are all determined at the same time, simultaneously; logically none of these values are determined before the rest. If we would like to understand the reason for the actual level of export from Hungary to Croatia, then all other potential trading partner countries also need to be appraised.

The group of countries taking part in the modeling exercise thus quickly expands. At first, we need to include Bosnia and Herzegovina, Serbia, Slovenia, Austria, Slovakia, the Ukraine and Romania in the analysis. Nevertheless, we cannot ignore the Czech Republic, Poland, Bulgaria, Macedonia, Montenegro, and Albania either, since these countries may have an impact on the countries which can directly trade with Hungary and Croatia, and thereby the Croatian-Hungarian export and import flows would be also affected.

Where should we draw the border of the analysis? Theoretically, we cannot exclude any country unless trading is physically impossible. Practically, this would be at the edge of UCTE, specifically, in addition to the already listed countries, Greece and all of Western Europe (including the Eastern half of Denmark, which is also connected to the UCTE system). This task, however, would be clearly beyond the scope of the study, what is more, it would imply excessive complications compared to the original question.

We expanded the group of modeled countries because of the mutually present back and forth impacts. One can easily imagine that a decrease in Serbian production capacities has an effect on Bulgarian market prices, and vice versa, therefore it makes sense to explicitly incorporate the producers of both countries into the modeling exercise. There are, however, large countries or groups of countries at the Western edge of the Central and South-East European region, where a price change will influence the Eastern neighbors, but this impact is unidirectional due to the large difference in size. The Slovenian market would be sensitive to changes in the Italian market, but this would not be true in the opposite direction.

In the case of these large and relatively advanced countries (which have, among others, a liquid power exchange) fortunately price information can be easily accessed, and as detailed above, such data can be considered exogenous from the perspective of the modeled region. The German-Swiss region and Italy can be regarded as "large countries". Due to their slight impact the following countries have also been placed among the non-modeled neighbors of the region: Sweden (a modest connection with Poland, used in one direction only), Western-Ukraine (limited size, quite cheap source of import), Greece (weak connection with the rest of the Balkan). The demand and supply side of the electricity markets of all the other, listed countries are explicitly represented during the modeling exercise.[28]

IV.2. Modeling of the supply side

A number of primary fuels are available to generate electricity, the most important being coal, natural gas, hydro power, and nuclear power. Since we are modeling short term competition, out of the costs of production we shall focus exclusively on marginal costs. It can be assumed with good approximation that the marginal cost of electricity generation for a given technology will stay within a narrow range even when the level of production itself changes; taking this into account, we will use constant marginal costs in our calculations.[29]

In order to estimate the marginal costs, most of all we need to determine the cost of fuel needed to generate 1 MWh of electricity. Essentially we have two options. We can either divide the observed fuel use (or the related expenditures) of the power plants with the volume of generated electricity, or we can estimate the technology based marginal cost of power generation based on the energy conversion efficiency rate of the generating units and the observed fuel prices in each of the regions.

Even though the first approach (use of actual cost data) is more attractive in theory, in practice this method is completely impossible to implement – at the level of consistency required by modeling – due to the confidential nature of the necessary business data. As opposed to this, the advantage of the method based on technological estimates is not only the substantially reduced data need, but also the consistency inherent in the process: even if we go wrong with the actual level of costs, the marginal costs of the power plants *compared to each other* will stay consistent.[30]

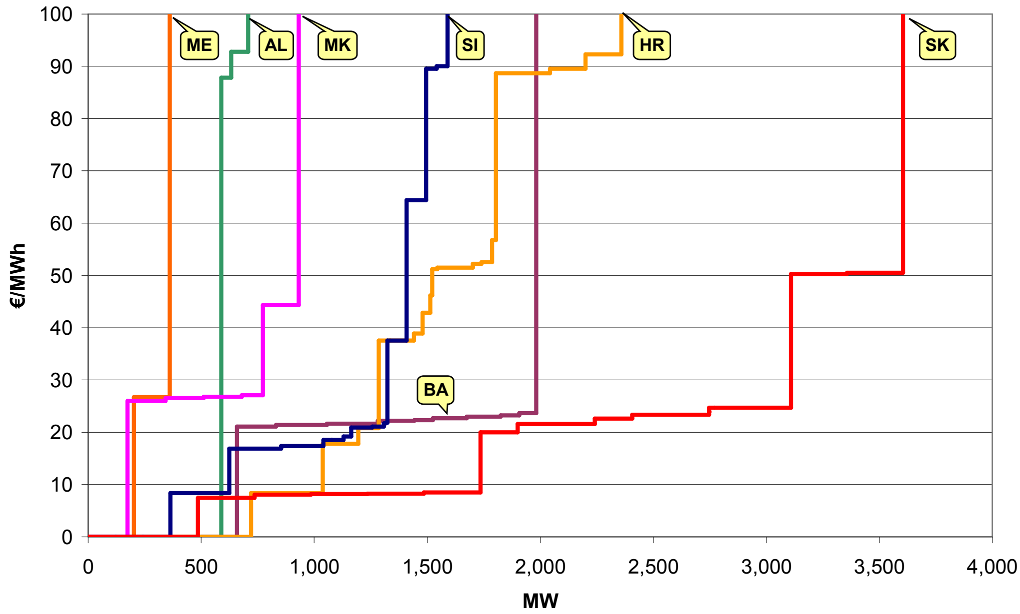
The marginal cost curves derived from the technological estimates were summed for each country; as shown in the following figures (Figure 12 and Figure 13). During this exercise we already accounted for the closure of generating units number 3 and 4 of the Bulgarian Kozloduy nuclear power plant, and the launch of the Romanian Cernavoda 2 nuclear generating unit. Since the size of Central and South-East European countries greatly vary, the horizontal axes of the two figures are scaled differently.

[28] In order to save room, when graphically describing the basic assumptions, the data, and the results, instead of the names of the countries, often only the abbreviations generally used in the UCTE system will be displayed, as follows: Albania (AL), Austria (AT), Bosnia and Herzegovina (BA), Bulgaria (BG), Czech Republic (CZ), Croatia (HR), Poland (PL), Macedonia (MK), Hungary (HU), Montenegro (ME), Romania (RO), Serbia (RS), Slovakia (SK), Slovenia (SI); and Greece (GR), Germany (DE), Italy (IT), Switzerland (CH), Sweden (SE) and (Western-)Ukraine (UA_W).

[29] Because of the presence of fixed costs, the average cost of production is of course not constant. Nevertheless, since we work with short term supply decisions, we handle fixed costs (such as salaries and capital costs) as sunk costs, which are irrelevant from the perspective of the optimal supply decisions of the power plants.

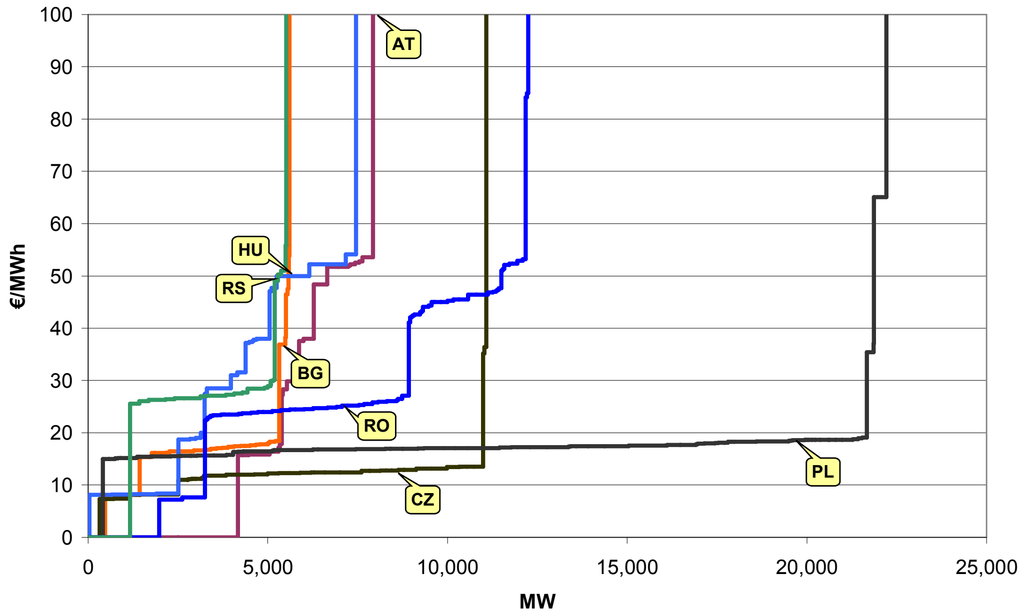
[30] In case of hydro power we need to apply a somewhat different approach, since the potential energy of water lacks a price in an everyday sense. The concept of opportunity cost, however, is also valid for this case: water utilized today cannot be used for power generation tomorrow, therefore tomorrow's revenue is lost. Estimating the opportunity costs, however, would require a complete dynamic market model, which is far beyond the scope of the present study. As a second best solution, we simply set the marginal cost of hydro power to zero, but limit the volume of electricity that can be produced to the level of the average annual capacity utilization.

Figure 12: Aggregated marginal cost curves for the countries with available capacities below 4 GW



Source: own calculations

Figure 13: Aggregated marginal cost curves for the countries with available capacities above 4 GW



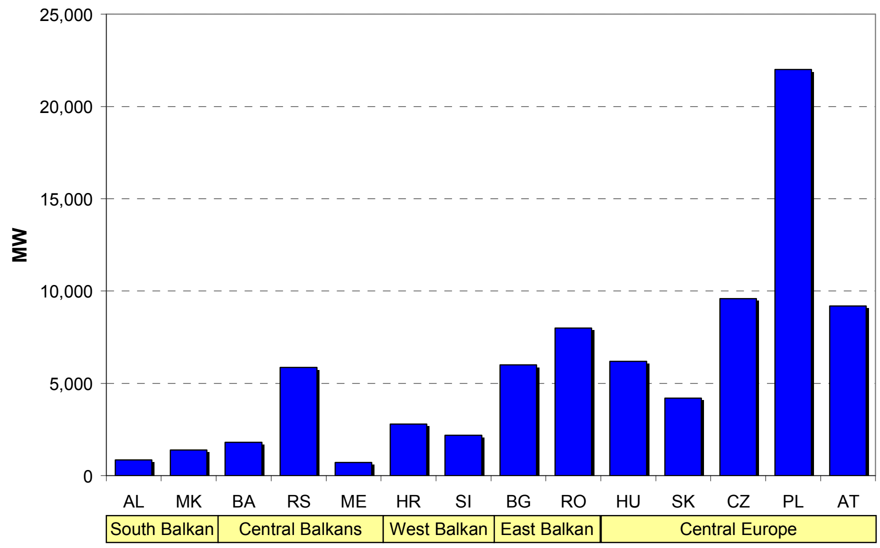
Source: own calculations

In the above figures, which depict the available production capacities and their costs, we also indicated the observed peak load for each country. The “bubbles” with the country codes point to the exact position of the supply curve at which 90% of annual domestic peak demand can be satisfied (we disregarded the price elasticity of demand here). In this sense, the figure also allows us to measure the "international competitiveness" of the power sectors of the individual countries. The lower a country's bubble is located, and the gentler the slope of the supply curve to the right from the bubble, the more low cost power are the country's power plants able to supply to the regional market. From this perspective, the Bosnian, the Czech, and Polish and the Romanian power plants are in an advantageous position.

IV.3. Modeling of the demand side

We describe the demand for electricity in each of the 14 countries with an aggregated demand curve. It is well known that even on the national level the consumption of power changes essentially every minute. However, what we are interested in is not this temporal variation, since our model is static. Instead, what we need to record is how the demanded quantity changes as a function of the market price of electricity at a given moment in time – which is usually the period of peak consumption in the winter. Figure 14 depicts the largest observed system load during the winter in each of the countries of the region.

Figure 14: Estimated peak consumption in the winter
(maximum system load) in the studied countries



Source: UCTE, own calculations

The quantities pictured in the figure represent the highest consumption in absolute terms, which take place for a few hours only even during the peak periods of the days with the highest demand. Nevertheless, we are in general interested in peak demand, therefore we set the quantity values on the demand curves used for modeling at 90% of the pictured data.

As we do not have sufficient data to estimate the demand curve, we will make various assumptions regarding the shape and location of the curve. To keep things simple, we choose a linear function, which we can perfectly describe with three pieces of (well conceivable) data.

The first is the already described demanded quantity, the second is the related price, which we assume to be a uniform 50 €/MWh in all markets - for the sake of simplicity. This way we essentially determined a position on the demand curve. The gradient of the curve (the third piece of data) is depicted by the elasticity of demand. The short run elasticity of demand for electricity is generally observed to be rather low: consumers cannot easily substitute this product.

Lacking factual data, again, we need to employ some assumptions: we set the elasticity of demand at -0.1 in all countries (at the selected point of demand). Based upon this, a 10% increase of the price in our model will result in approximately 1% of reduced demand (in the short run).

IV.4. Market behavior

During the modeling exercise the assumed market structure and the market behavior of the power generating companies is of utmost importance. The hypothesis of full price taking, according to which the (owners of the) power plants believe that changing their production decision will not impact the market price in any significant way, will lead us to the balance created by the textbook case of *perfect competition* and thereby an efficient, welfare maximizing outcome on the market. From the perspective of modeling – due to the complexity of the problem and the related data need – this is the only viable option for us.

As an alternative hypothesis, we could also use various models of oligopoly, which could be a more realistic assumption, given the size of the producers in the region. Nevertheless, on the one hand these are considerably more complicated than the competitive model, and on the other hand they inherently assume that the companies will take advantage of the market dominance derived from their size – which is in conflict with our view of competitive markets. Moreover, while there is exactly one competitive balance, there are quite a lot of oligopolistic models, and they typically generate different results.

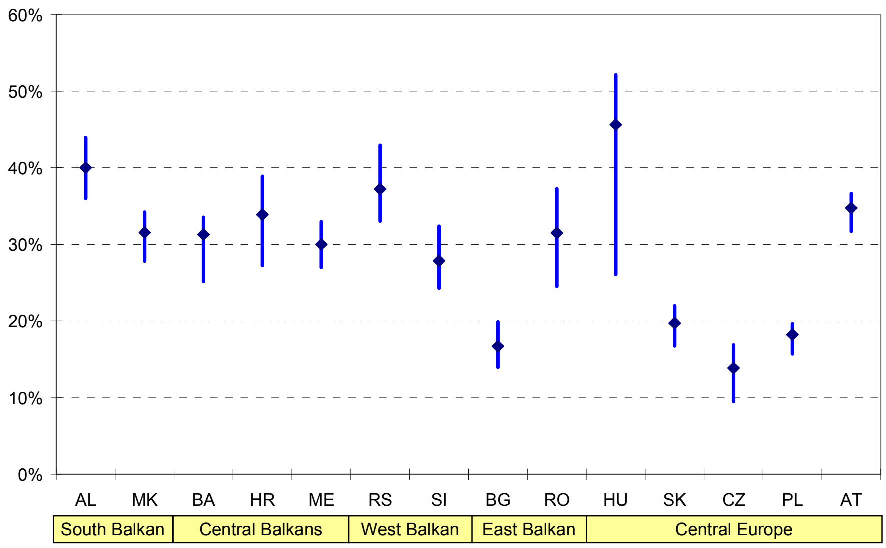
Besides, modeling of perfect competition does not entirely rule out the partial evaluation of the consequences of market dominance. The application of power market dominance almost always takes place through scaling back the use of production capacities, which will prompt a price increase due to the artificially created shortage of electricity. Since the maximum availability ratio of the national power plant capacities comprises one of the input parameter groups of our model, by fixing the capacity utilization rate below the average level we can – and we shall – model the market effects of the intentional under-utilization of the capacity.

IV.5. Availability of generating capacities

Our assumption on the availability of producing capacities varied with the generating technologies. In case of hydro power plants we based our assumption on the average annual utilization of the capacity, which is about one-third of the installed capacity on average in the region (31% in 2006). Implicitly we assumed that not even during peak hours can these plants produce more than the annual average. This is obviously not valid for hydro power plants with a reservoir, as in the short run they do not depend on the actual water flow, and they can adjust their intra-day production so that they would operate at a utilization rate substantially above average during peak periods (when electricity is more valuable). Since we apply peak hour demand in our model, therefore by restricting the production of the hydro power plants to the average utilization rate, the quantity of hydro power that can be produced in reality is somewhat underestimated.

It is also interesting to have a look at the variation among the national values of the annual capacity utilization of hydro power plants. We created the figure below (Figure 15) using data from the last four available years (2003-2006). The chart illustrates the lowest, the highest and the average annual utilization of hydro power stations.

Figure 15: Capacity utilization of hydro power plants
between 2003 and 2006



Source: UCTE

As the figure portrays, the capacity utilization of hydro power plants oscillates around the average value within a range of ± 3-6 percent.[31] Moreover, significant differences can be observed among the countries, likely due to differences between the pattern of water flow and the level of installed capacities compared to the full hydro power potential. The Central and southern segments of the Balkan region, as well as Romania and Austria have relatively higher, while Bulgaria and the Northern countries of the region (Slovakia, Czech Republic, and Poland) have particularly low ratios of hydro power utilization.

We assume that the nuclear power plants are capable of operating at 95% of their installed capacity, which is in line with common experience. The maximum technical ratio of utilization at thermal power plants (also considering their own electricity consumption) is at around 90%. We shall, however, use a much more conservative estimate, since in case of thermal power plants idle periods take place more frequently due to maintenance. According

[31] The fluctuation of the Hungarian data is excessively high, but the total installed capacity of the Hungarian hydro power stations is negligible within the region, thus it does not make sense to separately analyze the reasons.

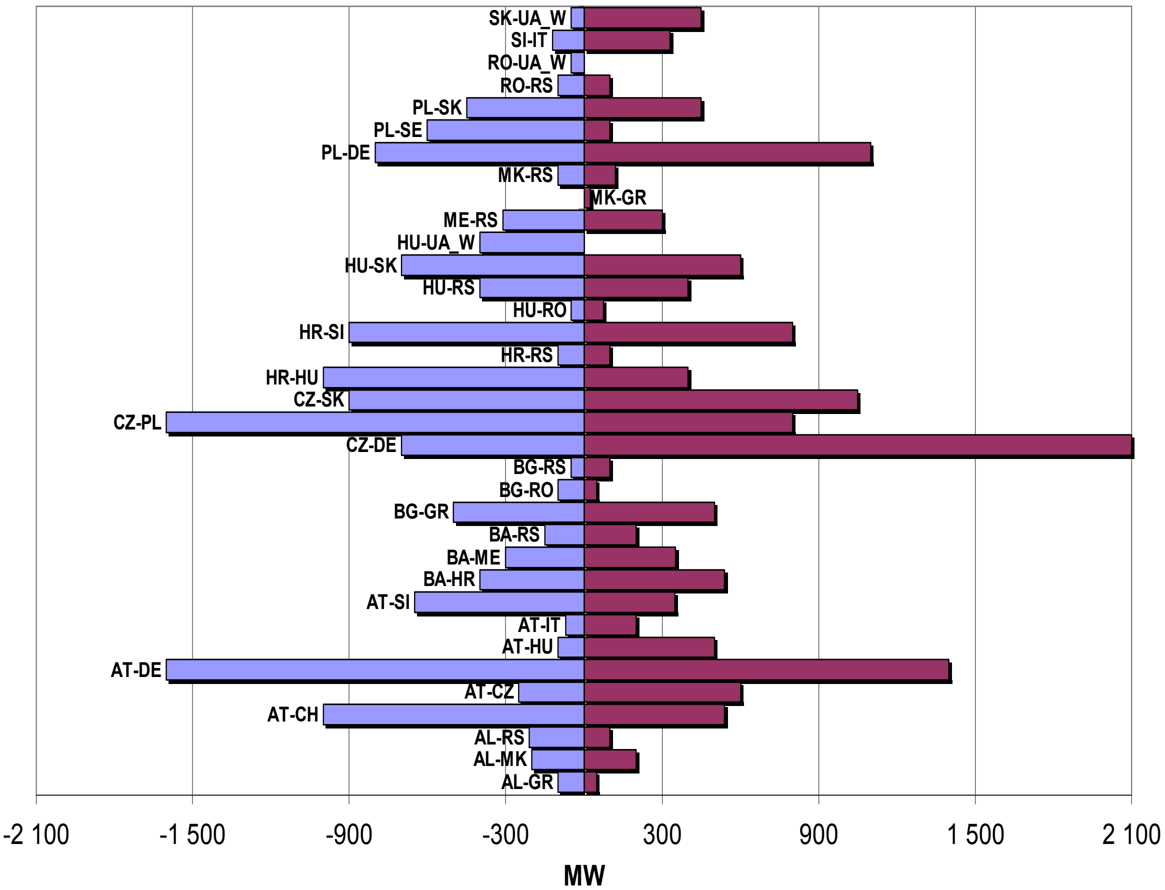
to our modeling assumptions effectively 75% of the installed capacity of gas and coal fired plants can be utilized during peak periods.

Other types of power plants (wind, biomass, other renewable) represent a rather small percentage within the production of the countries of the region, and modeling results are independent from their presumed level of potential utilization. For the sake of simplicity we used the average annual utilization factor for each country.

IV.6. Cross-border capacities

The size of cross-border capacities – which restrict international trade – are summarized by Figure 16. As shown, on a given border profile the volume of trade can generally be the same in both directions, but due to specific network features sometimes they will be different.

Figure 16: Size of cross-border capacities



Source: ETSO, Potomac Economics and own computations

We applied the so called Net Transfer Capacity (NTC) as the available cross-border capacity, announced by the system operators for their border profiles. The NTC in the present system is comprised of two components: the Already Allocated Capacity (AAC) and the Available Transfer Capacity (ATC). The first concept refers to the cross-border capacity needed for the transport of electricity reserved through long term export or import contracts, used by the exmonopolist companies (mostly) for free, while the ATC is the capacity that can be sold to the competitive market through auction.

Since now we model a 100 percent liberalized, competitive market, we assume that – in harmony with the regulations of the European Union – the favorable border position of the incumbent companies will end and the full NTC will become available through auctions.

Our only assumption about the auction itself is that the participants are traders who compete with each other (for profit), and they are willing to bid (almost) as much as the expected difference between the prices of the two countries. This way cross-border capacities are allocated efficiently.

IV.7. The price level of neighboring markets

As mentioned before, even though we explicitly model the demand and supply side of the 14 countries of the Central and South-East European region, trading at the border of the region also needs to be considered. Within the model the prices observed in the countries of the neighboring regions are treated as exogenous, at the levels shown in Table 1.

Table 1: Price level of the neighboring countries

Country	Assumed Peak Hour Price
Greece	65 €/MWh
Germany	65 €/MWh
Italy	80 €/MWh
Switzerland	65 €/MWh
Sweden	65 €/MWh
Ukraine	20 €/MWh[32]

[32] We lack price information from Ukraine, but we do know that Ukraine exports power to Slovakia, Hungary and Romania (according to an UCTE rule maximum 500 MW). Based on this our purpose was to set a price that is low enough so that the model would reproduce the same power flows.

V. MODELING RESULTS

We present our modeling results in several stages. At first we examine what kind of prices would evolve in the liberalized market if no international trade were allowed and all the countries should supply electricity for themselves in the peak periods. The other assumptions concerning demand and supply are the same as detailed before.

Although modeling without export and import possibilities is not realistic, it can bring very interesting results. Based on the prices formed in this way, we can formulate some statements about the internal provision of the individual countries and we can get a concept about their expected role in international trade. The countries with a relatively high market price will typically be net importers, while the ones with a relatively low price will export.

In the second stage we allow the possibility of international trade up to the given NTC values (which can be regarded as average ones). These results give the core of the lesson which can be drawn from the modeling. Namely this is the base case, which we consider the most credible outcome and which – in our opinion – describes the developments in the region in the most realistic way.[33]

On the other hand it is important to examine to what extent our results depend on the correctness of our assumptions, or using a terminology: how robust, or how sensitive they are to the changes of the different input parameters. Eventually, this is the way to get a full picture of the conclusions which can be drawn from our modeling. This sensitivity test will be performed in the third stage.

Finally, in the fourth stage – recognizing the deficiencies of our model, which takes the competitive conditions as given – we examine under which circumstances is it possible that we get high prices (above the German market) both in the Balkans and in Hungary. We close the presentation of our modeling results with the evaluation of the lessons.

V.1. Self-sufficient market equilibrium

Figure 17 summarizes the model results with self-sufficiency. The rectangles drawn to the territories of the countries on the map show the equilibrium price valid in the given country. As in this case no electricity trade with a price equalizing effect can be pursued among the countries, it can be expected, that different equilibrium prices evolve in the single countries.

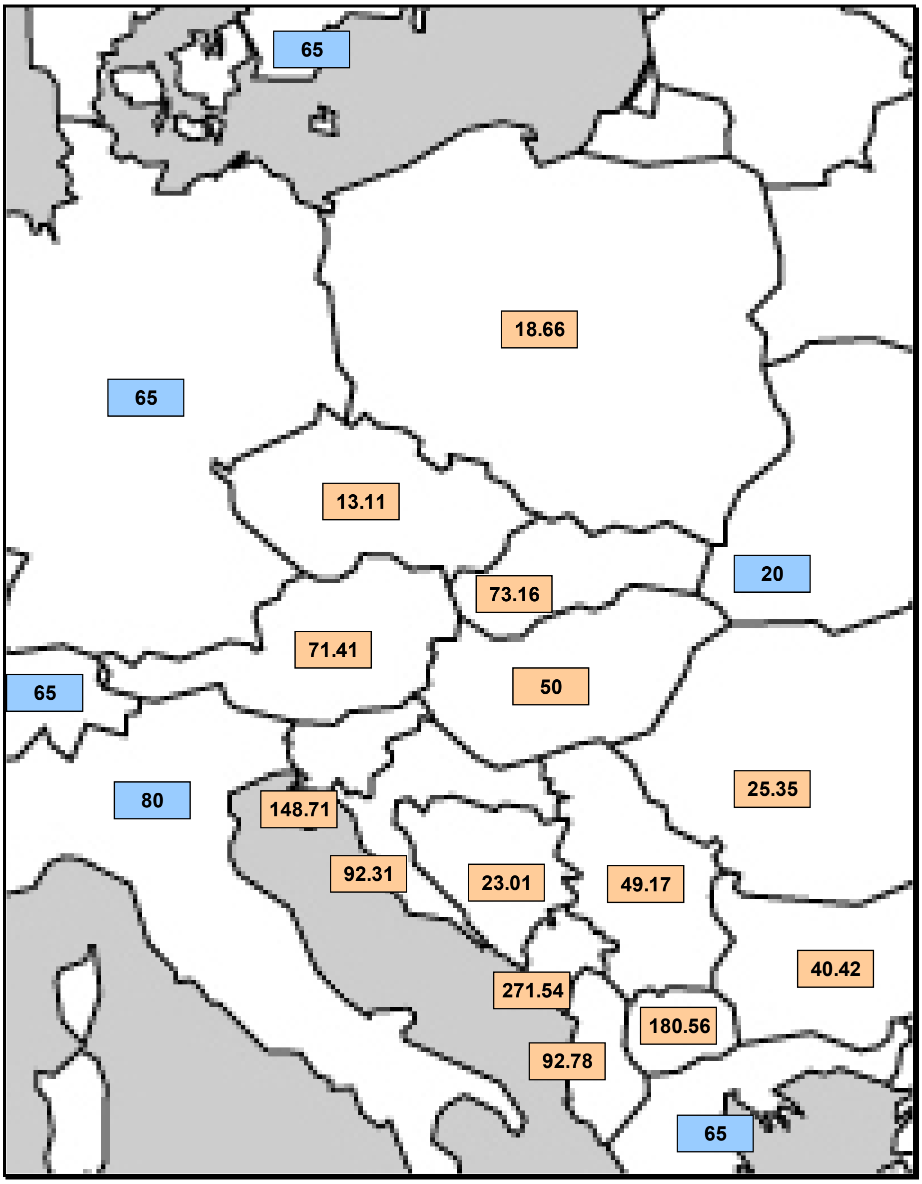
The rectangles with a blue background contain the neighboring market prices, which can also be seen in Table 1. These are naturally input parameters and not the results of the model. On the other hand, the equilibrium prices of 14 countries labeled with a yellow background are the results of the modeling.

It can be seen, that the prices spread significantly. In those countries where the values are above 80 €/MWh, the production capacity (considering availability limits) was practically

[33] Naturally only to the extent, to which a perfect competitive model can be realistic.

fully exhausted. The equilibrium is ensured here by the alignment of the demand: as prices go higher, consumption is reduced and falls finally to the level of supply.

Figure 17: Equilibrium prices with self-sufficient production



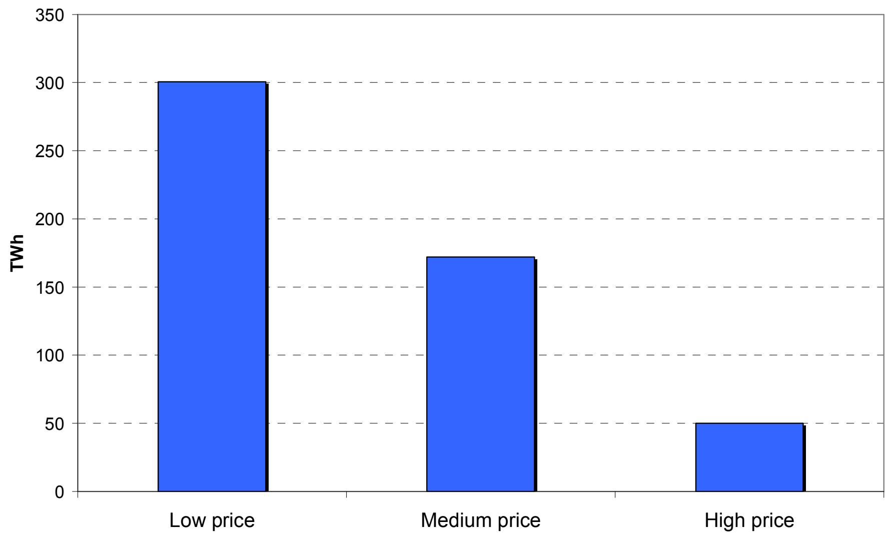
Let's examine the price levels of the single countries one by one. The prices are low in the Czech Republic, Poland, Romania and Bulgaria. (Don't forget, that we are looking at a peak period! It's worth to have the German prices as a reference.) For the first sight we can be surprised of the price level of Bosnia and Herzegovina, which is even more favorable than that of Romania. We definitely can't say that the Bosnian system is short of electricity.

Serbia, Hungary, Austria and Slovakia belong to the group of countries with a medium price level. In the case of Slovakia it may seem somewhat surprising why prices are not lower. However, it's imaginable, that the supply restricting effect of the recent power plant close-downs can give an adequate explanation to that.

The countries with a high price level can be found in two contiguous blocks: Slovenia and Croatia in the West and Macedonia, Montenegro and Albania in the South. In our opinion, the reason for the high prices in these countries is the high ratio of hydroelectric power plants, as taking into account the hydroelectric generation units only at an average level (which is one third of the capacity) causes the biggest problem in this case.

The self-sufficient (autarky) scenario seems to prove some preconceptions, that the countries with high prices, which are relatively short of supply, can be found mainly in the Balkans, especially in the southern part of it. For illustration Figure 18 shows the relationship of the countries in the three price groups defined above to each other in the sense of order of magnitude (based on total consumption).

Figure 18: Relative size of the countries (in the ratio of annual consumption) which belong to the low, medium and high price groups (assuming self-sufficiency)

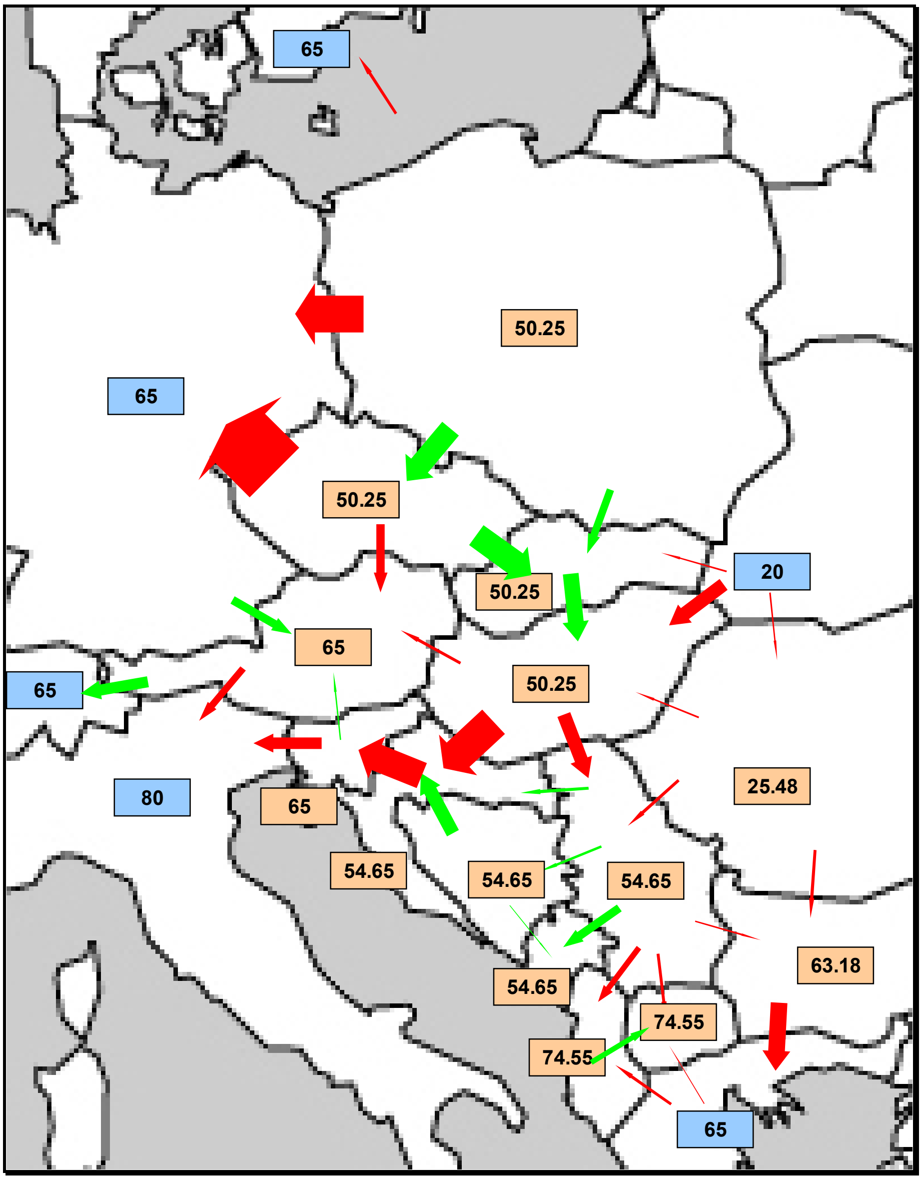


Regarding the figure, if we use a somewhat simplifying but intuitive reasoning, we are justified to expect that opening the international trade will give way to the predominance of the lower price countries. That is, the market prices of higher price countries will decrease to a bigger extent than the degree of the price rise in the lower price countries. Naturally this will be influenced by the price relations of the neighboring countries of the region and the size of the available cross-border capacities. However, the actual effect of these factors can only be evaluated after running the complete model, which takes into account international trade in an explicit way. This will be done next.

V.2. Base results of modeling

After analyzing the hypothetical scenario of self-sufficiency, let's go further to the next step of modeling and analyzing the characteristics of equilibrium reached when there is international electricity trade. The results are clearly summarized in Figure 19.

Figure 19: Base results of modeling



In the figure the arrows show the direction and the size of export and import flows. (The thickness of the arrows is proportional to the quantity of electricity traded on the interconnections.)[34] The colors indicate the saturation: on the borders marked with red the maximal available transmission capacity is exhausted, while on the green ones there is still opportunity for trading.

Following our earlier reasoning this fact also means, that the countries connected to each other directly or indirectly by green arrows have necessarily the same price level (they make up a common price zone), while the red arrows turn up on the border of different price zones.[35]

[34] Naturally we speak about traded quantities and not physical flows.

[35] Trade within the same price zone can happen in many configurations, which all lead to the same zone price and net export-import position of the countries. Because of that we represent just one of these configurations on the presented figures.

Let's analyze in details the results apparent on the Figure 19. Going from the North to the South we can make the following statements.

Poland, the Czech Republic, Slovakia and Hungary make up one price zone with an equilibrium price of 50,25 €/MWh, which is significantly lower than the German market prices (65 €/MWh). The flows within the zone go from the north to the south. A vivid trade continues on the zone borders. From the direction of Poland and the Czech Republic a highly significant export (together 3200 MW) goes to Germany. The export with a direction of Poland-Sweden, the Czech Republic-Austria and Hungary-Austria is with an order of magnitude smaller than that. Suiting to our intentions approximately 450 MW is imported from Ukraine into the price zone and similarly Romania also exports towards us.

We can be satisfied regarding the flows which were obtained on the Hungarian border, because these correspond to what is experienced in reality. Hungary gets imports from the direction of Slovakia and Ukraine, while to the direction of Serbia and Croatia goes an export flow from the country. On the Austrian and Romanian interconnections the trade is typically small and its direction is occasionally changing. Besides, the Polish-Czech-Slovak-Hungarian zone is a heavy exporter in the region, primarily to the west and to the south.

The next characteristic is that Austria and Slovenia is connected to the German-Swiss price zone of 65 €/MWh and in addition to that, with a fairly moderate trade in the Western direction. Based on that we might expect that the German market price will be valid in Austria in scenarios significantly different from the base case as well, which is also in accordance with the real developments. The links are weaker between Slovenia and Austria, so presumably there will be cases where the Slovenian price will differ from that of the Austrian-German-Swiss zone.

The third price zone is made up of Romania alone, because it has rather weak trading connections with its neighbors. That is the reason why the Romanian market price doesn't differ significantly from the one obtained when we assumed self-sufficient production.

The next price zone, which consists of more countries, could be called comprehensively the Central Balkan region (Bosnia and Herzegovina, Serbia, Montenegro), although Croatia, which belongs to the Western region is also here. In a somewhat surprising way, as the results of modeling we get a zone price (54,65 €/MWh) which is barely higher than the one in Central-Europe (50,25 €/MWh) and definitely lower than the German-Austrian-(Slovene) reference price of 65 €/MWh.

In our opinion this result is due to the joint effect of three factors. (1) There is no electricity shortage in Serbia, which is the biggest country of the zone, on the contrary, in the case of self-sufficiency there would evolve a price which is lower even than that of Hungary. (2) The countries inside the zone which are gravely short of capacity are small (Montenegro) or at best medium sized (Croatia). (3) A significant import flow comes from the direction of Hungary to the region, in an amount of about 1400 MW, while only 800 MW goes out towards Slovenia, which gives the mentioned four countries a positive balance of 600 MW.

In Albania and Macedonia, the two countries which we labeled as South Balkans, a considerably higher price (74,55 €/MWh) evolves, than in any other countries of the East and South-East European region. Fundamentally, two factors are responsible for this: the relative enclosure of the countries (weak external trading connections) and the deficiencies of the inner supply. As it will be seen, these two countries will form the "most problematic" price zone later on as well, but considering their weak external connections it can be reasoned why they don't have a significant effect on their neighbors.

Finally, there remains Bulgaria, which also forms a price zone alone, with a price higher than expected. Comparing to the relatively low equilibrium price at self-sufficiency (about 40 €/MWh) the 63,18 €/MWh, shown in Figure 19 means a relevant increase. That can be attributed to two factors again. On the one hand a transmission capacity of 500 MW is at disposal in the Greek direction, which is a considerable amount in Balkan relations, and causes flows towards the south, due to the higher Greek prices. On the other hand, the hydroelectric power plants can be exploited only to a low extent (just 17%!), so the Bulgarian supply function is very steep (see Figure 14), and that causes a remarkable price rise in Bulgaria even with a Greek export of 500 MW.

As a concluding point of the base case analysis it is worth to say a word about the "drawing effect" of the high price Italian market. Essentially Italy is connected to the Balkan only through Slovenia, which means 330 MW cross-border capacity on the whole. Regarding the base scenario this is simply too little to have a considerable price driving effect, whether in the South-East or in the Central European region.

V.2.1. The effect of the Balkan markets on the Hungarian electricity prices

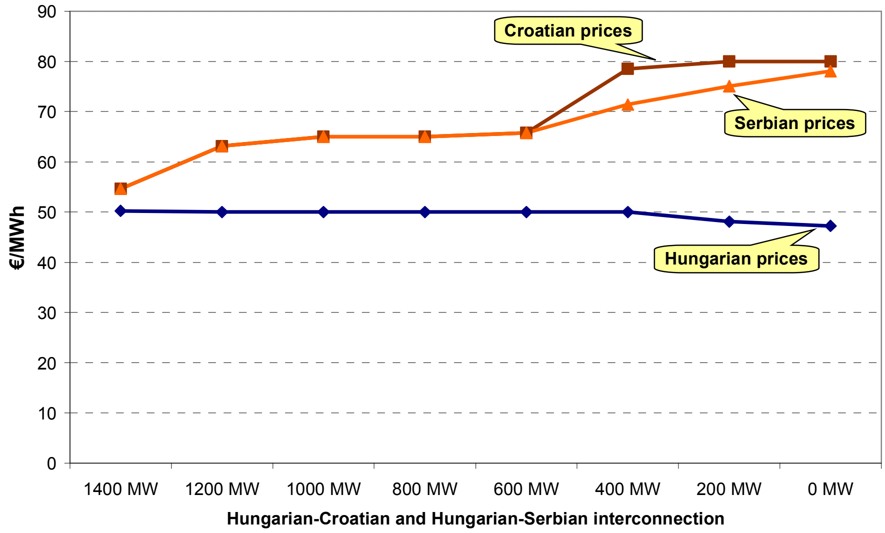
After presenting the results we can make an attempt to evaluate in advance the main point of our study. That means, we examine how the actual or the assumed electricity shortage of the Balkan countries influences the Hungarian prices formed on a competitive market.

The simplest tool of analysis is to compare the Hungarian prices assuming self-sufficiency with the base results gained when we take into account the export-import opportunities. Naturally with that not only the effect of Balkan is quantified alone, since there are also other differences between the two model executions. Anyway, the numbers are interesting: in Hungary a price rise of a quarter (!) euro per MWh occurs, which is approximately a price rise of 0,5%![36] It is a wholly negligible change from any aspect.

Certainly, we could say, that Hungary would win a lot, if we imported only from the north and exported nothing (or less than the possible 1400 MW) to the south. So, let's see, how much in fact: Figure 20 presents the changes of the Hungarian, Croatian and Serbian market prices assuming continuously diminishing values of cross-border capacities on Hungary's southern border.

[36] Measured in HUF/kWh, the extent of the price rise is 0,065 HUF/kWh, which is practically imperceptible.

Figure 20: The price effects of restricting the cross-border capacities on the southern border of Hungary



It can be seen, that even with extreme export restraints (cutting back 1000 MW) the Hungarian prices do not move downwards at all, simply because Hungary remains part of the Central European price zone, which is significantly bigger than the Balkans. If we closed the borders in the model entirely, we would achieve only that the Central European market prices were lowered to 47,27 €/MWh instead of 50,25 €/MWh, which is a negligible change, especially if we take into account how drastic the measure was.

As opposed to that, the Balkan countries really suffer from the lack of import coming from our region. Although we represented only Croatia and Serbia (our direct neighbors), the prices are valid for the other Balkan countries as well. Even an export restraint of about 400 MW generates a price rise of 10 €, driving up the Balkan prices eventually to 80 €/MWh, which corresponds to the Italian price level.

This highly asymmetric effect of the Hungarian export restrictions has to be kept in mind.

V.3. Sensitivity tests

Although the base results of our modeling contain the analysis of the most realistic scenario, they can't give a whole picture of the lessons which can be drawn from the model. The conditions of the electricity market – demand, supply, cross-border capacities, prices of the neighboring markets – change continuously. Accordingly, it is worth to examine, how our conclusion mentioned above, which says, that the developments in the Balkan have a negligible effect on the Hungarian market prices, is valid in case of a change in the market conditions.

In this chapter of the study we examine the modifying effect of the factors which we hold interesting and important. Included here are the exploitability of hydropower (due to the annual variation of the run-off), the availability of the thermal power plant capacities, changes in demand, fluctuations of the German market prices, and the tightening or broadening of the exhaustible cross-border capacities.

In all cases we outline the composition of the evolving price zones, the directions of the major flows, the prospective trade on the Hungarian border and we pay a special attention to the relative state of the Balkan countries compared to each other and to Hungary. At each alternative scenario we repeat the exercise named the “closure of the southern borders”, which means that we examine, what effect the gradual reduction of the capacities on the Hungarian-Croatian and Hungarian-Serbian border has on the electricity prices of Hungary and in the Balkans.

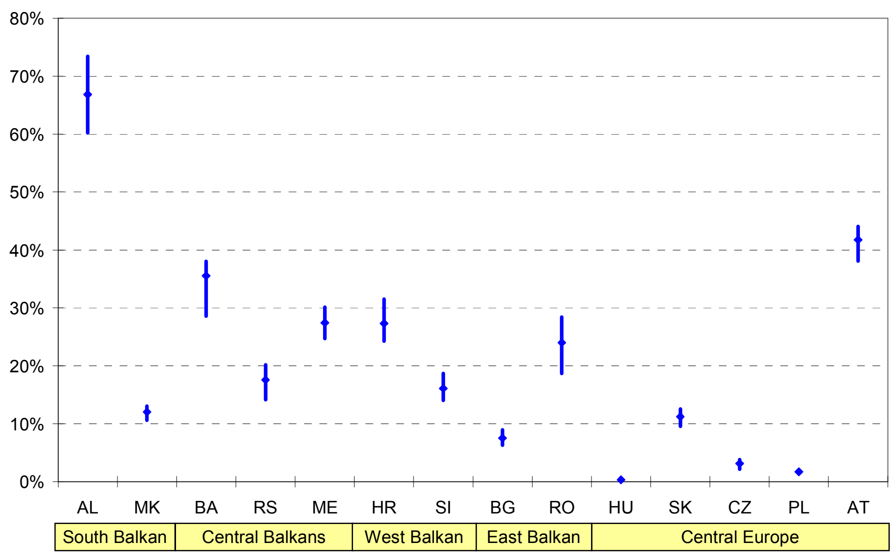
The results of the sensitivity tests are evaluated verbally, with the help of summarizing figures. Although we consider Figure 17 and Figure 19 highly expressive, for reasons of conciseness we present these sorts of graphs only in the appendix.

V.3.1. Variations in water yield

A problematic point which is often mentioned in connection with the electricity system of the Balkan countries is, that they are highly exposed to the annual variation of the water yield. With a low run-off the exploitable productive capacity of the hydroelectric power plants falls back significantly, which has to be substituted with more expensive thermal power plants (and import), insofar as it is possible.

Thus in our study we don’t challenge the extent of exposedness to the volatility of the water yield. On the other hand we note that in the East and South-East European region other countries can be similarly affected by this problem. To make the orders of magnitude perceivable, Figure 21 shows how the minimal, maximal and average values of the average available capacity of hydroelectric power plants changed between 2003 and 2006 compared to the peak demand of the modeled countries (see Figure 18).

Figure 21: Fluctuations of the exploitable hydropower capacity in the percent of the annual peak demand between 2003 and 2006



Source: UCTE and own computations

In the figure we can see that in the majority of the Balkan countries the change in the run-off causes a relatively notable fluctuation in the production capacity, while this is not true for the Central European countries (except for Austria). However, the effect of the water yield on the electricity prices is ambiguous, since the production falling out is more or less substitutable with import.

The regional market equilibrium calculated with assuming the minimal exploitability of hydropower between 2003 and 2006 has the following characteristics (see Figure 29(a) in the Appendix). Here also exists a Central European price zone with a relative low price level, which contains Poland, the Czech Republic, Slovakia and Hungary with a market price of 54,12 €/MWh. On the zone borders the export-import flows are the same as those in the base case.

The most interesting development is, that the West and Central Balkans regions are connected to the German price zone (65 €/MWh) through Austria. That means, when the water yield is low, in these countries we have to count with a price, which is higher with approximately 10 €.

In the South Balkans (Albania and Macedonia) the prices remain high (87,80 €/MWh). Bulgaria gets onto the same price level as Greece and there is hardly any change in Romania.

Lowering the transmission capacity of the Hungarian-Croatian (1000 MW) and Hungarian-Serbian (400 MW) interconnections by 50 %, the electricity prices of Hungary (together with that of the Central European price zone) fall with approximately 2 €, and with 4 € if we assume a total export prohibition. In line with that the prices of Central and West Balkans increase with 15-24 €. In this way, the asymmetric relationship is proven again: the import demand of the countries lying southwards from Hungary has a hardly perceptible effect on us, while the electricity coming from Hungary lowers significantly the prices forming in the Balkans.

Assuming a high water yield the occurring changes are negligible again, compared to the base case. The price of the Czech-Polish-Slovakian zone fall to 48,33 €/MWh (from 50,25 €/MWh). The price reduction in Hungary is smaller than that (0,25 €/MWh), and with that we quit the block formed by our northern neighbors (since the import capacity from the Slovakian direction is fully exploited).

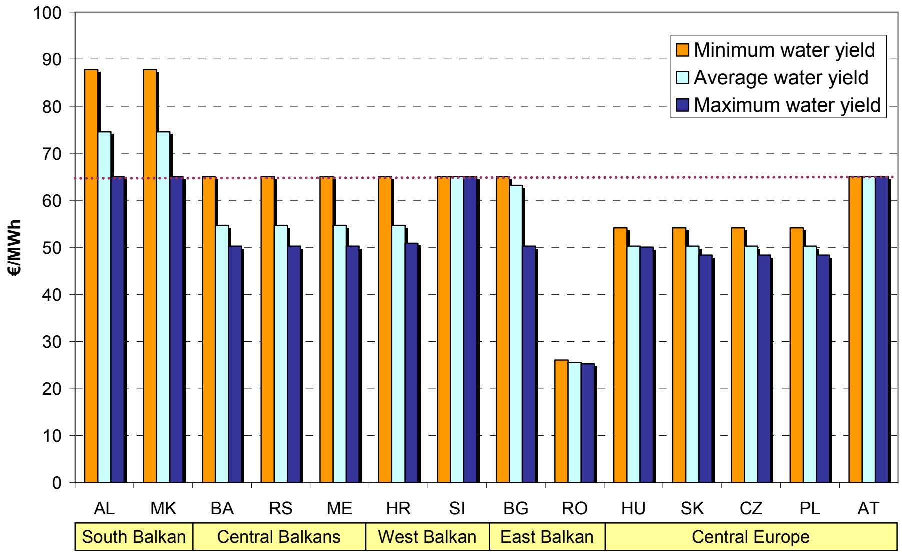
Southwards from us the market price decreases from 54,65 €/MWh to 50,24 €/MWh, due to the abundant available hydropower. Albania and Macedonia reaches (downwards) the Greek price level, furthermore, the prices decrease significantly also in Bulgaria (from 63,18 €/MWh to 50,24 €/MWh). With that, the country joins to the Central Balkan price zone through Serbia. In Romania there isn't any relevant change again.

A 50% restraint on our southern borders implies a decrease of 5 € in the Hungarian electricity price, while the full closure of the borders causes a further fall of 7 €, which is a more considerable change than before. A price rise of a similar extent is perceivable in the Balkans.

In this case, the symmetry can be attributed to the fact, that our southern neighbors aren't affected so much by the drop-out of the import coming from Hungary, due to the relative abundance of hydropower in those countries.

Figure 22 summarizes the effects of water yield changes on the price, which can be seen in the model. All in all, it can be stated, that the Central European region and within that especially Hungary isn't seriously affected by the fluctuations of the available amount of hydropower. This effect is much stronger in the Balkans, however, but even there only in the case of Albania and Macedonia can be expected, that the electricity prices go above the German market price.

Figure 22: Market prices with low, average and high water yield



The trade restraints on the southern borders of Hungary have just a negligible effect on the Hungarian market in each water yield scenario. However, assuming medium or low water level, it can affect the Balkan countries really sensitively.

V.3.2. Availability of thermal power plants

Regarding the availability of the production capacity of thermal power plants (coal and natural gas fired), we examined a low (65%) and a high (80%) exploitability compared to the value of 75% in the base scenario. In our opinion, these are extreme values in both directions. It's not typical, that considerably more than 80% of the installed capacity can be exploited in the production, particularly not from the aspect of holding reserves. According to Figure Thereafter we study what annual average utilization of hydroelectric power plants and thermal power plants are in each country.

, where the yearly *average* utilization of the thermal power plants can be seen, we can be sure, that 65% of the capacity is available by all means in the peak period (except for perhaps Albania).

At a low availability of thermal power plants we can expect, that higher prices evolve in the countries of the region, and exactly that is what happens. The four countries of the Central

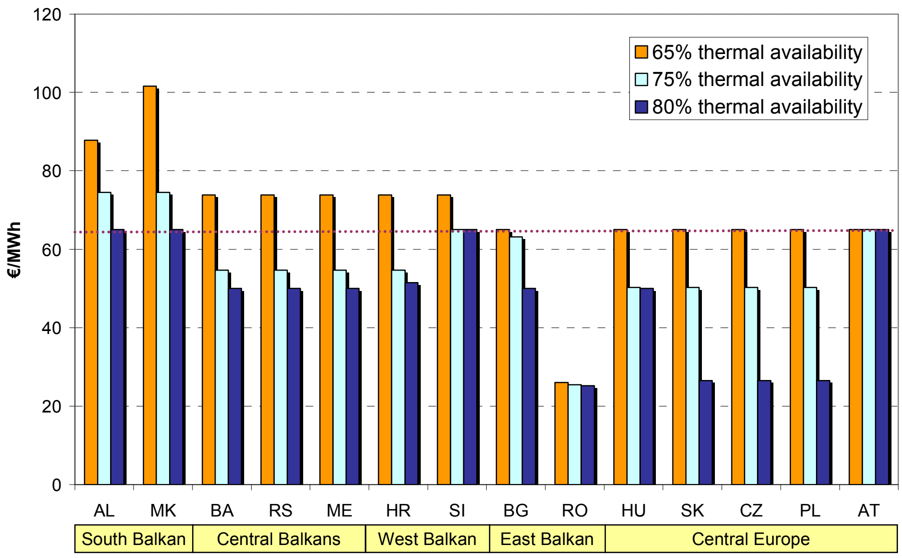
European region together with Austria become the part of the German price zone with 65 €, while in the central and western part of the Balkans the price becomes 73,86 €, which is somewhat lower than the Italian one. Albania and Macedonia separate again from the other markets.

The Hungarian prices fall below the German price level by 12 € as the capacities on the southern border are reduced by 50%, while a full export prohibition causes a further 2 € drop in the price (and together with that we *export* the electricity to Slovakia on full capacity). At the same time a gradual price rise of 20 €/MWh occurs in the Balkan region.

With an available capacity of 80% Hungary forms a common price zone with the Central Balkan countries at a price of 50 €/MWh. On the other hand, the price of the Polish-Czech-Slovakian zone is significantly lower than that, 26,56 €/MWh. If the southern export is lowered, the Hungarian prices fall by 6-12 €, while it has only an effect of a 2-4 € price rise at our southern neighbors.

The consequences of the thermal power plants availability are summarized in Figure 23. As it can be seen, the Hungarian prices rise at most to the level of the German ones, even with a low capacity, while in this case the Italian price level is valid for the Balkan countries.

Figure 23: Market prices with low, average and high thermal power plant availability



V.3.3. The effect of demand change

Since our analysis concentrates on the peak demand, only a moderate extent of demand change is modeled. As a reminder: in the base scenario we started from the 90% of the maximal annual system load. Compared to that, now we examine the 85% and the 100% cases.

With a low peak demand we get almost the same results as with a high thermal power plant availability, and restricting the trade on the southern border of Hungary also has consequences of a similar scale. Likewise, the high demand scenario is almost a perfect reflection of the low thermal power plant availability. This is naturally not an astonishing development, since the prices are formed by the relative proportion of the demand and supply.

V.3.4. The effect of the western markets

We analyze two alternative cases considering the development of the German-Swiss prices: 55 €/MWh and 75 €/MWh. Interestingly, neither has any effect on the Central and South-East European developments, except for the connected Austrian and Slovenian market of course. Because of that, the relations of Hungary and the Balkans remain also unchanged compared to the base case.

The ineffectiveness of the German-Swiss price changes can be attributed to the fact, that the electricity price formed on the free market of Central Europe is lower than even the German price of 55 €/MWh. In this way, the regional markets operate separated from Germany (except for the fixed amount of export to the western direction) due to the saturation of the cross-border capacities.

It has an important lesson regarding Hungary's Balkan relations as well. Assuming that the electricity flows from Hungary to Croatia and Serbia exploit the full transmission capacity, the further rise of the southern prices *can't have any effect* on the Hungarian market prices!

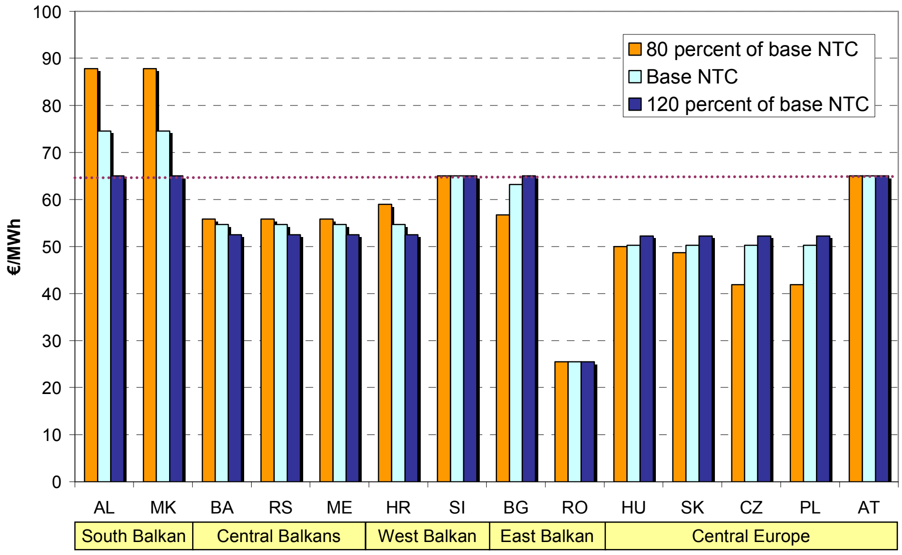
V.3.5. Changes in the cross-border trade

As a final part of our sensitivity test we examine the effect of changes in the cross-border transmission capacities expressed by the NTC values. The NTC values used in the base scenario come from the data published by ETSO, the coordinating institution of the European Transmission System Operators. These were further refined based on other information when available, primarily in the Balkans and in Hungary.

The base NTC values are modified again in two directions with ±20%, which can be regarded as significant changes. According to our expectations, with decreasing transmission capacities the market outcome approaches the results of the self-sufficient scenario, while the higher NTC values lead to further price convergence. The question is only the strength of these effects.

As Figure 24 shows, the decrease of cross-border capacities has a relevant effect mainly on the Central European price zone, because of the divergence of the Hungarian, Slovakian and the Czech-Polish prices. Each price moves downwards compared to the base case, which can be explained by the restraint on the German market's import demand. In the Balkans, Albania and Macedonia suffer (again) from the tightening of the trading possibilities, however, apart from that the price changes are minimal.

Figure 24: Sensitivity of the market prices to the size of cross-border capacities



The increasing cross-border trade has just an opposite effect on the market prices than experienced before. The Central European and Central Balkan price zones settle almost exactly on the same price level, significantly below the German price of 65 €. A further 50% restriction of the trade on the Hungarian-Croatian and Hungarian-Serbian border barely reduces the Hungarian prices and has a negligible effect on the Balkan prices as well.

V.4. Market calibration

All results of the recent modeling support that Hungary should form a common Central European price zone with the Czech Republic, Poland and Slovakia on a competitive electricity market. The price of this zone remains under the price level of both Germany and the Central Balkan countries.

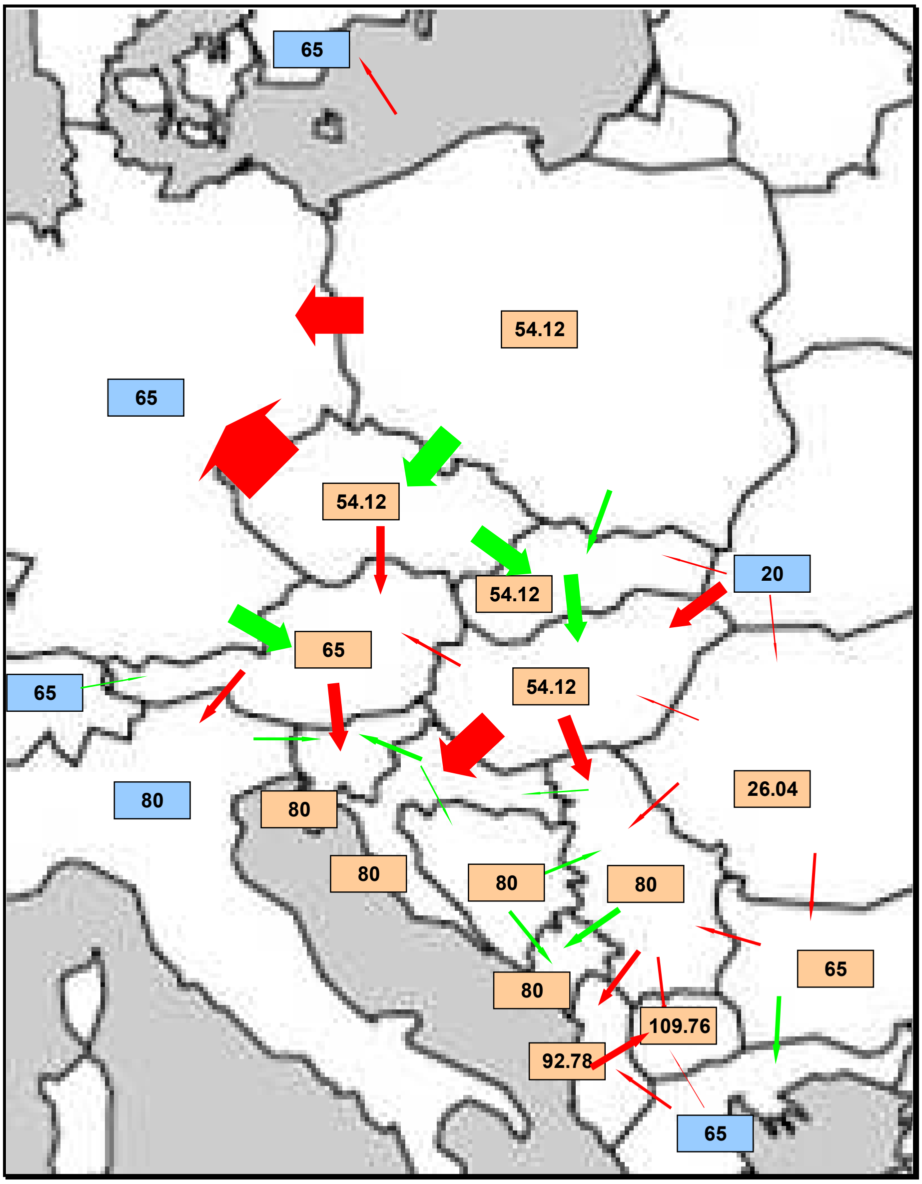
Furthermore, according to the demand-supply relations we do not see it reasonable either, that in the Balkans (except for Albania and Macedonia) the experienced prices exceed the price level of the German market, except for those cases, when due to the unfavorable external circumstances (low water yield, high demand), or when Hungary introduces drastic export reducing measures.

Nevertheless, we accept the possibility, that our model assuming market competition presumes a too advanced state of the Balkan markets. We can imagine for example, that the consumers who buy on a regulated price are strongly cross-financed, which drives up the equilibrium prices on the deregulated market to a higher level than justified by the demand-supply relations. It can happen, that they reach even the level of the Italian market.

The question is, what can our model tell us in this case about the effect of the high prices observed in the Balkan region on the Hungarian market. Can it be true even with a southern price of 80 €, that (1) Hungary remains a part of the low price Central European zone and (2) the Hungarian market price doesn't fall significantly when the southern cross-border capacities are restricted, implying that the Balkans do not "draw the electricity from us".

The results of the analysis are shown in Figure 25.[37] Since we assumed a low water yield, the Central European reference price is 54,12 €/MWh. In this way we can say, that assuming a competitive Central European market, the price of the Central European zone doesn't increase at all, even with high Balkan prices! This is simply because there doesn't go out more export than 1400 MW from Hungary even if the price of our southern neighbors is several hundred euros. Then the effect on Central Europe is unambiguously limited.

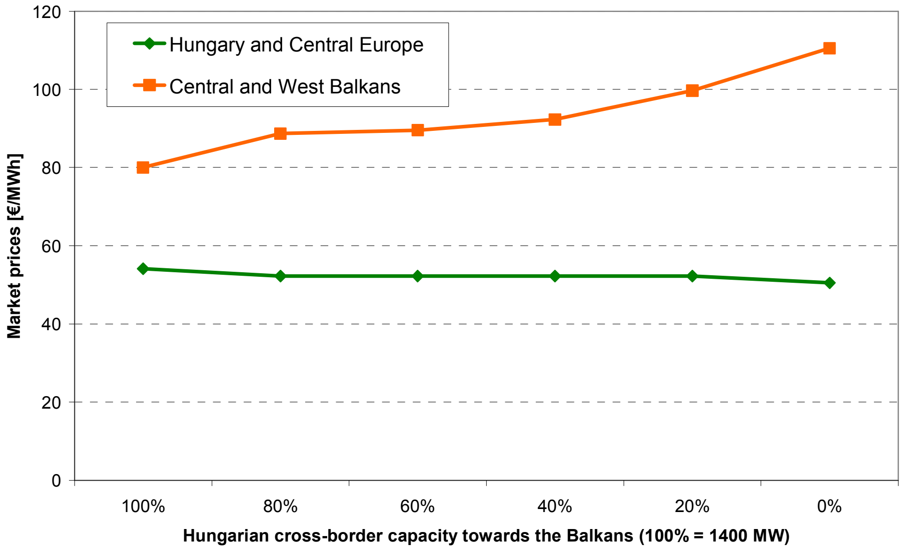
Figure 25: Effects of an artificially restricted Balkan supply



[37] We reached the Balkan prices of 80 €/MWh by lowering the production capacities of the Slovenian, Croatian, Serbian, Bosnian, Montenegrin, Albanian and Macedonian thermal power plants to 65% assuming a low water yield

How much could we gain if we put a restraint on the southern export, having this situation as a starting point? Figure 26 shows the answer given by the model: practically nothing. On the other hand, we can exert a serious price driving effect on the Central Balkan region.

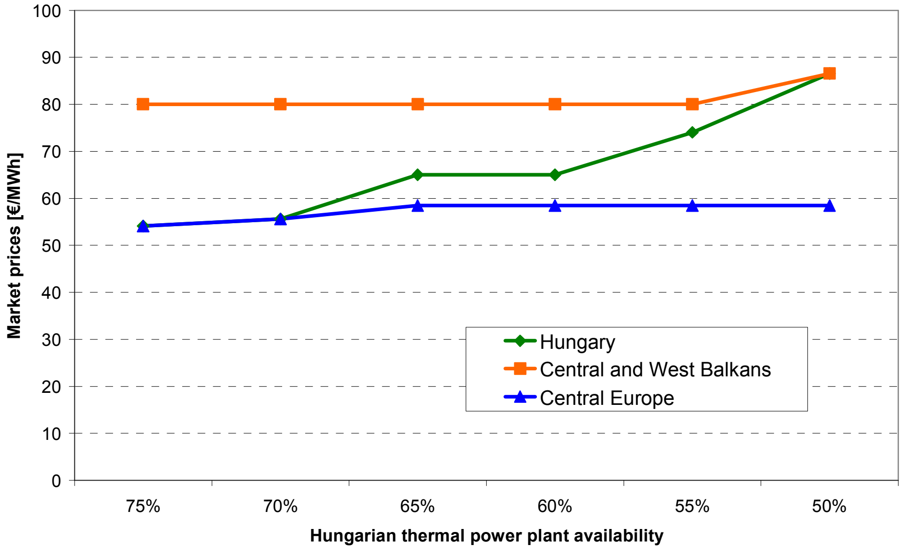
Figure 26: Effects of restraining the southern Hungarian cross-border capacities assuming high Balkan prices



It seems, if we sustain the competitive market circumstances in the Central European region, we can't explain how a high price can exist both in Hungary and on the Balkan at the same time. In our opinion the most probable reason for the high Hungarian prices is the capacity withholding of the Hungarian incumbent, MVM, who keeps a firm hand on the domestic producers' supply through a combination of ownership and long term power purchase agreements. Too much direct and indirect signs lead to this conclusion for us to neglect this possibility.

Figure 27 shows how the Hungarian and Central European market price of electricity changes if we assume high prices in the Balkans and we reduce gradually the availability of Hungarian thermal power plants.

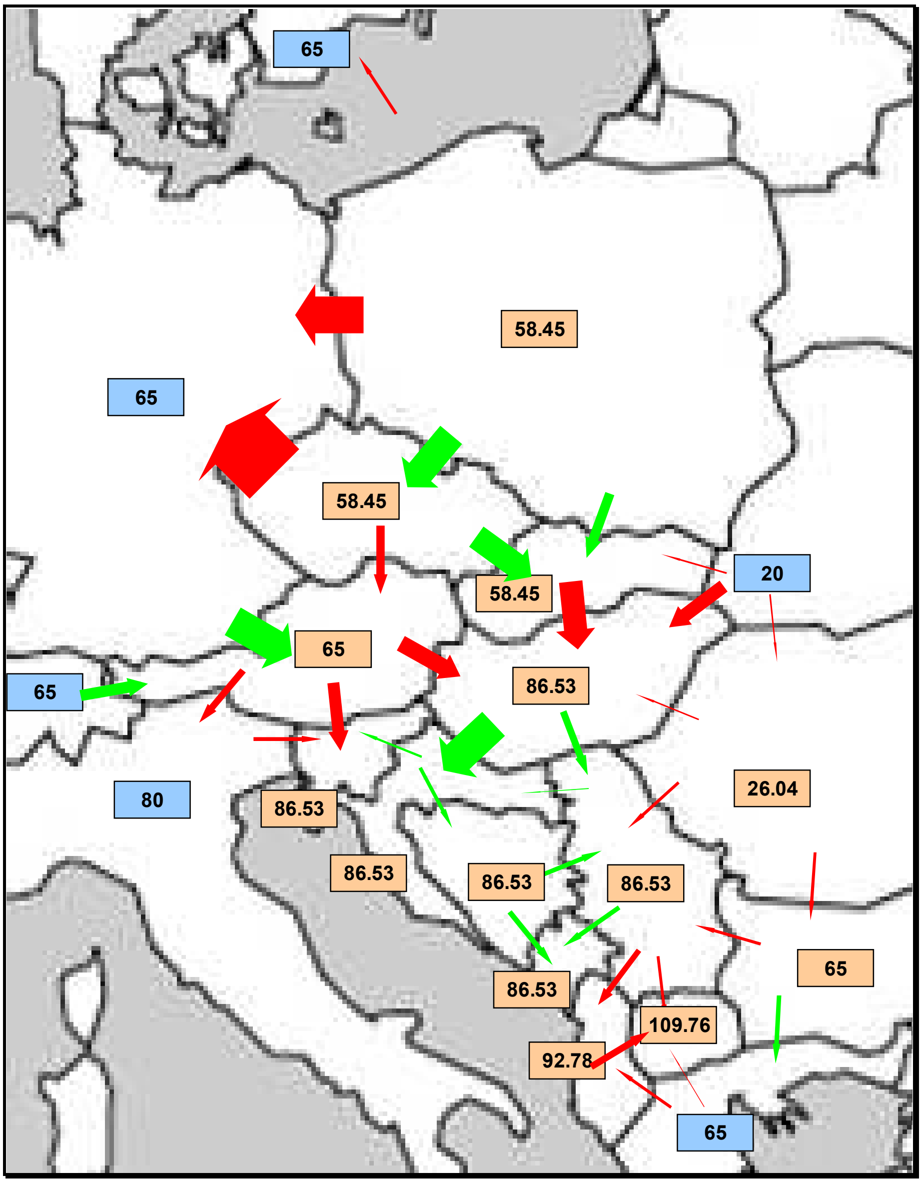
Figure 27: Effects of Hungarian capacity restrictions on the market prices



In Figure 27, we can observe how the gradual restrictions of the Hungarian production capacities leads to the separation of Hungary from the Central European price zone at first, and later to its connection to the Balkan price zone with continually growing prices. Based on the available information about demand and supply, it can be stated, that the high Hungarian prices are justified by the withholding of the domestic production capacities and not by the price level of the Balkan countries.[38]

[38] The results of László Paizs (2008) who modeled the connections of the domestic and the Balkan electricity market assuming an oligopoly market structure in the Hungarian market do not contradict to these results, in spite of the basic differences in the modeling method. In his study, the more concentrated domestic market structure results in capacity withholding, which leads to the convergence of the domestic and the Balkan prices.

Figure 28: Effects of capacity restrictions in Hungary

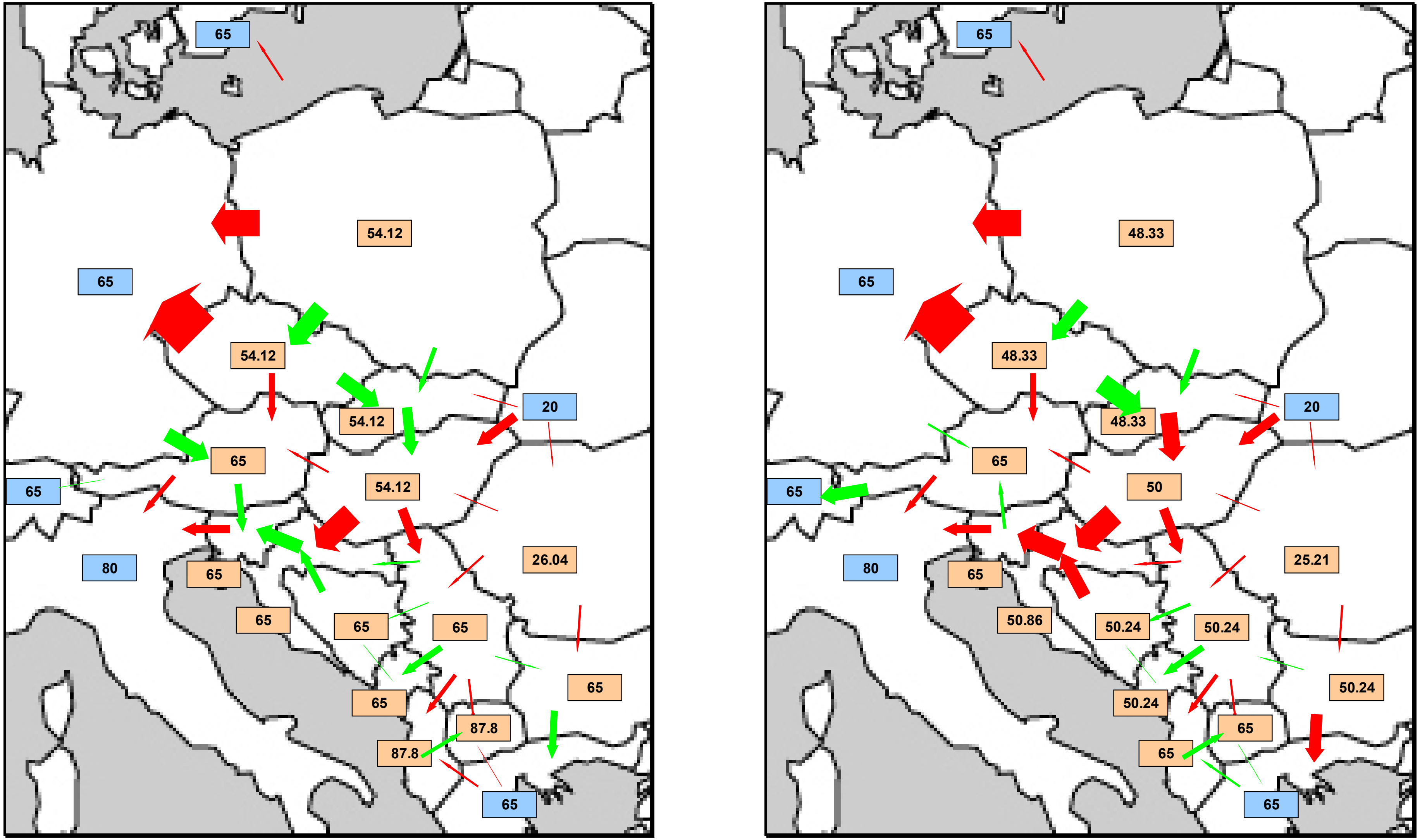


Our reasoning is supported by the following observations, which can be followed on the figure above.

1. The directions of the international electricity flows are the same as experienced in the reality.
2. The relative prices of the countries in the region also reflect the current relations regarding the orders of magnitude.
3. The only way of generating higher Hungarian prices than the Central European ones having the current cross-border capacities is, if the production shortages occur *inside* the country. If we argue, that the Hungarian prices approaching the Balkan ones can also be caused by the capacity restraint of big producers in other countries (e.g. CEZ), then we have to take into account, that in this case the *whole* Central European region would be on the price level of Balkan, not only Hungary.

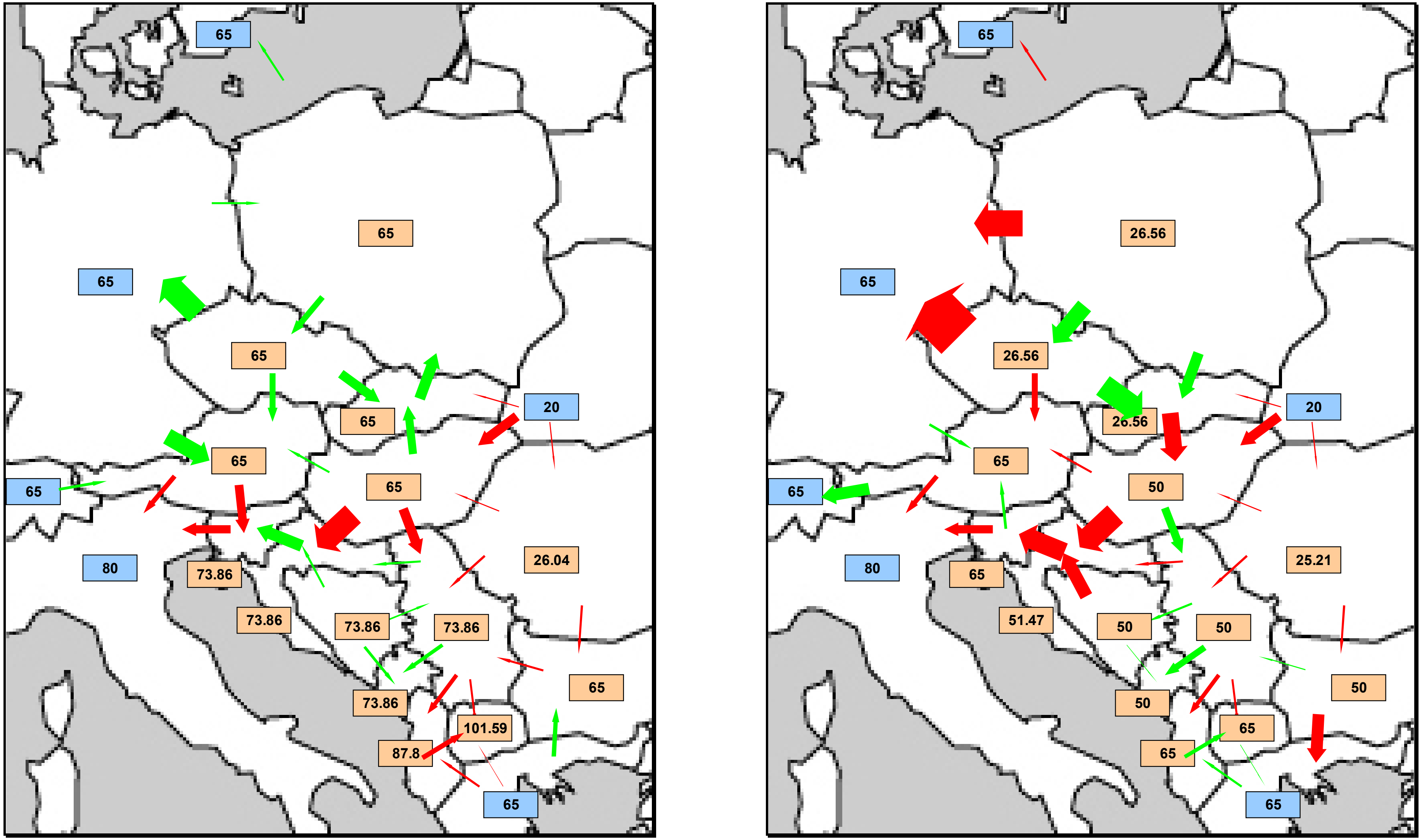
VI. APPENDIX

Figure 29: Modeling results with low (a) and high (b) water yield



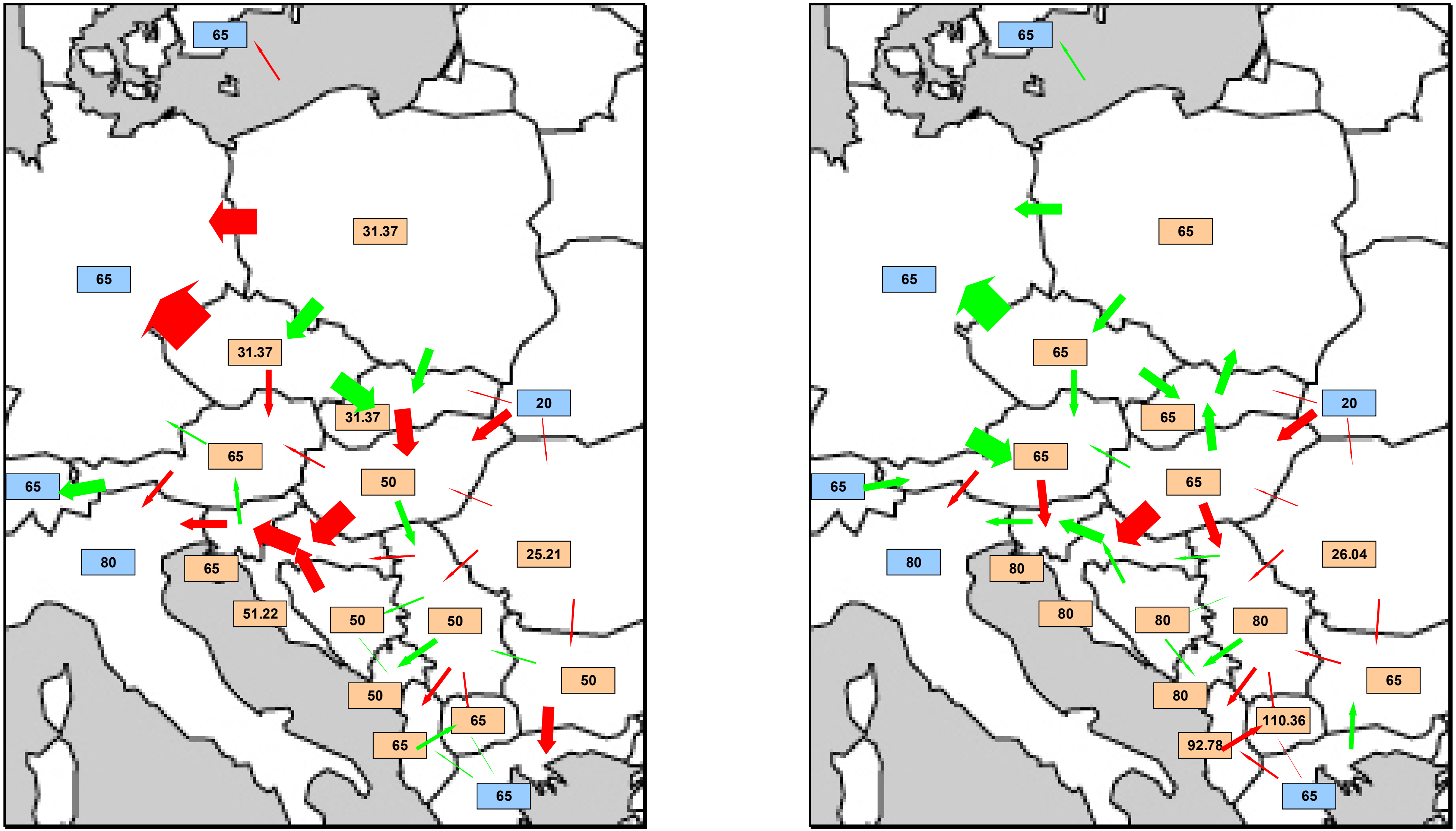
(a) (b)

Figure 30: Modeling results with low (a) and high (b) thermal power plant availability



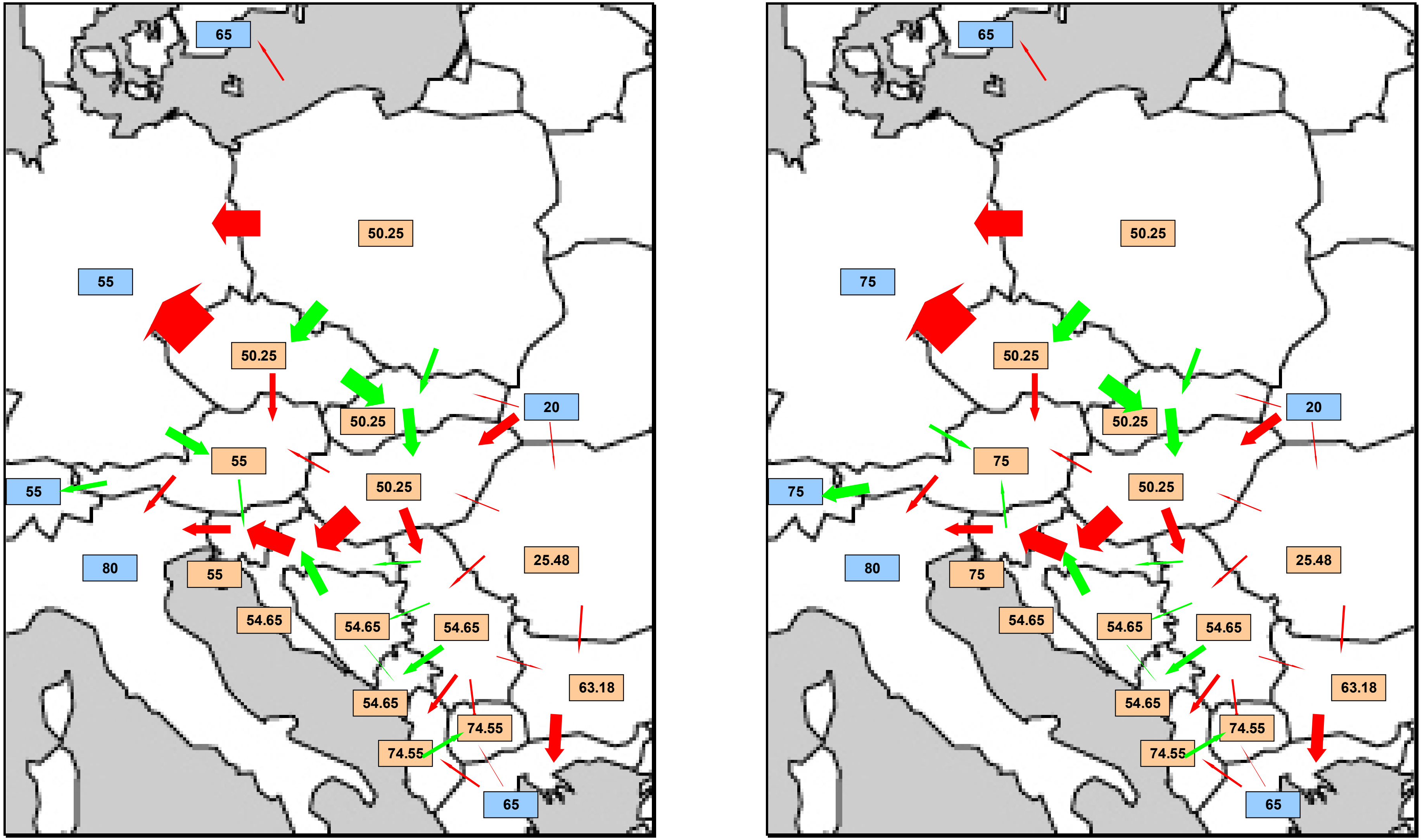
(a) (b)

Figure 31: Modeling results with low (a) and high (b) demand conditions



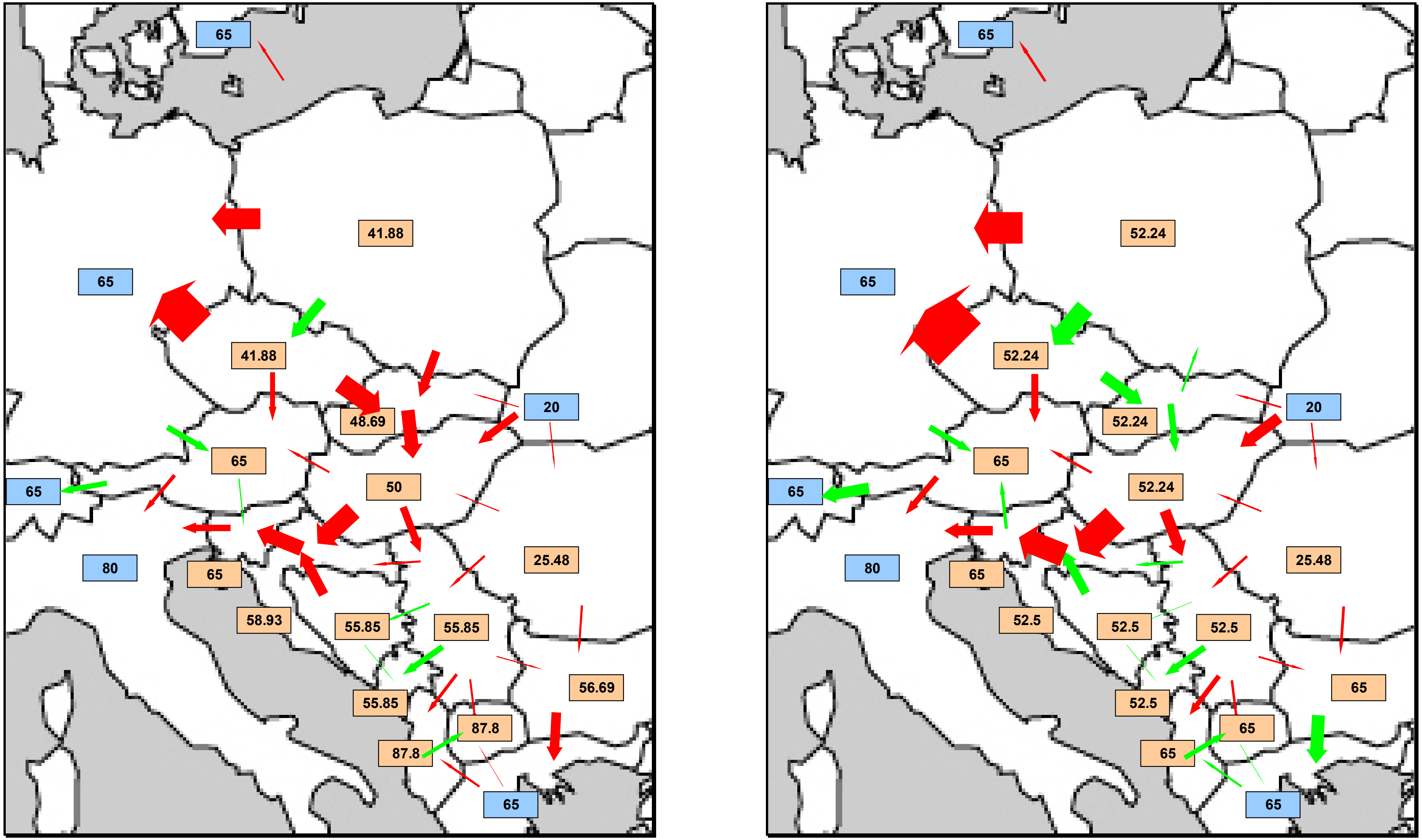
(a) (b)

Figure 32: Modeling results with low (a) and high (b) Western-European (German-Swiss) electricity market prices



(a) (b)

Figure 33: Modeling results with low (a) and high (b) cross-border capacities



(a) (b)