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Does More International Transmission Capacity Increase Competition in the Belgian Electricity Market?

From a national market perspective, taking transmission capacity into account reduces current concentration measures, although they remain fairly high even after substantial capacity increases. From an international perspective, a more efficient use of current transmission capacity by coupling regional markets can increase competition. That suggests it may not be appropriate to assess market concentration using national market shares.

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I. Introduction

The electricity industry has traditionally been vertically integrated. Individual utilities were responsible for all the components of electricity supply: generation, transmission, distribution, and retail. Liberalization began in the 1990s, with the aim of increasing efficiency by relying on competitive wholesale and retail markets. Those parts of the value chain that exhibit characteristics of a natural monopoly, namely the transmission and distribution network, remained state-owned or state-regulated.[1] The first European directive to create a competitive internal market for electricity dates from 1996.[2]

As a consequence, the Belgian electricity market

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has been gradually liberalized over the past years. Since January 2007, the market is fully liberalized up to the final residential consumer. However, many studies have expressed concerns over the level of market concentration. This article aims, therefore, to give some qualitative and quantitative results as to the potential effects of increasing international transmission capacity on market power in Belgium. We set the scene by describing several of these studies that focused on the existence of market power in the Belgian electricity market and possible remedies (Section II). This section, therefore, does not necessarily reflect our own opinion. Consequently we briefly describe the recent relevant changes in the Belgian market, which occurred after these studies have been performed (Section III). Finally we present our own analysis that revisits some of the concerns raised in previous studies and that discusses the effects of one possible market power remedy, i.e. increasing international transmission capacity (Section IV).

II. Previous Studies on Market Power in the Belgian Electricity Market

A. Competition in the Belgian electricity market

In 2003, the Belgian federal regulator CREG[3] commissioned London Economics to undertake a study on the competitiveness of the Belgian electricity market in a European context. Later, London Economics was also asked by the European Union's DG Competition to study six European electricity markets, among them the Belgian market, in the context of the sectoral inquiry into the European electricity and gas markets. The main conclusion of London Economics (2004, 2007) is that market dominance does constitute a serious problem in the Belgian market, while there is no evidence that market power has been exercised. However, London Economics also argues that the threat that the abuse of market power might occur in itself might already be sufficient to deter entry of new firms into the market, since these firms are uncertain about the behavior of the dominant company when entry would occur.[4]

Table 1: Concentration Measures for Selected European Electricity Markets (including installed generation capacity, pump storage and seasonal hydro capacity).

	Belgium	France	Germany	The Netherlands	United Kingdom
HHI	8431	8633	1275	2103	1405
CR(1)	91.47%	92.80%	22.43%	28.88%	24.88%

Source: VGE (2006).

The main impediment to competition, according to London Economics, is therefore the dominance of *Electrabel*, a company at present owned by *GDF Suez* and at the time of the study highly vertically integrated. The London Economics studies focus on the market share of Electrabel – at roughly 80–90 percent in electricity generation – which remains a dominant player in the retail market, despite the entry of new companies (CREG, 2007, at 42–46). Accordingly, standard measures of concentration, such as the *Herfindahl–Hirshmann* Index[5] and the *concentration ratio CR(1)*[6], are high (**Table 1**) compared to most of other European electricity markets. An important remark has to be made concerning the use of these indicators for Germany. The German market is divided into four regions, each dominated by a vertically integrated company. Calculating the HHI for such a single region might even reach the monopolistic value of 10,000. When considering Germany as a whole, however, the rather low values presented in Table 1 are obtained.

Furthermore, it is also considered as problematic that Electrabel is influential at the level of both electricity transmission and distribution.

B. Suggested remedies for market power

In light of the high concentration ratio in the Belgian electricity market, several remedies have been proposed and partly implemented. These remedies tackle four types of problems, mainly directly or indirectly related to the dominance of Electrabel: the vertically integrated structure of Electrabel, its excessive dominance in the generation market, the lack of transparency and information, and the limited geographical size of the Belgian market. Unfortunately, as will become clear in the discussion below, there is generally no agreement on the best way to stimulate competition.

According to London Economics (2004), the main impediment to workable competition is ''Electrabel's excessive dominance along the value chain.'' One of the suggestions is, therefore, to proceed to an ownership unbundling of the vertically integrated structure (generation, retail, distribution, and transmission), concerning direct as well as indirect participation. According to the Belgian federal regulator (CREG, 2006b), however, separating generation and retail activities is not necessarily the best solution, since this might render investment in generation capacity more risky and tends, hence, to increase electricity prices. As a matter of fact, investing in electricity generation requires large sunk investments and vertical integration reduces the risk associated with these investments as it guarantees a minimum customer base. In addition, investing in generation capacity might have a significant effect on prices in small markets like Belgium, and this renders potential entrants even more reluctant. The CREG (2006b, at 43) therefore comes out in favor of vertical integration (between generation and retail) and of harmonizing the way a company can integrate vertically. In particular, the preferential relation between a generator and a retailer of the same company should be broken. In this respect, CREG suggests studying the possibility of organizing obligatory auctions on the wholesale market.

Unfortunately, there is generally no agreement on the best way to stimulate competition.

London Economics also suggests that the most direct way to reduce Electrabel's dominant position in the generation market would be to split the company into several parts. Along with some other measures, especially the creation of a market power mitigation committee for monitoring and detecting market power abuse, seven to nine different companies in total (including the main competitors EdF and SPE) would be necessary to have a sufficiently competitive level. An alternative way of implementing this measure, if quasi impossible legally,[7] would be to significantly increase the amount of virtual power plants (VPPs, an amount of 9,507 MW, is estimated to be equivalent to splitting Electrabel into four parts).[8] Frontier Economics (2006) also points in the same direction as it argues that a contract cover (whether VPPs or other long-term contracts) of about 8,000 MW would be optimal.[9] The CREG (2006b, pp. 48–50), in contrast, is not in favor of these measures because, in a European context, splitting up a medium-sized company is not necessarily welfare-increasing, if the shares are bought by large European companies (like E.On, EdF or RWE). Furthermore, it would be better to enhance the current VPP system (with a total capacity of 1,200 MW) and, if necessary, to regulate prices until a sufficient level of competition is reached. Finally, Electrabel's dominant position in electricity generation might also be strengthened by the fact that production sites in Belgium are scarce and that a large proportion *may* be owned by Electrabel. Another remedy would thus be to oblige Electrabel to sell unused sites or to tax these sites. However, the effect of this measure has not been quantified yet and there exists no clear information on potential production sites (Frontier Economics, 2006).[10]

Furthermore, according to London Economics, a lack of transparency and information hampers the entry of new firms. ''A recurrent theme throughout

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the consultations was the opacity of the Belgian electricity market and lack of access by new entrants to basic information about production, prices, end-user profiles, etc. By virtue of its dominance in generation, supply and trading, vertical integration, and presence in all electricity markets, and its close relationship in ELIA[11] and many DSOs,[12] Electrabel has access to vastly superior information about all aspects of the Belgian electricity sector. It is also important to note that in many cases, it may not be a lack of information that is at issue, but the fact that Electrabel may have access to better information, or has the information in advance of potential competitors.'' (London Economics, 2004, at 187). Possible remedies would, for instance, include breaking the link between Elia and Electrabel and the divestiture of Electrabel's technical activities from the mixed intercommunales (London Economics, 2004, at 220–221).

London Economics (2004) offers as another possible remedy an increase in the relevant geographical market beyond Belgian borders by increasing international transmission capacity. However, it also argues that there is a cost (besides the investment cost) since prices tend to be equalized with increasing transmission capacity. This can imply that prices in the low-price country increase due to exports to the high-price country. Transmission capacity should also be allocated using an auction system.

The aim of this article is precisely to provide insight into the effects on market power of an increased electricity transmission capacity in Belgium with its neighboring countries.

III. Recent Developments in the Belgian Electricity Market

Note that since some of the previously mentioned reports have been published, several measures expected to improve competitiveness have been taken. We refer to the creation of the Belgian power exchange Belpex in 2006, the market coupling of the Belgian, Dutch (APX), and French (Powernext) wholesale electricity markets at the same moment (Trilateral Market Coupling, or TLC), an increase in interconnection capacity with France (the Avelgem-Avelin line), replacing long-term contracts for cross-border capacity by explicit auctioning, the so-called ''*pax electrica I*'' concluded between Suez and the Belgian federal government in 2005 in light of the takeover of Electrabel by Suez,[13] the reduction of Electrabel's share in Elia (from 64 to 24 percent; Elia, 2007)[14] or the first auctions of VPPs in 2004 and 2005 with a total capacity of 1,200 MW. Not without consequences for the Belgian electricity (and gas) market is the merger between Suez and Gaz de France, notified to and accepted by DG Competition in 2006 and realized in 2008.[15]

IV. Assessing the Competitive Effects of an Increased Transmission Capacity

Previous studies have suggested that transmission capacity may be an option to reduce market power in the Belgian electricity market. One should also note that the current transmission capacity of Belgium (**Table 2**), relative to the demand of electricity with a peak of about 14 GW, is among the highest in Europe.

The remainder of this article is structured as follows: We first have a look at economic theory and sketch the competitive effects of a transmission line between regional electricity markets. We present, subsequently, the methodology and the results of London Economics (2007) regarding the existing transmission capacity

Table 2: Transmission Capacity between Belgium and Its Neighboring Countries.

	France	Germany	Netherlands	United Kingdom	Total
Belgium	3200 MW	0 MW	2400 MW	0 MW	5600 MW

Based on net transfer capacity of the interconnectors *towards Belgium*. Values are winter 2007–2008 values, taken from ETSO (2008).

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between Belgium, France, and the Netherlands. This is done by including the transmission capacity into three measures of concentration: the Herfindahl–Hirschmann Index (HHI), the Pivotal Supplier Index (PSI) and the Residual Supplier Index (RSI). While the HHI is applied in all markets subject to a potential market power problem[16] and only considers the supply structure, the PSI and the RSI are specific to the electricity market and also take the demand for electricity into account. The following section aims to give a rough idea of the competitive effects of additional transmission capacity – according to the indexes mentioned before. Finally, we shortly describe the current working of the Trilateral Market Coupling between Belpex, APX, and Powernext and question whether the relevant market when challenging the position of Electrabel is national or broader.

We are aware of the fact that there exists a wide range of market power detection methods and the competitive effects of additional transmission capacity could be assessed more in-depth than we do in this article. Twomey *et al.* (2005) distinguish between four categories: structural and behavioral indices, simulation models, and transmission monitoring. We only focus on structural indices (HHI, PSI, and RSI) for different reasons: several methods require detailed data which are not publicly available, others are not suitable for assessing the effects of *additional* transmission capacity, and, finally, we want to apply a similar approach as in London Economics (2007) that focuses only on HHI, PSI, and RSI.

A. Competitive effects of transmission capacity in theory

Previous to the liberalization of the electricity market, the role of the transmission network was essentially to ensure stability of the system. Electricity was transported between regions to compensate disequilibria between regional demand and supply. In a liberalized market with profit-maximizing firms, this is only part of the story since firms use the transmission lines to arbitrage on regional price differences. For this reason, however, generators may also have an incentive to congest transmission lines with limited capacity in order to exercise market power on their regional demand. Therefore, the competitive effects of a transmission line between otherwise separated markets are not straightforward. **Fig. 1** shows the effect of transmission capacity on regional electricity demand D.

Without any transmission capacity, producers in each market face a demand D. With a transmission capacity k, regional demand depends on regional price differences. If market 1 is the high-price market (resp. low-price market), producers in this market face demand $D_{-k} = D - k$ (resp. $D_{+k} = D + k$) since producers of region 2 (resp. region 1) sell part of their output to this high-price region. A monopolist in market 1, for instance, can set a higher price than in market 2, congest in this way the transmission line and exercise his monopoly power on the lower residual demand D_{-k}. However, he could also set a lower price than in the other market while facing an increased demand D_{+k}.

Borenstein *et al.* (2000) give some interesting theoretical insights into the competitive effects of a transmission line connecting two regional markets where distinct regional monopolists are active.[17] For a sufficiently small transmission capacity, they show that no pure-strategy Nash equilibrium[18] exists in a symmetric world with identical demand and supply conditions.[19] Even a tiny

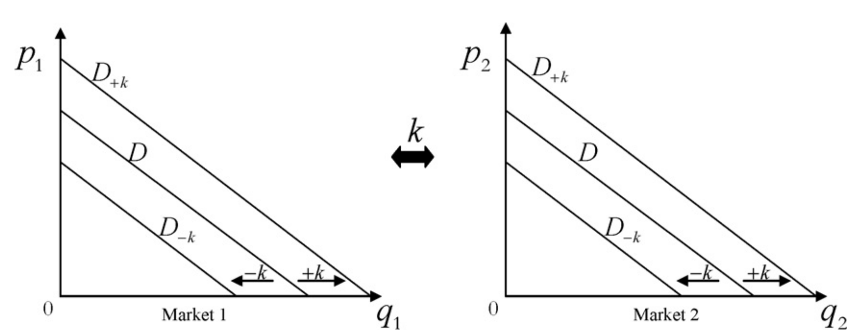

Fig. 1: Two Regional Markets that are Linked by a Transmission Capacity k

transmission capacity could lead to a situation where the outcome is the duopoly equilibrium in which the two markets are merged, although there is no electricity flowing on the transmission line (as regional prices are equal). Unfortunately, this symmetric equilibrium is not stable since each monopolist has an incentive to increase prices unilaterally and, hence, to congest the line in order to exercise monopoly power on the residual demand (regional demand minus imports which are equal to the capacity of the transmission line). However, one can show that such an asymmetric equilibrium is not stable either. Therefore, for small transmission capacities, only mixed-strategy equilibria exist in which firms choose different strategies (quantities) with a positive probability.[20] In this context, Borenstein *et al.* (2000, p. 306) also show ''...that small increases in line capacities can yield expected output increases much larger than the added line capacity.'' Léautier (2001) explicitly separates the effect of an increase of transmission capacity into a strategic effect (increase of competition reduces generators' profits and increases output) and a substitution effect (expensive generation can be substituted by cheap generation). He argues that in the past, regulators sometimes failed to recognize the strategic value of a network and the latter was, therefore, not expanded sufficiently.

For a sufficiently large transmission capacity, the only possible pure-strategy equilibrium is the unconstrained Cournot duopoly equilibrium and adding transmission capacity is futile.

The main conclusions[21] we have to keep in mind are therefore that unused transmission capacity is still useful as it provides a threat to anti-competitive behavior (''...if a connecting line is of sufficient capacity to reduce market power as much as possible, it may appear to be overbuilt and underused.'' Borenstein *et al.*, 2000, at 297); small increases of transmission capacities can yield large social payoffs in terms of reduced expected prices, especially if the initial capacity is small and the relevant geographical market can be regional (the two markets are separated) or interregional (the two markets are merged) depending on the transmission capacity and, therefore, on the strategies chosen by the monopolists. The third conclusion is relevant especially for competition and regulation authorities which have to assess the competitive structure of the electricity market.

B. Transmission capacity and standard concentration measures

The previous discussion shows that extending interregional transmission capacity can lower market power in electricity markets. In practice, however, decision-makers have to choose the frontier where the capacity should be increased and by how much. The lesson that we can draw for the moment is that transmission capacity should be increased between those regions (1) where transmission capacity is low or even inexistent, (2) that have different demand patterns (large substitution effect) and (3) where competition between generators is expected to increase significantly (strong strategic effect). Furthermore, one should not base the investment decision on historical congestion patterns (before liberalization) since lines are expected to be congested more often in liberalized markets due to strategic actions (Borenstein *et al.*, 2000). An additional problem is that real networks are more complex than two nodes connected by a line.[22] This renders interactions between the transmission network and the generators' strategic decisions even more opaque (Cardell *et al.*, 1997).

Unfortunately, we are not able, within the scope of this article, to perform a complete analysis of the competitive effects on the

Belgian market of increased transmission capacity, which would require the use of a large-scale oligopoly model. Nevertheless, we aim to give a rough idea of what would happen if the transmission capacity would be raised. For this analysis, we integrate transmission capacity into commonly used structural concentration indicators. First, we discuss shortly the results of London Economics (2007) where *existing* transmission capacity on the Belgian border was integrated in concentration indicators.

1. *The competitive effect of existing transmission capacity.* For the computation of the Herfindahl–Hirschmann Index (HHI) and the concentration ratio CR(1),[23] London Economics (2007, at 116) uses two scenarios:

- ***Atomistic competition***: ''The aggregated impact of the interconnector is included in the denominator of both CR(1) and HHI measures, such that the net impact of the interconnectors is only added to the market. Thus, the atomistic competition scenario reduces the measured concentration by the maximum amount possible due to the interconnector.'' In practice:

$$CR(1) = \frac{AIC_1}{\sum_1^N AIC_i + IC}$$

and

$$HHI = \sum_1^N \left(\frac{AIC_i}{\sum_1^N AIC_i + IC} \right)^2$$

where AIC_i refers to the hourly available installed capacity of firm $i = 1, \ldots, N$, ordered from the largest to the smallest firm in the Belgian market. *IC* gives the hourly availability of interconnector capacity (net transfer capacity).

- ***Largest company apportionment***: ''The hourly impact of the interconnectors is apportioned entirely to the largest company in the market as measured by available installed capacity. This scenario thus represents the largest increase in measured concentration possible due to the allocation of the interconnector.'' The concentration ratios become

$$CR(1) = \frac{AIC_1 + IC}{\sum_1^N AIC_i + IC}$$

and

$$HHI = \sum_1^N \left(\frac{AIC_i + z \times IC}{\sum_1^N AIC_i + IC} \right)^2$$

where z is a dummy taking the value 1 for $i = 1$ and 0 otherwise.

These two scenarios give thus the lower and the upper bound of *HHI* values when transmission capacity is taken into account. If foreign companies use this transmission capacity to sell electricity on the Belgian market, the *HHI* will be between these limits.

London Economics (2007, at 133) included transmission capacity also in two electricity specific measures: the Pivotal Supplier Index and the Residual Supplier Index. They indicate, respectively, whether a given generator is pivotal, i.e. needed to meet the demand for electricity in a given hour, and the extent to which this generator might have an influence on the wholesale price. The advantage, compared to the previous indicators, is that they rely on both the supply and the demand side. Two scenarios were considered:

- ***IC domestic***: ''The hourly interconnector capacity IC_c, aggregated over the interconnectors, is added to the total supply of the market and apportioned in accordance with the companies' market shares (as measured by installed capacity C_i) in the market being assessed (Belgium). The hourly aggregated interconnector flows IC_f (which can be positive or negative) are added to the load.'' According to this scenario, the modified RSI and PSI become (for the largest company in the market)[24]:

$$RSI_1 = \frac{\left(\sum_1^N AIC_i + IC_c\right) - \left(AC_1 + IC_c\left(\frac{C_1}{\sum_1^N C_i}\right)\right)}{\sum_1^N hourly\_generation_i + IC_f}$$

and

$$PSI_1 = 0 \quad \text{if}\left[\left(\sum_1^N AIC_i + IC_c\right) - \left(AC_1 + IC_c\left(\frac{C_1}{\sum_1^N C_i}\right)\right) - \left(\sum_1^N hourly\_generation_i + IC_f\right)\right] \geq 0$$
$$PSI_1 = 1 \quad \text{otherwise}$$

where AC_i denotes the available capacity of company i and AIC_i the Available Installed Capacity: $AC_i = AIC_i - \text{Reserve Commitments}_i + \text{Long-Term Contracts}_i$.

- ***IC foreign***: ''The hourly interconnector capacity IC_c of each interconnector is added to the total supply of the market and the hourly available capacity of each interconnector is apportioned in accordance with the companies' market shares (as measured by installed capacity) in the markets from which electricity can be imported. The hourly aggregated interconnector flows IC_f are added to the load.'' Under this second scenario, indicators are equal to:

$$RSI_1 = \frac{\left(\sum_1^N AIC_i + IC_c\right) - \left(AC_1 + IC_c\left(\frac{C3_1}{\sum_1^N C3_i}\right)\right)}{\sum_1^N hourly\_generation_i + IC_f}$$

and

$$PSI_1 = 0 \quad \text{if}\left[\left(\sum_1^N AIC_i + IC_c\right) - \left(AC_1 + IC_c\left(\frac{C3_1}{\sum_1^N C3_i}\right)\right) - \left(\sum_1^N hourly\_generation_i + IC_f\right)\right] \geq 0$$
$$PSI_1 = 1 \quad \text{otherwise}$$

where $C3_i$ is the installed generation capacity of company i in the exporting country. If the RSI is smaller than 1 (or 100 percent) then company i is pivotal. The larger this value, the less influence this company is expected to have on wholesale prices.

Results for the CR(1) and the HHI are presented in **Table 3**.

For the RSI and the PSI, London Economics (2007) get the results shown in **Table 4**.

The figures clearly indicate that including existent transmission capacity lowers concentration measures, although it does not change the overall picture of a highly concentrated Belgian electricity market. In the most competitive scenario (''Atomistic Competition'' in Table 3), the largest company in the market (Electrabel) keeps a share of 77 percent and the HHI remains largely above values that are generally considered as acceptable in terms of competition.[25] The same is true for the RSI and PSI: Electrabel remains nearly always pivotal and 20 to 50 percent of total load cannot be served without Electrabel's generation capacity, i.e. it is, theoretically, in a position to influence wholesale electricity prices significantly. The next section extends this analysis and looks at the effect of *additional* transmission capacity.

2. The competitive effect of additional transmission capacity. For the computation of the HHI, we define two scenarios, in addition to the two scenarios by London Economics (Atomistic Competition and Largest Company Apportionment): In a first scenario (scenario A), we assume that the current electricity generation structure remains the same and that the transmission capacity is allocated to *foreign* firms according to the market share in their country (based on installed generation capacity). In a second scenario (scenario

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Table 3: CR(1) and HHI with Interconnector Capacity (years 2003–2005).

	No IC		Atomistic Competition		Largest Company Apportionment	
Scenario	*CR*(*1*)	*HHI*	*CR*(*1*)	*HHI*	*CR*(*1*)	*HHI*
Average	90.70%	8307	72.60%	5332	92.50%	8617
Max	97.50%	9508	77.50%	6030	96%	9236
Mm	87.20%	7761	67.90%	4678	90.50%	8266

Source: London Economics (2007, p. 118).

Table 4: RSI and PSI with Interconnector Capacity (years 2003–2005, for largest company).

	No IC		IC Domestic		IC Foreign	
Scenario	*RSI*	*PSI*	*RSI*	*PSI*	*RSI*	*PSI*
Average and % hours PSI = 1	0.55	100%	0.53	100%	0.79	97.20%
Max	0.81		0.82		1.16	
Min	0.35		0.33		0.53	

Source: London Economics (2007, p. 126–140).

B), we assume that the increase of transmission capacity attracts *new* firms. In this case, we assume that the additional transmission is used by a single new firm. While it matters in scenario A on which border the capacity is increased, it has no importance for computing the HHI in scenario B. Furthermore, the HHI is the same (in scenario B) whether the new entrant is located in the Belgian or in a foreign market. Finally, the way we include the transmission capacity into the HHI assumes that electricity flows from the neighboring countries into the Belgian market. This is an extreme case since flows depend on regional price differences and electricity would only flow to Belgium if the spot market price was higher in Belgium than in all other countries. In this sense, we evaluate the maximum effect that transmission capacity might have on concentration and the two scenarios differ in the user of this capacity. Results are presented in **Table 5**. For the current situation (0 additional MW), we allocated the existing transmission capacity in both scenarios A and B to the foreign companies according to their market shares in their market.

For capacity increases between 500 and 4,000 MW, the results show that concentration remains fairly high. Except for France, the concentration level of the Belgian electricity (generation) market stays higher than the current level in all other neighboring countries, even in the most competitive ''Atomistic Competition'' scenario (see Table 1). Although there are no significant

Table 5: HHI and Additional Transmission Capacity (based on installed capacity and Net Transfer Capacity).

	Additional Transmission Capacity								
	0 MW	500 MW	1000 MW	1500 MW	2000 MW	2500 MW	3000 MW	3500 MW	4000 MW
Atomistic competition	4536	4133	3781	3473	3201	2959	2744	2552	2379
Largest company apportionment	8823	8451	8118	7820	7550	7305	7081	6877	6690
Scenario A									
B-F	4763	4609	4472	4352	4245	4152	4070	3998	3936
B-G	4763	4545	4343	4155	3981	3819	3667	3526	3394
B-NL	4763	4557	4366	4189	4025	3874	3733	3602	3480
B-UK	4763	4545	4343	4156	3982	3820	3669	3529	3397
Scenario B	4763	4550	4361	4194	4047	3917	3804	3704	3617

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Table 6: Installed Capacity by Technology (note that the presence of *pump storage* in this table has to be interpreted with care).

%	B	FR	G	NL	UK
Coal	15	8	46	27	33
Gas	37	2	17	58	30
Nuclear	30	66	24	3	14
Pump storage	10	5	7	–	1
Other	8	19	6	12	22
Total	100	100	100	100	100

Source: London Economics (2007).

differences between scenario A and B and the border on which capacity is increased, it seems that it would be most beneficial to build transmission capacity connecting Belgium with Germany and the United Kingdom. These are also the least concentrated markets according to the HHI and CR(1) indexes (Table 1). Note that there is currently no transmission capacity connected to these countries.[26] However, the German market is dominated by four vertically integrated companies (EnBW, E.ON, RWE, and Vattenfall)[27] and it is unlikely that a new transmission line would be used by these companies according to their national market shares. The strategic effect is thus likely to be lower, as shown earlier. Additionally, Germany's electricity production is mainly coal-based and production in the United Kingdom is coal- and gas-based. These technologies have a higher production cost than nuclear power, which next to gas is the main technology used in Belgium (see **Table 6**). Furthermore, electricity demand patterns (**Fig. 2**) are similar such that the substitution effect is expected to be low. Therefore, our results should be interpreted with care.

Finally, our approach shows that it matters to include transmission capacity into concentration measures like the HHI. For the current situation (0 MW additional capacity), the HHI is likely to drop far below the current level of 8,431 (Table 1).

Concerning the PSI and the RSI, we evaluate the competitive effect of increased transmission capacity by adding it to the total regional supply capacity. As with the HHI, this approach assumes that electricity flows only into Belgium. Therefore, the competitive effect of transmission capacity we measure is the largest possible according to the PSI and RSI. Note that for the calculations, it has no importance to know on which border the capacity is increased. The indices are computed for the largest Belgian company (Electrabel) whose absolute size does not change by adding additional capacity. The results are presented in the figures below.

Fig. 3 indicates that the largest Belgian electricity company (Electrabel) is always pivotal at current levels of transmission

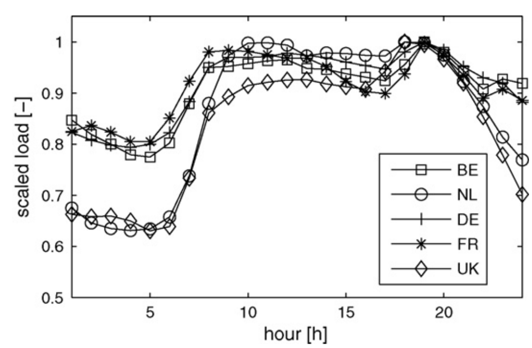

Fig. 2: Electricity Demand Profiles in Belgium and Its Neighboring Countries

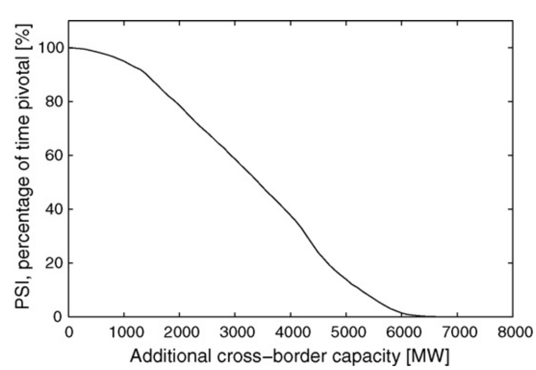

Fig. 3: Effect of Additional Transmission Capacity on the Pivotal Supplier Index (PSI)

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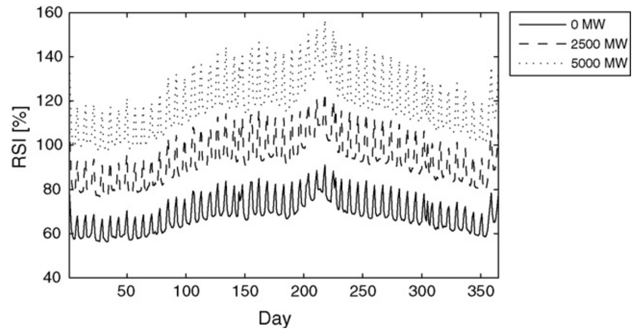

Fig. 4: The Effect of Additional Transmission Capacity on the Residual Supplier Index (RSI), Presented as Daily Averaged Values

capacity (see also Table 4). For small capacity increases, the marginal competitive effect of the transmission capacity on the dominant position of Electrabel seems to be increasing (up to 2,000 MW additional capacity).

Figs. 4 and 5 also show that the dominant position of Electrabel is sensibly weakened for further investments in transmission capacity. Fig. 4 indicates that Electrabel has less potential market power during summer and in the end of a year (the demand for electricity is lower).

Taking the current transmission capacity into account, Electrabel is, on average, responsible for 30 percent of the total demand for electricity in Belgium. On average, Electrabel would not be pivotal anymore for an additional capacity of around 3,100 MW (Fig. 5).

In summary: According to the structural concentration indicators, it seems that the most efficient way to increase competition through an increase of transmission capacity would be to increase capacity with neighboring countries with which transmission capacity is low or non-existent, i.e. Great Britain and Germany. This result should, however, be interpreted with care since the German electricity market is fragmented into four regions dominated each by one player and production costs are expected to be higher in these countries. Substantial capacity increases of about 3,100 MW would be necessary to render Electrabel, on average, not pivotal anymore. For small increases up to 2,000 MW, the marginal competitive effect seems to be increasing. These findings confirm the theoretical conclusions of Section IV-A.

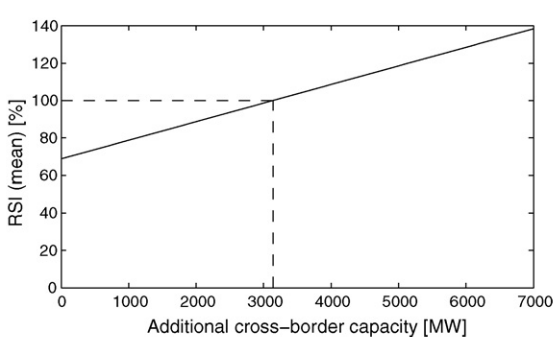

Fig. 5: The Average Effect of Additional Transmission Capacity on the Residual Supplier Index (RSI)

C. An application: the trilateral market coupling

1. Expectations. The term ''market coupling'' suggests that it is about coupling markets that were previously not coupled. From the start of market reforms in Europe, cross-border trade was however possible, but it required traders to buy border transmission rights from the involved TSOs. A Belgian market party that acquired such a transmission right could for instance introduce an order on the Dutch power exchange.

Instead of auctioning these rights in a separate market, as done on many borders, they can also be used by the power exchanges to optimize the clearing of their auctions, which is referred to as ''market coupling.'' Market coupling therefore means that orders from different locations are handled jointly and settled at a single price to the extent that the exchanges have enough transmission rights available.

In other words, market coupling increases the liquidity of the involved power exchanges because an order introduced in France can, for instance, be matched with an order introduced in the

Netherlands. This is important for exchanges that are voluntary fine-tuning markets, which means that their liquidity is by definition limited, especially if they operate in concentrated markets with vertical integration between generation and retail/supply, which is the case in most European countries. The so-called *Trilateral Market Coupling* (TLC) between the Belgian (Belpex), the Dutch (APX), and the French (Powernext) electricity spot markets is one example.[28]

Prior to the realization of the TLC in 2006, Hobbs *et al.* (2005) analyzed the potential effects of such a market coupling for the Dutch and the Belgian electricity markets (note that at that time, Belpex did not exist yet). Their main conclusions were that the proposed market coupling should lead to lower overall generation costs since the two markets are complementary (asymmetric load profiles and different generation mixes) and it was expected to increase competition especially in the Belgian market.[29]

However, Hobbs *et al.* (2005) also identified two caveats related to the strategic behavior of Electrabel (before and after the realization of the market coupling) and to distributional effects. As we have seen above, the Belgian market is largely dominated by Electrabel. Hobbs *et al.* (2005) argued that due to public pressure, Electrabel could be pushed to set prices closer to competitive levels. With market coupling, it would set prices (or quantities) according to the Cournot assumption since it would feel less public pressure, as the market would be less concentrated.[30] In this worst case, market coupling would actually lead to an overall welfare loss since prices would increase in both countries. Additionally, even if overall welfare increases (if Electrabel is playing Cournot also before coupling), Dutch consumers would actually lose from the market coupling since it would be in Dutch producers' interest to sell in Belgium (which leads to a decrease of the electricity price in Belgium and to an increase of prices in the Netherlands).

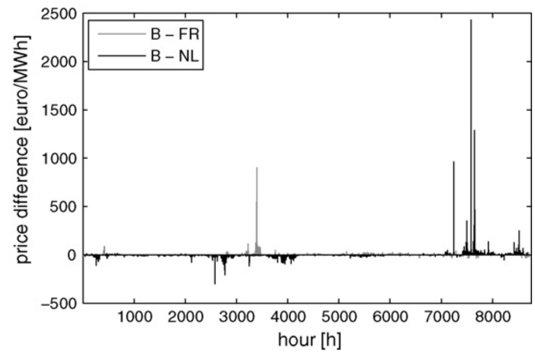

Fig. 6: The Wholesale Electricity Price Difference of Belgium with its Neighboring Countries (hourly prices, year 2007; a positive difference indicates a higher price in Belgium)

2. *Results.* The TLC is operating since November 2006. This allows us to take a look at the historic data of the TLC for the year 2007 (hourly day-ahead electricity prices of 2007 of Belpex, Powernext, and APX) and to investigate whether prices moved closer to each other. Fig. 6 presents the difference in price between Belgium and both France and the Netherlands, for each hour of the year.

Table 7 gives an overview of the electricity price differentials in the TLC area. P_i is the electricity price in country i = Belgium (B), France (FR) or Netherlands (NL).

We notice that the case of three different prices (first column) occurs only rarely, namely 2.8 percent of the time. Furthermore, during hours of congestion on

Table 7: Price Differences within the TLC Region (hourly data, year 2007).

B		B + FR or B + NL		B + FR + NL	
$P_B > P_{FR} > P_{NL}$	0.02%	$P_{NL} > P_B = P_{FR}$	19.75%	$P_B = P_{FR} = P_{NL}$	59.94%
$P_B > P_{NL} > P_{FR}$	0.00%	$P_{NL} < P_B = P_{FR}$	5.42%		
$P_{FR} > P_{NL} > P_B$	0.33%	$P_{FR} > P_B = P_{NL}$	5.29%		
$P_{FR} > P_B > P_{NL}$	0.61%	$P_{FR} < P_B = P_{NL}$	6.78%		
$P_{NL} > P_B > P_{FR}$	0.76%				
$P_{NL} > P_{FR} > P_B$	1.10%				
Total	2.82%	Total	37.24%	Total	59.94%

both borders, prices do not seem to be excessive in Belgium (Fig. 5). In 37.2 percent of the time, either France or the Netherlands has the same price as in Belgium. In the majority of time (about 60 percent), prices are equal in all countries.

Having equal prices among at least two electricity wholesale markets means that the concerned transmission lines are not congested and that generation companies are, therefore, competing over the combined market (two or even three countries). Recall from Section IV-A that unconstrained lines may still be useful, as they constitute a competitive threat. The findings above suggest thus that in most of the hours in 2007, Electrabel was competing over a market that encompassed at least two markets. This leads us to conclude that the competitive position of Electrabel should probably be assessed by relying on a broader relevant market than just the Belgian market. Likewise, we doubt whether an increase of the transmission capacity with France or the Netherlands would change the competitive situation a lot. Other alternatives (increasing capacity with Germany or Great Britain, as mentioned in the discussion on the HHI) could be more effective in promoting competition.

V. Conclusions

This article investigated whether increasing electricity transmission capacity would be an option to decrease the dominant position of Belgium's largest electricity generation company Electrabel. According to standard measures of concentration, the Belgian electricity market is indeed highly concentrated and there is, accordingly, a problem of *potential* market power abuse – although an abuse has never been proven.

Theoretically, a transmission line connecting regional electricity markets can be a powerful instrument to foster competition. We concluded that increasing transmission capacity is expected to be most efficient where transmission capacity is small or inexistent, when regions have heterogeneous demand profiles and generation mixes, and when the other region has a higher level of competition.

London Economics (2007) concluded that existing transmission capacity does not change the overall conclusion that the Belgian market is highly concentrated. According to a similar methodology as used by London Economics and based on concentration indices, we can confirm that this also holds for additional transmission capacity, if Belgium is considered to be the relevant market.

Finally, we looked at the Trilateral Market Coupling between the Belgian, Dutch, and French electricity markets. It shows that, besides a physical increase of capacity, improving the use of existing capacity by allocating it in a more efficient way also enhances the competitive effects of a transmission line. In a majority of the hours in 2007, prices in Belgium were equal to Dutch and/or French prices. This led us to conclude that a broader market than the national one should be considered when assessing the competitive position of Electrabel. Furthermore, one should question whether increasing capacity towards France or the Netherlands will lead to significantly more competition in Belgium, and whether other options might be more effective (Germany, Great Britain).

This article is not intended to give a precise idea of whether and where transmission capacity should be increased. Instead, our aim was to give some critical insights, both theoretically and practically, into the problem. One should not forget that there are other alternatives that may be more effective in spurring competition, e.g., favoring entry into a given market.

This is important for exchanges that are voluntary fine-tuning markets.

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Endnotes:

1. ''Liberalization'' is not to be confused with ''privatization.'' ''Privatization is the transfer of ownership and control by the state to private owners'' (Newbery, 2004, at 2). A market or industry is liberalized when its firms are exposed to competition. The objective of competition is to achieve allocative efficiency (the market price equals the marginal production cost) through market forces. Hence, one can say that privatization of companies is possible without liberalizing the market in which these companies operate, while liberalization normally requires privatization. However, allocative efficiency in a market can also be achieved by regulation, i.e. the conduct of the firms is limited by a certain number of rules. Network industries (like the grid for transporting and distributing electricity or the railway system), for instance, cannot be exposed to competition due to economies of scale. Therefore, these networks should either be regulated private companies or remain state-owned. For a more detailed discussion on the relative benefits of regulation and liberalization, see Armstrong and Sappington (2006).

2. *Directive 96/92/EC of the European Parliament and of the Council of 19 of December 1996 concerning common rules for the internal market in electricity*, OJ 30.01.1997 L 027.

3. *Commission de Régulation de l'Electricité et du Gaz/Commissie voor de Regulering van de Elektriciteit en het Gas*. Note that the CREG is the federal regulator. Besides the federal regulator, each of the three Regions also has its own regulator, namely the VREG (Flanders), the CWaPE (Wallonia), and the BRUGEL (Brussels).

4. According to London Economics (2004, at 113–117), there is some indication that a ''margin squeeze'' may have occurred in the Belgian electricity market. A margin squeeze occurs if a vertically integrated company (Electrabel) supplies an essential input (electricity) to a downstream market (the retail market) and if this company increases the wholesale price of the input to reduce margins in the retail market. This strategy shifts profit from the retail market to the wholesale market and may deter new entry in the retail market.

5. The Herfindahl–Hirshmann index (HHI) is defined as follows:

$HHI = \sum_{i=1}^{N} s_i^2$, where s_i is the market share of firm i and N is the number of firms in this market. It measures the degree of concentration in a given market and indicates, therefore, whether market power is likely to occur. The maximum value of the HHI is thus equal to 10,000 (monopoly).

6. The concentration ratio $CR(m)$ gives the sum of the market shares of the m largest companies in a market.

7. See also the discussion in CREG (2006b), at 57–59.

8. VPPs are contracts in which the owner of a generation plant sells the right, and not the obligation, to use part of his generation capacity to other market participants, who have to pay the virtual production cost. Willems (2006, at 5–6) distinguishes between two types of VPPs: financial and physical VPPs. A financial VPP hedges against price increases and the buyer does not intervene actively in the spot market by selling electricity. In a physical VPP, however, the buyer has the option for physical delivery of electricity and can resell it on the spot market. He therefore plays an active role in this market. For this reason, Willems (2006) argues that physical VPPs imply more competitive outcomes than financial VPPs, for a given contract level. However, he also shows that firms are less inclined to offer this type of contracts such that it is not clear cut to know which type yields higher welfare.

9. Electricity customers, like retail companies or large firms, either have to rely on the spot market (or the day-ahead market) or on long-term contracts to purchase electricity. The contract cover of a generation company indicates the share of electricity demand which is satisfied by contracts. Since prices are fixed by contracts, the generation company has fewer incentives to raise prices in the wholesale market.

10. ''The CREG has indicated that the availability of suitable sites for the construction of new generation is a potential concern in Belgium. In particular, the CREG has indicated that Electrabel may own a large proportion of such sites, including the most attractive sites for new build...we have been unable to gather data either to support or refute this assertion'' (Frontier Economics, 2006, at 53). Furthermore, we read: ''...there is reason to suppose that Electrabel might have both a number of relevant sites and also faces financial incentives to retain those sites even if it does not intend to build on them in the foreseeable future'' (Frontier Economics, 2006, at 54).

11. ELIA is the Belgian transmission system operator.

12. Distribution system operators.

13. Suez committed to reduce the share of Electrabel in Elia to 24 percent, to sell unused production sites (1,500 MW) and to offer 500 MW on Belpex (CREG, 2006a, at 28).

14. Note that Electrabel also has a share of 30 to 49 percent in most of the regional network operators (CREG, 2007, at 19).

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15. The merger has been declared compatible with the common market subject to the compliance with commitments taken by the parties. A commitment with importance for the Belgian electricity market is the divestiture of Gaz de France's holding in SPE, which is the main competitor of Electrabel (European Commission, 2006, at 243). The French State holds a share of 35.7 percent of GDF Suez, which gives it the right to block certain decisions which are against French interests. Additionally, the new group took commitments towards the Belgian State that should not jeopardize the competitiveness of the Belgian electricity market. These commitments are also known under the term ''pax electrica II'' (Gez de France Suez, 2008, at 2 and 65).

16. See, for instance, the merger cases of EU DG Competition: http://ec.europa.eu/comm/competition/mergers/cases/.

17. Note that in this setting, it does not matter who is using the line: producers, large consumers, or trading companies.

18. This is an equilibrium in which each player chooses a given strategy (a quantity to produce, for instance) with certainty, given the other players' strategies.

19. Firms are assumed to compete à la Cournot and the transmission cost is determined by *nodal pricing*, i.e. shipping one unit of electricity from one region to the other is costless in case of no congestion and equal to the regional electricity price difference if the transmission line is congested. Note that the allocation of scarce transmission capacity among generators can be designed in different ways which are not neutral with respect to the ability to exercise market power in electricity production (Gilbert *et al.*, 2004).

20. This implies that the transmission line is congested with some probability.

21. These are broad conclusions and extend beyond the simplifying assumption of identical demand and supply conditions.

22. If we consider a model of at least three nodes, we need to take ''loop flows'' into account. Electricity flows are determined by physical laws and take more than one path to flow from the generation to the consumption point (Stoft, 2002, at 397).

23. Classical concentration indicators have the drawback that they only consider the supply side in a static approach and they may be sensitive to the definition of the relevant product and geographical market. Furthermore, it is not obvious to define the critical concentration level above which market power raises a problem. In electricity markets, even a small generator can have significant market power in some circumstances. Moreover, the market power of large firms also depends on other supply-side characteristics than just the relative sizes, like, for example, the shape of the cost curves and the generation capacity of the competitive fringe (Borenstein *et al.*, 1995), or the contract position of a firm (Allaz and Vila, 1993). Finally, network constraints often affect the competitive outcome too, while this is not necessarily reflected in concentration measures (for a simple illustration of some of these aspects, see Crespo and Herrera, 2002).

24. If we set $IC = 0$, we get the usual definition of the indicators.

25. A HHI of 1,800 or higher is generally accepted as a benchmark in competition policy for cases to raise a market power issue. To be indicative of a HHI equal to 1,800, this means the presence of five to six companies with an identical market share. Note that in electricity markets, this critical value is probably lower. Given the characteristics of demand and supply of electricity, even small companies can exercise market power in some moments (when demand is high and generation capacities close to full utilization).

26. There are currently discussions between the Belgian and the British network operators (Elia and National Grid) to build a transmission line of a capacity between 700 and 1,300 MW (Elia, Communiqué de presse, Feb. 8, 2008).

27. Note that E.ON recently proposed to divest its electricity transmission network (European Commission, MEMO/08/132, Feb. 28, 2008).

28. For a discussion of other examples, see for instance Meeus and Belmans (2008).

29. Note that in times of congested transmission lines, market coupling can reduce overall welfare, although competition is increased. This might especially be the case for the Belgian-Dutch border (Kupper and Willems, 2007).

30. This assumption, however, can be challenged. One could also argue, for instance, that with increased integration and harmonization, more market information is available which renders anticompetitive behavior more difficult. Neuhoff and Newbery (2005) refer to a similar effect as Hobbs *et al.* (2005). If the markets in two neighboring countries are integrated, both regulators reduce their monitoring efforts since the impact on the neighboring consumers is not internalized by the regional regulatory authority. This externality is large compared to the competitive effect of a market coupling when the number of firms is small.

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