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POWER TO THE PEOPLE OF EUROPE

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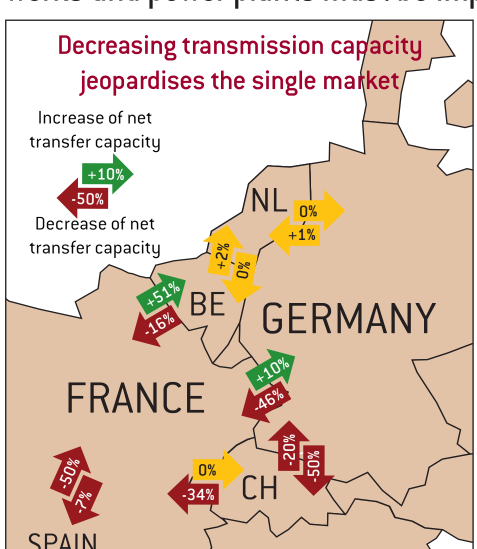
SUMMARY The European Union has taken steps towards the completion of the single electricity market, and thus to reduce costs and boost competitiveness. But there is still much to do. The growing share of intermittent wind power and the relocation of load and generation centres has put aging networks under severe pressure. In addition, electricity systems operate at national level while the physical network is international. Consequently, at certain borders, almost half of the electricity flows from high to low price areas, and urgently needed transmission lines are not built because costs and benefits are asymmetrically distributed across borders. Current cautious plans for more international network planning and better coordination of national markets will not tap the full efficiency potential.

POLICY CHALLENGE

The challenge of creating a single electricity market is twofold: available transmission capacity must be increased and the operation of existing networks and power plants must be improved. Only EU-level electricity network design can deliver the required network infrastructure. The European Commission should therefore continue to push for binding European network planning, based on both technical and cost-benefit analyses, while member states need to move away from the artificial setting of single national prices. Electricity prices must be able to take into account the physical constraints of meshed international networks, resulting in market-led optimisation of the operation of the system and ultimately reducing prices.



Source: ENTSO-E. Figure shows change in net transfer capacities between winter 2004/05 and winter 2009/10 in direction of arrow.

THE FUNDAMENTAL IMPORTANCE OF ELECTRICITY to modern economies is shown by the fact that final sales of the power sector represent approximately three percent of European Union GDP. The price of electricity is not only relevant for direct consumer purchasing power and welfare. Power is a production factor that is difficult to replace and the cost of which thus determines the competitiveness of many production processes. And – in contrast to other forms of energy – electricity is mainly generated domestically. Thus, efficiency gains in the electricity sector could boost Europe's competitiveness.

There is nothing new in attempting to reap the benefits of completing the single electricity market (SEM). The European Commission has been striving to do this since the beginning of the 1990s. Most recently, the Commission's EU2020 strategy paper (European Commission, 2010) explicitly refers to the need 'to complete the internal energy market' as a central plank in putting the EU on a 'green growth' track. The Commission asserts that further integration of European electricity markets can boost GDP by 0.5-0.6 percent (European Commission, 2007). The somewhat simplistic analysis, based on an assumed average electricity-price reduction of 20 percent, seems over optimistic. That said, and although it is difficult to quantify, further market integration does promise significant efficiency gains[1]. As well as boosting competitiveness, a SEM would improve supply security and facilitate the integration of renewables into the EU energy mix.

'Efficiency gains in the electricity sector could boost Europe's competitiveness.'

Pivotal decisions in this policy area will be made this year. Apart from the changing of the political guard at the Commission, the mandate and powers of newly established institutions (the European Network of Transmission System Operators for Electricity and the Agency for Cooperation of Energy Regulators) will be defined, and decisions will be taken on mid-term infrastructure plans, which might result in the locking-in of long-term investment paths.

In this policy brief we will analyse to what extent the SEM has been completed in terms of market design and physical infrastructure. Furthermore, we ask if the envisaged reforms will tackle the two major challenges that lie ahead in the electricity sector, namely increasing the available transmission capacity and improving the use of existing networks and power plants.

The next section considers why the SEM is important and the policy steps towards it that have been taken so far. The subsequent section presents empirical evidence on the progress towards the SEM in terms of price convergence, transmission-capacity utilisation and extension of cross-border networks. Section 3 sets out the challenges and presents the changes planned to the organisation of the international electricity trade and the planning and financing of network connections. The final section presents our recommendations on the planning and operation of the electricity network.

1 THE SEM VISION AND PROGRESS TO DATE

In broad terms, a fully functioning SEM would be a level playing field where, at any given time, electricity demand is met by the most economic[2] power plants irrespective of the member state in which they are located. Taking a long-term perspective, the SEM implies that investments in networks and generation assets should be designed to decrease the overall cost of the system. Compared to a system of national electricity markets (with occasional cross-border trade of some surplus electricity) an integrated EU electricity market would have obvious advantages. First, the cost of operation of the power-plant fleet would be reduced, because expensive production in one country – which might be optimal in a purely national setting – would be replaced by cheaper generation in another country. Second, the exercise of market power by national incumbents would become more difficult as the market grows and foreign competitors punish the withholding of capacity by acquiring market shares. Third, the need for transmission and generation

1. Partial evidence suggests that the efficiency gains could be huge: deep integration of the four German electricity market zones alone would reduce the annual cost of electricity by an estimated €205 million (Bundesnetzagentur, 2009, p.69) to €400 million (BMU, 2009).

2. In this sentence, 'economic' should be understood as a very comprehensive concept encompassing the minimising of short and long-term costs subject to given technical and legal limitations (network capacity, emission caps, reliability provisions, etc).

assets would decline in an integrated market because a larger market would render some reserve capacity redundant. Finally, it might be cheaper to integrate renewable energy, because national supply variability is somewhat offset in an international system.

However, electricity has some unique characteristics that make designing functioning markets challenging. Electricity delivery requires the existence of networks; though electricity is a commodity, it is produced by very different technologies; it is not possible to store it cost-effectively; and consumers are less willing, in comparison to other commodities, to reduce their consumption in periods of high prices. Consequently, EU countries have been reluctant to move away from the traditional model of vertically integrated national monopolies and towards EU-wide market liberalisation.

By and large it has been pressure applied by the EU's single market policy which has moved liberalisation of national electricity markets forward. The EU's efforts to develop a SEM have taken the form of three legislative packages (1998, 2003 and 2009). Many analysts consider that the first two packages made only limited progress. According to a European Commission sector inquiry, opened in 2005 (European Commission, 2007a), and academic analyses[3], an inadequate electricity grid, defective rules for allocation of the right to use cross-border electricity lines, differing national support schemes for renewables and possibly the strategic behaviour of market participants have prevented the development of a fully functioning single electricity market.

2 HOW INTEGRATED ARE EUROPEAN ELECTRICITY MARKETS?

In the member states' electricity markets, domestic incumbents compete to sell electricity with foreign incumbents and some independent power producers. Apart from longer-term contracts, electricity is traded on the day-ahead market. This market, with its hourly prices, serves as a reference for scheduling power plants. In the day-ahead market (typically a power exchange) a seller/buyer bids for how much electricity he wishes to deliver/order at a certain price. The market clears at the intersection of the supply and demand curve. Markets in different countries produce different prices. Thus, taking electricity from a low-price country to a high-price country is profitable. If transmission lines were unlimited, arbitrage should lead to a single European market with a single European price. However, transmission lines within and between countries are not unlimited. Consequently, on most borders, the valuable right to use cross-border transmission lines is auctioned off. Thus, electricity prices between countries differ. It may be noted that, despite the fact that, within countries, transporting electricity over long distances incurs losses, and network capacity may be constrained, most EU member states (Italy being one exception) apply a single domestic electricity price.

In terms of operation, investment incentives and the international trade in electricity, this system of linking countries that have single national prices has obvious flaws. As each power plant in a country obtains the same price whether it is located close to a major industrial consumer or in a remote area, system operators have the costly duty of rebalancing the system in case of internal congestion. The cheap power plant in the remote area might be asked to reduce production while the more expensive plant in the industrial area might increase its supply. Although, in theory, this approach might come close to optimal, in practice the process is often inferior to a market solution that allows for regional price differences[4].

Another flaw in current arrangements is the existence of skewed investment incentives for consumers and producers. These lead to underinvestment by consumers close to cheap plants and underinvestment by generators close to high-demand centres. Finally, effective international linking of such systems is very difficult.

Electrons passing through international electricity networks follow the complicated physics of meshed alternating-current grids and do not respect price-zone borders. Correspondingly, scheduling power plants on the basis of

3. See Pollitt (2009), Buglione et al (2009) and Bunn and Zachmann (2009).

4. One obvious drawback is that cheap power plants are compensated for agreeing to reduce their output. This creates opportunities for gaming and pricing mechanisms often overcompensate cheap power plants, perversely increasing the incentive to locate to remote areas.

national prices without taking into account the real physical networks within and between countries makes it necessary for the system operator to take non-market measures to ensure system stability[5]. This is illustrated by two obvious inefficiencies. First, cross-border transmission lines are rarely fully utilised despite persisting price differentials. Second, electricity very often flows from high- to low-price areas[6]. Overall, the current system is light years away from the theoretically optimal use of European power plants and transmission lines that would characterise a fully functioning SEM.

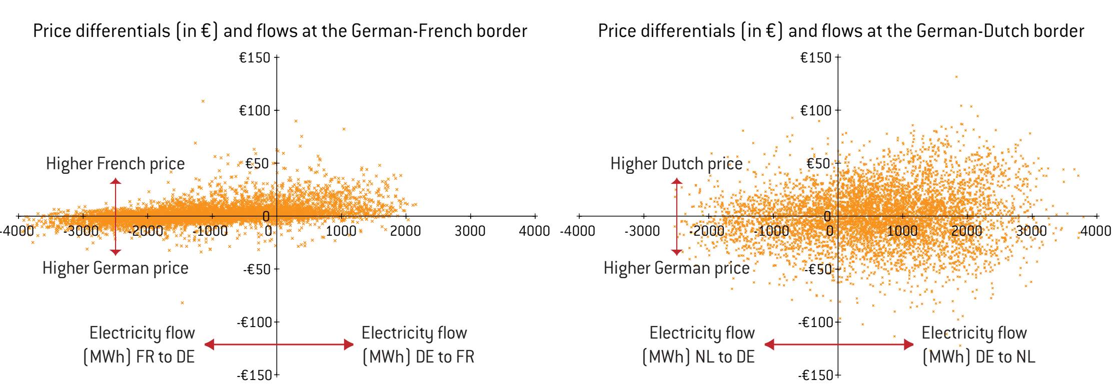
Despite institutional progress between 2005 and 2009[7], we argue, using the case of the systemically important German market[8], that progress has been limited in the last five years. We base our claim on three observations:

First, prices in the countries that border Germany have not converged significantly with German prices, and high hourly price differentials were common between 2005 and 2009. In the electricity market as currently structured, decreasing differences between national hourly electricity prices could be a sign of greater market efficiency and/or increasing commercially available transmission capacity. However, Nitsche et al (2009) found that German electricity spot prices in 60-90 percent of instances differed by more than five percent from the price in almost all neighbouring countries. In addition, the absolute annual average price differences in 2009 for almost all of these market combinations exceeded their corresponding 2004 value[9]. Thus, recent reforms have failed to produce a consistent reduction in price differentials that would point to increasing market integration.

Second, price differentials are almost unrelated to capacity usage. In an integrated market, as long as lines are not fully used, the price differential should be zero while, as soon as congestion occurs (at full capacity), the price differential depends on the difference in marginal cost in both systems. In reality, however, electricity often flows against the price differential. In the German-Dutch case, electricity flowed from the high price area to the low price area for 49 percent of total hours in 2009 (Figure 1). At the German-French border this occurred for 46 percent of total hours. This illustrates the flaws of a system based on coupling large national zones that face internal congestion.

Third, physical interconnections have not developed substantially in recent years. Figure 2 shows the net transfer capacities from and to Germany between 2005 and 2009. While the import capacity remained constant, the export capacity decreased by more than 15 percent. The absence of progress in Germany's cross-border transmission capacity is representative of the EU-wide picture. Between 2005 and 2009, the average net transfer import capacity of all countries in the European transmission system decreased by more than 15 percent. This is mainly due to the need for

Figure 1: Hourly price differentials and corresponding electricity flows in 2009



Source: Bruegel based on data from EEX, Powernext, APX and ENTSO-E. MWh = megawatt hours.

5. In 2009 the Commission opened antitrust proceedings against Swedish electricity transmission system operator Svenska Kraftnät (SvK) for having limited interconnector capacity for electricity exports. SvK contended that export curtailments were necessary to alleviate internal congestion.

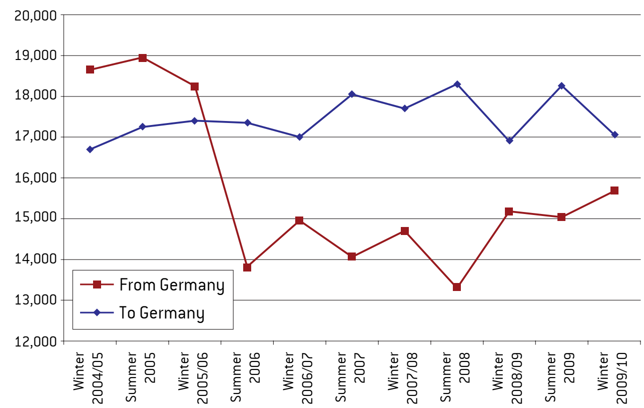
6. One country's electricity flows might loop through other countries, eg electricity produced in north German wind plants goes via Poland to southern Germany, though Poland's electricity price is lower than Germany's.

7. For example the national implementation of the 2003 directive; the installation of a national regulatory authority in Germany in 2005; market coupling between France, Belgium and the Netherlands in 2006; and the 2008 merger of French and German power exchanges.

8. The German market is central to European market integration because it is directly connected to 10 foreign electricity zones.

9. We note that increased correlation or cointegration are not a sign of electricity market integration

Figure 2: Net transfer capacities from/to Germany in megawatts, 2004/05-2009/10



Source: BRUEGEL based on data from ENTSO-E.

increased security margins for cross-border trade because of growing shares of intermittent renewable production. Thus, decreasing availability of cross-border transmission for commercial operations becomes an increasingly limiting factor for market integration.

In conclusion, the remaining international price differentials, the insufficient response of electricity flows to price signals and non-increasing cross-border transmission capacity demonstrate that in the last five years progress towards a single market for electricity has been limited.

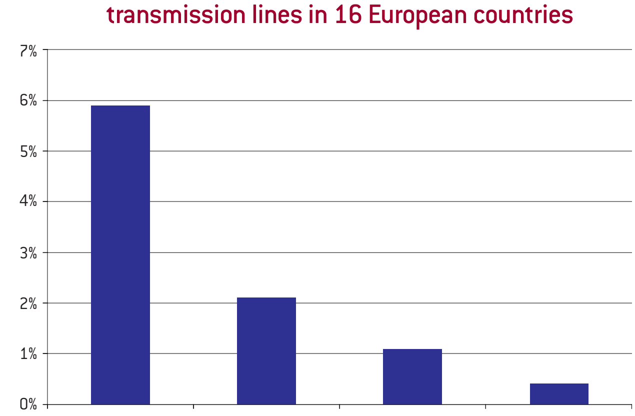
3 CHALLENGES AND PLANNED CHANGES

The SEM faces two challenges: increasing the available transmission capacity and improving the use of existing networks and power plants.

Increasing investment in interconnection is needed because the commercially available transmission capacity will otherwise decrease for three reasons. First, the increasing share of intermittent wind power will require even higher safety margins. As these must be taken into account in the calculation of commercially available transmission capacity, the latter will shrink. Second, national and cross-border infrastructure is ageing and thus becoming less reliable. Third, the massive shift in generation mix (the scaling-up of renewables) leads to a new geographic distribution of generation in central-western Europe. This development will challenge the transmission systems, which saw their last significant construction boom in the 1960s and 1970s (as shown by Figure 3), when they carried electricity from the large thermal and nuclear power plants built at that time. As a consequence of the longer distances between renewable generation sites and load centres, national and regional imbalances will increase. Through the peculiarities of electricity flows this could lead to an increase in the general level of congestion in Europe. Thus, to avoid a deterioration of the current congestion situation, significant investment in European transmission networks is needed.

The extension of electricity grids is, however, still jointly decided by national transmission system operators and regulators based on mainly technical (ie not economic) criteria. In this process the positive and negative effects of national network investment on other countries' electricity systems are insufficiently taken into account. Electricity lines that

Figure 3: Annual average increase in length of 220-400kV transmission lines in 16 European countries



Source: International Energy Agency (2005).

would increase cross-border transfer capacity and thereby global welfare are not being built because the national regulators do not take into account welfare gains in other zones[10]. Thus, those investments are typically not optimal with respect to the SEM.

To resolve this issue the EU has come up with different, not fully coherent, solutions:

1 **Definition of priority projects linked to possible access to EU funds:** in 2010 the old Trans-European Network guidelines will be replaced by an 'EU Energy Security and Infrastructure Instrument'. This instrument is intended to be based less on projects proposed by individual member states (and their national interests) but is to be developed from a European perspective on security of supply and efficiency. As EU funding is limited and discretionary, decisions are subject to intra-EU distribution considerations. This instrument might fix some bottlenecks but is not an integral network development solution.

2 **Presentation of a coordinated network development plan:** in 2010 the European Network of Transmission System Operators for Electricity in cooperation with the Agency for Cooperation of Energy Regulators and the European Commission will prepare a Ten-Year Network Development Plan. This non-binding plan will combine the bottom-up approach underpinning national or regional investment plans with top-down policy goals (primarily the EU's so-called '20-20-20' green target). However, the absence of formal obligations on grid users to provide the information necessary to calculate prospective load-patterns, and the lack of a European network model within the European Network of Transmission System Operators for Electricity and the Agency for Cooperation of Energy Regulators, will make it difficult to obtain an accurate picture of the investment needs. Furthermore, the means of implementation of this non-binding plan are rather weak. Consequently, it is unlikely that the first Ten-Year Network Development Plan will deliver an ambitious blueprint for a European electricity network.

'Network development and power sector operation must be optimised at European level.'

3 **Exemptions from regulation for interconnectors:** national regulatory agencies might, for a limited period, allow transmission system operators to retain revenues from auctioning capacity in new interconnectors between countries with different prices. As demonstrated by the cable between the Netherlands and Norway, this mechanism can incentivise some highly profitable direct links between countries. However, as these exemptions only concern direct cross-border interconnectors, they will be unable to incentivise the construction of the domestic transmission lines that are necessary to remove cross-border bottlenecks.

In order to increase the available transmission capacities, it will not be enough to upgrade existing, or construct new, cross-border transmission lines. It will also be necessary to use the transmission system better. For this, the EU has defined in general terms the introduction of an improved congestion management method[11]. This approach is derived from the market coupling initiatives in central-western Europe. The idea of market coupling is that cross-border transmission capacity is not auctioned off explicitly but allocated by the power exchanges concerned based on price differentials. The trilateral market coupling between Belgium, France and the Netherlands has been highly successful in reducing the number of hours in which price differentials between these countries have persisted (the share of hours with equal prices increased from 20 percent to around 70 percent) and flows now always follow prices. The planned inclusion of Germany and Luxembourg into a 'pentalateral' market coupling in 2010 as well as the envisaged European market coupling will lead to the desired decrease in the number of hours with low-to-medium price differentials. But market coupling will not deliver

10. For instance, a connection between north and south Germany that would relieve the Netherlands and Polish networks (from inner-German flows) would need to be funded by German electricity consumers.

11. Elaborated at the 17th Florence Electricity Regulatory Forum. Participants include national regulatory authorities, member state governments, the European Commission, transmission system operators, electricity traders, consumers, network users, and power exchanges.

significantly better use of transmission capacity and not allow efficient coordination of power plant scheduling internationally. Both would require a coordinated optimisation of system operations instead of coupling nationally optimised single-price zones.

In summary, the proposed changes are not capable of delivering fully on increasing the available transmission capacities and improving the use of existing networks and power plants.

4 RECOMMENDATIONS

To address the outlined challenges, network development and power sector operation need to be optimised at the European level.

European network development: as implicitly acknowledged by the Ten-Year Network Development Plan, only EU-level electricity network design would be effective in delivering the required network infrastructure. The EU should therefore continue to push for jointly optimised and properly implemented network development. This would require defining fair legal rules for sharing the costs and benefits of investment in transmission lines that have effects on more than one country's electricity system. Such a cost-benefit allocation system might allow a departure from the requirement for agreement by unanimity for network planning and thus might allow the European Network of Transmission System Operators for Electricity to be given the power to produce binding network planning at EU level that is based on international cost-benefit considerations. Money spent on integrated network planning and cost-benefit reallocation could in fact be much more productive in terms of achieving the single market than multi-billion-euro EU funding to (politically) selected infrastructure projects.

European power sector operation: linking nationally optimised systems does not mean that all potential efficiency gains from an integrated market will be reaped. If one accepts coordinated optimisation, there are three alternatives to the current system: a jointly optimised European single-price area, a jointly optimised European system of sub-national zones, or jointly optimised European nodal pricing. In the first case, the drawbacks of national single-price systems (difficult market-based operation and skewed investment incentives) will be present. In a European zonal system, these flaws will vanish with decreasing zone size. The workability and efficiency of such a sub-national zonal system can be seen in Scandinavia, where Denmark and Norway are split into different zones. But splitting the highly meshed European transmission system into hundreds of meaningful zones is difficult. Nodal pricing circumvents this problem by making each injection/withdrawal point of a network (node) into a price zone of its own. This first-best solution – which provides correct locational incentives to generators and consumers, allows almost fully market-based optimisation of power plant scheduling and gives valuable information on transmission bottlenecks – has been successfully applied in Australia, New Zealand and the US. Various case studies find that efficiency improvements are possible with this solution (Eto et al, 2006).

European-level implementation of jointly optimised network development and power sector operation is a delicate issue. On one hand, bottom-up approaches based on unilateral (or only regionally coordinated) implementation of nodal pricing and network planning might result in persisting incompatibilities between regions. The difficult coexistence of different regional nodal pricing arrangements in the US provides an illustration of this issue that might have even worse effects in the highly meshed continental European electricity network (see Germany with its ten electricity borders).

On the other hand, the technical and political complexity of coordinating some twenty national regulatory systems and thousands of stakeholders (regulators, transmission system operators, generators, consumers, etc.) seems bound to lead to failure.

A combination of both approaches is required. The long-term vision of jointly optimised network development and power plant operation should be laid out in a binding EU instrument. The technical details should provide enough freedom for gradual implementation and adaptation to different regulatory systems, while ensuring that the exchange of information required to optimally coordinate power-plant operation across borders is standardised. In addition to these top-down components the transmission system operators should be given stronger incentives for deep cooperation. Currently, transmission systems are primarily operated within national boundaries[12]. This is unnatural, as mergers of transmission system operators across borders could reap significant efficiencies of scale and scope[13]. So far, however, the necessary institutions to regulate and incentivise more cooperation between cross-border transmission system operators are not in place. If national regulatory agencies find ways to incentivise increasing cooperation of network companies to jointly optimise their networks (both in terms of day-to-day operation and investment) this could lead to a 'bottom-up' approach to optimal electricity network planning and operation. Competition authorities will need to keep pace with the integration of energy markets (for example with respect to market definitions).

We should not wait for the results of the European market coupling and the first network development plan to appear between 2015 and 2020 before bringing forward a blueprint for a truly European electricity network.

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12. The exceptions are two recent acquisitions: the Dutch transmission system operator TenneT acquired the German Transpower and the Belgian transmission system operator Elia bought the German 50Hertz Transmission.

13. Here, a determined implementation of the unbundling requirements in the third package might speed up a meaningful consolidation of European transmission system operators.

REFERENCES:

BMU (2009) 'Gutachten über die freiwillige Übertragung der Energie-übertragungsnetze, die Errichtung einer bundesweiten Netzgesellschaft und die regulatorischen Rahmenbedingungen', available at http://bmu.info/energieeffizienz/down loads/doc/44833.php, accessed 28 May 2010

Buglione, Giuseppe, Guido Cervigni, Eileen Fumagalli, Elena Fumagalli and Clara Poletti (2009) 'Integrating European Electricity Markets', *IEFE Research Report* no.2, October

Bundesnetzagentur (2009) 'Optimierung der Ausregelung von Leistungsungleichgewichten', available at http://www.bundesnetzagentur.de/cae/servlet/contentblob/151484/publicationFile/6058/Gutachten_optimierte_Ausregelung_ZNR.pdf, accessed 28 May 2010

Bunn, Derek and Georg Zachmann (2009) 'Inefficient arbitrage in inter-regional electricity transmission', *Journal of Regulatory Economics* 37(3)

Eto, Joseph H., Douglas R. Hale and Bernard C. Lesieutre (2006) 'Toward More Comprehensive Assessments of FERC Electricity Restructuring Policies: A Review of Recent Benefit-Cost Studies of RTOs', *The Electricity Journal* 19(10)

European Commission (2007) 'Impact Assessment accompanying the legislative package on the internal market for electricity and gas', Commission staff working document SEC(2007) 1179

European Commission (2007a) 'DG Competition Report on Energy Sector Inquiry', SEC(2006) 1724, available at http://ec.europa.eu/competition/sectors/energy/inquiry/index.html, accessed 28 May 2010

European Commission (2010) 'Communication from the Commission: Europe 2020 a strategy for smart, sustainable and inclusive growth', COM(2010) 2020

International Energy Agency (2005) *Lessons from Liberalised Electricity Markets*, Paris

Nitsche, Rainer, Axel Ockenfels, Lars-Hendrik Röller and Lars Wiethaus (2009) 'The Electricity Wholesale Sector – Market Integration and Market Power', *ESMT Competition Analysis*

Pollitt, Michael G. (2009) 'Electricity Liberalisation in the European Union: A Progress Report', *EPRG Working Paper* 0929

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