Cost of Non-Europe

in the Single Market for Energy

ANNEX IV

Benefits of an integrated European electricity market: the role of competition

Research paper
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Abstract

This paper analyses the benefits of further market integration of European wholesale electricity markets. Major gains from trade are still left unrealized due to (1) uncompleted market coupling of national wholesale markets, (2) isolated national regulation of capacity and reserve mechanisms (CRM) and (3) a lack of harmonization of national support schemes for renewable energies.

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Executive Summary

The integration of European electricity markets can bring about major efficiency gains in welfare terms to European consumers and industries. Through a process of market coupling electricity markets can be further integrated.

Efficiency gains result, as market coupling uses generation capacity more efficiently and, thus, reduces the necessity of large idle generation capacity. The potential for savings is indicated through the share of diverging high-peak periods between Member States. The larger the share of divergence, the more generation capacities could gain in utilization. This holds in particular for an integration of European capacity and reserve mechanisms (CRM). Given that CRM are subsidies paid to safeguard security of supply better exchange and further market integration could reduce the required subsidy levels by (a) inducing more competition and (b) reducing the absolute levels of additional capacity needed.

Hence, while market coupling theoretically increases market efficiency, issues such as market design or other regulatory interventions have a significant impact on the performance of market coupling. Therefore, it is important to align the different existing national regulatory frameworks across Europe or to set up a new *common* framework altogether.

While levels of wholesale market concentration have generally decreased across Europe, a major benefit of further market integration would be the increased level of competition in European electricity markets. Based on simulations published by ACER (2012), the CWE region alone has achieved gains from trade worth more than 250 million Euros in comparison to isolated national markets now. Major trade gains are still left unrealized, however, between Italy and France (about 19 million Euros per year), Germany and Sweden (about 10.5 million Euros per year) and the Netherlands and Norway (about 12 million Euros per year). Significant gains can also be expected from increasing transmission capacities between Spain and France as well as between Sweden and Poland..

The different support schemes for renewable energies have induced major inefficiencies if viewed from a European perspective. Most importantly, since all support schemes only support renewable energies *within their own national territory* massive gains from trade and from market integration are foregone. These gains from trade could easily result, as climate and weather conditions vary heavily across and even within member states. For example, conditions for wind power are typically superior in Northern Europe while the conditions to produce solar-based electricity are much better in Southern Europe. Hence, enormous gains from trade could be realized by focusing on solar power in Southern Europe and on wind energy in Northern Europe. However, since almost all RES support schemes (with the particular exception of Sweden and Norway) are based on national frontiers so that only domestic production is supported, these benefits are foregone, resulting in according inefficiencies. A cautious calculation reveals that the efficient allocation of solar energy plants between Germany and Spain alone would have resulted in additional electricity worth about 740 Million Euro within a single year. Additional savings could easily be generated by considering (a) more countries than just these two and (b) considering other technologies such as wind.

Significant gains can also be expected from increasing transmission capacities between Spain and France as well as between Sweden and Poland.

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1. Introduction

Markets with effective competition are generally characterized by consumer choice, low prices and quality levels desired by consumers. Effective competition thereby directly benefits (1) consumers by increasing consumer surplus through lower prices and also (2) firms by protecting competitors against the abuse of market power by dominant firms (e.g., incumbents). This major economic insight is also the underlying principle for the liberalization of European energy markets. Fostering competition in energy markets is even more important than in many other sectors of the economy due to the outstanding importance of energy prices and availability for production processes, economic growth and consumer welfare in modern industrialized economies.

While there are, in fact, many energy markets for different products, this report focuses on competition in electricity markets. Due to time and space constraints we cannot focus on gas and oil markets. Our neglect of gas and oil markets in this paper does not reflect a view that these markets are less important, bit is simply a result of the time and space constraints which were exogenously given.

A means to foster competition and to increase the utilization of electricity networks and generation capacities is the integration of European wholesale markets through physical and commercial coupling of the national electricity systems. It is the declared main objective of the European Commission to create a single European wholesale market for electricity (Internal Energy Market, IEM), which is also clearly stated in the Directive 2009/72/EC of the European Parliament and of the Council concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

> *A secure supply of electricity is of vital importance for the development of European society, the implementation of a sustainable climate change policy, and the fostering of competitiveness within the internal market. To that end, cross-border interconnections should be further developed in order to secure the supply of all energy sources at the most competitive prices to consumers and industry within the Community. A well-functioning internal market in electricity should provide producers with the appropriate incentives for investing in new power generation, including in electricity from renewable energy sources, paying special attention to the most isolated countries and regions in the Communi-ty's energy market. A well-functioning market should also provide consumers with adequate measures to promote the more efficient use of energy for which a secure supply of energy is a precondition.*

Our paper proceeds from this position and consists of three parts, following this introduction. In the next chapter we discuss the relationship between economic market definition and the integration of European power markets, before we describe the state of competition in European wholesale electricity markets in chapter 3. In chapter 4 we then present empirical evidence for the extent of the Internal Energy Market (IEM) and analyze the costs that result from the lack of further European integration, i.e. the costs of national energy markets still being too isolated.

An assessment of the benefits of market integration from a competition perspective requires a description of the close relationship between market definition and market integration. Market definition is the basis for any analysis of the degree of competition in a given market. Therefore, analyzing power markets requires an understanding how wide the relevant market is to be defined geographically. As we will show in chapter 2 this is by no means a trivial task in terms of practical delineation and consequences to regulation and competition policy.

Chapter 3 starts with a recap of the results of the European Commission's sector inquiry which were published in 2007 (section 3.1), before we present an update of the status quo from 2011 (section 3.2). The chapter, thereby, provides an overview of the European history of competition in wholesale electricity markets and serves as a benchmark for recent market developments. We also provide an overview of the degree of fragmentation of national support schemes for renewable energies as well as capacity mechanisms.

In chapter 4, we provide an empirical assessment on two matters of market integration, the contemporary extent of markets and the welfare effects of coupling markets. We start with demand fluctuations and resulting free generation capacities, which are the basis for energy flows across borders. We give special emphasis to renewable energies, as the stochastic nature of electricity generation by renewable energy sources (RES) significantly affects the free capacity levels and the need for cross-border flows. We also present results on price effects of cross-country energy transmission based on own calculations and compare the potential evolution of market concentration under different scenarios of market integration.

Against this background we then provide an overview of empirical studies on the benefits of further market integration (section 4.2), which includes the cost of isolated national energy markets in Europe. The main reason for isolated markets in general and also isolated energy markets are barriers to entry, which basically materializes in insufficient cross-border interconnections. We discuss institutional differences between countries, which are related to differences in laws, regulation and market design. We present examples for different barriers to entry and discuss costs related to these barriers. Furthermore, our paper analyzes who is harmed by barriers to entry.

We conclude the research paper with a brief summary of our results and policy recommendations for future energy policy and regulation in the European Union in chapter 5.

2. Competition and market integration

To understand the concept of market coupling and its importance from a competition economics and policy perspective, let us first explain how markets can be defined and why this relevant for any competition analysis. We then show that market integration and delineation are related and then describe the basic concepts of market integration. At the end of this section we will discuss potential factors which can distort the otherwise efficiency enhancing integration of wholesale electricity markets.

A thorough competition analysis usually necessitates the delineation of the relevant market. Broadly speaking, the market definition exercise identifies all firms which are actively or potentially competing with each other, thereby limiting each others' scope for the exercise (and abuse) of market power.

Typically markets are defined along two or three dimensions, namely time, space (geography) and the products' characteristics.[1] Hence, any market should be delineated with respect to (i) geography, (ii) product characteristics and, if necessary, (iii) time dimensions. In principles, the key principle for market definition is the same with respect to all three dimensions, as the main question is: Is there a critical mass of consumers which regard a certain product (location or time of purchase) to be a potential substitute for another product (location or time of purchase)?. Technically the question is whether there is a critical elasticity of demand, so that sufficiently many consumers would switch to a different product, location, or time of purchase to render a price increase (or any other potential use of market power) unprofitable, implying that competitive forces are sufficiently strong to discipline the firm(s) under consideration.

For instance, while apples and oranges are different products, they can be still regarded as potential substitutes. Hence, if the price for apples reaches a critical point, at least some consumers will substitute them against oranges. The geographic dimension concerns the inclusion of products from other regions into the relevant market. For example, products such as raw sugar or crude oil are trade in wholesale markets which are considered to be world-wide markets whereas transportation or, more generally, transaction costs for other goods are so high with respect to interregional trade that these markets have to be delineated more narrowly, e.g. for retail grocery products. This aspect becomes very important for the following delineation of the relevant wholesale market(s) for electricity.

In the case of electricity markets the product dimension is rather straight forward. The direct benefit of electricity is mostly irrelevant to consumers because it is more a precondition to consume or use other goods such as television shows, cell phones, light, refrigerator, computer and so on. This indirect utility is crucial as there is typically no direct substitute for electricity. Moreover, since (a) the electricity itself cannot be distinguished by type or production while (b) certificates of origin (e.g., for green

[1] See for example Motta, M. (2004), Competition Policy: Theory and Practice, Cambridge University Press: Cambridge.

electricity versus electricity from fossil fuels) are typically traded separately from the electricity itself, electricity can be regarded as a homogenous product, at least at the wholesale level. Its specific product characteristics also require a market delineation with regard to the time dimension. Note that electricity is a network bound product and that power consumption (demand) and production (supply) have to be balanced at all time. Therefore, electricity generation largely depends on expectations about demand. These expectations only vary to a certain extent, so electricity can be sold based on consumption predictions, leading to a wide array of products differentiated by time. There are financial and physical contracts which mostly cover a period of one year, quarter, month or day ahead of the actual delivery date. The products with the shortest time distance between trade and delivery, e.g., minutes or seconds, are labelled as "balancing energy" and are clearly distinguished from the others. In detail, the „shortest" products are in fact two-part tariffs as the provision and actual generation is being traded. The importance of this differentiation is derived from the fact that the day-ahead market has become the reference market for other products and is also the main focus when analyzing the extent of the relevant market in its geographic dimension.

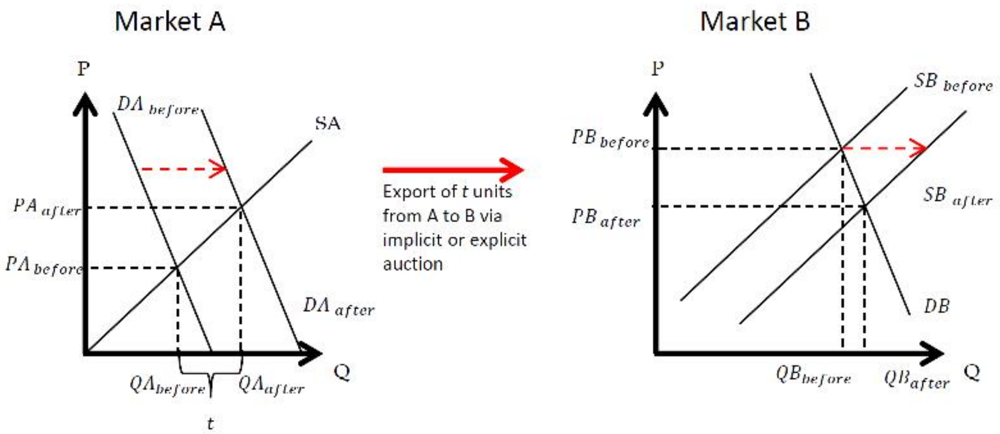
When analyzing the geographic extent of the market, the network dependence becomes crucial. Electricity is transported via a network and if there is no physical connection between two regions, then those markets cannot belong together unless they are indirectly connected via another region. Existence of cross-border network capacities is, therefore, the cornerstone of any market covering more than one region. This is the core of the discussion about the integration of European energy markets. An analysis of market integration almost always circles around an analysis of the relevant geographic market. In theory, any two power markets are integrated when demand elasticity keep suppliers in any of the two markets from raising prices above competitive levels. Since power is an almost perfectly homogenous product, the *Law of One Price* is supposed to hold, i.e., in the absence of transaction costs, wholesale prices (net of any taxes) in two areas should be equal to each other. In this context, transaction costs include transportation costs which in turn translate into costs of network congestion. An isolated power market, therefore, goes along with insufficiency in cross-border transmission capacity. A difficulty in practice is the definition and identification of a relevant threshold that marks the switch between integrated and isolated energy markets from a competition point of view. This will be discussed in the next section.

Before we explain the concept of power market integration, and market coupling in particular, it is important to add that power is traded either bilaterally, called *over the counter* (OTC), or over power exchanges. The trading system of these power exchanges is basically that of a uniform-price auction, where the last successful bid sets the market price. In these auctions, bids can be sorted in increasing order of prices, called the merit order. If the market is sufficiently liquid, the day-ahead auction becomes the reference price for contracts of different lengths, e.g. yearly or monthly contracts.

A textbook example of for market integration is that of two regional markets, say A and B.[2] For simplicity, power in each market is traded over a day-ahead power exchange and the equilibrium prices and quantities for each market, indexed by *A* and *B*, are labelled as *p* and *x*, respectively. In addition we assume identical production facilities, i.e., identical production costs. There exists a direct link between both transmission networks with a total capacity of *T* units. The actually traded quantity is defined as *t*, with $t \leq T$. We define market *A* to have lower demand and higher excess capacity than market *B*. It would then be optimal, if these sellers of excess capacities from market *A* bid into market *B* which are cheaper than those of market *B*. This would result in a decrease in market *B* from p_B down to p_B^*.

There are two market-based options to combine cross-border trade and cross-border transmission capacities: explicit and implicit capacity auctions.[3] In the case of explicit auctions, power trading does not directly integrate the auction of cross-border capacities, but potential energy seller bid for energy and transmission capacities separately

Figure 1: Principle of Market Coupling



DA= Demand Market A, DB= Demand Market B, SA= Supply Market A, SB= Supply Market B, PA= Price Market A, PB= Price Market B, QA= Quantity Market A, QB= Quantity Market B, Before= Before Market Coupling, After= After Market Coupling.

There are two main inefficiencies endemic to the method because of the relation of transmission auctioning to the day-ahead energy market. Cross-border transmission capacities are booked prior to the actual day-ahead market. Therefore, the transmission auction is based on predictions of the expected day-ahead prices. Therefore, the booked transmission capacity, *k*, is not necessarily equal to the power units finally sold. This constitutes the first inefficiency. Secondly, a further inefficiency stems from the fact that

[2] See especially European Market Coupling Company (2013) Internetquelle for an introduction to the topic.

[3] Both concepts can even be combined. Let us assume that a company in market A decides to sell power for a full year to buyer in market B. The necessary transmission capacity for this long-run contract could be booked via an explicit auction. The day-ahead market could be part of the implicit auction design.

transmission capacities are booked for both directions (A to B and B to A). So capacities can be booked for the "wrong" direction, i.e., they are booked for one direction despite the fact that this turns out to be unnecessary in the end.

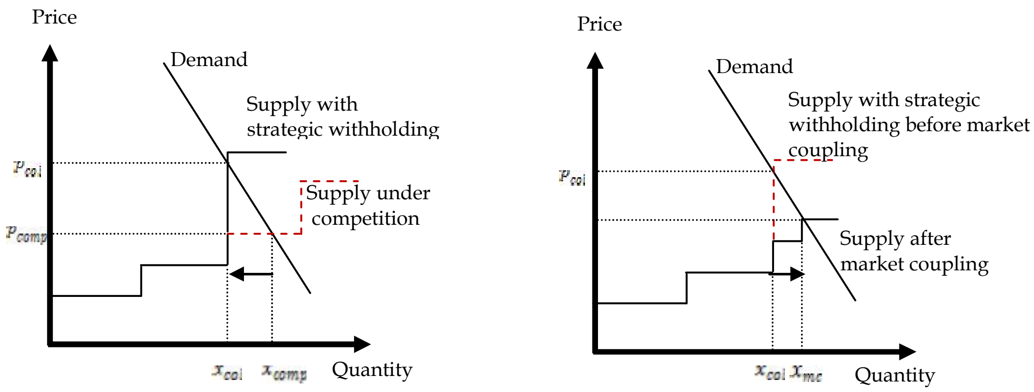
An implicit auction combines both energy and transmission trade to resolve the problems just mentioned. A prerequisite for this concept to work optimally is a common auction office. Information on the availability of transmission capacities is gathered from the various transmission system operators and incorporated in the algorithm that optimizes the respective power auctions in market A and B. In addition to the elimination of the aforementioned inefficiencies, the simplicity of a single auction also leads to a decrease in transaction costs. It is important to note that the new responsible auction office is in fact a monopolist. Therefore, it is crucial that the auctioneer remains independent from other market participants and does not discriminate among different generators and/or traders.

Market coupling and market splitting are two subclasses of the implicit auction concept. The former concept defines relevant local markets, *A* and *B* in our example, that are fixed for a given period and then performs the implicit auction. So even while there is not necessarily any congestion between these two areas, some power markets are treated as separated areas which simply clear with the same wholesale price if congestion is no problem. Market splitting defines the relevant local submarkets according to congestion. So if there was no congestion problem at a specific point in time between area *A* and *B*, then both would be treated as a single area. The difference becomes clearer if shown in a practical example. For instance, the French, Belgian, Dutch and German Power exchanges are linked together via market coupling, where every country constitutes as separate market. The Nordic countries, Sweden, Denmark, Norway and Finland, are linked via market splitting. There is not a single Swedish area but fragments which are defined by transmission capacities and potential congestion. Therefore, power prices can vary even in Sweden while the remaining markets may, for example, have equal prices.

When we stated that the use of power is more efficiently used in a market integration framework, this meant that power flows, economically, from the lower price area to the more expensive area, leading to a balancing of prices on a lower level on average than before. We implicitly assumed that the bids from both, sellers and buyers were based on competitive behaviour. It is well known in competition economics that most real markets are best described by models of oligopolistic interdependence and less than perfect competition, which in turn implies the existence and exercise of some degree of market power. The use of market power is especially lucrative in the case of collusive behaviour, where companies act strategically together to increase profits. In electricity markets, the two most common strategies are excessive pricing and withholding of capacity in order to increase prices. These practices become especially interesting during times of high and very high demand (peak hours) which are usually on weekdays between 8 a.m. and 8 p.m.[4]

[4] This varies with regard to region-specific weather conditions, economic performance in general

Figure 2: Market Coupling and strategic withholding



The major contribution of market coupling to competition is that it increases the number of competitors, therefore constraining the exercise of market power and lessening the likelihood of anticompetitive behaviour. This is where the independence of the market coupling operator becomes crucial as bids have to be arranged in an efficient way in order to reach the welfare maximizing equilibrium. An integration of markets may guarantee competitive results, but market integration increases their likelihood, as firms which are dominant in one market now face competitors which may themselves be dominant in their respective market area. As most national power markets are rather concentrated, in particular France (see section 3.2), this is an important factor for the efficiency of an integrated (European) market.

Even if most firms acted competitively there are a number of other factors, caused by the fact that many countries are involved in the process, which interfere with market coupling and may yield inefficient results. These factors are differences in the participants' wholesale market design, general energy policies and national regulatory frameworks. To avoid the resulting systematic inefficiencies, the overall economic and legal framework should be aligned. Two examples show the difficulties that can arise from different policies and frameworks that lack compatibility or harmonization.

In many European countries competition authorities, transmission system operators, power plant operators, retailers and other stakeholders debate about the introduction of so-called capacity mechanisms to safeguard the security of power supply at the wholesale level. The core question of this debate is whether the energy-only market, the basic version of wholesale electricity trading, is still capable of inducing sufficient investment into generation capacity in the context of emissions trading and the increasing share of intermittent renewable generation. Capacity mechanisms reduce investment risks via an extra payment for provision of generation capacity. A number of European countries have already introduced such a system. However, the largest countries have not yet done so and the actual capacity mechanism design is likely to vary significantly

and energy-intensive industries in particular.

between Member States.[5] This is important to know because the different capacity mechanisms have clearly different advantages and disadvantages as well as diverging degrees of permanent regulatory intervention. If two markets with different market designs are to be coupled, then these differences affect the functioning of market coupling significantly. Eurelectric has indicated in their working paper that investment decisions can be distorted for the case of a market with strategic reserves, paid for availability and only activated in extreme cases,[6] and a full-blown capacity market, where each supplier receives a premium. The market coupling process as such is not distorted, i.e. bids are still efficiently ordered under competition. However, cross-payments are likely to occur which may jeopardize the integration of markets in the long run. If, in our example, the regulator in market *A* would only pay premiums to (strategic) reserve capacities that are solely activated in the case of insufficient generation, while a capacity market would be set up in market *B*, market *A* would benefit from spare capacities of market *B* without paying the capacity premium. As a consequence, the own strategic reserves would be activated less frequently if at all, and buyers in market *B* would pay the premium for capacities which help to secure supply for market *A*. This may, in general, not create inefficiency but is a matter of rent distribution. In addition, investment decisions of potential plant owners are based on the most lucrative market (*A* vs. *B*). If the allocation of new generation becomes sufficiently asymmetric, a new congestion situation may result, necessitating new investment into transmission capacities.

The second example concerns regulatory interventions such as price caps. For instance, the German cartel office has concluded in its 2011 sector inquiry that according to §§ 19 and 29 GWB (German law against restraints of competition) and article 102 TFEU that dominant electricity generators are subject to marginal-cost pricing, i.e., they are not allowed to place bids which exceed their marginal costs.[7] An exception could only be made if the generator could prove that higher bids are necessary to cover the fixed cost of its generation portfolio (i.e., not even the power plant under consideration). In addition, the German government ordered especially dominant companies to keep unprofitable power plants online for security of supply reasons. However, this interferes with the concept of market coupling. First, a well-functioning coupling of market areas also leads to a reconsideration of the relevant market. However, the basis for the regulatory intervention is the assignment of dominance, which in practice is often the result of a quantitative assessment of market shares. In our example, a (theoretically) perfect market coupling with sufficient cross-border transmission capacities would mean that these two markets are in fact one and only stochastic shortages in either transmission or generation capacities would create temporary congestion and price differences. Market shares have to be recalculated. So the difficulty of such a regulatory intervention, regardless of its economic benefits and disadvantages, is based on both a divergence between the

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[5] See for example Sioshansi (2008): Competitive Electricity Markets: Design, Implementation and Performance, Elsevier: Amsterdam.

[6] Eurelectric (2011): RES Integration and Market Design: are Capacity Remuneration Mechanisms needed to ensure generation adequacy?, Working Paper.

[7] German Cartel Office (2011): „Sektoruntersuchung Stromerzeugung Stromgroßhandel, Bericht gemäß §32e Abs. 3 GWB“, Bonn: p. 193 ff.

economic and legal market and the quantitative estimation of market shares inside a coupled submarket. Let us assume that in market *A* a price cap is introduced that forces to companies to place bids no higher than their marginal costs. Now a market participant from market *B* has unsuccessfully placed a bid which is estimated to be above her marginal costs. This bid, however, could satisfy demand from market *A* if shifted by the market coupling operator. It is questionable whether this bid is compliant with the actual marginal-price cap. Put simply, does a price cap based on market shares which are calculated on the basis of a joint market still hold for only that submarket? The economic consequences can be as large as in the example described before.

We, therefore, conclude this section with the finding that market coupling theoretically increases market efficiency, but issues such as market design or other regulatory interventions have a significant impact on the performance of market coupling. Therefore, it is important to align the different existing national regulatory frameworks across Europe or to set up a new *common* framework altogether.

3. Status quo of European electricity markets

The liberalization process of European wholesale electricity markets started in the 1990s. However, the process did not progress simultaneously across the EU Member States, but national market designs and national energy policies still differ heavily. Accordingly, the lack of harmonization and integration has been a long standing concern for the European Commission.

In 2005, the European Commission then launched a sector inquiry into European wholesale markets for electricity and gas.[8] An increase in wholesale electricity prices, their divergence across countries as well as complaints of market participants about the (lack of) competitiveness of the market had raised severe competition concerns. As a result, many structural deficiencies have been analyzed in the inquiry.

In the following, we first describe the key findings of the 2005 report before we present more recent information about progress and persistence of these problems. Assessing the competitive structure of the European wholesale markets and possible barriers to entry can help to understand the recent development of market integration.

3.1 Competitive deficiencies in the early stages

As mentioned in the previous section, market integration can only unfold its full potential if there are no major distortions such as collusive behavior. Electricity markets bear some characteristics that facilitate collusion. The main concerns are listed below:

- No storability of the good to an economically relevant extent
- Homogeneity of the final product (i.e., not the fuel-type used to generate electricity)
- Low elasticity of demand, in particular for private households
- High barriers to entry due to high investment lead time, capital-intensity and network dependency
- High vertical information asymmetry to the detriment of consumers and competition authorities
- High horizontal information symmetry among generators or even transmission system operators
- High levels of concentration and cross-shareholding

In its sector inquiry, the European Commission concluded that some of these factors can be attributed to the European wholesale markets (European Commission, 2012: pp. 7) and that the overall state of competition was not satisfactory. The key findings can be summarized as follows:

[8] European Commission DG Competition (2007): DG COMPETITION REPORT ON ENERGY SECTOR INQUIRY, Brussels.

- High level of concentration in wholesale markets, enabling generators to exercise market power by raising prices or withholding capacity. Quantitative concentration tests based on hourly data were conducted to reveal whether specific generators were capable of significantly influencing the market through capacity withholding in a given number of hours per year. A large potential exists during peak hours regardless of the overall concentration level. Even during off-peak hours, where competition should be most effective, countries with high concentration ratios exhibit large potentials for capacity withholding.
- Interregional competition was not effective as the then current interconnection capacity was not sufficient. Long-term pre-liberalization capacity reservations and the fact that vertically integrated companies controlling the network have incentives to invest into new cross-border transmission capacity.
- Vertical foreclosure hinders effectively new market entry, e.g. by means of denying of hampering access to the network.
- Lack of information transparency on all levels, i.e. wholesale, network and retail which leads to a distrust in market results and the price mechanism.

Table 1: Concentration ratios of available capacity and effective generation in selected European countries in 2004

Country	CR1	CR 3
Austria	43.2% (AC) /46 % (EG)	83.3% / 85,2%
Belgium	83% /82.3%	100%/ 100% (CR1+ Fringe)
Denmark East	85%/76.3%	100% /100% (CR1+Fringe)
Denmark West	54%/60.6%	100% /100% (CR1+Fringe)
France	86.7%/75.4%	97.4%/ 90.7%
Finland	37.4%/33.7%	84.1%/81.8%
Germany	24.4%/28.4%	68.5%/67.9%
Italy	51.4%/43.9%	74.4%/76.7%
Poland	25.7%/33.8%	67%/70.7%
Spain	35.6%/48.3%	83%/86.7%
Sweden	42.8%/47.1%	83.4%/86.7%
Netherlands	28.3%/26.6%	72%/70.2%
United Kingdom	15.5%/19.7%	42.8%/48.1%

AC= Available Capacity, EG= Effective Generation. The CR1 generator in the AC category is not necessarily equal to that of EG.

Source: European Commission (2007: pp. 336).

The insufficient level of market integration leads to a general delineation of the relevant geographical markets at national levels. An analysis by DG Competition for the year 2004 showed that most European markets were highly concentrated. A more detailed assessment of the concentration ratios for the years 2003 to 2005 can be found in the report by London Economics (2007)[9] which in essence comes to the same conclusion as the Commission's sector inquiry.

[9] London Economics (2007): Structure and Performance of Six European Wholesale Electricity

3.2 Assessment of competition in 2011

Over the course of the years after the sector inquiry some major changes to the wholesale electricity market and generation in general have taken place. The Member States have mostly implemented (or at least started to implement) the regulations contained in the third Package of the European Parliament and Council, in particular Directive 2009/72/EC. In the context of this report, the most important change affects the rules for the internal energy market and Regulation (EC) No 714/2009, which concerns network access for cross-border exchange. Predominantly, electricity generation from renewable energy sources (RES) has increased and lead to a change in the composition of European generation parks, in particular in Spain and Germany. The impact of RES will be discussed in the next subsection, along with the discussion of possible adjustments to the market design of various European markets.

National regulation and competition authorities report yearly on the competitive development of the wholesale, transmission and retail level. We focus on the wholesale level and summarize the essential findings for a number of Member States, which are also part of the quantitative analysis in the next section.

Wholesale prices have seen a decline in some Member States in 2011, which can not be fully attributed to the introduction of market coupling. An overall downslide in the European economies, a sharp drop in emission certificates as well as the combination of large generation overcapacities and increase in intermittent RES generation can be made responsible for the low level of wholesale prices. A key finding in the context of competition in the internal energy market is that there is an increasing discrepancy between the interpretation of an economically relevant market and the physical market. An example can be found in the national report for Bulgaria (2012: p.4) [10] for the year 2011:

> *The electricity market in Bulgaria can be characterized as national and at the same time, well-integrated with the neighbouring countries.*

From this statement it is clear that the Bulgarian regulation office regards the Bulgarian market to be geographically defined along its national border. Stating in the same sentence that the country is "well-integrated" raises the question as to what the extent markets are integrated. If cross-border transmission capacity is large enough, then the economically and physically relevant market must be the same under competition. The following presents a summary of a selection of national regulation reports for the year 2011.[11]

Markets in 2003, 2004 and 2005, London.

[10] State Energy and water Regulatory Commission (SEWERC) Bulgaria (2012): Annual Report to the European Commission.

[11] The national reports can be found under the following link at the Council of European Energy Regulators: http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202012

Austria & Germany

- Austria and Germany constitute a fully integrated market. Due to the significant difference in installed generation capacities, Austrian power generators are no dominant competitors on the wholesale market. The four largest generators in Germany hold approx. 73% of the competitive generation capacity. Including Austria lowers the share by one tenth, i.e., approximately 66.7% remain. [12]
- One-sided competition between RES generation (beneficiary) and conventional generation affects wholesale prices and creates large generation overcapacities.
- De-commissioning of nuclear power plants in Germany reduces market shares of the four largest generation companies in Germany.
- Germany acts as the pivotal hub for electricity exchange despite a decrease in available cross-border capacity of 7.12% on average, in particular to France, Sweden and Denmark.

Belgium

- The four largest generators in terms of total generation capacity are Electrabel (70%) SPE/EdF (14%),E.ON (9%) and T-Power (3%).[13]
- A decoupling of the market on 28 March 2011 lead to a significant upward effect on wholesale prices in Belgium, with an average price of € 206.1/MWh for base load and € 2999/MWh in the 8th hour of the day. An analysis of the dispatching process and offering behavior came to the conclusion that capacity proposed was sufficient to prevent the peak. It is not made clear in the national report which consequences this result has on a potential antitrust case.

Czech Republic

- The Power Exchange Central Europe now enables electricity trades for the Czech Republic, Slovakia and Hungary.

Denmark

- Dong Energy and Vattenfall are the two largest players in Denmark[14] with market shares of 47.21% and 15.71% of installed capacity. In relation to the Nordic region these shares change to 6.2% (Dong Energy) and 18.7% (Vattenfall), respectively.
- With the exception of the border between Germany and Western Denmark, all cross-border capacities are controlled via day-ahead market coupling.
- Large share of actual generation can be attributed to wind power (30%)
- Two Danish price areas inside the coupled Nordic markets which for most of the time are different from other price regions, in particular Norway and Sweden. East Denmark exhibits both the highest and lowest prices in the whole region.

[12] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.
[13] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.
[14] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.

Norway

- Statkraft, E-CO Energi and Norsk Hydro are the three largest players in Norway[15] with market shares of 38.63%, 9.16% and 5.93% of installed capacity. In relation to the Nordic region these shares change to 11.3% (Statkraft), 2.8% (E-CO Energi) and 1.9% (Norsk Hydro).
- Low precipitation lead to price increases because Norwegian power generation is mainly based on hydro (95% of installed capacity) and nuclear.

Sweden

- In 2011 the formerly single Swedish price region was divided into four submarkets.
- According to the Swedish Energy Market Inspectorate (2012: p.36), the three largest generation companies are Vattenfall (41%), Fortum (20%) and E.ON Sweden (18%).[16] The market shares of these three generators in the Nordic region are 18.7% (Vattenfall), 6.7% (E.ON Sweden) and 11.2% (Fortum). The Herfindahl-Hirschman-Index (HHI) in the four Swedish submarkets reflects a very high concentration in SE1 (6375) and moderate concentration in the other regions SE2 (1866), SE3 (1956), SE4 (2325). However, the four areas were not isolated for the entire time span. Therefore, the actual HHI, depending on the state of congestion, was quite moderate for most of the time, i.e., significantly below an HHI of 2000.
- Co-ownership of power plants, especially nuclear plants, is still regarded as a limiting factor for competition.
- Low precipitation lead to price increases.

France

- EdF and GdF are the two largest players in France[17] with market shares of 83.16% and 5.36% of installed capacity.
- Virtual power plant capacity is offered as a remedy for the dominance of EdF.
- Like Norway and Sweden, France is highly dependent on nuclear and hydro power plants. Therefore, precipitation and temperature play a very large role in security of supply.
- The French regulator conducted an investigation into the price mark-ups of EdF, i.e. the difference between marginal costs of production and spot prices. An average mark-up of 3.2% was found for 2010, which was not considered an abuse of a dominant position.[18] Few offers exceeded 100 €/MWh, and they were found to reflect system marginal costs in the EPEX Spot auction.
- Transparency and availability of production and consumption data was increased significantly since 2010 and 2011.

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[15] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.
[16] Energy Market Inspectorate: Swedish Electricity and Gas Markets 2011.
[17] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.
[18] French Regulatory Office (2011): The French wholesale electricity, natural gas and CO2 markets in 2010 -2011.

Spain

- Iberdrola, Endesa and Gas Natural Fenosa are the three largest players in Spain[19] with market shares of 23.5%, 22.7% and 15% of electricity generation.
- The degree of congestion between Spain and Portugal decreased from 80% of the time in 2007 to 9% in 2011.
- Apart from the progress in its market integration with France, Spain and Portugal also pursue the integration with the whole North-West European region.

The Netherlands

- GDF Suez, RWE AG and Vattenfall AB are the three largest players in the Netherlands[20] with market shares of 22.07%, 17.16% and 16.22% of installed generation capacity.
- As a part of the CWE region, the Netherlands successfully integrated with Germany at the end of 2010. Next step of integration of the entire North-Western region expected to happen in 2012.

United Kingdom

- EDF, SSE and RWE Npower are the three largest players in the Great Britain[21] with market shares of 22%, 16% and 10% of electricity generation.
- The Department for Energy and Climate Change started a consultation on a draft which intends to prohibit output manipulation. This is supposed to prevent anti-competitive behavior like withholding of generation capacity

A comparison of concentration ratios between 2004 and 2011 may lead to the assessment that the situation has improved in many countries. However, most markets are still highly concentrated. Especially the French market cannot be expected to exhibit significant reductions in concentration any time soon. Despite the high national concentration ratios, the increasing degree of integration between the markets is a positive development, which will be discussed in more detail in the next chapter. In addition, Germany and Austria are now considered to constitute a common market area. While Austria is too small to cause drastic changes in the competition assessment, it is a positive aspect nonetheless.

The largest impact on competition, however, can be attributed to the increasing share of subsidized generation from renewable resources. The various support schemes will be addressed in the next subsection, but what is important from a competition point of view is that these foster a one-sided competition relationship to the detriment of conventional generation. Since the latter is the source of high concentration, market shares for the

[19] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.
[20] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.
[21] Analysis based on PLATTS Power Vision Data, 3rd Quarter 2011.

largest generators decrease. This development comes at the cost of a well-functioning market-based energy system. So it is unclear whether this development should be described as positive.

Deconcentration may have an impact on market power and the incentives for its abuse through capacity withholding, but it is not expected to be large enough to completely rule out its possibility. Capacity withholding still remains difficult to prove and it can be still very profitable for firms to engage in this sort of behavior even if concentration ratios are very low.

Progress has been made in other crucial points listed in the 2004 competition assessment: Information transparency, data availability in particular, and vertical ownership unbundling between network and generation, which has decreased the likelihood of vertical foreclosure.

It is important to stress the discrepancy between physically and economically integrated markets. As described before in this chapter, market definition has a very large impact on the assessment of competition. For instance, relying on a very narrow definition will have (too) negative effects on mergers, while the opposite holds true for a very broad definition. Remedies like price caps or structural divestiture remedies are often based on the assessment of market power, which is (partly) based on concentration ratios.

The market definition problem arises because the two examples where the assessment is the easiest are also the most extreme. If there was no physical connection between two areas, and no third country was involved, then these two areas cannot belong to the same market. If cross-border capacities were as high as maximum demand, then these two should belong together, as prices would be equal all the time. Any status in between is less clear. The European Commission should define under what conditions it regards two areas as belonging to a common market. It could be argued that a clear definition is not a relevant matter because all that is important is sufficient competitive pressure from outside. This is, however, a rather incomplete assessment because all that matters inside a relevant market is sufficient pressure from competitors. Therefore, an assessment of sufficient pressure means that markets belong together. In power markets, and coupled markets in particular, this translates into price equality. So the question is, how often sufficient pressure can be observed.

3.3 Support schemes for renewable energies and market design

As the European Commission has recently pointed out in a number of documents (COM (2012) 271; COM (2013) 169) SWD (2013) 102), support mechanisms for electricity production from renewable energies vary heavily between member states. In principle, three types of support mechanisms can be used:

- Government administered feed-in tariffs (FIT),
- Government guaranteed feed-in premia on top of market prices (FIP), and
- Government set renewable quota systems (RQS).

While we can distinguish between these three "pure" systems there are also hybrid systems where different support schemes are combined. For example, solar energy may be supported through the use of feed-in tariffs while wind power may be supported through feed-in premia or renewable quotas. These systems are partially complemented by tax incentives, public procurement auctions and investment grants.

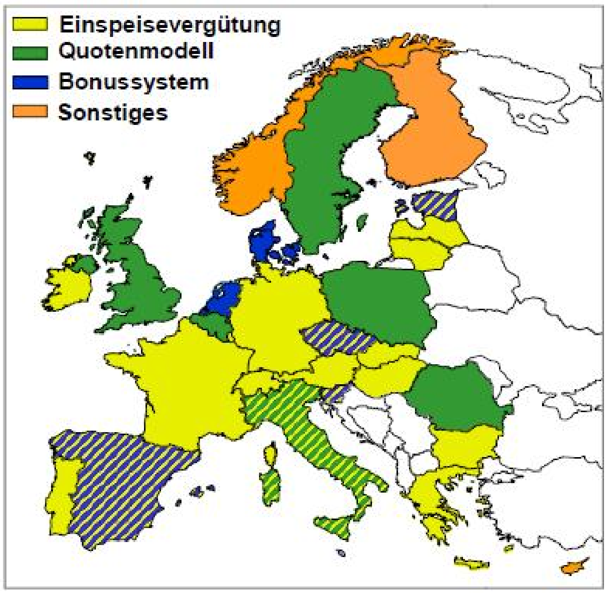
As of today, all EU Member States have adopted somewhat different support systems even though some of them may be more similar to each other than others. Table 2 and Figure 3 provide a rough overview over different support systems established in Europe.

Table 2: Support schemes for renewable energies in Europe

		AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Electricity	FIT	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x			x			x	x	x
	Premium					x	x	X	x	x						x					x					x		x
	Quota obligation		x													x	x		x			x		x	x			x
	Investment grants		x		x	x					x		x	x			x	x	x	x								
	Tax reductions/ exemptions		x							x	x		x						x		x	x			x		x	x
	Financial incentives			x			x		x											x	x	x				x		
heating	Investment grants	x	x	x	x	x	x		x		x		x	x	x		x	x	x	x	x	x	x		x	x	x	x
	Tax reductions/ exemptions	x	x					X				x	x			x	x				x				x			x
	Financial incentives			x			x		x			x											x					
	Premiums											x																
trans-port	Quota obligation	X		x	x	x	x	X		x	x	x			x		x	x	x		x	x	x	x		x	x	x
	Tax reductions/ exemptions	X	x		x	x	x	X	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x

Source: (updated) Commission staff working paper on financing renewable energy SEC(2011)131

Figure 3: Support schemes for electricity from renewable energies

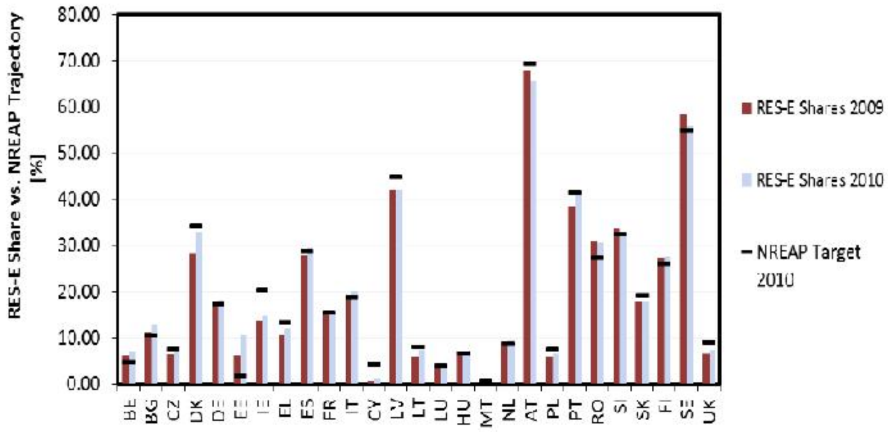


Source: Wissen (2012: p. 17)

In Figure 3, yellow countries mainly rely on feed-in tariffs, while blue countries mainly use feed-in premia and green countries rely on renewable quota obligations. As can be seen, there are also a number of hybrid schemes.

The extent to which electricity generated from renewable energies is used in the Member States also varies heavily between countries, as is illustrated in Figure 4.

Figure 4: Share of electricity from renewable energies



Source: European Commission COM (2013) 175 final, p. 4

The different support schemes have induced major inefficiencies if viewed from a European perspective. Most importantly, since all support schemes only support renewable energies *within their own national territory* massive gains from trade and from market integration are foregone. These gains from trade could easily result, as climate and weather conditions vary heavily across and even within member states. For example, conditions for wind power are typically superior in Northern Europe while the conditions to produce solar-based electricity are much better in Southern Europe. Hence, enormous gains from trade could be realized by focusing on solar power in Southern Europe and on wind energy in Northern Europe. However, since almost all RES support schemes (with the particular exception of Sweden and Norway) are based on national frontiers so that only domestic production is supported, these benefits are foregone, resulting in according inefficiencies (for more details see section 4.3 below).

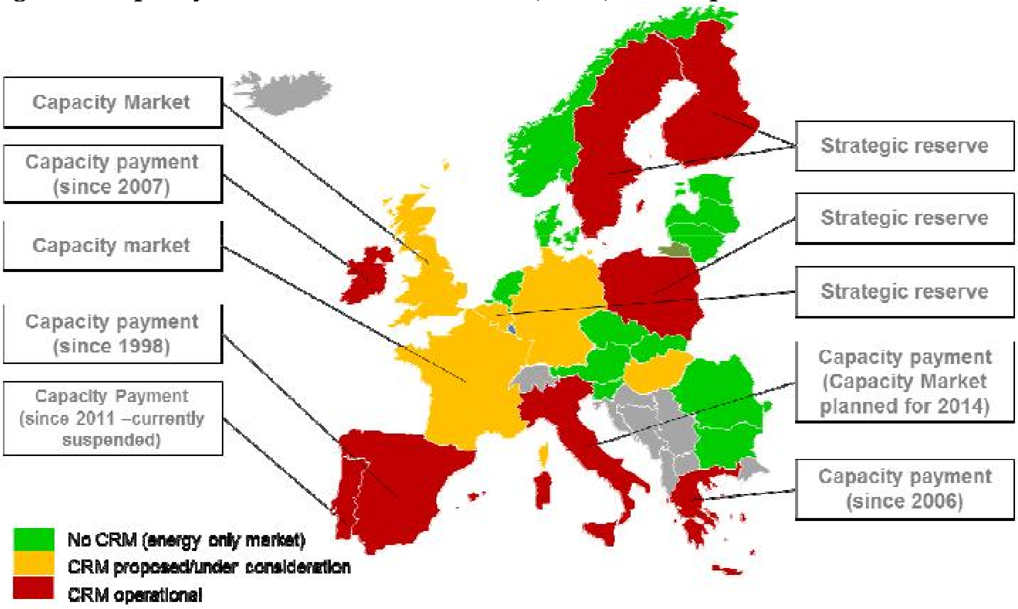
For example, Germany had in 2011 more than 35% of the worldwide installed solar PV operating capacity, while Italy had only 18.3% and Spain 6.5%[22] even though in Spain the very same PV modules could produce – due to the naturally better sun conditions in Spain – produce about twice as much electricity as in Germany. From a European perspective the massive investment in solar PV capacity instead of Spain must be regarded as a misallocation of resources.

[22] See *Renewable Energy Policy Network for the 21st Century*, Renewables 2012 Global Status Report, (2012: p. 48).

In addition, European electricity markets are threatened to be fragmented by national capacity and reserve mechanisms (CRM). CRM are various support mechanisms in order to secure the adequacy of generation investment. Again, as Member States tend to only make capacity payments to power plants within their own territory, significant benefits from trade and integration are foregone, as larger market areas typically require much lower capacity payments as (a) they increase competition within capacity auctions/markets and (b) less capacity is needed overall to safeguard the security of supply.

Figure 5 illustrates the variety of mechanisms which are implemented or are planned in Member States today.

Figure 5: Capacity and Reserve Mechanisms (CRM) in Europe



Source: ACER (2013)

4. Quantitative analysis of market integration

In the two previous sections we learned that a physical integration of two market areas may increase the efficient utilization of power plants to cover demand and foster competition on the generation level. However, there are some difficulties in assessing the practical usefulness, the actual degree and welfare effects of market integration. In the following subsection we explain that the potential for market integration crucially hinges on the demand profile of the two areas. In addition, we give an indication as to how far wholesale markets have been integrated. The last subsection provides an overview of empirical evidence on the benefits of market coupling.

4.1 Potential and degree of market integration

Market integration has progressed since the last sector inquiry for the European Commission. A thorough analysis on the subject of market integration has been conducted by the Agency for the Cooperation of Energy Regulators (ACER). The following markets have been coupled:

- Denmark Finland, Norway and Sweden (Nordic countries) have stepwise adopted a market splitting model directly after market liberalization in the 1990s.
- France, Belgium and the Netherlands coupled their markets (Central Western Europe – CWE) before Germany and Great Britain joined in 2010 and 2011, respectively. The transmission allocation method is expected to switch from open market coupling to flow-based market coupling at November 2013 earliest (CWE, 2013).[23]
- The Nordic and CWE region have started the process of integration.
- Spain and Portugal coupled their markets in 2007.
- The Czech Republic and Slovakia integrated in 2010. A new project has begun in 2011 to explore the integration of Hungary (CERO, 2012: p.5).[24]
- Italy and Slovenia coupled their markets in 2011.

The analysis of common high peak-hours provides a first indicator of how large the impact of cross-border trade can actually be and how strongly this can affect prices and help securing supply. In this calculation, high peak is defined as the highest 10% of load hours per country. During these hours, supply is expected to be tight[25] causing prices to rise. The higher the share of hours, in which two connected market areas have simultaneous high peak-phases, the less market coupling can help reducing wholesale prices, as the two generation parks are simultaneously fully used. On the other extreme, if two market areas exhibit no correlation in high peak-hours, the capacity level that is needed in each market to fully cover demand at all times is much lower than in the case

[23] Central Western Europe Market Coupling, https://www.europeanpricecoupling.eu/

[24] Energy Regulatory Office on the Electricity and Gas Industries in the Czech Republic (2012): National Report of the Energy Regulatory Office on the Electricity and Gas Industries in the Czech Republic for 2011.

[25] Another reason is simply a large share of (technically) unavailable generation capacity.

of perfect correlation of peak hours. In other words, the same demand can be covered with less installed generation capacities if high peak demand between two areas is not correlated.

Table 3: Descriptive statistics of country load hours

Variable	Country	Obs	Mean	Std. Dev.	Min	Max
load_at	Austria	62640	6675.404	1273.071	3622	10040
load_be	Belgium	61224	10009.37	1495.701	5973	14191
load_ba	Bosnia-Herzegovina	63384	1366.085	254.5111	796	2150
load_bg	Bulgaria	63384	4282.015	869.4377	2459	26948
load_cr	Croatia	62640	2397.018	1020.493	1016	5945
load_cz	Czech Republic	63384	7254.845	1229.556	4096	16589
load_dk	Denmark	52536	3194.301	1058.795	1266	6347
load_fr	France	62640	56008.04	12230.22	29896	102000
load_fi	Finland	27048	9816.381	1757.215	5219	14965
load_de	Germany	61224	55162.17	9937.933	28984	79884
load_hu	Hungary	62640	4702.163	707.7632	1173	6602
load_it	Italia	53185	37257.72	7839.498	18819	56822
load_lu	Luxembourg	61968	749.9997	127.8918	148	1188
load_no	Norway	27048	14662.44	3489.561	180	25229
load_pl	Poland	62640	16209.31	2757.065	8815	23728
load_pt	Portugal	63384	5727.244	1097.442	3171	9397
load_es	Spain	53880	29170.52	5252.556	1067	44880
load_se	Sweden	61992	16030.13	3553.045	8016.77	26713
load_ch	Switzerland	62602	5593.407	1097.824	736	10829
load_nl	Netherlands	62640	12538.25	2325.712	5767	18465
load_sl	Slovenia	62640	1437.358	263.1574	341	2100
load_sk	Slovakia	61968	3234.878	432.9248	2039	4423

Source: ENTSO-E (2013).

Our analysis covers the years from 2006 to 2012 and is based on load data from the European Network of System Operators (ENTSOE), covering 21 European countries, which are part of six regional transmission groups, defined as South-Western European (SWE), Central-Western European (CWE), Central-Southern European (CSE), Central-Eastern European (CEE) and Northern European (NE). The analysis of common high peak-hours is conducted pairwise for each member of each regional transmission group.[26] So duplicates can occur, e.g. Germany-France. The data set is unbalanced as

[26] If up to three consecutive load values of a single day are missing or zero, they are replaced by nonzero positive values of the previous hour. Any longer period of missing or zero values is set to missing. This majorly happened in the case of Switzerland. There are other implausible values for Switzerland which were set to missing, e.g. on 12 July 2007 with indicated values well below 1 GW during a period which had load values of around 4 GW on previous and later days of the same month.

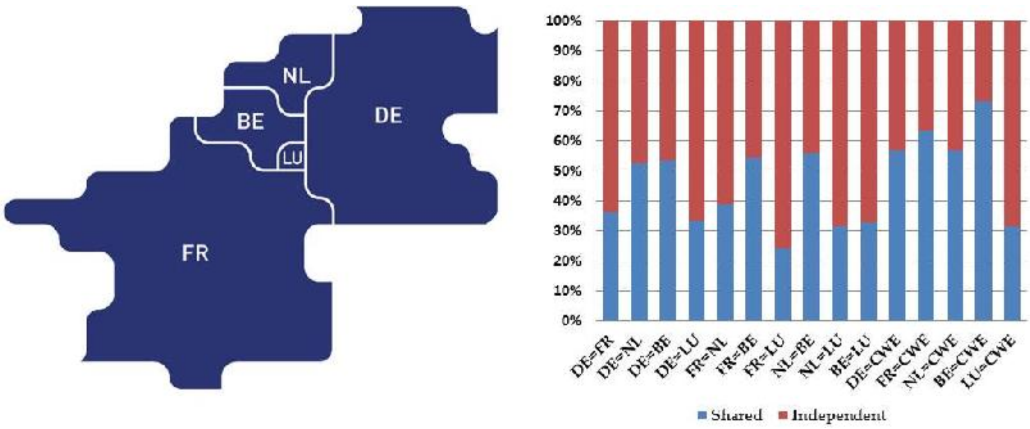
ENTSOE only covers the last three years (2010-2012) for the Nordic countries. In the case of Sweden and Denmark, data was retrieved directly from the TSOs.[27]

In addition, we calculated the total load for each transmission group as the sum of all of its Member States and also compared each Member State of each region with the respective total regional load. A consequence of this is that larger countries gain higher weight in the total regional load, but this is appropriate because it is also these large countries which influence cross-border trade most. For example, average German load over all years is ca. 55 GW, whereas average Belgium load is roughly 10 GW and that of Luxembourg as low as 0.7 GW.

The overall result is that shared and independent high peak-hours are relatively balanced, but there are a few exceptions that stand out. So the raw potential for market coupling is given and could have a large impact on the technological composition of the European power plant landscape.

In the CWE region, where France and Germany are located as well as the Benelux states, the share of independent high peak phases is roughly around 50 % for most pair wise comparisons. Especially France and Germany do not seem to share the majority of high peak-hours. This indicates that the potential for market coupling is quite large. This can have enormous consequences for the smaller countries, in particular caused by RES generation. In Germany, the yearly share of renewable resources in power generation has already reached roughly 25 %. If applied to the average load, that gives approximately 14 GW of power pushing into the German wholesale power exchange at bidding price of near-zero. This so-called merit-order effect causes a crowding out of conventional power plants which in turn can still be successful in neighbouring markets. So the final crowding-out happens to the more expensive power plants in the smaller countries.

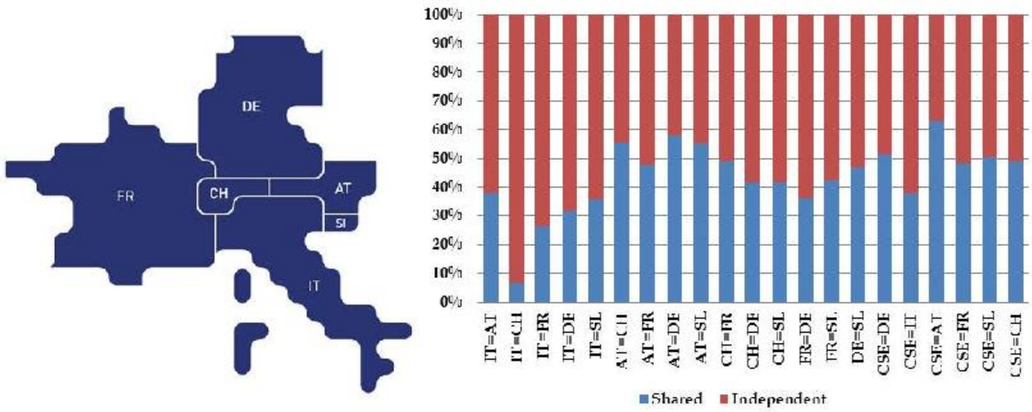
Figure 6: Potential for cross-border trade during largest 10% high peak-hours, CWE Area



[27] The data for Denmark consists of Denmark West from 2006-2010.

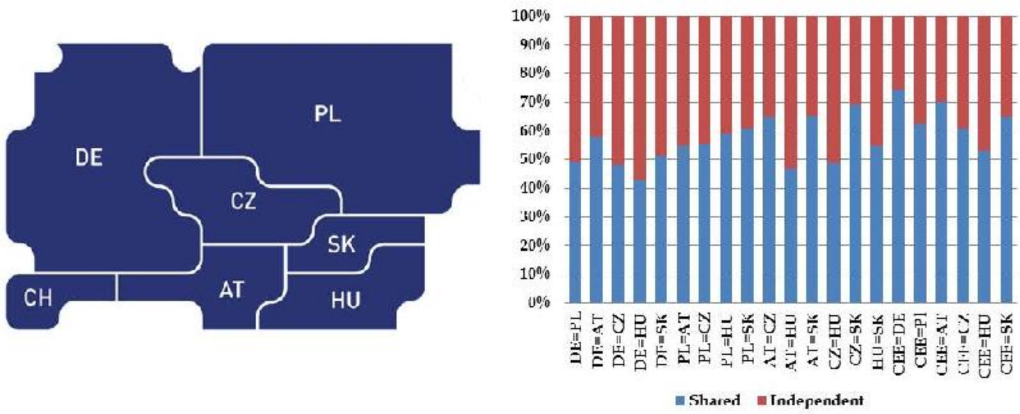
A similar picture can be drawn in the Central-Southern-European region, where common high peak-hours are mostly between 40-60%. Here, Italy stands out as its common share is well below 40% for all its neighbouring countries and even below 10% with Switzerland. The latter relationship is interesting because Italian load is on average around 37 GW while that of Switzerland is 5.6 GW. If the transmission capacity between Switzerland and Italy was sufficient, Italy could help securing Switzerland's supply.

Figure 7: Potential for cross-border trade during largest 10% high peak-hours, CSE Area



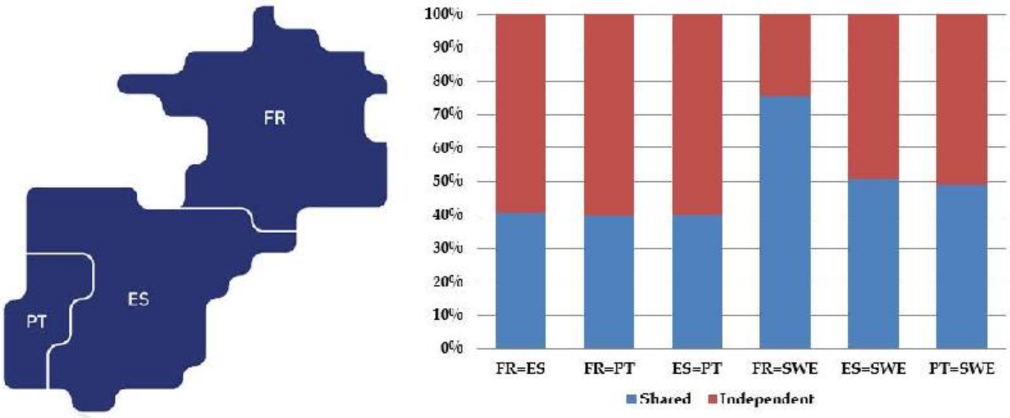
In the Central-Eastern region, the share of common hours does not fall below 40% and is basically quite balanced over all members of that region. However, the share of independent hours is still large enough for potential benefits of market coupling. The share of common high peak-hours between each member and total CEE is apparently larger than the country-pair wise comparisons.

Figure 8: Potential for cross-border trade during largest 10% high peak-hours, CEE Area



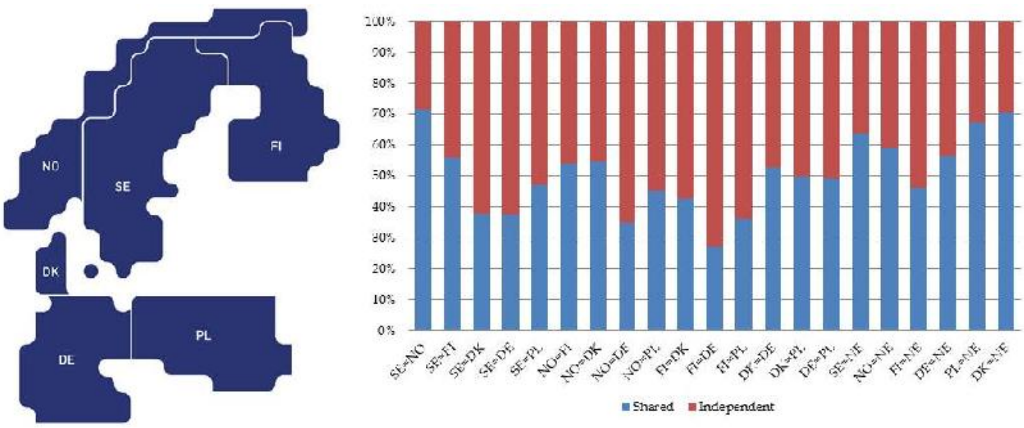
In the South-Western region the share of common high peak-hours is 40%, creating a large potential for market coupling to increase efficiency. A comparison with the total-regional load shows that France shares 70% of high peak-hours. Spain and Portugal are already coupled and the potential for securing each other's supply is relatively large with 60% of individual high peak-hours.

Figure 9: Potential for cross-border trade during largest 10% high peak-hours, SWE Area



Sweden and Norway share 70% of their high peak hours, but the other pair wise comparisons with the Nordic countries do not exhibit such large shares. This is an interesting finding because the Nordic countries, along with connected Baltic countries, have already established a market splitting system since liberalization of the Nordic markets. Germany shares less than 50% of the common hours with the Nordic countries except for Denmark.

Figure 10: Potential for Cross-Border Trade during largest 10% Highpeak-hours, NE Area



After the analysis of the potential for market coupling to efficiently distribute bids and asks on the wholesale level, we give a first indicator of the degree of market integration by analyzing whether prices series of the coupled markets behave as theory predicts. If there are two perfectly homogenous products and transactions costs are zero, then the

Law of One Price predicts price equality. If transaction costs are nonzero, then these should be reflected in the price differences.

We analyze hours of price equality between direct neighbours from 2006 to 2012.[28] For some countries we also have data going back as far as 2001, but price convergence was insignificant (<1%). Results indicate that market coupling has a large impact on price convergence and thus on the integration of markets physically and economically. The strongest impact can be seen in the CWE and SWE region because unlike the Nordic countries, market coupling has been introduced only recently. Especially the coupling of Spain and Portugal in combination with further upgrade of cross border capacities appears to have strengthened the link between both markets.

Figure 11: Price convergence and market coupling in the CWE region 2006-2012

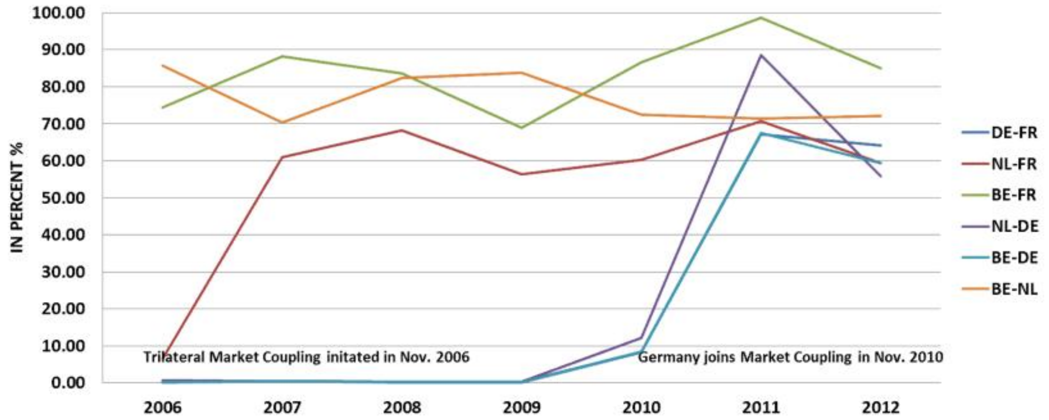
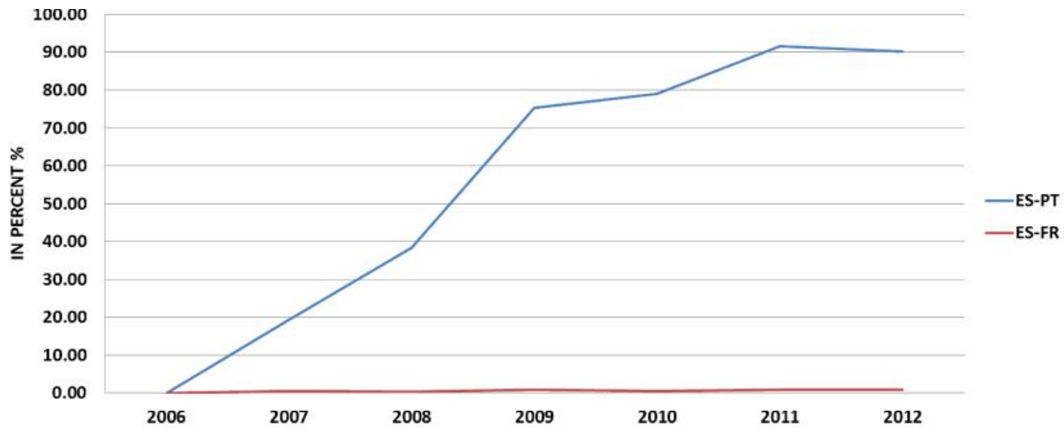


Figure 12: Price Convergence and Market Coupling in the SWE Region 2006-2012



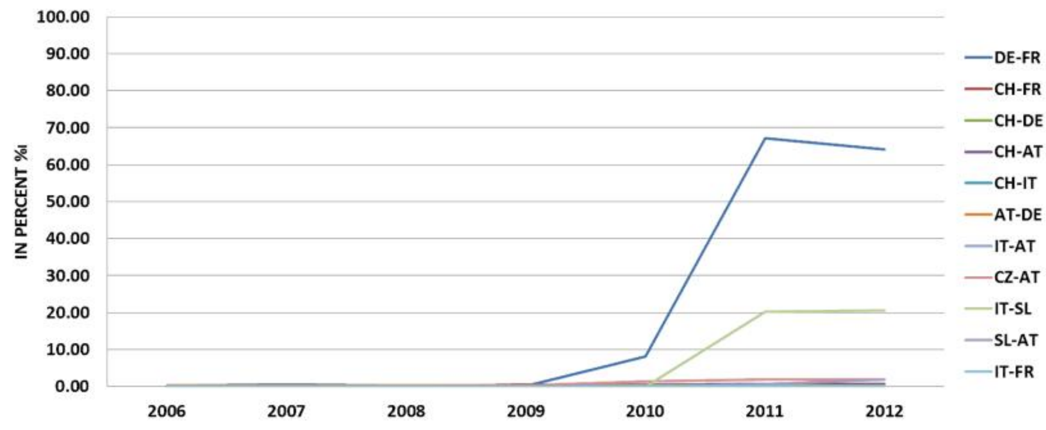
The initial effect of market coupling on the price difference between Germany and the other members of the CWE region was quite large, but has decreased to around 60% in

[28] Price data was collected from the respective power exchange or from PLATTS Power Vision Data, 3rd Quarter 2011. Corrections were made for daylight savings.

2012. A possible explanation for this could be a cross-border transmission capacity overload, caused by diverging economic situations, e.g. an economic crisis in one country, or too much intermittent renewable generation in Germany. Overall, the CWE region appears to have increased the degree of integration. For the years 2011 and 2012, the CWE region had equal prices for 28.21% and 27.54% of the time.

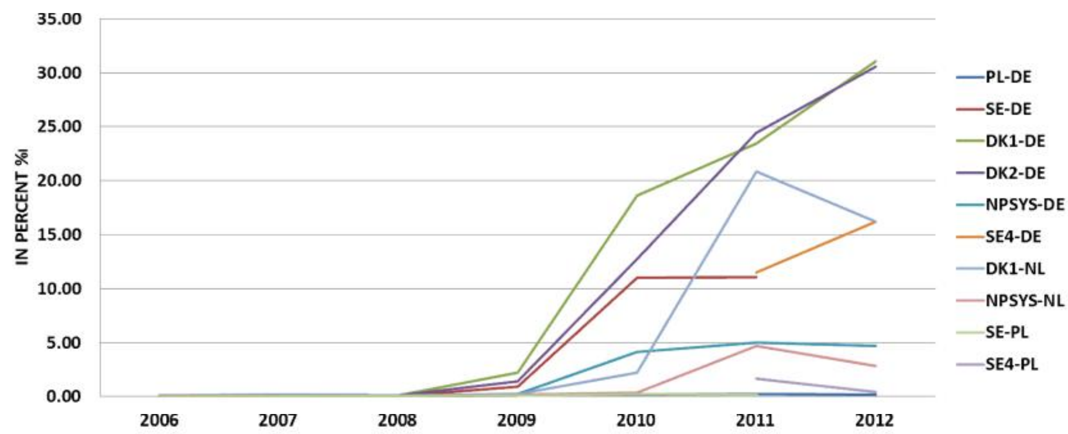
This stands in contrast to the development in the CSE and CEE region, where only the coupled markets of France and Germany as well as Italy and Slovenia show a significant change. In the CEE region, there was no year in which any price convergence was higher than 2%.

Figure 13: Price convergence and market coupling in the CSE region 2006-2012



For the Northern European region, we subdivide the analysis in three parts. First, the price effect of the integration process with Poland, the Netherlands and Germany is presented. The connection of the Danish (DK1 and DK2) and German market shows the strongest progress. The Netherlands also exhibit a large jump in equal price hours with Denmark (DK1) from about 2.23% in 2010 to 20.84% and 16.2 % in 2011 and 2012, respectively.

Figure 14: Price convergence and market coupling in the NE region 2006-2012, A



Between the Nordic countries, price convergence was relatively high in comparison to other regions. Price equality between Norwegian price areas (not depicted in the figure) varied a lot over the years. On the one hand, price equality between NO2 and NO3 dropped from 96.23% in 2006 to 33.46% in 2010 and increased to 54.14% again in 2012. On the other hand the connection between NO1 and NO2 saw an increase of 66.43% in 2005 to 85.11% in 2012. Before Sweden was subdivided into four price areas, its price convergence with Norway was already on a relatively high level, as can be seen below.

Figure 15: Price convergence and market coupling in the NE region 2006-2012, B

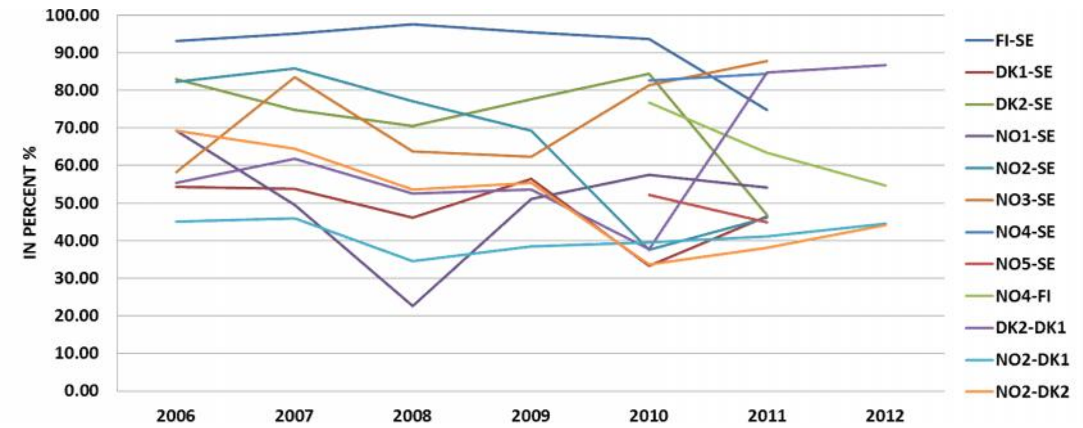


Table 4: Price convergence since market splitting in Sweden 2011-2012

Region	2011	2012
SE2-SE1	100.00 %	97.73 %
SE3-SE1	91.19 %	93.69 %
SE4-SE1	68.92 %	83.34 %
SE4-SE2	68.92 %	85.26 %
SE3-SE2	91.19 %	95.96 %
SE4-SE3	72.68 %	88.51 %
SE3-DK2	69.60 %	59.81%
SE4-DK2	96.11 %	68.02 %
SE3-NO1	70.49 %	68.18 %
SE1-NO3	83.20 %	92.27 %
SE2-NO3	83.20 %	90.01 %
SE1-NO4	66.26 %	86.42 %
SE2-NO4	66.26 %	84.15 %
SE3-DK1	83.27 %	55.08 %
SE1-FI	95.90 %	61.20 %
SE3-FI	92.49 %	64.45 %

Since the splitting of the single Swedish price area into four different areas, price convergence has increased between Norway and Sweden. However, it can also be seen that there is enough congestion inside the Swedish system to cause price divergence.

With regard to the north pool system price, there is a decline in price convergence down to 15 % in 2012. This shows that despite the early coupling of the markets, prices are unequal for most of the time.

Table 5: Impact of German holidays on price changes of selected countries

	Sample 2004-2006		Sample 2007-2011	
	Peak	Off-peak	Peak	Off-peak
Belgium	n.a.	n.a.	-9.843325*	-1.743196
			(5.262398)	(1.97875)
Netherlands	-0.9748106	0.9668218	-10.3958***	-2.571479**
	(7.600033)	(2.218313)	(3.803098)	(1.058827)
Austria	-9.603162**	-3.745586	-21.29731**	-8.35961***
	(4.893564)	(0.7657268)	(10.45279)	2.27339
Denmark West	-1.618624	-0.4898536	-10.93239*	-5.022301***
	(1.795621)	(0.6807416)	(5.860749)	(1.150887)

Standard errors in parentheses and significance on a ***1%, **5% and * 10% level.
Source: Böckers and Heimeshoff (2011: p. 34).

Table 6: Impact of holidays from selected countries on German price changes

	Sample 2004-2006		Sample 2007-2011	
	Peak	Off-peak	Peak	Off-peak
Belgium	n.a.	n.a.	-0.1589637	1.524406*
			(1.105428)	(0.853278)
Netherlands	-0.5880856	-0.4413457	-3.480985	2.657571
	(3.229754)	(1.885455)	(2.632742)	(2.570162)
Austria	-14.42094**	-9.37018***	-19.69268***	-9.18183***
	(5.843017)	(2.075196)	(5.768293)	(2.852531)
Denmark West	-4.735957	-2.436494	-12.50101**	-4.741009*
	(4.194162)	(2.893563)	(5.954492)	(2.822306)

Standard errors in parentheses and significance on a ***1%, **5% and * 10% level.
Source: Böckers and Heimeshoff (2011: p. 36).

Böckers and Heimeshoff (2011)[29] have analyzed the degree of market integration between Germany and eight neighboring countries. Among the empirical methods applied are price correlations, price-difference stationarity, and a vector autoregressive model. These methods have been subject to criticism in the market delineation literature.[30] Therefore, Böckers and Heimeshoff also use nation-specific holidays as an exogenous shock to

[29] Böckers, V. and U. Heimeshoff (2011): The Extent of the European Power Markets, Working paper, latest version online at http://www.dice.hhu.de/en/diceteam/researchers/doctoral-researchers/dipl-oek-veit-boeckers.html.
[30] See Böckers and Heimeshoff (2011) for a discussion on the matter.

identify the degree of integration. The study focuses on pair wise comparisons with Germany, and there is strong empirical evidence that Germany and Austria have been integrated before market coupling of the CWE region in October 2010 and also before the German cartel office came to the same conclusion in her sector inquiry in 2011. In addition, the areas Denmark West, Belgium and the Netherlands also show strong signs of market integration with Germany.

In its report of 2012, ACER calculated hours of price equality for selected European countries, see Table 7 and Figure 16. The Nordic countries had equal price hours even in 2003, which is due to the early adoption of market coupling after liberalization.

Table 7: Percentage of hours for equal hourly day-ahead prices

Pairing	2006	2007	2008	2009	2010	2011
DE=FR	0%	0%	0%	0%	8%	68%
DE=FR=NL	0%	0%	0%	0%	8%	63%
FR=NL	4%	60%	66%	54%	58%	67%
NL=DE	0%	0%	0%	0%	12%	87%
SE=NO=FI=DK	33%	28%	9%	25%	19%	26%
ES=PT	n.a.	19%	38%	75%	79%	92%

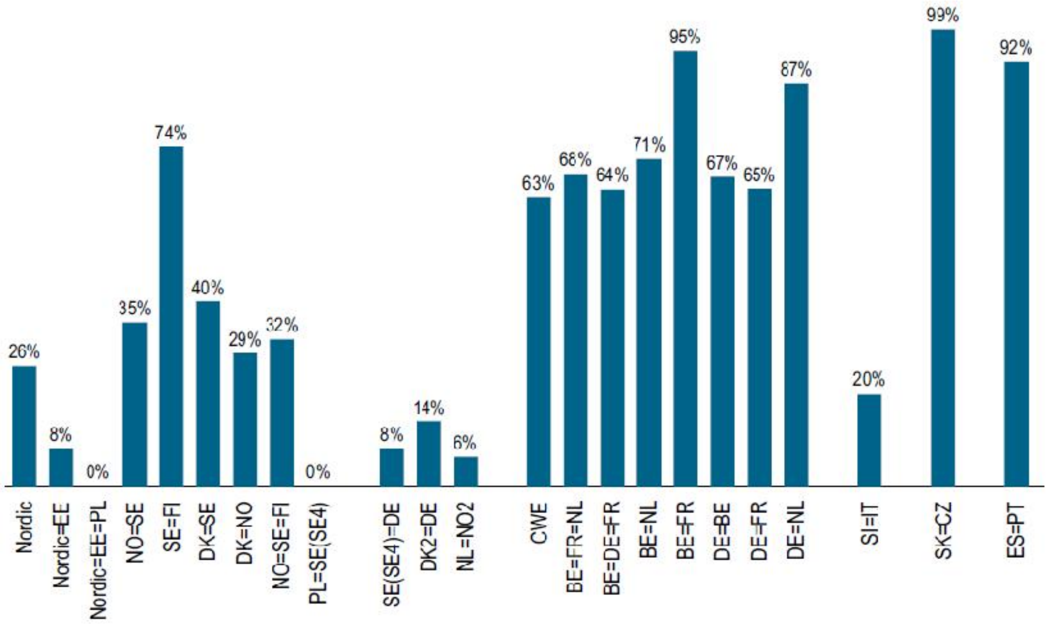
Source: ACER (2012: p.52).

Results show that market coupling leads to a higher percentage of equal price hours between its members. While the pair wise comparison of German and Dutch prices does not necessarily yield the highest percentage, it clearly shows a large jump from 0% in 2009 to 12 % in 2010 and finally 87 % in 2011. The nonzero percentage in 2010 can be almost solely attributed to the integration of Germany into the CWE market coupling in October 2010, because the share of equal hours was less than 1% in peak and off-peak hours and rose up to 86.5% in off-peak and 78.7% in peak hours after the integration. The pairs Spain-Portugal, Belgium-France and, in particular, Slovakia-Czech Republic stand out most with regard to price convergence. Concerning the whole CWE region, in 63% of all hours prices were equal.

It can be concluded that market coupling leads to price convergence, but it is not clear, what the welfare effects are. In addition, it is not clear, whether new barriers to entry have emerged. ACER reports the case of Sweden, where the subdivision into smaller submarkets, depending on congestion, has raised concerns by the European Commission that the Swedish network operator (Svenska Kraftnät, SvK) may have abused its dominant position, when it curtailed export capacity for congestion reasons (ACER, 2012: p.57) .

Another issue raised by ACER (2012) concerns the large differences in liquidity of the power exchanges. In the CWE region, France and Belgium have only 13% of trade volumes as a percentage of national demand, while Germany and the Netherlands have 40% and 32% respectively. If the trading volumes are very low, then the efficiency of market coupling can be negatively affected.

Figure 16: Percentage of hours where prices were equal in 2011



Please note that *SE4*, *No2* or *DK2* are submarkets of Sweden, Norway and Denmark respectively. *Source: ACER (2012: p. 53).*

4.2 Empirical studies on welfare effects of market integration

To analyze welfare cost of an absence of market integration ("the cost of non-Europe") is basically the flipside of calculating the benefits of market integration of two formerly disconnected areas. While a separation of two previously connected areas also entails adjustment costs, (which have not been modeled yet to the best of our knowledge), these costs should be similar to the gains expected from a switch from disconnection to sufficient cross-border connection. These adjustment costs include, for example, an increase of installed generation capacities inside the respective areas. In case of market coupling, this also includes efficiency losses from the transition of implicit to explicit cross-border trade, which includes the "false" booking of cross-border capacity if cross-border trade is feasible after disconnection at all.

The quantification of welfare benefits of market integration requires either regression analysis or simulation. Any regression analysis is difficult in this context as there are many endogenous problems which, if unresolved, cause a severe estimation bias.[31] This concerns, for example, generation investment decisions and expected performance of the market coupling operator and the simultaneous causality between demand and supply.

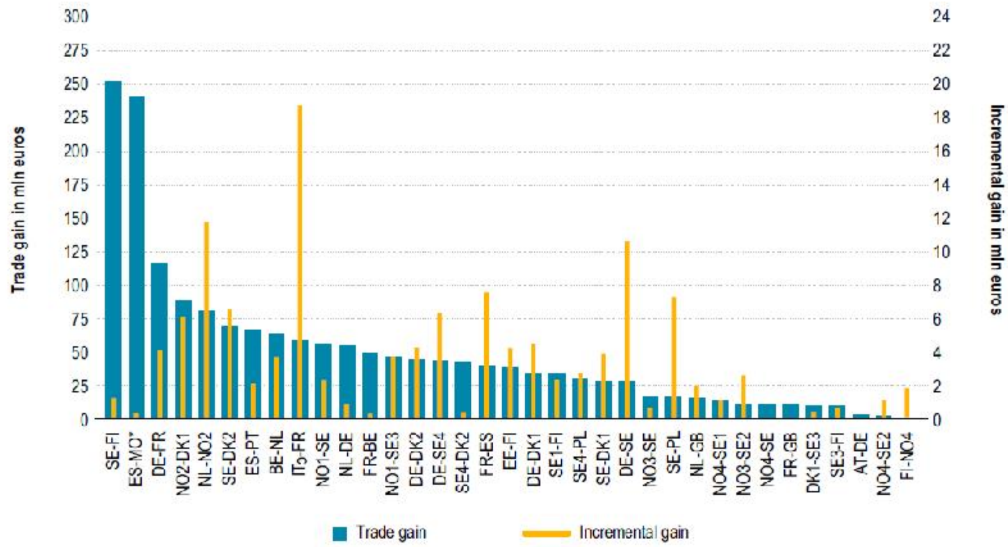
Market simulation studies are often linear or mixed-integer optimization models, where many parameters, e.g., demand elasticity and its level as well as type and level of installed capacity, are exogenously given and a key parameter is varied artificially to generate different scenarios, here in principal the cross-border trade. Examples for such

[31] See simulatenous causality problems in any econometric textbook.

simulation of power markets can be found in Hobbs & Helman (2004), Hobbs & Rijkers (2004) and Kurzidem (2010).[32]

Several European Power exchanges were requested by ACER to perform simulations to give an indication about the scale of welfare benefits. Three scenarios, which only differ on the availability of cross-border capacities, were used and applied to real data from 2011. Despite the limitations of the analysis,[33] the results suggest that the welfare gains of market integration are highly positive. Based on these simulations, the CWE region alone achieved gains from trade worth more than 250 million Euros in comparison to isolated national markets.

Figure 17: Welfare gains from market integration based on 2011 data



The base scenario relying on historical data is compared to the isolation scenario (*Trade gain*) and the scenario with increased transmission capacity (*Incremental Gain*).
Source: ACER (2012: p.68).

Figure 17 illustrates the estimated trade gains (in million Euros) of various forms of bilateral market integration (blue bars, left-hand scale) as well as incremental gains (yellow lines, right-hand scale). As can be seen, major trade gains are still left unrealized between Italy and France (about 19 million Euros per year), Germany and Sweden (about 10.5 million Euros per year) and the Netherlands and Norway (about 12 million Euros per year). Significant gains can also be expected from increasing transmission capacities between Spain and France as well as between Sweden and Poland.

[32] Hobbs, B.F. and U. Helman (2004): Complementarity-Based Equilibrium Modeling for Electric Power Markets, in D. Bunn (Ed.), Modelling Prices in Competitive Electricity Markets, J. Wiley, London. ; Hobbs, B.F. and F.A.M. Rijkers (2004): Modeling Strategic Generator Behavior with Conjectured Transmission Price Responses in a Mixed Transmission Pricing System I: Formulation and II. Application, IEEE Trans. On Power Systems 19 (2): 707-717.
[33] See ACER (2012: pp. 66) for a more detailed description.

As was stated in the theory section above (section 2), perfect competition is not to be expected in practice. Hence, an analysis which takes oligopolistic market structures into account could give a more realistic impression of the welfare enhancing impact of market integration. Hobbs and Rijkers (2005)[34] have simulated oligopolistic power markets based on Cournot competition. Subject of analysis is the market coupling of the CWE region, and the demand conditions of 2000 are used to simulate three scenarios.[35] The main findings, depicted in Table 8, are similar to those of ACER (2012).

Table 8: Welfare effects of the introduction of market coupling

		Electrabel Cournot		**Electrabel Price-Taking in Belgium**	
	Base Scenario	Present Transmission	Market Coupling	Present Transmission	Market Coupling
Mean Market Prices by Country in €/MWh					
Belgium	28.36	45.01	36.69	30.72	29.27
France	14.40	14.15	14.25	14.32	14.32
Germany	18.86	22.41	22.06	22.39	22.40
Netherlands	27.34	32.87	37.08	31.54	28.94
Annual Welfare Measures in M€/year					
Generation Cost	12993	12072	12206	12072	12206
Consumer Surplus	26139	22974	23371	23965	24315
Producer Surplus	6820	8914	8721	8609	8363
TSO congestion revenue	470	796	787	574	523
Social Surplus	33430	32684	32879	33147	33201
Loss of social surplus compared to base scenario	0	-746	-550	-282	-229

Source: Hobbs and Rijkers (2005).

Prices drop in Germany and Belgium while France and, in particular, the Netherlands experience a price increase. Overall market coupling still increases welfare, especially with regard to the oligopolistic scenario. A comparison of the base scenario (perfect competition) with the two models of oligopolistic behavior shows that the welfare loss resulting from imperfect competition are significantly lower with market coupling than without (-550 M€/year vs. -746 M€/year and -229 M€/year vs. -282 M€/year). Hence, depending on the degree of competition, market coupling (integration) leads to significant welfare gains.

A study presented by a group of transmission system operators of the CWE region compares social welfare gains with real and without congestion. While welfare is

34 Hobbs, B. F. And F. A. M. Rijkers (2005): The More Cooperation, the More Competition? A Cournot Analysis of the Benefits of Electric Market Coupling, Cambridge Working Papers in Economics CWPE 0509.

35 The base scenario assumes competition, while the second and third scenarios both assume Electrabel to act either as a Cournot player or price restraint player.

expected to increase by € 14.7 M€, the sole beneficiary are producers.[36] However, no information on the calculation method is available.

Kurzidem (2010) shows that a so-called flow-based market coupling reduces trading costs in comparison to regular market coupling and that it depicts actual congestion and thus prices differences between markets more accurately. Flow-based market coupling takes the actual physical flow into account which is different from the commercial flow. If a generator in market *A* sells power to a buyer in market *B*, then it is not necessarily, or even likely, given that electricity flows the same direction to the full extent, but rather splits along any transmission paths. These so-called loop flows are not considered in the basic market coupling concept despite their potential to jeopardize network security (Kurzidem, 2010: pp.15).

For the CWE region, stakeholders (regulators and other project partners of the CWE region) calculated the social welfare benefits if there was no congestion inside the area on a monthly basis.[37] According to the results of these calculations it is mostly producers that gain most from market coupling.

To sum up, market coupling uses generation capacity more efficiently and thus reduces the necessity of large idle generation capacity. The potential for savings is indicated through the share of diverging high-peak periods between Member States. The larger the share of divergence, the more generation capacities could gain in utilization. This holds in particular for an integration of European capacity and reserve mechanisms (CRM). Given that CRM are subsidies paid to safeguard security of supply better exchange and further market integration could reduce the required subsidy levels by (a) inducing more competition and (b) reducing the absolute levels of additional capacity needed.

4.3 Benefits from harmonizing support schemes for renewable energies

As mentioned in section 3.3 in 2011, Germany had more than five times as much solar PV operating capacity than Spain, even though a solar PV is twice as effective in Spain as in Germany. This inefficiency could be avoided if a truly European market for renewable energies would be created.

A European market could easily be implemented if national feed-in tariffs would be substituted by a European tradeable quota system. Under a renewable quota system, electricity retailers and energy-intensive businesses would be obliged to procure an annually increasing share of power from renewable energies as would be those electricity users who either generate their own power, who import electricity or who directly purchase electricity from an energy exchange.

This green power does not have to be procured physically but evidence of such has to be furnished by means of corresponding green power certificates. These certificates are allocated

[36] EPEXSPOT: See Social Welfare Report 2013, http://www.epexspot.com/de/Marktkopplung/dokumentation_cwe
[37] See Belpex (2013), http://www.belpex.be/index.php?id=95.

to the producers of electricity from renewable energy sources to the extent to which they produce such anywhere in the EU. The green power certificates should be tradable.

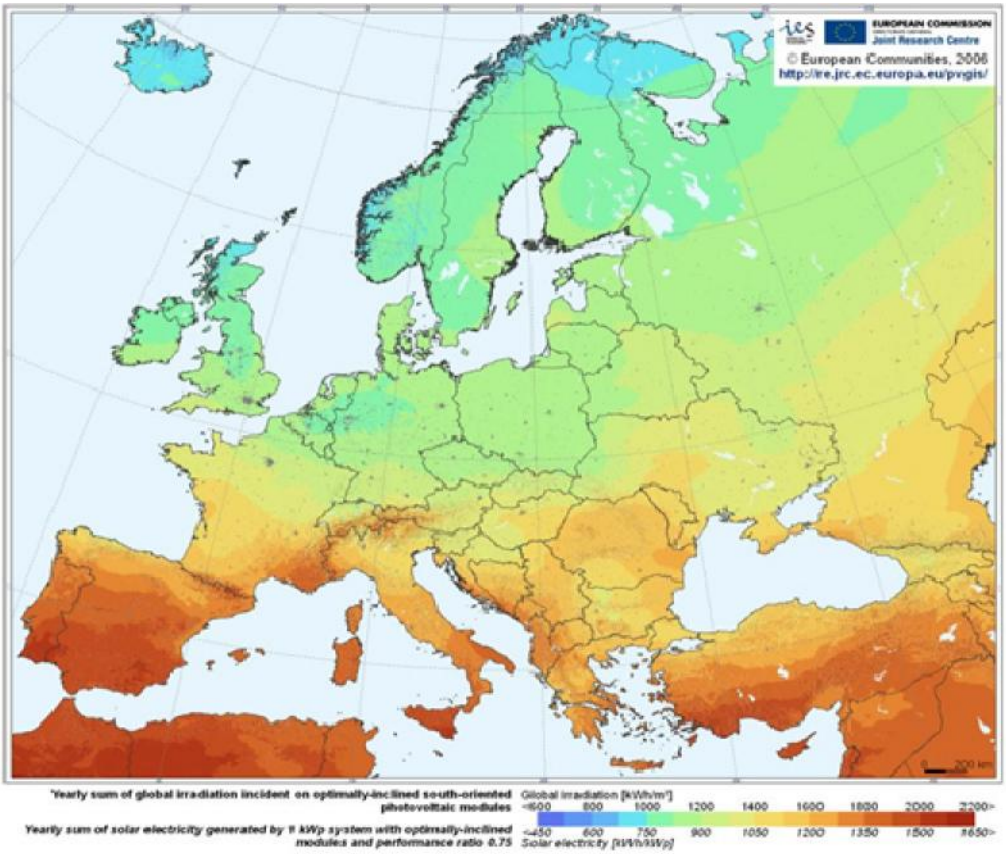
The advantages of a quota system include the possibility to accurately adjust the speed of network expansion and to facilitate better planning of network expansion requirements. Moreover, competition within the segment of electricity generated from renewable energy sources also means that efficient technologies, locations and plant sizes will tend to be selected. Sweden is already (along with Norway) pursuing a very similar model.

This is also in line with most recent efforts by the European Commission to counteract the tendency for a fragmentation of the single market on account of incompatible systems promoting renewable energies.

As wind power generation is more efficiently located in the north of Europe, while solar PV is efficiently located in the South, a quota system would generate significant efficiencies (also see Wissen, 2011, p. 47 & 49).

Figure 18 illustrates the different solar PV electricity potential across Europe.

Figure 18: Photovoltaic solar electricity potential in European countries



Source: European Commission (2006)

As can be easily seen solar PV can be more cheaply produced in the south compared to the north. Still the vast majority of Europe's solar PV capacity is located in the north. Market integration could remove these inefficiencies. As Energy Commissioner Günther Oettinger recently stated: "We should continue to develop renewable energy and promote innovative solutions. We have to do it in a cost-efficient way. This means: producing wind and solar power where it makes economic sense and trading it within Europe, as we do for other products and services." (IP/12/571).

As a cautious calculation one could use the following approximation: If the solar capacity currently installed in Germany which produced about 18.500 GWh in 2011 (and much more in 2012, due to additional capacities) would have been located in Spain, the very same capacity could have easily produced about 37.000 GWh. Working with a rather conservatively low electricity price of 40 Euro/MWh, the efficient allocation of solar PV between Germany and Spain alone would have resulted in additional electricity worth about 740 Million Euro within a single year. Additional savings could easily be generated by reducing the necessary support schemes in Germany (currently about 8 Billion Euro per year for solar PV) and from considering (a) more countries than just these two and (b) considering other technologies such as wind.

5. Conclusion and recommendations

The integration of European electricity markets can bring about major efficiency gains in welfare terms to European consumers and industries. Through a process of market coupling electricity markets can be further integrated.

Efficiency gains result, as market coupling uses generation capacity more efficiently and, thus, reduces the necessity of large idle generation capacity. The potential for savings is indicated through the share of diverging high-peak periods between Member States. The larger the share of divergence, the more generation capacities could gain in utilization. This holds in particular for an integration of European capacity and reserve mechanisms (CRM). Given that CRM are subsidies paid to safeguard security of supply better exchange and further market integration could reduce the required subsidy leveks by (a) inducing more competition and (b) reducing the absolute levels of additional capacity needed.

Hence, while market coupling theoretically increases market efficiency, issues such as market design or other regulatory interventions have a significant impact on the performance of market coupling. Therefore, it is important to align the different existing national regulatory frameworks across Europe or to set up a new *common* framework altogether.

While levels of wholesale market concentration have generally decreased across Europe, a major benefit of further market integration would be the increased level of competition in European electricity markets. Based on simulations published by ACER (2012), the CWE region alone has achieved gains from trade worth more than 250 million Euros in comparison to isolated national markets now. Major trade gains are still left unrealized, however, between Italy and France (about 19 million Euros per year), Germany and Sweden (about 10.5 million Euros per year) and the Netherlands and Norway (about 12 million Euros per year). Significant gains can also be expected from increasing transmission capacities between Spain and France as well as between Sweden and Poland.

The different support schemes for renewable energies have induced major inefficiencies if viewed from a European perspective. Most importantly, since all support schemes only support renewable energies *within their own national territory* massive gains from trade and from market integration are foregone. These gains from trade could easily result, as climate and weather conditions vary heavily across and even within Member States. For example, conditions for wind power are typically superior in Northern Europe while the conditions to produce solar-based electricity are much better in Southern Europe. Hence, enormous gains from trade could be realized by focusing on solar power in Southern Europe and on wind energy in Northern Europe. However, since almost all RES support schemes (with the particular exception of Sweden and Norway) are based on national frontiers so that only domestic production is supported, these benefits are foregone, resulting in according inefficiencies. A cautious calculation reveals that the efficient allocation of solar energy plants between Germany and Spain alone would have resulted in additional electricity worth about 740 Million Euro within a single year. Additional savings could easily be generated by considering (a) more countries than just these two and (b) considering other technologies such as wind.

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