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COUNTING ON THE NEIGHBOURS: CHALLENGES AND PRACTICAL APPROACHES FOR CROSS BORDER PARTICIPATION IN CAPACITY MECHANISMS

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COUNTING ON THE NEIGHBOURS: CHALLENGES AND PRACTICAL APPROACHES FOR CROSS BORDER PARTICIPATION IN CAPACITY MECHANISMS[1]

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Abstract

Capacity mechanisms have been implemented in an uncoordinated way by many countries in Europe in recent years to ensure security of supply. The European Commission has defined via the state aid guidelines principles to minimize their impact on trade and competition in European electricity markets. The paper identifies the different drivers of these national reforms, maps the key issues associated with the coordination of capacity mechanisms across countries, and explores alternative approaches to allow for explicit cross border participation in capacity mechanisms.

Key Words: Capacity Mechanisms, Generation Adequacy, Security of Supply, Cross Border Participation.

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I. INTRODUCTION

There is currently much debate about the need for and design of capacity mechanism in several European countries. Concerns about the ability of "energy only" electricity markets to provide adequate incentives for investment have grown and manage the pace of decommissioning of some of the plants needed to ensure the secure operations of the electricity system given the growth of variable renewable generation. Most European countries have thus taken steps to introduce or reform a capacity mechanism, using various approaches. The result is a patchwork of different national capacity mechanisms which interfere with the further integration of European electricity markets.

Capacity mechanisms have an impact on competition in the internal European electricity market. Some of these capacity mechanisms involve State aid, and the European Commission (EC) launched in 2015 a State aid sector inquiry into national capacity mechanisms (European Commission, 2015a). In its final report, the EC identified the openness of market-wide capacity mechanisms to foreign capacities as a key issue, given that the lack of cooperation and coordination may distort cross-border electricity trade and competition, and lead to increased market fragmentation (European Commission, 2016). As a consequence, the EC recommended that market-wide capacity mechanisms should be open to explicit cross-border participation – meaning that foreign capacity can directly bid in the capacity auctions. The aim is to minimise distortions to locational investment signals and ensure longer-term competition between the domestic and foreign capacity that both contribute to domestic security of supply.

In this context, the EC has since then systematically required has a pre-condition for approving under state aid rules the different national capacity mechanisms that Member States enable explicit cross-border participation. However, due to the complexity of implementing this solution, the EC allowed for transitory arrangements in the form of implicit contribution or explicit participation of interconnectors only. In the implicit participation model, the cross-border contribution is evaluated statistically and deducted from capacity target to be procured to ensure the security of supply. This transitory approach was adopted in Great-Britain, France and Italy.

In order to further improve the integration of European markets, the Clean Energy Package under negotiation seeks to better coordinate national capacity mechanisms. It provides that mechanisms other than strategic reserves shall be open to direct participation of cross-border capacity providers, and conversely that Member States shall not restrict capacity located in their territory from participating in other capacity mechanisms (European Commission, 2017). However, there is currently no existing model for the explicit participation of cross-border capacity providers in capacity mechanisms, and the issue is attracting much academic and practitioners' debate.

Whilst there is much research on the theoretical rationale for capacity mechanisms, there has been so far relatively little focus on the issue of cross-border participation in capacity mechanisms. Thus, the objective of this paper is first to review the state of play with the ongoing reforms on implementing capacity mechanisms in Europe, and to identify the drivers of the different approaches. Second, we focus on the impact of uncoordinated national approaches to the security of supply in the integration of Europe's power markets, and map the key issues associated with cross border participation in capacity mechanisms. We identify the prerequisites to a common approach for cross border capacity mechanism participation and conclude by providing a comparative assessment of different options for implementing cross border participation.

II. LITERATURE REVIEW

Most power markets in Europe were originally "energy only" markets, which means that there was no specific mechanism to remunerate generators for their availability during peak hours or when the system is tight. This is grounded theoretically in the "Peak Load Pricing Theory", according to which marginal pricing can provide fixed cost recovery for investment based on the scarcity rents that all power producers earn when the system is tight (see Boiteux 1949, 1951, Steiner, 1957, Chao, 1983, Schweppe et al. 1988).

However, in practice for a variety of reasons (ranging from operational price caps to the political unacceptability of very high-power prices), power prices are not allowed to reach the theoretical value of lost load (VOLL), leading to a chronic shortage of revenue for plant operators. This is referred to as the "missing money" issue in the academic literature (See for instance Hogan, 2005, Joskow and Tirole, 2007, Joskow , 2008, Cramton and Soft, 2008, Cramton and Ausubel, 2010). A range of administrative procedures as well as market distortions such as price caps cause this rigidity of power prices.

The key issue, however, is that in the absence of active demand-side participation for load metered in real time, market participants have no way to express their value for power at various times. Many other market imperfections have also been mentioned in the academic literature, ranging from market participants short sightedness, risk aversion or the difficulty to hedge or transfer risks on a long-term basis, to argue for separate arrangements to guarantee security of supply (See eg. De Vries, 2007, Roques, 2008, Kepler, 2014).

Whist the theoretical rationale for the introduction of capacity mechanisms is well documented in the academic literature, there has been so far relatively little research on the specific European context and the drivers for implementation of capacity mechanisms in this context (see e.g. Finon and Pignon, 2008, or Batlle and Perez-Arriaga, 2007). In Europe, policy-driven renewables development aggravates the missing money issue because renewables are subsidised and drive down wholesale prices by crowding out those technologies with higher variable costs like coal and gas (see e.g. Cepeda and Finon, 2013, and Hach and Spinler, 2014). Our paper contributes to the literature by providing a comprehensive overview of the specific drivers of capacity mechanisms' implementation in different European countries.

In addition, the issue of coordinating capacity mechanisms and the possible approaches for cross-border participation has so far received little attention. The seminal literature focussed on the cross-subsidization effect of capacity built and paid for through the capacity mechanisms on one side of a border to export energy to the other side, which is often referred to as "capacity leakage" (see Creti and Fabra, 2007). Cepeda and Finon (2011) test the effect of heterogeneous designs between two interdependent markets with and without capacity mechanisms using a numerical simulation model and show that differences in market designs affect both price and reliability.

Furthermore, Finon (2014) considers that a capacity remuneration mechanism which excludes cross border participants would also have distortive effects on long term competition, as it doesn't capture the advantages of multi-system competition. More recent works such as, among others, Hawker et al.(2017), Ringler et al. (2017), and Roques et al. (2016), have supported these arguments. They suggest that the design of capacity mechanisms need to be coordinated with the possibility of cross-border participation in order to promote cross-EU trade and competition in electricity generation with investment signals for new generation capacity and interconnection coming from zonal electricity prices that reflect scarcity value.

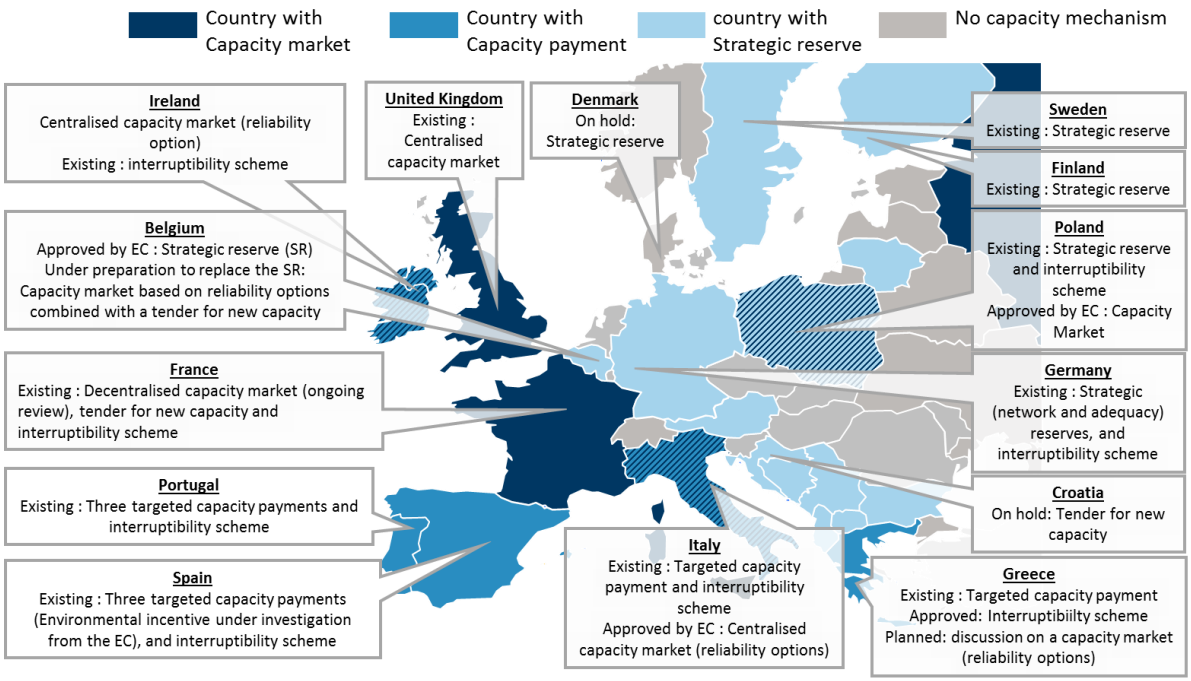
The potential benefits of cross-border participation materialise in several aspects that have been identified in these papers. On the one hand, there will be additional available capacity committed to a capacity mechanism, further ensuring cross-border security of supply. On the other hand, as enhanced generation adequacy reduced the occurrences of loss-of-load events, cross-border participation in a capacity mechanism can further reduce overall costs, and therefore improve consumer and social welfare.

Nonetheless, cross-border participation in capacity mechanisms raises a number of issues both from an economic and a legal point of view, which could lead to wonder what would be the best approach to take interconnection in account in capacity mechanisms - and whether forcing explicit cross-border participation of foreign entities is proportionate and efficient. Our paper complements this literature by focussing on the practical issues associated with the cross-border participation in capacity mechanisms in Europe and provides a qualitative evaluation of the pros and cons associated with different models. In this respect, the paper is directly relevant to the ongoing policy debate in Europe.

III. NATIONAL APPROACHES TOWARD CAPACITY MECHANISMS IN EUROPE: DIFFERENT DESIGNS FIT DIFFERENT NEEDS

Many governments in Europe have implemented or are considering the introduction of capacity mechanisms. There is a range of approaches for the design of capacity mechanisms, and different mechanisms are being put in place across Europe (Figure 1).

Figure 1 – Map of capacity mechanisms in Europe



Source: own analysis

A taxonomy of capacity mechanisms

The different capacity mechanisms can be grouped as follows:

- **Capacity payments** have been in place for several years, usually in less well interconnected markets in the periphery of Europe such as Spain, Ireland, Greece and Italy. The payments can be fixed or variable and are awarded to all or part of the eligible capacity declared or actually available. Italy recently decided to move to a capacity market but this has not yet been implemented, and reform discussions in Greece could lead to a change from the current approach, which relies on administratively setting capacity prices, toward a more market based approach.

- **Strategic reserves** of plants which are contracted by the system operator and remain out of the market have been in place in Sweden and Finland for a number of years, which are hydro-dominated and need to ensure the availability of enough capacity to meet demand in case of a dry year. In addition, strategic reserves have been implemented in Belgium and Germany as an interim solution.

- **Capacity markets** have been implemented in the UK, in France and are being implemented in Poland and Ireland. In the centralised UK approach, the TSO launches an auction several years prior to delivery and selects at least cost the resources to satisfy a target margin above projected peak load demand. In the French decentralised approach, each supplier has an obligation to meet the anticipated load of its customer portfolio augmented by a predefined security margin. The Polish capacity market is centralised, in the same way as the British scheme.

- **Reliability options** are being implemented in Italy and in Ireland, through a central auctioning. In such a design, the TSO auctions forward capacity options (contracts for difference), which give the holder right to reimbursement between the energy market spot price and strike price.

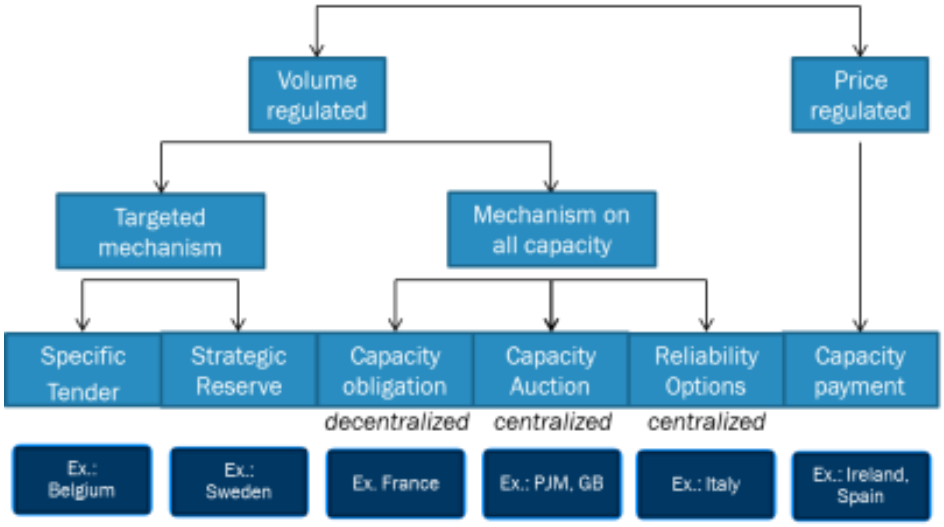
Whilst there is a range of approaches, a key difference relates to the competitive or regulated nature of the mechanism, namely whether it is a regulated approach or a market-based mechanism that determines the price of capacity. Furthermore, many specific implementation features may strongly influence the functioning of the mechanism and its relevance to address issues in different contexts. Capacity mechanisms differ on key aspects such as whether the mechanism is (Figure 2):

- **Price-based or volume-based**: in a price-based mechanism, policymakers set a price and let the market investment take into account this stimulus, whereas, in a volume-based mechanism, the capacity requirement is defined and a price will emerge through a market dynamic;

- **Centralised or decentralised**: contracts can be awarded centrally or though bilateral arrangements;

- **Market-wide or targeted at specific plants or technologies**: the mechanism can reward all capacities or only a subset of them.

Figure 2: Taxonomy of capacity mechanisms



Source: own analysis

Different drivers for capacity mechanisms explain the range of approaches

The patchwork of approaches across Europe for capacity mechanisms originates in different drivers for reform which depend on many country specific factors such as:

- Whether security of supply concerns are related to generation adequacy, to a local imbalance issue tied to network constraints, or to the issue of integrating intermittent renewables;

- The current and anticipated supply / demand balance, i.e. whether significant investment will be required or whether the key issue is to drive an efficient rebalancing of an oversupplied system and to manage stranded assets;

- The current and anticipated need for flexibility in the system, including the level of interconnection with neighbouring countries, the share of flexible generation such as hydropower, or the existence of demand response to manage the growth of intermittent generation.

- Local market arrangements and whether special design features such as price caps and / or constraints to scarcity pricing lead to a shortfall of revenues for existing units.

Table 1 summarizes the local issues related to security of supply in the five largest European countries and highlights the very different drivers of capacity mechanisms' implementation.

Table 1 – Local drivers of the introduction of capacity mechanisms

	FRANCE	GERMANY	UK	SPAIN	ITALY
Local specificities	Thermo sensitivity of power demand (electric heating) Growth of peak demand	Grid constraints in the South Nuclear phase-out Strong RES growth	Large retirements of thermal plants Limited interconnection Strong RES growth	Strong RES growth Limited interconnection	Internal zones and grid constraints Strong RES growth
Key issues	Peak demand growth Missing money for peaking plants Low profitability of some thermal plants	Capacity needs in the south Need for flexibility Low profitability of some thermal	Major investment needs ('capacity gap') Retirements driven by LCPD and IED Need for flexibility	Low profitability of CCGTs and significant coal retirements Need for flexibility / dependable resources	Low profitability of CCGTs Coordination of generation and network investment Need for flexibility
Main objectives of CM	Maintain generation adequacy Development of demand-response Robust to exercise of market power	Retain existing capacity in the south & drive new investment Ensure availability of flexible back-up generation	Maintain generation adequacy Drive new investment Ensure availability of flexible back-up generation	Incentivize availability and flexibility of existing plants Manage smooth rebalancing / avoid massive retirements	Incentivize availability and flexibility of existing plants Manage smooth rebalancing / avoid massive retirements

Source: own analysis

In some countries, the key threat to security of supply is one of meeting the anticipated growth of power demand and/or renewables. In other countries such as Germany, security of supply concerns originate in regional imbalances and network constraints.

Whilst the drivers of capacity mechanisms' implementation across Europe vary, explaining to some extent the difference in approaches, it is likely that in the future, European countries will face some similar challenges, such as integrating intermittent renewables and ensuring sufficient investment in flexible and dependable capacity. Looking forward, capacity mechanisms which were originally designed to address the generation adequacy and missing money issue will therefore need to evolve and take into consideration the growing impact of intermittent renewables on power market dynamics.

One key issue revolves around the nature of the capacity product, and recent discussions in Germany, Italy and Spain have focused on rewarded not just capacity but also the operating flexibility of power plants. Hogan (2012) describes the possible evolution of traditional capacity mechanisms into more sophisticated schemes rewarding 'capabilities'. The product

that is being traded is likely to change as the needs associated with system security evolve with the growing need of resources with specific flexibility attributes. Whilst the standard products have traditionally being defined based on the guaranteed availability the resources over certain periods of peak demand, in the future the capacity obligation also entails some flexibility requirements such as ramp rates or minimum stable load.

Capacity mechanisms in the wider context of EU power markets integration

Some of the key differences in the design of capacity mechanisms originate from the local specific electricity system and electricity market designs in different member states. In this context, the coordination and possible harmonization of capacity mechanisms should be thought of as part of the wider issue that is the definition of a common Target model for electricity markets in Europe.

The Third Energy package adopted in July 2009 marked a significant step in the integration of European power markets. It defined a process for the harmonization of some of the key building blocks of power markets, through the drafting of network codes and Framework Guidelines. The progress with the implementation of the Target Model, and in particular some of the Network codes, has been slow and illustrated the strong divergences that remain in the member states' approach to electricity makrut design.[3]

Looking backward, one of the key issues that has slowed down progress in European electricity markets integration is that there have been only been few efforts to harmonize power market design as a prerequisite to integration, which proved to complexify the definition of workable cross-border arrangements. This raises one fundamental question, how much harmonization of the key market design building blocks – including capacity mechanisms – is required as a prerequisite to further market integration?

In this respect, one could ask whether capacity mechanisms coordination is to be assessed in a different way from the coordination of the other electricity market design building blocks, given the it touches on the security of supply issue which remains a national issue. Given the different drivers of capacity mechanisms across Europe, it is indeed unlikely that a common approach at the European level will be practical without significant political integration as a prerequisite on the issue of security of supply.

However, there are be merits in working in the meantime toward some degree of coordination in order to minimize the potential distortions associated with different capacity mechanism approaches. The next section addresses this issue. The European Commission has used competition policy and the state aid framework to ensure some degree of coordination and convergence in capacity mechanisms justification and design. The 2014 state aid guidelines contained some specific provisions on capacity mechanisms (EC, 2014), and the Sector Inquiry on Capacity Mechanisms (EC, 2016) provided a comprehensive assessment of the different types of capacity mechanism and a framework for assessing combability with EU state aid rules. more recently, the Clean Energy Package provides some more prescriptive recommendations on the design of capacity mechanisms and cross border coordination (EC, 2018).

[3] For a thorough description of the different network codes please see ENTSO-E's Network Codes Website at http://networkcodes.entsoe.eu/.

IV. THE DIFFERENT APPROACHES TO TAKE INTO ACCOUNT CROSS-BORDER CONTRIBUTION

Whilst a common approach is unlikely to work for the reasons detailed in previous sections, there are some merits in driving some coordination in design and putting in place a framework for cross border participation in CMs in order to minimize potential distortions on the energy markets.

Indeed, interconnection contributes to domestic security of supply by giving consumers access to generation or DSR capacities abroad. If these connections are not taken into account properly during the planning process, there is a risk of overinvestment. This would create additional costs for consumers and lead to potential long-term distortions in the market.

Possible models for cross border participation in capacity mechanisms

In theory, different approaches could be envisaged to take into account the contribution of interconnection to security of supply in the capacity mechanism country (Table 2):

- **No contribution**: neither interconnectors nor foreign capacity can contribute to domestic adequacy assessments. Most countries with CRMs follow this approach.
- **Statistical contribution**: foreign capacity contributions are evaluated statistically and deducted from the capacity target, but the capacity itself is not formally included in the mechanism.
- **Interconnector participation: interconnectors are able to participate directly in capacity mechanisms**.
- **Foreign capacity participation**: foreign capacity providers themselves can participate directly in capacity mechanisms.
- **Cross-border capacity mechanism**: capacity mechanisms cover several countries or zones, or alternatively national CRMs may be coupled.

Table 2 – Models to take into account cross-border contribution

Approach	**No contribution**	**Statistical contribution**	**Explicit participation via interconnectors**	**Explicit participation of foreign capacity**	**Cross-border capacity mechanism**
Does the interconnectors / foreign capacity provides contribute to the foreign capacity mechanism?	Neither interconnectors nor foreign providers contribute	Contribution evaluated statistically and deducted from capacity target	Interconnector participates directly in capacity mechanism	Foreign capacity providers participate directly in capacity mechanism	Capacity mechanisms cover several zones OR national capacity mechanisms are "coupled"

Example of countries using this approach	This applies to most countries with capacity payment mechanisms (price based)	Initial /default approach in Europe for initial CRMs.	Solution adopted in GB	This has been implemented in the PJM capacity market; implemented in 2019 in France and later in other EU countries (Poland, Italy, etc.)	No current international examples (though zonal capacity mechanism exists in PJM and proposed in Italy

Source: own analysis

In practice, looking at the European state of play as of mid-2019, there are only few examples of cross-border participation in CMs. In Great Britain (GB), the capacity mechanism has allowed, since its 2nd year of operation, for interconnections to participate directly in the auction. The French capacity mechanism takes into account the contribution of interconnection through a reduction of the capacity to be procured by obliged parties and an explicit framework for cross border contribution has just been implemented. Poland and Italy are in the process of implementing explicit cross border participation. The German grid reserve allows for Austrian generators to participate in the Grid Reserve. This is made possible insofar as there is no commercial congestion between Germany and Austria.

Assessment of models for cross border participation

There are several factors to consider when assessing the impact of any cross-border coordination of capacity mechanisms. These factors include, but are not limited to, their efficiency, their likelihood of achieving security of supply, their impact on markets and on competition, their effect on incentives for investment, their complexity and their compatibility with State Aid guidelines.

The cross-border capacity mechanism appears to be the most efficient solution in theory as it fosters competition and efficiency in procurement. It allows participants to optimise the level of contracted capacity, and it facilitates an efficient use of cross-border capacity. However, it is highly complex to implement as it requires first to agree on the implementation of capacity mechanisms and to harmonise, at least to a certain extent, capacity mechanism designs and operational coordination. Due to this complexity, and as discussed in the previous section the lack of an integrated framework to deal with security of electricity supply, the cross-border capacity mechanism solution appears unlikely in the short-term, so any of the other options (except for 'no contribution') should be considered, and the one which is to be used should depend on the various trade-offs and on the specifics of the two neighbouring markets.

Explicit foreign participation should be an efficient solution, but it raises some complex implementation issues which have been discussed in the previous section. Guaranteeing the contribution of cross-border capacity to security of supply is difficult, and there may need to be distortions to energy markets to be successful. These distortions would be limited to the rare occurrence of coincidental scarcity, but they can still raise major issues of political

acceptance, especially as these mechanisms aim to address situations of scarcity over the long term. Thus, there is a trade-off between the benefits of securing the contribution of cross-border capacity and the potential distortions caused by interventions in energy markets. Explicit foreign participation would be most suitable in countries with similar capacity mechanisms designs and philosophies.

Of the other approaches, direct interconnector participation would be most suitable when cross-border participation capacity is limited. This approach would incentivise development of new interconnection lines, especially in a merchant framework. Consequently, when incentives for cross-border capacity investment are not critical and no capacity mechanism is implemented in the neighbouring countries, statistical contribution can still be useful as it is a simple approach which can be efficient if calculated correctly. While it may not provide the long-term investment incentives that are needed, this issue can be partly addressed by TSO regulation.

V. KEY ISSUES ASSOCIATED WITH EXPLICIT CROSS BORDER PARTICIPATION IN CAPACITY MECHANISMS

In its 2014 State Aid Guidelines the European Commission (2014) recommends that European countries ensure cross-border participation in their national capacity mechanisms. More recently, the European Commission has gone further and recommended the direct cross-border participation of foreign capacities as the privileged approach. More recently, the European Commission has strengthened the conditions for approving the state aid eligibility of capacity mechanisms: the Regulation of the European Parliament and of the Council on the Internal Market for Electricity provides some more prescriptive recommendations requiring that an explicit cross border participation framework be put in place (EC, 2018).

This raises a number of challenges a technical, economic and legal perspective which are reviewed in the next subsection.

Prerequisites for cross border participation in capacity mechanisms

A number of preliminary steps can be identified, which would be necessary prerequisites before outlining a coordination of the capacity mechanisms themselves.

- **Define explicit reliability standard criteria and ensure a consistent approach for adequacy assessment**

A critical first step for a coordinated approach across European countries consists of defining explicit reliability standard criteria in each country (e.g. loss of load expectation or target reserve margin) and ensuring a consistent approach for adequacy assessments. Many countries do not have an explicit security of supply standard, but rather rely on engineering principles to evaluate the necessary investments to upgrade or reinforce networks. Moreover, the indicators used are different in nature (e.g. target reserve margin versus a target probability of lost load), raising the issue of the harmonization of criteria and approaches used to derive them. European TSOs have been working as part of ENTSOE to spread best practice in terms of forward adequacy assessments (ENTSOE, 2014). The ENTSOE Ten Year

Development Plan released every other year by ENTSOE have shown some convergence as ENTSOE has developed a common approach for adequacy assessments.

One of the key steps forward of the Regulation of the European Parliament and of the Council on the Internal Market for Electricity is that it requires ENTSOE to define a common framework for defining a reliability criteria as well as a common approach for the adequacy assessment in the different European countries (EC, 2018). This does constitute a first important step toward integration of the dimensioning of resource needs at the supra national level.

- **Develop a legislative and operational framework to deal with situations of joint scarcity**

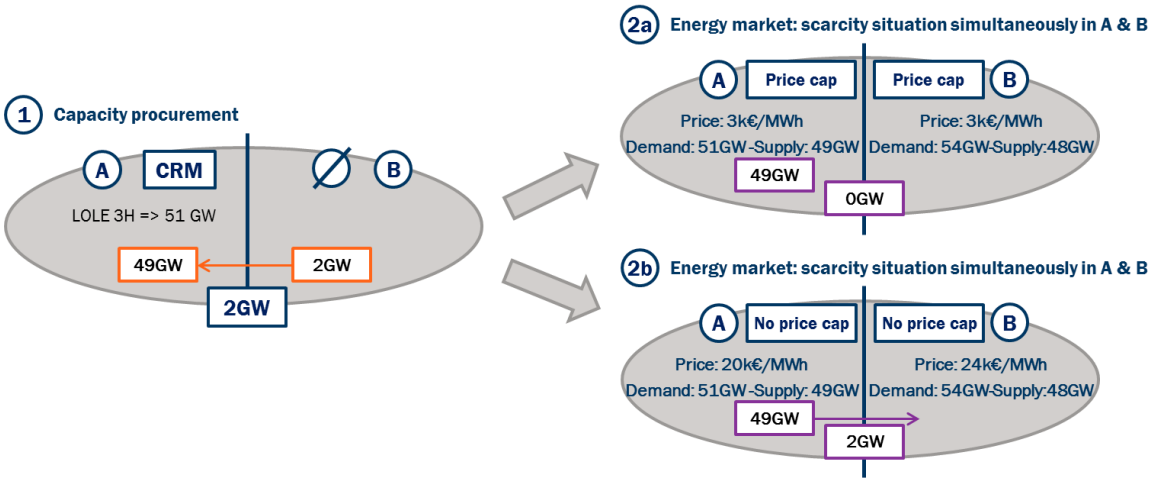
Most importantly, TSOs will need to develop on a regional basis a common coordination framework, including operational rules, to deal with situations of system stress. At times of capacity shortage in one or two countries, there needs to be clear rules and corresponding operational practices in place to ensure the physical delivery of energy according to the commercial contracts that have been signed. Directive 2005/89 requires Member States to ensure that curtailment of supply in emergency situations is based on predefined criteria related to the management of imbalances by transmission system operators and are taken in close consultation with other TSOs. However, it does not specify what such an emergency framework should look like, other than stating that Member States should not take discriminatory measures and should respect the requirements for a competitive internal market (European Commission, 2005).

Figure 3 hereafter shows that energy market functioning does not ensure that capacity contracted abroad benefits CRM country supply. The left-hand side of the figure shows that Country A has introduced a capacity mechanism, whereas Country B has not. This capacity mechanism contracts a total of 51 GW, 49 GW of which comes from country A while 2 GW comes from Country B, maximising the 2 GW de-rated capacity of the interconnector. In this scenario, Country A is paying to guarantee its supply, in part through cross-border capacities. However, without interventions in the functioning of energy markets, Country A is not able to rely on these cross-border capacities when Country B is in a scarcity scenario.

- In the first scenario, shown in the top-right part of the above diagram (2a), both Country A and B are experiencing energy scarcity, and both have harmonised price caps of €3,000/MWh. There is load curtailment in both countries due to excess demand, and because there is no price differential, there are no cross-border transfers of energy. Country A has not been able to rely on the 2 GW of contracted capacity.

- We also present a scenario without price caps. In the second scenario (2b), Country A is worse off. In this illustrative example, the price is higher in Country B because demand in B is higher, and energy market rules lead to transfers of energy from Country A to Country B. These transfers are equal to the interconnector's capacity of 2GW. In this scenario, curtailment in Country A rises during times of coincidental scarcity. Capacity contracted abroad through the CM does not help it secure supply.

Figure 3 : Illustration of coincidental scarcity in neighbouring countries



Source : own analysis

In other words, without specific rules or controls over capacity contracted abroad, particularly in times of scarcity, cross-border participation in capacity mechanisms is not necessarily beneficial. To overcome the issue highlighted on Figure 3, two alternatives may be implemented. Either TSOs would have to agree on operational arrangements, backed by Member States, to modify flows determined by market functioning and "export load shedding". Alternatively, financial penalties could be introduced in case of non-delivery, or the interconnector capacity could be de-rated down to zero if the risk is not deemed negligible, but this implies that consumers would then not benefit from the contribution of interconnection to security of supply.

- **Develop a regional governance approach for cross border participation via an expanded role for regional service providers**

The issue of ensuring that capacity contracted abroad benefits the capacity mechanism country supply is further exacerbated in a flow-based market coupling environment: De-rating, delivery and control become more complex as it is difficult to trace which country's generators provide their power. Where flow-based is implemented, this tends to require either a statistical approach within the national CRM, or for a coordinated mechanism at the regional level.

In any case, all these preliminary steps require close collaboration of TSOs and regulators, and a practical way forward would be to set up regional task forces. Whilst the EU-wide process led by ENTSOE should continue, regional approaches have proven to be a successful way to find pragmatic solutions, and TSOs have a long history of working with their neighbours. Indeed, many of the key drivers for introducing capacity mechanisms are similar on a regional basis, and the creation of the Regional Initiatives (RIs) have proven to be an efficient "bottom up" alternative for market integration compared to the more EU driven top-down process.[4]

[4] See e.g. "From Regional Markets to a Single European Market", Everis and Mercados (2010).

In the Clean Energy package, The European Commission highlights the importance of regional coordination and suggested that Regional Security Coordinators could play a growing role in the years to come. In a study for ENTSOE, Roques and Verhaeghe (2016) identified a number of tasks that regional service providers to TSOs could play in addition the different services that they already provide today, including :

- RSCs could perform generation / flexibility adequacy analysis for TSOs at the regional levels, focusing on key regional issues and going into more details than ENTSO-E ;
- Given the changes in system needs, flexibility adequacy assessment could also be integrated in the analysis: not only would the RSC would consider generation adequacy at peaks, but it would also look at a number of situations where the system might be at stress due to the lack of downward resources, of inertia sources, or of flexible capacity for instance; Even though they might not be sufficient as such, these analyses could contribute to establish the need (or not) for capacity mechanisms;
- In addition, RSCs could contribute to TSOs additional analyses in the context of implementing capacity mechanisms cross border, e.g. to set up parameters of possible capacity mechanisms.

- **Put in place common certification and verification procedures to determine the actual contribution to security of supply**

Another important issue is the necessary collaboration of TSOs to define common certification and verification procedures for plants and DSM that will participate in capacity mechanisms across borders. In practice, exchanging capacity between countries raises several implementation issues, such as : How to certify the foreign capacity ? How to make sure the foreign capacity is comparable to internal capacity and provide the same product / service to security of supply ? And what happens in the case of scarcity in both countries ? Certifying capacity in a foreign country implies either that the national certification body – usually the TSO – may operate in the foreign country, outside its "jurisdiction", and have access to all necessary information ; or that a strong coordination is put in place with the neighbouring TSO. This requires for instance a common registry of plants and other resources, as well as common approaches to certify and verify the availability of plants in line with the definition of the capacity product.

Given that the contribution to security of supply depends both upon interconnector capacity and on foreign generation capacity, a process is needed to evaluate and reward both contributions. On the specific issue of de-rating interconnector capacity, it is worth investigating the different types of risks associated with interconnectors' availability. These risks include: i) operational failure due to a technical fault, i.e. the risk that a fault in the interconnector prevents the flow of electricity to the CRM country in times of stress; ii) market risk due to coincidental scarcity, i.e. the risk that the connected market has insufficient surplus energy in excess of its own demand, higher energy prices, and so does not export energy to the CRM country; and iii) market risk due to market failure, in case prices do not correctly reflect scarcity, and electricity does not flow to the CRM country in a scarcity situation. While the operational risk is similar to the availability of risk of a domestic power plant and is straightforward to evaluate based e.g. on historical availability, the two other types of risk are harder to quantify and are beyond the control of the interconnector operator.

Options for interconnection capacity access in the case of explicit participation

In energy markets, as cross-border capacity between Member States is limited, congestion management mechanisms need to be put in place to allocate interconnection capacity between market participants in the most efficient manner. Similarly, in case of direct participation of foreign generators in capacity mechanisms, interconnection capacity allocation should be implemented, to allow for cross-border trading of capacity.

A range of possible approaches are possible, with pros and cons :

- The reservation of cross-border capacity (such as in the US markets) would withdraw capacity from the market especially when additional imports would be valuable and necessary in the capacity mechanism country, to allow for out-of-market exchanges. Such an approach would have a detrimental impact on the energy market, on security of supply and on overall efficiency, whereas similar concerns in terms of acceptability of scheduling exports to the capacity mechanism country when the neighbouring country is in scarcity situations. Moreover, the legality of this approach in Europe could be questioned, as TSOs are supposed to maximise the interconnection capacity which is made available to the market.
- The acquisition of transmission rights, allocated by TSOs for cross-border trading of energy, does not appear to be an efficient solution either. It would have in practice limited impact on effective cross-border flows because, close to real-time, flows are scheduled based on the market prices' differences, and so it would not guarantee the effective contribution of foreign capacity, even if the nomination of these rights was compulsory.
- TSOs could allocate specific products for capacity trading ('tickets'), independent of the wholesale energy market, thus avoiding any interference with the market. Interconnections would get additional revenues, which should in theory reflect the split of value between foreign generation/DR capacity and interconnection capacity. Conceptually, the tickets should be priced at the difference between the (marginal) capacity price in the CM country and the (marginal) capacity price in the neighbouring country.

The analysis of the different options leads us to think that the acquisition of specific interconnection products for capacity trading ('tickets') as the most suitable approach. The allocation of these tickets for capacity trading could follow similar principles as the allocation of transmission rights for energy trading. They could be allocated through :

- Explicit auction of tickets. Foreign capacity providers would first participate in an auction to acquire tickets. The revenue of the ticket auction would accrue the total revenues of the interconnection. Successful bidders would then participate in the foreign capacity market.
- Implicit auction of tickets. Foreign capacity providers would participate directly in the CM auction but, when the market clears, they will get the marginal capacity price of the foreign generation/DR capacity. The price difference between this price and the clearing price of the capacity market would be attributed to the interconnection.

VI. CONCLUSIONS

Capacity mechanisms are being introduced or reformed in different member states in Europe as many market players and most policy makers believe that the current market and regulatory arrangements are unlikely to provide adequate investment incentives. This results in a patchwork of approaches which raises concerns about the potential impact of uncoordinated capacity mechanisms on the integration of European energy markets.

This paper contributes to the literature by analysing the local drivers for the implementation of capacity mechanisms in Europe, in order to understand if a common or coordinated approach would be possible. The analysis showed that the drivers vary depending on : i) the local electricity system needs (i.e. whether the key issue is one of investment need, of local network constraints, or of intermittency management); ii) the local electricity market arrangements and whether special design features such as price caps and / or constraints to scarcity pricing lead to a shortfall of revenues for existing units.

It follows from these differences that a common approach at the European level, i.e. a harmonized capacity mechanism, is unlikely to work, and that the effort should focus on ensuring the coordination and cross border contribution across neighbouring countries' capacity mechanisms to enhance efficiency and minimize potential distortions. Moreover, given that the drivers for the implementation of capacity mechanism are often shared on a regional basis, a regional approach toward capacity mechanisms would make a lot of sense. Key design choices could be gradually harmonised, with a minimum requirement that they be volume-based, market-wide and have a consistent product definition. A regional approach would lead to cost reductions through coordination of capacity assessments and through 'sharing' of capacity, which would lead to reduced amounts of contracted capacity and thus help avoid overinvestment.

The paper then focused on the different practical models of cross border participation and we identified a number of alternative approaches, and concluded that the explicit cross border participation would be the most practical way forward in the European context. The paper then identified the necessary prerequisite steps to the implementation of coordinated capacity mechanisms as well as initial thoughts on how to take into account cross-border contribution to generation adequacy. We identified the need to : i) define a common methodology to establish explicit reliability standard criteria; ii) use a common methodological framework for resource adequacy assessment (ENTSOE work underway for both); iii) define common certification and verification procedures for plants & DSM by harmonizing TSO's practices; and iv) develop a regional governance cooperation framework, including operational rules, to deal with situations of system stress.

Bibliography:

[1] ACER (2013), "Capacity remuneration mechanisms and the Internal Market for Electricity". Available at:

http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/CRMs%20and%20the%20IEM%20Report%20130730.pdf

[2] Batlle, C. and I. J. Perez-Arriaga (2007). Design criteria for implementing a capacity mechanism in deregulated electricity markets. Utilities Policy 16 (2008).

[3] Boiteux M. (1949), "La Tarification des demandes en point : application de la théorie de la vente au coût marginal.", revue Générale de l'Electricité 58 (August) : 321-40.

[4] Boiteux M. (1951), "La Tarification au coût marginal et les demandes aléatoires.", cahiers du Séminaire d'Econometric 1 : 56-59.

[5] Cepeda, M. and D. Finon (2011). Generation capacity adequacy in interdependent electricity markets. Energy Policy 39(2011)3128–3143.

[6] Cepeda, Mauricio and Dominique Finon (2013). How to correct for long-term externalities of large-scale wind power development by a capacity mechanism? Energy Policy 61(2013)671–685.

[7] Chao H-P. (1983). Peak-Load Pricing and Capacity Planning with Demand and Supply Uncertainty, Bell Journal of Economics 14(1)(Spring): 170-90.

[8] Cramton P. and Ausubel L. (2010), "Using Forward Markets to Improve Electricity Market Design" *Utilities Policy* 18 (2010): 195-200. Available at: http://works.bepress.com/cramton/167

[9] Cramton P. and Stoft S. (2008). Forward reliability markets: less risk, less market power, more efficiency." Utilities Policy (16): 194-201. Available at: http://works.bepress.com/cramton/18/

[10] Creti, A. and N. Fabra (2007). Supply security and short-run capacity markets for electricity. Energy Economics, 2007, vol. 29, issue 2, pages 259-276.

[11] De Vries, L.J. (2007). Generation adequacy: helping the market do its job. Utilities Policy 15 (1), 20-35.

[12] ENTSOE (2014). ENTSO-E Target Methodology for Adequacy Assessment, 14 October 2014, https://www.entsoe.eu/Documents/SDC%20documents/SOAF/141014_Target_Methodology_for_Adequacy_Assessment_after_Consultation.pdf

[13] European Commission (2005). Directive 2005/89/EC concerning measures to safeguard security of electricity supply and infrastructure investment. 18 January 2006. Available at:

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005L0089&from=EN

[14] European Commission (2014). "Guidelines on State aid for environmental protection and energy 2014-2020". Available at:

http://ec.europa.eu/competition/sectors/energy/eeag_en.pdf

[15] European Commission (2015a). Commission Decision of 29.4.2015, initiating an inquiry on capacity mechanisms in the electricity sector pursuant to Article 20a of Council Regulation (EC) No 659/1999 of 22 March 1999. C(2015) 2814 final. http://ec.europa.eu/competition/sectors/energy/decision_on_sector_inquiry_en.pdf

[16] European Commission (2015b), Communication Launching the public consultation process on a new energy market design, Brussels, 15.7.2015, COM(2015) 340 final

http://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v11.pdf

[17] European Commission (2016), Final Report of the Sector Inquiry on Capacity Mechanisms {SWD(2016) 385 final}.

[18] European Commission (2017). Clean Energy for All Europeans - European Commission. Proposal for a regulation of the European Parliament and of the Council on the internal market for electricity – Chapter IV on Resource Adequacy, Article 21 on Cross-border participation in capacity mechanisms.

[19] European Commission (2018). Regulation of the European Parliament and of the Council on the Internal Market for Electricity" (recast), ST 5070 2019 INIT. available at:

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_5070_2019_INIT&from=EN

[20] Everis and Mercados (2010), From Regional Markets to a Single European Market. Available at

http://ec.europa.eu/energy/sites/ener/files/documents/2010_gas_electricity_markets.pdf

[21] Finon D. et V. Pignon (2008), Electricity and Long−Term Capacity Adequacy, The Quest for Regulatory Mechanism Compatible with Electricity Market, Utilities Policy 16 (2008).

[22] Finon D. (2014). Capacity Mechanisms and Cross-Border Participation: The EU Wide Approach in Question. CEEM Working Paper, available at: https://hal.archives-ouvertes.fr/hal-01687454/document

[23] Hach, D. and S. Spinler (2014). Capacity payment impact on gas-fired generation investments under rising renewable feed-in — A real options analysis. Energy Economics (2014) – In press.

[24] Hawker, G, K Bell and S Gill, 'Electricity Security in the European Union (2017). The Conflict between National Capacity Mechanisms and the Single Market. (2017) 24 Energy Research & Social Science.

[25] Hogan W. (2005), "On an "Energy Only" Electricity Market Design for Resource Adequacy.", retrieved from

http://www.hks.harvard.edu/fs/whogan/Hogan_Energy_Only_092305.pdf

[26] Hogan, William (2012). What Lies "Beyond Capacity Markets"? Delivering Least-Cost Reliability Under the New Resource Paradigm. A "straw man" proposal for discussion, issued August 14, 2012, available online at www.raponline.org

[27] Joskow P. (2008), "Capacity payments in imperfect electricity markets: Need and design.", Utilities Policy, 16(3): 159–170.

http://dx.doi.org/10.1016/j.jup.2007.10.003

[28] Joskow P. and Tirole J. (2007), Reliability and competitive electricity markets. The RAND Journal of Economics, 38(1): 60–84. http://dx.doi.org/10.1111/j.1756-2171.2007.tb00044.x

[29] Joskow, P.L. and R. Schmalensee. (1983). Markets for Power: An Analysis of Electric Utility Deregulation, Cambridge. MIT Press.

[30] Keppler, Jan Horst (2014). First principles, Market failures and endogenous obsolescence: the dynamic approach to capacity mechanisms. CEEM Working Paper 2014-8. Novembre 2014.

http://www.ceem-dauphine.org/assets/wp/pdf/CEEM_Working_Paper_8_Jan_Horst_KEPPLER.pdf

[31] Meyer R., and O Gore (2015). Cross-border effects of capacity mechanisms: Do uncoordinated market design changes contradict the goals of the European market integration? (2015) 51 Energy Economics 9.

[32] Neuhoff, K., J Diekmann, F Kunz, S Rüster, WP Schill and S Schwenen (2016). A Coordinated Strategic Reserve to Safeguard the European Energy Transition (2016) 41 Utilities Policy 252.

[33] Ringler, P., D Keles and W Fichtner (2017). How to Benefit from a Common European Electricity Market Design. (2017) 101 Energy Policy 629.

[34] Roques F. (2008). Market design for generation adequacy: Healing causes rather than symptoms, Utilities Policy, Elsevier, vol. 16(3), pages 171-183.

[35] Roques F., C. Verhaeghe, and G. Dezobry (2015). Different approaches for capacity mechanisms in Europe: rationale and potential for coordination? in "The Law & Economics of EU Capacity Mechanisms" edited by. L. Hancher, A. de Hauteclocque, and M. Sadowska, 2015, ISBN-10: 0198749252.

[36] Roques, F. and C. Verhaeghe (2016). Options for the future of Power System Regional Coordination, an FTI-CL Energy report for ENTSOE. Available at https://docstore.entsoe.eu/Documents/Publications/Position%20papers%20and%20reports/entsoe_fti_161207.pdf

[37] Schweppe F., Caramanis M., Tabors R. and Bohn R., 1988, "Spot Pricing of Electricity", Kluwer Academic Publishers.

[38] Steiner P.O., 1957, "Peak Loads and Efficient Pricing.", Quarterly Journal of Economics 71 (November): 585-610.