The integration of European electricity markets – Achievements to date and way forward

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Abstract

The European model for electricity markets has been shaped by successive legislations and reforms driving some convergence of design. The initial focus in the 1990s was on creating an integrated market fostering efficient cross border trade and competition. Significant benefits were achieved thanks to the gradual market integration process which culminated with the network code process and the Clean Energy Package. However, changing policy priorities in the 2000s with the emergence of climate change and security of supply concerns have led to a revival of national uncoordinated state and regulatory interventions. European electricity markets have therefore in recent years evolved toward hybrid markets with a number of new building blocks including: i) support mechanisms for clean technologies; ii) capacity mechanisms addressing security of supply concerns; and iii) new planning processes to coordinate generation and grid development. These national and uncoordinated interventions have had in turn a number of side effects on the market functioning and raise the question of the need for further coordination of policies and governance to foster or even preserve market integration at the European level if the policy interventions are here to stay.

Key Words: Electricity market, liberalisation, market design, integration.

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I. INTRODUCTION

Energy has been at the core of the European integration project since the beginning, with the creation in 1951 of the European Coal and Steel Community (ECSC) - an organisation of six European countries aiming at regulating their industrial production under a centralised authority. But until the end of the 1990s, most electricity and natural gas industries in Europe were national and organised around monopolies. In the late 1990s, the European Union and the Member States decided to open these markets gradually to competition. The first liberalisation directives (First Energy Package) were adopted in 1996 (electricity) and 1998 (gas), to be transposed into Member States' legal systems by 1998 (electricity) and 2000 (gas).

More than twenty years after the start of liberalisation of national electricity industries started, the integration process remains incomplete. There have been significant achievements in removing barriers to cross border trade, and liberalisation had delivered benefits in a range of countries to consumers. However, the progress has been slowed by the technical challenges associated with integrating markets with different designs and governance approaches. This partly results from the choice that was made not to impose a standard market design at the beginning, but instead to try and ensure gradual convergence of different market designs by gradually tightening the rules to drive further convergence through the harmonisation of some of the technical rules affecting cross border trade.

Moreover, in the past decade, a change in policy objectives with the emergence of concerns related to security of supply, and policy commitments to fight climate change, has created new challenges for European power markets integration. National policies have not been coordinated and led to a number of new market features being introduced in a non-coordinated way, such as support mechanisms to support the development of clean technologies and capacity mechanisms to ensure security of supply. This created the challenge of driving further market integration while some of the underlying policies and the governance remain largely shaped at a national level. The 2018 clean energy package marks another step toward technical convergence but also shows the limits of further market integration absent further coordination of energy and climate policies.

This paper aims to contribute to the existing literature by providing a review of the drivers and tensions that have been shaping the difficult progress towards liberalisation and integration of European power markets. The paper is organised in four sections:

- I first describe the initial drivers and approach for market liberalisation and integration across Europe which started in the late 1990s. I show how the process has been driven by successive European legislations driving further coordination on a set of technical market rules despite the diverging starting points in terms of market organisation across countries, which culminated recently with the network codes and the 2018 Clean Energy Package;
- I then argue that the changing policy focus in the late 2000s with the focus turning on security of supply and climate change mitigation as created new challenges for European power market integration. A revival of national uncoordinated policy interventions has gotten in the way of further market integration and led to a range of new approaches being explored for market design across Europe; I also show how the changes in the dominant technologies costs structure and generation patterns has led to a shift in focus toward the improvement of the design of markets close to real time;
- The paper argues in the third section that the European power market model is evolving toward a hybrid approach mixing liberalised markets with state interventions introducing a number of new market building blocks to drive investment choices and support clean technologies. I argue that such hybrid approach takes different forms across Europe and is largely shaped by the differences in the national policies and governance.

- I conclude by exploring the challenge in the next years to preserve and deepen the benefits of integrated markets and argue that the key to unleash further market integration and further benefits for consumers lies in the coordination of some of the underlying policies and governance issues as a prerequisite to further market integration.

II. THE GRADUAL APPROACH TO DRIVE CONVERGENCE OF EU ELECTRICITY MARKETS

The initial steps of EU electricity market liberalisation

Prior to 1996, EU electricity markets were dominated by a few incumbent domestic monopolists vertically integrated from generation, transmission, distribution to retail. Customers of these utilities had no ability to switch suppliers and cross border trade was controlled by the bilateral monopolists setting cross border tariffs and allocating cross border transfer capacity. The only example of zonal cross-border trading was the NordPool market between Norway, Sweden, and later Finland.

Three European legislative packages, in 1996, 2002 and 2009 have been adopted in order to achieve a liberalised internal energy market, from national electricity systems to an integrated European electricity market. The successive legislative packages opened markets to competition through the unbundling of supply, generation and networks, and through the market access to third parties. The directives also promoted cross border markets.

The 1996 Directive (96/92/EC) initiated the opening up to competition of generation, retail, as well as transmission and distribution systems. By the end of 1999, all generation would be either subject to free entry into a wholesale market arrangement or competitively procured by a single buyer under a tendering procedure. Access to transmission and distribution systems would be subject to negotiated or regulated third party access. And finally, competition was introduced in the retail sector with customers representing 1/3 of demand allowed to choose their retail supplier. Accounting unbundling was introduced with transmission and distribution businesses having to produce separate accounts. This first directive offered arrangements with different degrees of competition allowing reluctant MS reformers to begin their reform procedure.

The EU member states liberalised their industries without much coordination on the initial market design. As a result, a patchwork of approaches emerged. Figure 1 identifies the key differences in approaches for the key building blocks shaping the electricity market design across Europe, including the forward, day ahead and intraday market design. This lack of harmonisation of the underlying key buildings blocks contributed to making the cross-border integration of these different markets challenging. In hindsight, one may wonder why there was not greater focus on ensuring some harmonization of the different market building blocks as a pre-requisite to market integration.

The 2003 Directive (03/54/EC) went further in the wholesale and retail competition and forced slowly reforming countries to catch-up with leading countries (see Jamasb and Pollitt, 2005). By the end of 2007, all generation would be subject to wholesale market arrangements, all access to transmission and distribution systems would take the form of regulated third party access, and all retail customers could choose their retail supplier, competing with one another to acquire customers. Unbundling of vertically integrated transmission and distribution businesses becomes legal. All cross-border trade would be subject to regulated third party access.

Figure 1: Key differences in the building blocks of the electricity market design across EU countries

	Ireland	ES, PT, IT	Nordic, CWE	GB
Forward Market	• No meaningful forward market	• Financial forward market	• Financial and physical forward markets	• Mainly physical forward market
Day Ahead	• Central dispatch • Traded volumes/ prices not firm • Locational bidding	• Quasi-mandatory day-ahead auction • Locational bidding	• DA auction with strong market support • Portfolio bidding	• No particular significance of DA • Portfolio bidding
Intraday	• D-1 gate closure • No intraday market	• Intraday auction slots • H-4 gate closure or more	• Continuous trading • H-1 gate closure (or less being considered)	• Continuous trading • H-1 gate closure

Source: Own analysis

The attempt to define a European 'target model'

Whilst national electricity markets reformed and became more competitive (though with significant differences across countries), the integration of markets into a single electricity market had made little progress. In 2004, the European Commission developed a set of proposals to support what became the 'target model'[3] with the aim of gradually integrating markets through a system of market coupling allowing energy traders to implicitly bid for grid capacity through their energy bids instead of bidding in two separate auctions. Under market coupling, available transfer capacity is declared to markets and power can be traded between both markets with flows going from low priced market to high priced market with transmission constraints arise (see Pollitt, 2018).

In 2005, the European Commission launched an energy sector competition inquiry following concerns of inefficient cross border transfer capacity and more broadly of lack of market integration (European Commission, 2007). The inquiry concluded that the slow progress in the single electricity market was the result of insufficient interconnecting infrastructures, inefficient allocation of existing capacities as well as incompatible market design between TSOs and spot market operators (Meeus and Belmans, 2008).

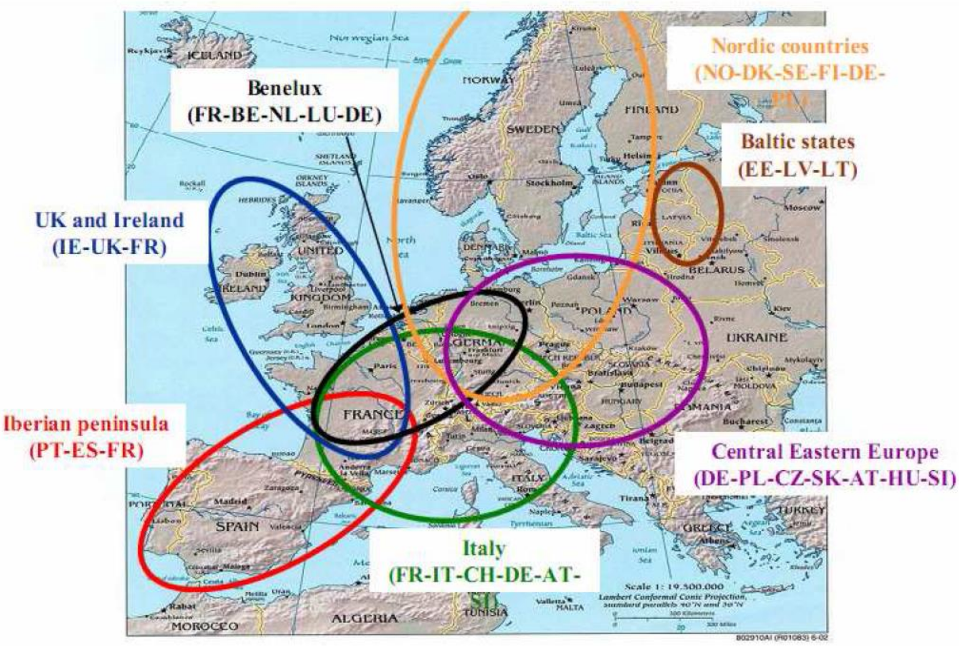
As a result of the energy sector competition inquiry in 2005 the third electricity single market directive was introduced. The 2009 Directive (09/72/EC) enforced greater competition within the electricity sector strengthening the unbundling requirements on transmission businesses and also established a pan-European regulatory agency for electricity and gas (Agency for the Cooperation of Energy Regulators - ACER) responsible for cross-border competition.

In parallel, the Third Energy Package fostered the development of a more bottom-up market integration process through the creation of the Regional Initiatives and other, independent regional integration projects (such as the Trilateral Market Coupling). Figure 2 describes the 7 key regional initiatives. These regional initiatives have had mixed successes in driving regional market integration.

[3] See Moffatt Associates (2007) and European Commission (2011).

One key achievement has been the implementation of market coupling on a regional basis which is further developed in the next section.[4]

Figure 2: The seven Regional Initiatives



Source: Everis and Mercados (2010)

The latest developments to drive further technical convergence: the Network Codes and the Energy Market Regulation

The development of network codes and guidelines has been a key element in the achievement of an internal energy market in the Third Energy package. A European market design grew out of the drafting of the first EU grid codes co-developed by the ENTSO-E, ACER, and the Commission through the EU regulation approval process named the “Comitology Process”. These codes are a detailed set of rules pushing for the harmonisation of previously more nationally oriented electricity markets and regulations. A total of eight network codes and guidelines entered into force by the end of 2017:

- Grid connection related network codes which provide a set of connection requirements for all parties connecting to transmission networks (including generators, demand customers and high-voltage direct-current - HVDC - connections). There are three network codes from the grid connection area: Network Code on Requirements for Generators (NC RfG), Demand Connection Network Code (NC DCC) and Network Code on HVDC connections (NC HVDC).
- System operation related network codes which define common pan-European operation standards for the existing and future European electricity system in response to an increasing penetration of renewable energy generation and a greater interconnection between transmission systems in Europe: Operational Security (SO GL), and Emergency & Restoration (NC ER).

[4] Market coupling in wholesale power markets uses implicit auctions in which players do not receive allocations of cross-border capacity themselves but bid for energy on their exchange. The exchanges then use the Available Transmission Capacity (ATC) to minimize the price differences between two or more areas. In so doing, market coupling optimizes the interconnection capacity and maximizes social welfare. This process increases price convergence between market areas, eliminates counter-flows. Price differentials send a price signal for investments in cross-border transmission capacities.

- Market related codes which outline the main features of a pan-European electricity market to promote effective competition, minimize risks for all parties and give incentives for market players to act in a way that supports an efficient operation of the system. They provide rules for calculating cross-border capacity and operating the markets in different timeframes. Three network codes from the market area focus on the Capacity Allocation & Congestion Management (GL CACM), Forward Capacity Allocation (GL FCA) and Electricity Balancing (GL EB).
  The network code CACM plays a fundamental role in setting transparent conditions for fair access to cross zonal capacity. This code is at the centre of Europe's market coupling development and progress towards a single market for electricity.

The 2018 Clean Energy Package introduces a second generation of network codes with an extended scope to focus areas such as demand response including aggregation, energy storage, and demand curtailment rules, and also empowers the Commission to adopt certain network codes as delegated acts depending on their area of focus (third party access rules, and network connection rules for example).

The Clean Energy Package made up of four Directives and four Regulations was adopted in June 2019 with the underlying objectives of promoting energy efficiency, achieving global leadership in renewable energies, and providing a 'fair deal' for consumers. The new Directive on common rules for the internal market for electricity (EU) 2019/944, and the new Regulation on the internal market for electricity (EU) 2019/943 amend existing energy legislation in a number of areas with the objective to remove some of the barriers to efficient market functioning and cross border trade.

III. THE NEED TO RECONCILE MARKET INTEGRATION WITH CHANGES IN POLICY PRIORITIES AND TECHNOLOGIES

The changes in policy priorities that affected the electricity liberalisation process

Whilst in the late 1990s and early 2000s, European policy efforts focused on creating the regulatory framework and common rules for the internal market in electricity, the focus of European energy policy in the mid-2000s turned onto the environment, as EU leaders set in March 2007 a set of targets for a low-carbon economy, which then was implemented through a set of Directives in 2009 often referred to as the "Climate and Energy Package". These targets, known as the "20-20-20" targets, set three key objectives for 2020: i) A 20% reduction in EU greenhouse gas emissions from 1990 levels; ii) Raising the share of EU energy consumption produced from renewable resources to 20%; iii) A 20% improvement in the EU's energy efficiency. As part of the 2011 discussions on a 2050 Roadmap, EU leaders committed to reducing Europe's greenhouse gas emissions by 80-95% by 2050 compared to 1990 levels.

In the late 2000s, security of supply also came back to the forefront of the European energy policy agenda. The Russian-Ukrainian gas crisis of January 2009 which led to supply disruptions in several member states reminded Europeans of their dependence on imported gas and revived discussions on both a common approach toward energy supplies from external countries and a strengthened set of criteria for ensuring security of energy supplies within the internal market. More recently, the 2014 Russian-Ukraine dispute and the discussions on gas supplies have revived concerns about security of imported gas supplies in Europe. In response to the political crisis in Ukraine, the European Commission released in May 2014 a communication defining a new EU energy security strategy.[5]

Finally, the 2009-2009 economic crisis also brought a new dimension into the European energy policy trilemma: policy scrutiny about the cost of some of the climate and green policies intensified, and concerns have grown that the uncontrolled deployment of low carbon technologies could both undermine European's economic competitiveness and raise concerns about security of supply. The Green Paper "A 2030 framework for climate and energy policies" (COM(2013) 169, 27/03/2013) represents an inflexion point in European energy policy that clearly heralds competitiveness and affordability as one of the key issues for the years to come.

The emergence or re-emergence of environmental objectives, security of supply and competitiveness concerns led to a new context for the liberalisation and further integration of European power markets. These trends indeed market a profound shift as creating a competitive liberalized internal market was not an end objective in itself anymore, but should instead serve the other policy objectives – namely ensuring the safe and affordable supplied of energy to European citizens, and working towards the long term decarbonization objective.

In concrete terms, these new policy objectives led policy makers to intervene in electricity markets via a set of national uncoordinated policy interventions which got in the way of further market integration and led to a range of new approaches being explored for market design across Europe. These approaches are further explored in section 4.

The changes in the dominant technologies and impact on short term markets

Another fundamental change in context that affected the European market liberalisation process in recent years is the emergence and policy support for low carbon technologies, which have both a different cost structure and production patterns compared to the thermal plants that historically shaped the dynamics of European power markets. The issue of the interaction of the support mechanisms and policies of these clean technologies with the market is discussed in the next section.

The theory for electricity market liberalization was indeed developed in the early 1980s in a different technology context from today, when thermal plants (either cola, gas, fuel oil or nuclear) were dominant. These dominant technologies presented significant variable costs and were dependable. In contrast, all low carbon technologies – renewables, nuclear, batteries, carbon capture and storage – are essentially fixed costs technologies, as the investment costs represent a large charge of the total generation costs.

The theory underpinning competitive power markets is based on the fundamental principles of the peak load pricing approach. Market participants bid their short run marginal costs (SRMC), and fixed cost are recovered through: i) inframarginal rents as technologies with higher SRMC clear the market and set the power price, and ii) scarcity rents when the market is tight and prices go beyond the SRMC of the technology clearing the market. Whilst in theory marginal cost pricing can still work with a part of the generation mix having zero or very low SRMCs, prices have become more volatile as the share of renewables increases. This has led for instance in some European countries to the emergence of negative of zero power prices in some periods, triggering a debate on the need for further market reforms.

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5 European Commission Communication. "European Energy Security Strategy", COM(2014) 330 final, Brussels, 28.5.2014.

This market paradigm worked well to induce competition between technologies with significant variable costs, but the growing shares of variable fixed costs renewables in European markets led to adaptations of the market design to reflect the changes in the technology costs structure and production patterns associated with the growth of clean technologies. In particular, the development of variable renewables reinforces the need to reward operational flexibility as well as dependability on short time frames, both for flexible power plants and demand side response. The value of short term operating flexibility is typically captured through intraday and ancillary services, and there has been growing focus in the past years and in the recent Clean Energy package on addressing the market design issues that distort short term prices signals in real time.

Indeed, concerns have emerged in recent years that European power markets do not convey the proper scarcity value of operating flexibility in many countries, calling for revisiting the current arrangements for intraday trading and ancillary service procurement. Intraday exchanges remain indeed limited in most member states. In addition, there are also concerns with the current arrangements for balancing and reserve procurement in many countries which are not always procured by system operators on a competitive and transparent basis; and even where competitive auctions for the procurement of these products are in place, these are often based on long term contracts and the lack contestability and/or liquidity of such short term products makes it difficult to reflect the fast evolving value of these short term balancing services to the system.

This recent focus on short term markets represents a significant shift, as European power market integration efforts had primarily focussed in the 2000s on ensuring efficient cross border trade via day head markets, which culminated with the toll out European wide of day ahead market coupling. Most countries are indeed exploring ways to improve their balancing and ancillary services mechanisms, driven both by the network code harmonization process and the need to improve the market design to integrate growing shares of renewables.

IV. THE STATUS QUO: ASSESSMENT OF THE SINGLE MARKET BENEFITS

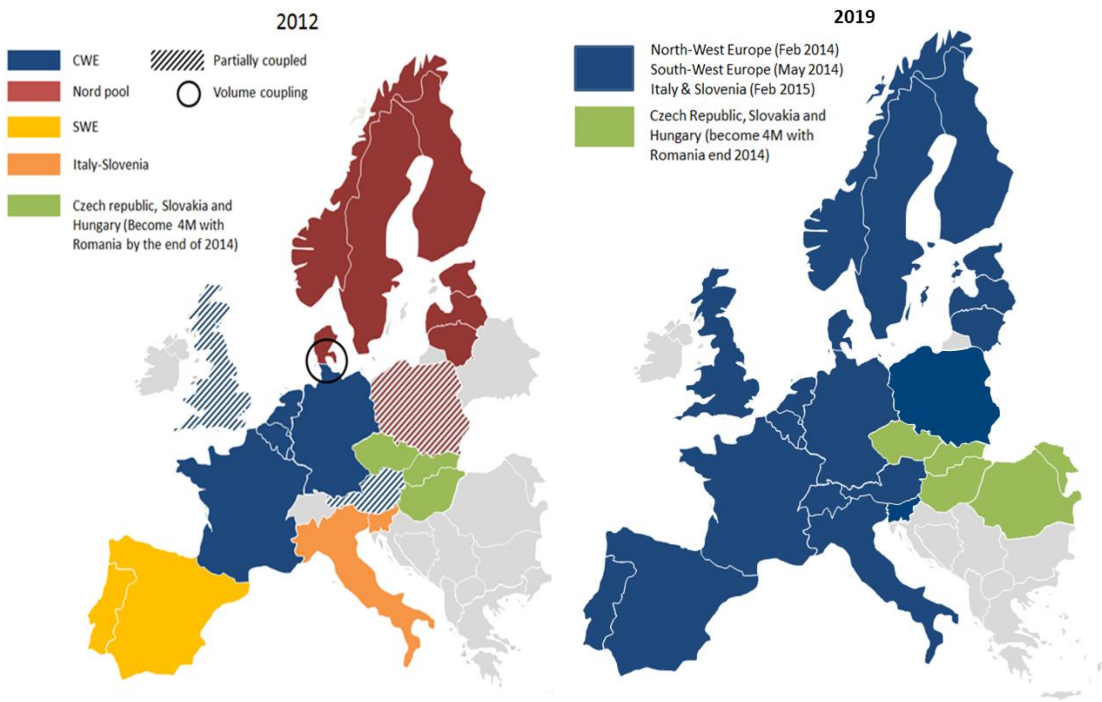
Assessing the economic effects of the liberalisation and integration of European power markets is challenging as some of the effects will only be felt in the long term. Politt (2018) provides a thorough literature review which shows strong evidence of positive benefits. The scope of this paper does not allow a comprehensive assessment, and I concentrate on some of the key indicators of market integration, namely wholesale and retail price convergence, before discussing the potential for significantly greater gains that remain though deeper market and infrastructure integration.

Market coupling and the efficiency of cross border trade

The successive legislative packages have contributed to the gradual integration of national markets. Trading of electricity across national borders went from 6% in 1976 to nearly 14% of electricity produced in the ENTSO-E area in 2015 (ENTSO-E, 2017). this has been driven both by further market integration and the development of interconnections.

The main success story of the European push for electricity market integration is the implementation of day ahead market coupling. At the end of 2019, market coupling had risen to cover most of Europe. Figure 3 illustrates the progress with day ahead market coupling implementation across Europe.

Figure 3: Progress with market coupling in Europe



Source: own analysis

Day-ahead market coupling has made significant progress with 27 countries representing 90% of European electricity consumption involved in market coupling. Intraday coupling has witnessed a slower progression due to complexities linked to technical issues, as well as market design and governance. However, recent progress has been made with the signing of the Intraday Operational Agreement by 26 countries (ENTSO-E, 2019).

Progress on the day-ahead market coupling has resulted in an improvement of the efficiency of interconnector, i.e. available commercial capacity used from low to high price areas, from 60% in 2010 to 86% in 2017. Intraday efficiency is lower at 50% although this is expected to improve with the new Single Intraday Coupling platform introduced in 2018. (ENTSO-E, 2019).

However, analysis from the pan-European regulator ACER shows that further gains could be realized if market coupling was extended to remaining borders (€203m per year of potential gains). The regulator also notes that in some selected areas, only 50% of intraday capacity is allocated in the right direction, i.e. from low to high price areas (ACER/CEER, 2017).

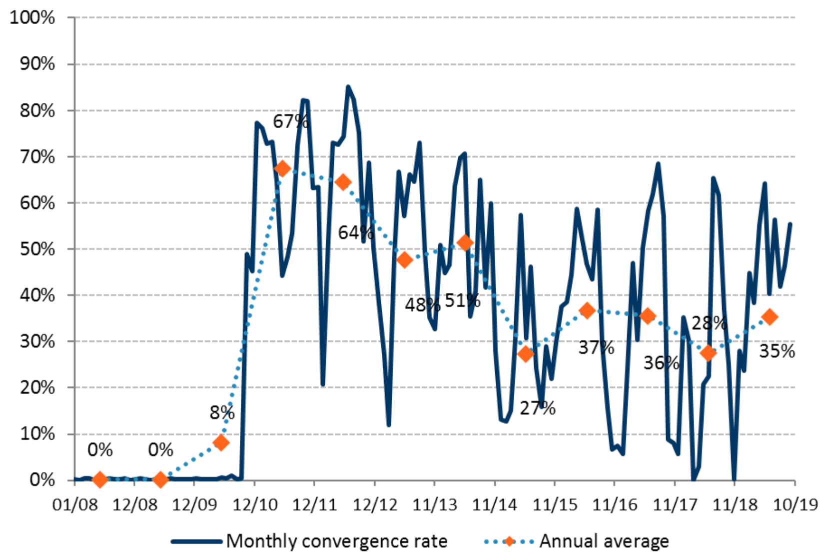
Wholesale market price convergence

Wholesale price convergence is an indicator of the progress of market integration achieved through market coupling and interconnection. After implementation of market coupling, regional price convergence started to increase, with levels reaching 60% in 2011 in the Central Western European (CWE) area whilst other areas such as the Baltics or South Western European (SWE) still experienced very low levels of price convergence (ENTSOE, 2019).

However, whilst the historical trends show that price convergence has been increasing overall across Europe, there remain significant variations in the levels of price convergence across those regions. In the Baltics, price convergence reaches 80% in 2017 thanks to an increase in the interconnection capacity, while the CWE region shows levels around 40%.

Worryingly, the growing penetration of renewables has led to a decrease in price convergence in some of the regions. Figure 4 illustrates the decrease in price convergence in the CWE region compared to earlier years with large price differentials during winter seasons when there are significant amounts of wind power generated in Germany. This decrease of price convergence in the CWE region is a result of the bottlenecks created by insufficient interconnection size that leads to more frequent price divergences.

Figure 4: Convergence rate between French and German day-ahead prices



Source: Own analysis based on data from EPEX

Note: Convergence rate is the percentage of hours where price difference is lower than €0.01/MWH

Retail prices: significant differences remain

The European Commission measures the standard deviation of retail electricity prices in the EU member states through quarterly reports. Retail prices still remain largely heterogenous across Europe, in particular for retail electricity prices.

Those retail prices mainly differ due to the growing weight of energy taxes and levies, as well as network charges. Cities where the highest retail prices for households are observed are Berlin and Copenhagen (32.3 and 30.0 c€/kWh respectively) where energy taxes accounted for approximately a third of the final bill (European Commission, 2019).

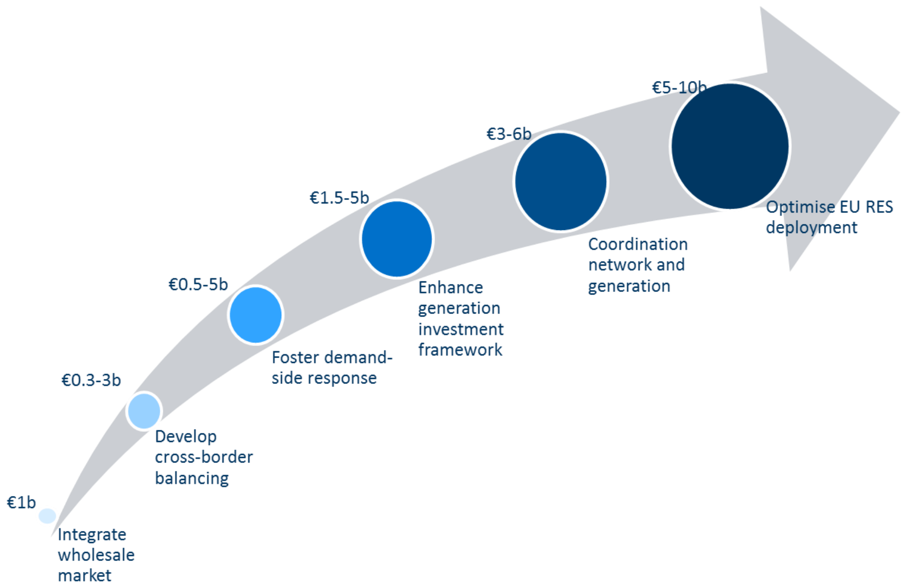
Potential for larger gains from further market integration and coordination of infrastructure

The impacts of the single market have been estimated in a study by Booz & Company (2013) carried out for the European Commission, which was later published by Newbery et al. (2016). Booz & Company's study found that the benefits of integration due to market coupling could be up to €4bn per year if markets were fully coupled. The study suggests that much larger benefits could be expected if market coupling of interconnectors was extended to intra-day trading of electricity, balancing services and financial transmission rights.

Newbery et al (2016) estimates a similar range of long-term potential benefits coming from short-term trading and balancing benefits, which would represent a 100% increase of the current gains from trade over the interconnectors. The paper stresses the policy implications of those estimated benefits, which should be used to compensate interconnector owners in order to incentivize them to make the necessary investments to increase interconnection capacity.

In addition, there are significant potential economic gains associated with a more coordinated approach toward the planning of investment in key energy infrastructures. Figure 5 is based on a large survey of the academic literature, and shows the expected financial gains associated with different types of coordination measures at the European level. Figure 5 demonstrates that greater economic gains could be achieved via European coordination of the deployment of network infrastructure, as well as greater coordination of investments in generation – including RES development across Europe, instead of having national policies and targets.

Figure 5 - Orders of magnitude of the potential gains associated with different types of reforms (EU wide, billion €/year)



Source: Own analysis based on survey of academic literature and expert interviews

V. WHAT NEXT - TOWARD A NEW TARGET MODEL?

The evolution toward 'hybrid markets' with state and regulatory interventions

As discussed in the previous section, the initial market model has evolved to take into account the changes in policy objectives and European electricity markets are today 'hybridised' with various forms of regulatory intervention. Finon and Roques (2017) have studied how the revival of public interventions in electricity markets is driving a transformation of the standard historical approach of competitive market design towards a hybrid regime that combines planning and long-term arrangements established with public or regulated entities on one side, and short term "organised markets" on the other side.

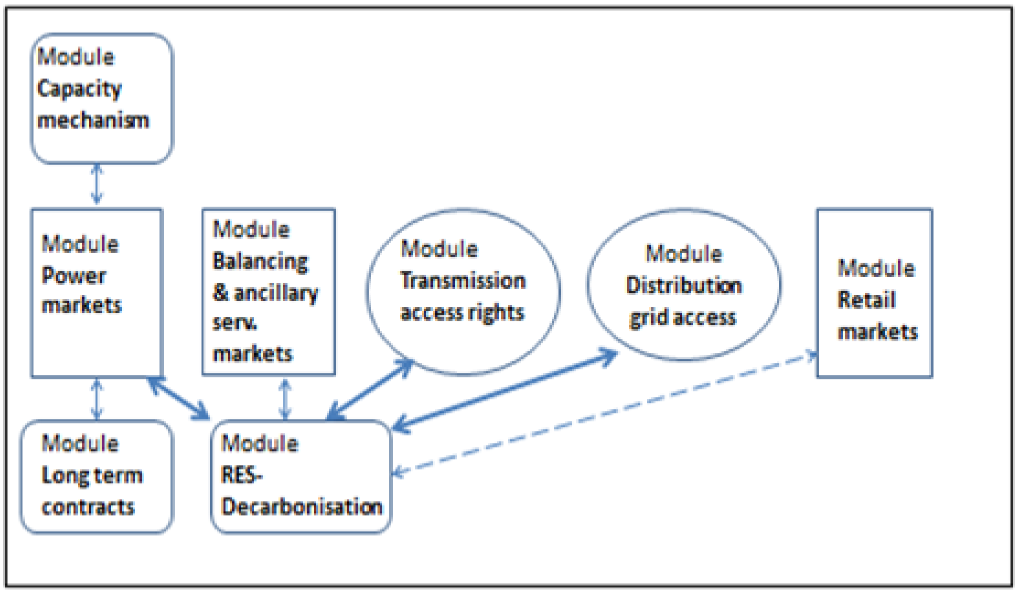
The primary motivations for public intervention comprise three drivers that have recently attracted attention in most European countries:

- the need to overcome the perceived market failures that undermine investment in sufficient generation capacity to satisfy growing load needs and maintain security of supply;
- the determination of part of the generation mix through support for the clean or low carbon technologies; and
- system planning to optimise generation and transmission system development.

Following on the seminal analysis of Glachant and Perez (2009) which provide an institutional framework to analyse the different modules in the electricity value chain, Roques and Finon (2017) analyse the "reforms of the reforms" of electricity industries which aim to correct the market and regulatory imperfections stemming from the initial market architectures and address the new policy objectives by introducing some new modules.

Roques and Finon (2007) explain that three different types of new modules are typically implemented to resolve these issues. The Long-Term Contracts module to support risk transfers and facilitate investment, the Capacity Mechanism module to guarantee security of supply and the RES-Decarbonisation module to drive the decarbonisation of the energy mix as described on Figure 6.

Figure 6: The initial electricity market modules and the three additional long-term modules in the hybrid market regime



Source: Roques and Finon (2017)

These new long-term 'out-of-market' building blocks are designed to add a remuneration to the revenues from the energy markets, to guarantee the recovery of fixed costs and to de-risk investment via some risk-sharing arrangements between producers and consumers, while some of them make it also possible to subsidise production in the long-run for the new technologies. However, this raises the issue of the consistency of these new elements with the initial wholesale market building blocks, and their subsequent evolution.

These policy and regulatory interventions have in turn had significant impacts on electricity European markets and further undermined the ability of energy market prices to provide adequate coordination signals to market participants. Across Europe, policy interventions have for instance created a number of inconsistencies with the market arrangements, leading to merit-order distortions, system balancing challenges, insufficient valuation of the flexibility of resources, or the lack of coordination of generation and transmission system development. These inconsistencies, in turn, have lead to the adaptation of the former set of market rules, such that there is a switch from the initial "market regime" to a new "hybrid regime" is underway.

This marks a significant shift away from the initial theoretical textbook electricity market design that underpinned the liberalisation, in which investment decisions are made by market participants based on price expectations. In other words, the initial reforms were based on the belief that the market is able to assume both the short-term coordination between market players for the economic dispatching and the long-term coordination function between them for investing in generation so that an optimal mix and capacity adequacy can be achieved in a timely way.

In the next paragraphs, we describe in a more concrete way two sets of interventions for i/security of supply; and ii: support to clean technologies in European electricity markets; and the way in which these are affecting the market integration process and raise new market integration challenges.

Security of supply: the capacity mechanism module

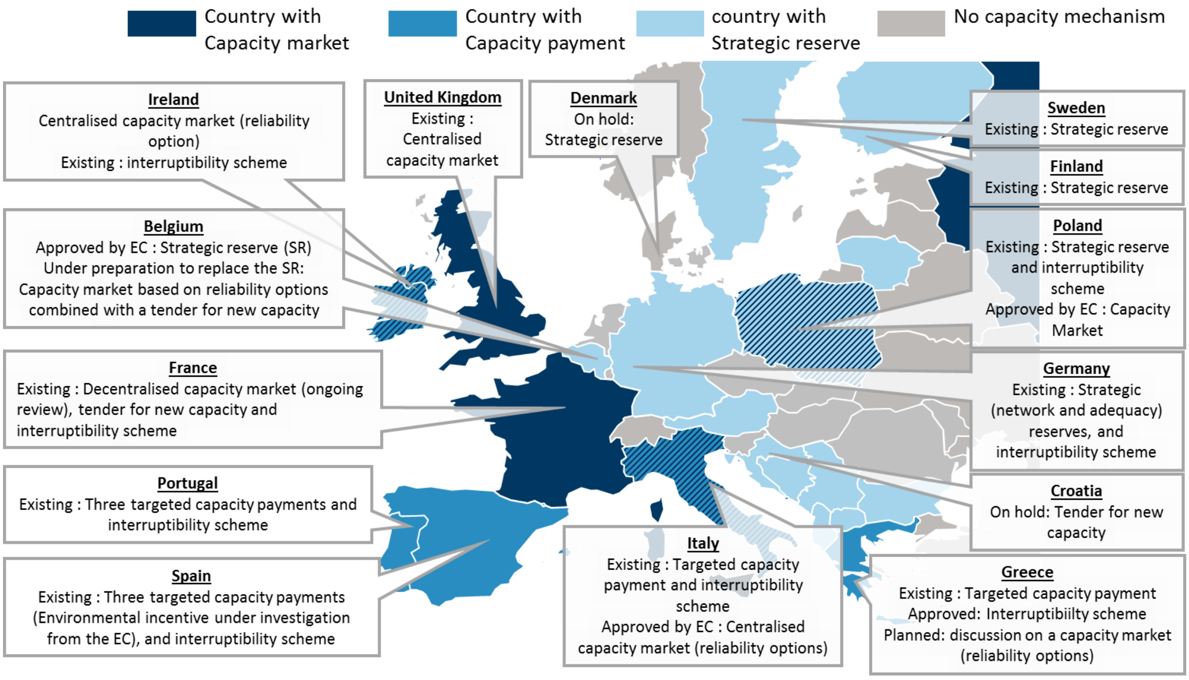
There is growing belief across Europe that the current markets cannot guarantee reliability of supply in every situation in the long-term, for various reasons including : 1) price caps and barriers to scarcity pricing (the so-called "missing money" issue); 2) aversion to risk associated with investing on the basis of uncertain revenues; 3) the difficulty related to hedging or transferring risk on a long-term basis (Cramton, Stoft, 2006; De Vries, 2007; Joskow, 2008b; Roques, 2008; Cramton, Stoft, 2014; Keppler, 2016). This issue is exacerbated by the development of variable renewables which amplifies price volatility in peak and creates greater uncertainty for annual sales by peaking units (Cramton, Ockenfel, Stoft, 2013).

Fundamentally, the origin of the resource adequacy problem lies in two issues: 1) a market imperfection, which entails the absence of price-reactive demand – at least for the time being for a large part of consumers until smart meters are deployed and time varying tariffs become widespread; and 2) the willingness of policymakers to define an administrative SoS criterion that may differ from the socially optimal one.

In parallel to the reforms addressing market imperfections, most European countries have also introduced a capacity remuneration mechanism (CRM). There is a wide range of options – strategic reserves focused on some existing or specific new units, regulated capacity payment, capacity obligation on suppliers, forward capacity auctioning, reliability options auctioning -- with different attributes in terms of effectiveness, market power mitigation, cost efficiency and risk management. The scope of this paper does not allow a comparison of these mechanisms, which are well-covered in the literature.[6]

[6] The respective advantages and drawbacks of the different CRMs are compared in several publications (Cramton and Stoft, 2006; De Vries, 2007; Roques, 2008; Finon and Pignon, 2009; Cramton et al., 2013; The Brattle Group, 2012, 2014).

Figure 7: Implementation of capacity mechanisms increased in Europe



Source: Roques, F. (2019). "Counting on the neighbours: challenges and practical approaches for cross-border participation in capacity mechanisms". Oxford Review of Economic Policy, Volume 35, Issue 2, Summer 2019, Pages 332–349.

Figure 7 shows that most countries have taken steps to introduce or reform a capacity mechanism, using different approaches. The result is a patchwork of different national capacity mechanisms which could undermine the further integration of European electricity markets.

I have explained in previous publications (see e.g. Roques, 2018) that the drivers of capacity mechanisms across Europe are different depending on the country considered, such that it is unlikely that a common approach at the Europe level will be practical or even suitable.[7] But I explained that there would be merits in working toward some degree of coordination in order to minimize the potential distortions associated with different capacity mechanism approaches.

- A framework for cross border participation in capacity mechanisms has started to emerge as part of the Clean Energy package but will need to be developed further in the coming years. I list below a number of preliminary steps that would be necessary prerequisites for the coordination of capacity mechanisms across borders:
- A critical first step for a coordinated approach across European countries consists in defining explicit reliability standard criteria in each country and ensuring their consistency (e.g. loss of load expectation or target reserve margin);
- Regional coordination of TSOs is necessary to define a common methodological framework for resource adequacy assessment, as well as to define common certification and verification procedures for plants and demand response that will participate in capacity mechanisms across borders. This requires at minimum, a common registry of plants and other resources,

[7] Roques, F. (2018). "Counting on the neighbours: Challenges and practical approaches for cross border participation in capacity mechanisms". Oxford Energy Review, in press.

as well as common approaches to certify and verify the availability of plants in line with the definition of the capacity product.

- Most importantly, TSOs will need to develop on a regional basis a common coordination framework, including operational rules, to deal with situations of joint system stress across borders. At time of capacity shortage in one or two countries, there need to be clear rules and corresponding operational practices in place to ensure the physical delivery of energy according to the commercial contracts that have been signed.

The Green agenda – toward a new market model to support investment in clean technologies

There is a large literature that investigates the need for out of market support mechanism to support investment in clean technologies, in addition to the implementation of a carbon price (Neuhoff et al., 2007, Grubb et al., 2007; Boot, 2010; Grubb and Newbery, 2008; Newbery, 2011; Finon, 2011; Finon and Roques, 2009, 2013). These mechanisms therefore can have a double function to both subsidize the deployment of immature technologies in their infant phase, and to support de-risking for the more mature ones to facilitate investment. The scope of this paper does not allow revisiting this literature in details, and we focus instead on the later issue, that is the role of some form of long term arrangements to de-risk investment in clean technologies.

As the clean technologies mature and become competitive, the role of the support mechanisms that took the form of long-term arrangements changes and concentrates mainly on the de-risking necessary to facilitate financing of capital-intensive technologies, rather than providing a higher revenue level that what these technologies would earn in the market. Across Europe different countries have in the past years revisited the first generation of support mechanisms for renewables by e.g. phasing out feed in tariffs and Green Certificate schemes and are replacing these with a range of arrangements contributing to reducing the investment costs by securing revenues in the long term, whilst introducing completive pressure, often via the auctioning of long term contracts.

As a result, the new market model that seems to emerge in most European countries features competition in two steps, with 'completion for the market' in the form of tenders for longer term contracts followed by 'competition in the market' based on the set of short-term markets, as described on Figure 8.[8] The readers interested into the international experience and lessons on such markets organized competition in two steps are referred to Roques (2015).

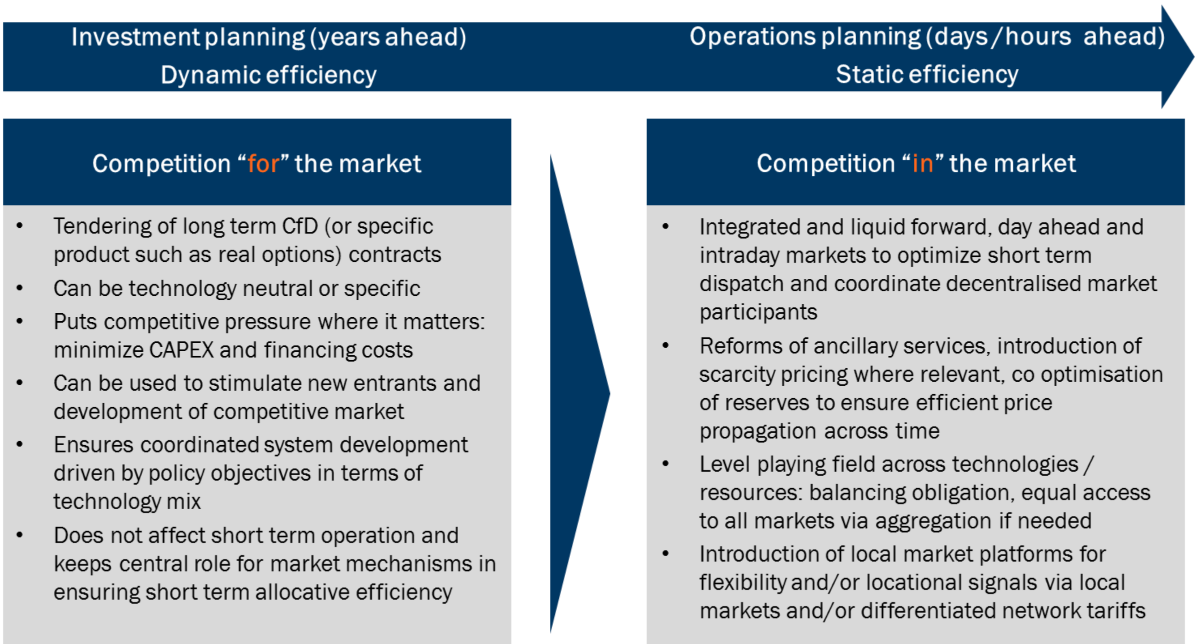
The first step 'competition for the market' involves the tendering of long-term contracts based on the technology and infrastructure indicative planning processes at national or ideally in the future regional and Europe levels. Long term commitments help facilitate investment and financing of low carbon as well as storage and other flexibility resources. The tendering of long-term contracts concentrates competition on the investment decision, which is the most important cost minimisation driver for capital intensive technologies.

Such long-term contracts and auctioning processes typically involve different products depending on the local electricity system needs, and there is currently a great diversity of approaches across Europe. One key issue if to ensure that these contracts are designed in a way that does minimize any potential distortions of the markets. Going forward, a new European market model could emerge which would coordinate and harmonize the types of contracts and their interface with the market. I provide further

[8] For greater details, please see Fabien Roques (2015). FTI-CL Energy study "Toward the Target Model 2.0". Available at https://www.fticonsulting.com/fti-intelligence/energy/research/eu-power-gas-markets/toward-the-target-model-2

details in Roques (2019) on the necessary steps and conditions for the emergence of such new market model.

Figure 8: The emergence of a two-step market design with competition "for the market" followed by competition "in the market"



Source: Fabien Roques (2015). FTI-CL Energy study "Toward the Target Model 2.0".

VI. CONCLUSION

Twenty-five years after the start of liberalisation of electricity markets in Europe, the European project to integrate electricity markets has reached a crossroad.

On the hand, there have been significant achievements in removing barriers to cross border trade, and the successive legislations have driven some degree of convergence in market design and improved trade efficiency - notably though the implementation of day had market coupling.

On the other hand, progress has been slowed down by the technical challenges associated with integrating markets with different designs and governance approaches. This originates in the initial choice not to impose a standard market design, but instead to try and focus on the harmonisation of some of the technical rules affecting cross border trade.

Moreover, I argued in the paper that the change in policy objectives in the past decade - with the emergence of concerns related to security of supply, and policy commitments to fight climate change - has created new challenges for European power markets integration. National policies have not been coordinated and have led to a number of new market building blocks being introduced in a national and non-coordinated way, such as mechanisms to support the development of clean technologies and capacity mechanisms to ensure security of supply. I also showed how the changes in the dominant technologies (i.e. variable renewables) cost structure and generation patterns have led to a shift in focus toward the improvement of the design of markets close to real time – in practice materializing through reforms of the intraday and balancing markets, as well as ancillary services to allow more efficient price formation at times of scarcity (so called “scarcity pricing”).

The last section of the paper then explored how the mechanisms implemented at a national level to support investment in clean technologies, and to keep security of supply (capacity mechanisms) are leading to the emergence of a new “hybrid market” model mixing liberalised markets with state intervention and long-term contracts. I showed that such hybrid approach takes different forms across Europe but presents some common features such as an organisation in two steps with ‘competition for the market’ via tenders of long-term contracts followed by ‘competition in the market’.

In conclusion, the main challenge had in the next years in order to preserve and deepen the benefits of integrated markets in Europe lies primarily in the coordination of the national policies driving interventions in markets as well as the associated governance issues. Further market integration in Europe requires as a prerequisite further coordination across neighbouring countries of the key policy decisions affecting the common energy market and deployment of critical infrastructures. To foster a stronger cooperation for policy and regulation, I have put forward in a recent study the concept of “policy regions”, based on a three-layer coordination forum involving both TSOs, NRAs, and a range of stakeholders at a regional and European level (Roques and Verhaegue, 2016).

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