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National capacity mechanisms in the European internal energy market: Opening the doors to neighbours

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HIGHLIGHTS

- We discuss the regulatory basis for the effective participation of foreign agents in national CRMs.
- Stronger coordination among TSOs and respect for the Security of Supply Directive is required.
- A new type of firm cross-border nominations linked to the CRMs commitments should be introduced.
- These proposed nominations are to be considered only in situations of system stress.
- No ex-ante cross-border capacity reservation would be needed.

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ABSTRACT

After decades of strong opposition, several European countries are now in the process of implementing some kind of Capacity Remuneration Mechanism (CRM). Unfortunately, these national initiatives seem to aim at energy autarky rather than seeking a wider regional coordination. This situation can significantly affect the potential benefits of an integrated long-term expansion of the European power system.

In this paper the regulatory basis for the effective participation of foreign agents in national CRMs is discussed. The authors support that two pillars are required: (1) stronger coordination among TSOs[1] and respect for the Security of Supply Directive and (2) introduce a particular type of firm cross-border nominations associated to the CRMs commitments. These proposed nominations are to be considered only in situations of system stress. As discussed here, this allows not requiring any type of ex-ante cross-border capacity reservation, thus avoiding many of the inefficiencies associated to traditional physical bilateral contracts.

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1. Introduction

1.1. Caveat

The ultimate objective of regional integration of energy markets is to achieve a coordinated planning of generation and transportation infrastructures that allows to exploit as efficiently as possible the regional resources. Among other necessary preconditions, this implies that countries in a regional energy market accept to rely on neighbours at the moment of supplying their national demand. In order to establish confidence in the regional market, countries must commit to face potential system stress events through a coordinated regional approach, fulfilling also during energy scarcity conditions contracts and agreements previously signed, without trying to protect exclusively the rights of their national demand. Following this vision, the European Commission, when designing its Internal Energy Market, issued several pieces of regulation which claim for the respect of cross-border contracts also during emergency situations.

Despite of this, the vast majority of people working in the power sector still consider the security of supply as a strictly national issue, assuming that no Member State would allow exports of electricity during scarcity conditions, unless their national

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[1] The following abbreviations will be used throughout the article. CRM (Capacity Remuneration Mechanism); TSO (Transmission System Operator); EU (European Union); EUPHEMIA (EU Pan-European Hybrid Electricity Market Integration Algorithm); PCR (Price Coupling of the Regions); PTR (Physical Transmission Right); UIOSI (Use-It-Or-Sell-It, clause of the PTR); FTR (Financial Transmission Rights); MiFID (Markets in Financial Instruments Directive).

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demand is fully covered. According to these experts, it is naive to believe that a stress event can be solved through a coordinated regional approach. Contrary to this widespread point of view, the paper that follows is based on the requirements of the European legislation and on the principles that lie behind the Internal Energy Market. The authors of this document believe that this autarkic vision of the long-term security of supply is totally contrary to the current effort towards the short-term market integration, and that this conflict will limit the scope of the Internal Energy Market to a short-term market for "left-overs".

Another fundamental premise at the basis of the discussion that follows is the assumption that the widespread implementation of (diverse) CRMs is already a fact in the European context. Therefore, no assessment on the suitability of such regulatory tools is developed. The aim is to discuss how the current regulation should be adapted to allow for a proper development of the EU internal market for electricity when this kind of mechanisms are implemented in different Member States.

1.2. CRMs in the European context

Since the early times of power sector restructuring and liberalisation, the ability of electricity markets to provide enough generation to reliably meet demand has been called into question. In Europe, after several years of firm opposition to the implementation of capacity mechanisms (with some exceptions, e.g. Spain, Ireland or Italy), a general rethink is swiftly taking place, as evidenced by e.g. the consultation paper on generation adequacy and capacity mechanisms that the European Commission launched in 2012 (EC, 2012).

This wave of regulatory reforms overlaps in time with another paramount change of paradigm for the power systems in the region: the shift towards the European Internal Energy Market, which, after a long process, is finally taking place. Until now, the efforts of the European Commission, ACER, CEER and ENTSO-E have focused on the security and the economic efficiency of the shorter-term time horizon, concerning day-ahead and operation markets. Recent outcomes of this effort are the Framework Guidelines and Network Codes that will result in an EU-wide Target Model for the wholesale electricity market. Coordination will be accomplished for EU-wide congestion management, with a day-ahead market that will encompass the entire region with harmonised bidding and pricing rules[2]. Further harmonisation is also being sought for more complex short-term issues, such as the coordination of the balancing markets of the different Member States, a very demanding task that requires a great deal of engineering and organisation skills.

While these efforts are already resulting in the integration of the short-term wholesale markets, in the (long-term) system adequacy dimension, an EU-wide approach on capacity mechanisms is far from being achieved. In fact, it is not completely unrealistic to state that the most recent legislation from national governments is moving exactly in the opposite direction. Over the last few years, several countries in Europe have implemented, or are in the process of implementing, a diversity of regulatory instruments that try to address their concerns regarding generation adequacy. However, the mechanisms under design seem to rely almost exclusively on the domestic generation (i.e., directly connected to the network managed by the national system operator) and clearly aim at increasing the self-sufficiency of the national power systems. Foreign agents are not allowed to actively participate in these capacity mechanisms and they are excluded from the resulting remuneration. This is the approach that, according to the most recent reform proposals, is being followed in the design and implementation of CRMs in the United Kingdom (DECC, 2014), France (RTE, 2014), and Italy (AEEG, 2011)[3].

So far, European institutions have not yet adopted any direct measure regarding the convenience of harmonising the efforts in the generation adequacy dimension[4]. Nevertheless, limiting the integration efforts to the short-term dimension would be short-sighted and harmful for the future development of the European internal market.

Concerns on this issue have been expressed in several documents recently released by key EU institutions in power sector regulation. Just to mention some of the most relevant:

- In EC (2012) it is stated that "if capacity mechanisms are introduced prematurely or without proper coordination at EU level, they risk being counterproductive" and that "poorly designed capacity mechanisms will tend to distort investment signals".
- In ACER (2013a) it is observed that the "lack of coordination (on generation adequacy measures) has resulted in a patchwork of CRMs in the EU, which may be at the detriment of the market integration process".
- In ENTSO-e (2013) it is said that although "there are significant difficulties in standardizing generation adequacy analyses methodologies (…), there would be a clear benefit in reporting in a systematic harmonised fashion the key security metrics across the internal market".
- EURELECTRIC (2013) outlines as a key message that "CRM should be open to cross-border participation, underpinned by close coordination between Member States and respective system operators (TSOs)".
- Finally, EFET (2013) underlines that CRMs have to be "non-discriminatory, by taking into account the contribution of non-national generation through interconnection which may decrease local needs".

However, the strongest position assumed so far can be found in the EC (2013) working document on generation adequacy in the Internal Electricity Market. In this communication, it is specifically stated that "given the increasing integration of electricity markets and systems across borders it is now increasingly difficult to address the issue of generation adequacy on a purely national basis".

1.3. Levels of CRMs harmonisation in the regional market

As regards capacity mechanisms in a regional market framework, different degrees of harmonisation are possible. The highest level would be represented by the implementation of an EU-wide capacity mechanism, covering the entire regional demand. Nonetheless, this scenario is not only extremely unlikely for the

[2] Under this framework, the Price Coupling of Regions (PCR) initiative will allow different power exchanges to use a common clearing algorithm (called EUPHEMIA) for the day-ahead market (ACER, 2013b). Further details regarding the PCR project are provided throughout the article.

[3] The first auction of the Capacity Market being introduced in the UK will consider a "zero net contribution" from interconnectors (Newbery and Grubb, 2014), as proposed by the System Operator (National Grid, 2014). The capacity obligations mechanism under design in France will implicitly consider cross-border capacity, by somehow reducing the obligation of each supplier (RTE, 2014), but the explicit participation of foreign agents, with the consequent access to the capacity remuneration, is only foreseen as an hypothesis for the future. The Italian CRM will consider cross-border imports conservatively and no active participation of foreign agents is foreseen at the moment (AEEG, 2011). On the general EU context, ACER (2013a) well resumes the situation when it states that "the experience with cross-border participation (in national CRMs) is virtually non-existing".

[4] Actually, it should be underlined that, at the moment, no EU Agency has the power to issue restrictive legislation regarding national capacity mechanisms. The elaboration of guidelines has apparently not been sufficient to influence decisions from Member States.

moment, but also unnecessary from the theoretical and practical point of view. In fact, the final goal of these mechanisms is to guarantee a certain level of reliability of electricity supply. Regulators in different Member States can and should be allowed to require different levels of reliability, depending on the expected impact of a potential electricity curtailment in their system.

The implementation of different national capacity remuneration mechanisms to achieve a range of diverse reliability targets is therefore the most likely scenario. In this context, most of the benefits of market integration can still be exploited. The only basic requirement is that, using the words of EC (2013), “mechanisms to ensure generation adequacy should be open to all capacity which can effectively contribute to meeting the required generation adequacy standard, including from other Member States”. To this end, a minimum requirement in a regional market should be that all agents in the market must be allowed to participate in whatever capacity mechanism is established by any local authority, being the commercial capacity of the interconnections the only limit to this participation. How to ensure the proper conditions to comply with this minimum integration requirement is the focus of this paper.

The article is organised as follows. Section 2 presents the methodology used to study the problem, analysing the current barriers to the cross-border participation in national CRMs in the EU context, presenting an approach to remove these barriers, and outlining the theoretical framework which is used in Section 3 to test the proposed approach with a capacity mechanism based on reliability option contracts, studying different combinations of short-term market conditions in two neighbouring systems. Finally, Section 4 summarises the main conclusions of this article.

2. Methods

2.1. Problem diagnosis: identifying current barriers to cross-border participation in CRMs

The overall objective of a capacity remuneration mechanism is (or should be) to ensure that the system has enough generation (or demand-response) resources during scarcity conditions. In order to include generation from a neighbouring system in a capacity mechanism, the TSO of the country launching the CRM (hereafter CRM-system) must be sure that, during scarcity conditions, the foreign generation has to be able to fulfil its physical supply commitment linked to the capacity mechanism. Unfortunately this is not currently the case, basically because of two reasons.

- The first reason is related to the mistrust of the fulfilment of article 4.3 in the Security of Supply Directive (2005/89/EC), when it states that “Member States shall not discriminate between cross-border contracts and national contracts”. This mistrust is based on the existence in most electricity laws and national network codes in force in the Member States of clauses that maintain that exports to other countries will be interrupted in case of a domestic emergency of supply. Therefore, in case of concurrent scarcity conditions, the TSO of the foreign country will surely limit the flow through the interconnection, thus impeding the foreign agent to fulfil its capacity mechanism contract[5]. As an example of this contradiction, the case of the Iberian MIBEL can be analysed. In the MIBEL, the market splitting assigns all the transmission capacity through an implicit auction. Bilateral contracts are considered through balanced bids at the two sides of the interconnection (also known as mirror bids -as in Batlle et al. 2014-, i.e., the combination of a selling bid at the injection node and a purchasing bid at the withdrawal node) and are not backed by physical transmission rights. In the Proceedings of the common Market Operator OMIE (SEE, 2013), the rule 30.2.4 foresees that in case of scarcity conditions, the missing energy will be spread among all the demand, regardless of its location. However, the actual operation of the system is managed separately by the two System Operators. In the Operation Procedures of the Spanish System Operator REE (SEE, 2002), one of the measures to be taken in case of scarcity is the interruption of export programmes in those hours when they represent a threat to the security of supply. This seems to violate the article 4.3 of the Security of Supply Directive and to be in opposition to the Market Operator Proceeding[6].
- The second reason is linked to the future consideration of long-term cross-border contracts in the market coupling mechanism. A strict application of the so-called Target Model would result in the automatic allocation of the entire transmission capacity through the short-term market clearing algorithm, being the flows through the interconnections determined by the equilibrium between generation and demand in the different zones. This approach would impede the fulfilment of capacity mechanism contracts by foreign agents during system stress events. This fear is clearly expressed in DECC (2013), where it is stated that “the Target Model being introduced across Europe to promote efficient operation of the Internal Energy Market means that interconnector flows will be determined largely by energy price differentials between interconnected markets” and that this arrangement could impede a foreign reliability provider to export towards Great Britain when scarcity conditions arise in this system. A similar concern is expressed in RTE (2014), where it is asked “what should happen to capacity contracted through a capacity mechanism and the energy it generates (when there is a shortage in two countries simultaneously)? The market coupling algorithm might not be able to clear in those situations”. If these concerns are well-funded, it is even possible that, during these scarcity conditions in the entire regional system, national generation which could have committed in the CRM could “slip out” through the interconnection driven by price differentials with neighbouring countries. Paradoxically, this would mean that the presence of cross-border interconnection could increase the amount of capacity to be procured and could result in overinvestment in the country implementing the CRM.

[5] Some authors seem to support this right of Member States to give its domestic consumptions higher priority during scarcity conditions -e.g. Finon (2012)- and claim in favour of the exemption of capacity rights exchanges from the above mentioned Security of Supply Directive and from the trade provisions of the Treaty of Functioning of the European Union. The usual alternative proposed by these authors is to consider the contribution that foreign generators can provide to the adequacy of a system in a statistical way when designing the capacity mechanism, calculating the expected import through the interconnections during scarcity conditions. This approach, besides the difficulties involved in the definition of this statistical measure has the evident flaw of not considering concurrent scarcity conditions.

[6] Also the regional Network Codes being draughted by ENTSO-e do not seem to properly address this issue. In a letter to the European Commission, EURELECTRIC clearly claims for amendments to article 69.1 of ENTSO-e draught guidelines on Capacity Allocation and Congestion Management, which states “in the event of force majeure or an emergency situation (…), where the TSO shall act in an expeditious manner and redispatching or countertrading is not possible, each TSO shall have the right to curtail cross-zonal allocated capacity”. EURELECTRIC argues that, with such approach, “capacity contracts for adequacy purposes with foreign generators would not be as reliable as in-land generation and cross-border participation in CRM would be more difficult”.

2.2. An approach to remove the existing barriers

2.2.1. Removing the first barrier

The first of the two aforementioned barriers can only be tackled by means of a stronger coordination and commitment between TSOs regarding the requirement established in the Security of Supply Directive. In particular, this requirement should be accomplished through the modification of the national (and regional) network codes and operation procedures applied by several system operators in the region and through an actual responsibility transfer on security of supply issues from the system operator to the market operator. This is based on the basic principle that the outcome of a properly designed market, considering both the short and the long term, should not be modified by the system operator, unless because of the occurrence of technical issues.

2.2.2. Removing the second barrier

The second barrier, i.e., the way long-term contracts are expected to be considered in the PCR context, is the one that seems to be more challenging for a number of reasons. It must be reminded again that the final objective should be to allow the TSO of the CRM-system to be sure that, during scarcity conditions, all generation contracted through the CRM, either national or cross-border, is able to fulfil its physical capacity commitment.

2.2.3. Traditional approach

Such a simple but crucial condition could be achieved through the existence of Physical Transmission Rights (PTRs). This has been traditionally considered as the only mean to ensure an effective cross-border trading of capacity. However, it is worth noting that allowing PTRs is not in line with the guidelines expressed by ACER for the future development of the regional market[7]. Apparently, the explicit auctioning of PTRs is supposed to be eventually removed and all the interconnection capacity will be assigned through the PCR algorithm. That being said, it is worthwhile considering other solutions that allow not to resort to these tools.

2.2.4. Proposed approach: the conditional nominations

The alternative approach proposed in this article is a soft version of physical cross-border commitments. In particular, the authors claim that it would be sufficient if the PCR allows to declare a sort of "conditional nomination" associated to CRM contracts. This conditional nomination would allow agents to physically contribute to the supply of electricity to the CRM-system during scarcity conditions. However, the "physical" supply from the reliability providers holding a CRM contract (both national and cross-border) should be claimed by the CRM-system only in specific combinations of scarcity conditions and flows through the cross-border interconnection. In order to justify this statement, Fig. 1 presents four possible scenarios, resulting from the combinations of having or not declared scarcity conditions in the CRM-system (non-scarcity -"NS"- and scarcity -"S"-) and having imports from -"I"- or exports to -"E"- the neighbouring country flowing through the interconnection. For the sake of simplicity, it will be assumed in this preliminary example that imports and exports involve the use of the full cross-border capacity.

Obviously, in the upper cases in Fig. 1 (NS-I and NS-E) there is neither the need nor the right of claiming for the CRM contracted capacity and the flow through the interconnection will be determined by the commercial considerations. On the other hand, in the lower cases, when scarcity conditions are declared in the CRM-system, the TSO of the latter has to guarantee the delivery of the contracted CRM capacity. In case S-I, scarcity conditions in the CRM-system are concurrent with the congestion of the interconnection in the importing direction (towards the CRM-system). In this situation, no further benefit could be achieved from ensuring that cross-border reliability providers are supplying the CRM-system, because the maximum capacity is already flowing through the interconnection. Therefore, as explained in detail in the following section, there is no need to include in the design of the CRM a cross-border delivery checking in this case.

In case S-E, even if scarcity conditions have been declared in the CRM-system, the interconnection is congested in the exporting direction, i.e., leaving the CRM-system. In this case, the TSO of the latter has to check if all CRM resources are delivering the contracted capacity and if this delivery is actually contributing to relieve the scarcity condition in the CRM-system. In order to ensure both the delivery and the contribution to the CRM-system adequacy, both national and cross-border reliability providers must be allowed to express a conditional nomination that assigns their delivery to the CRM-system. In the case of cross-border agents, this nomination will apply only as long as the interconnection is not congested in the direction towards the CRM-system. Therefore the conditional nomination will have a slightly different scope for the two different groups:

- For national reliability providers, the "conditional nomination" contract allows national providers to nominate energy within the CRM-system frontiers whenever the latter declares scarcity conditions.
- For cross-border reliability providers, the "conditional nomination" allows agents in the regional market to "nominate" cross-border contracts to be exercised whenever the following two conditions are simultaneously met:
- The CRM-system declares a scarcity situation (as it is the case with the national providers).
- There is free capacity in the interconnection (as determined by the PCR) in the direction towards the CRM-system. As it will be further discussed in the next section, if there is no cross-border capacity available, the CRM-system is already receiving all possible support to its reliability from the neighbouring system. This second condition is the key to avoid ex-ante capacity reservation, and leaves much more space to the PCR for it to efficiently assign transmission capacity in the regional market both during normal operation and stress events.

The previous characteristics ensure the physical delivery of the reliability providers when such delivery actually contributes to relieving the scarcity condition in the CRM-system. After having presented the proposed approach, in the following section it will be demonstrated, by means of several representative and comprehensive examples, that if this type of "conditional nomination" contract is considered in the regional market design, (i) there is no hurdle to the effective participation of foreign agents in the capacity mechanism of a system in the same regional market and (ii) the short-term market efficiency is not distorted, but as discussed in Section 3.3, right the contrary.

2.3. Reference framework

In order to assess the effectiveness of the proposed approach, a theoretical framework is defined herewith in terms of capacity mechanism, consideration of bilateral contracts, and short-term market integration, that is used for a case-by-case analysis in the next section.

[7] The major drawback of PTRs (even if they are of the use-it-or-lose-it type) is that if they are not properly managed, due to for example (among other potential reasons) information asymmetries, they could affect the short-term efficiency of cross-border exchanges (Batlle et al., 2014).

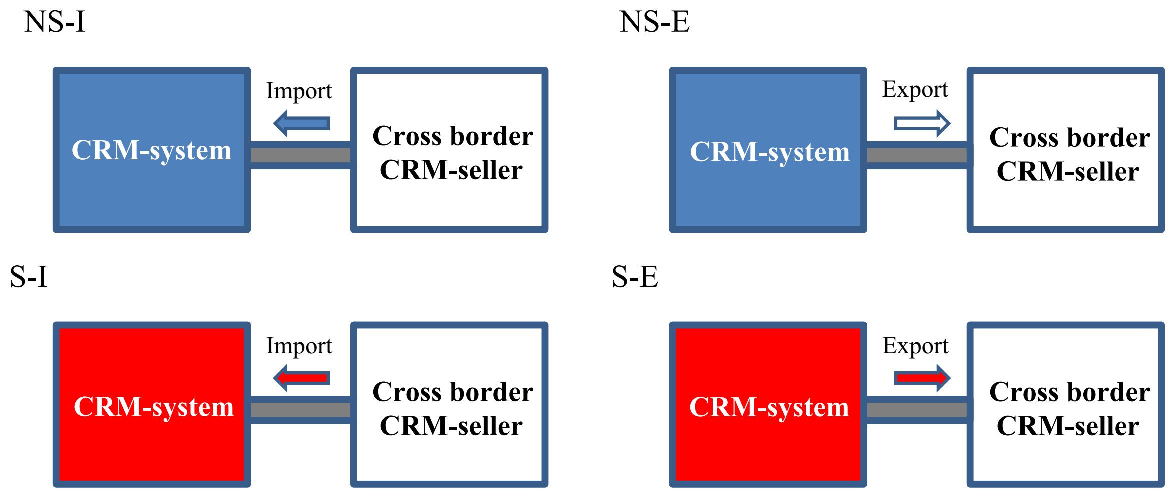

Fig. 1. Four relevant cases for the regional CRM mechanism.

2.3.1. Reliability option contracts in a regional context

2.3.1.1. The basic product. There is a broad variety of possible capacity remuneration mechanism designs (Rodilla and Batlle, 2013). The current global trend is to move from price-based mechanisms (as capacity payments administratively set by the regulator) to quantity-based mechanisms based on bilateral contracting or auctions, whose underlying principle is to set the "price" of the adequacy of the system in a competitive and (in the case of centralised auctions) transparent way.

In this document, in order to provide a realistic background to our discussion, a specific capacity mechanism will be considered for the examples in the dissertation, namely, the reliability option contracts proposed and presented in full in Vázquez et al. (2002) and briefly summarised right below, where the terminology used in the discussion is presented, that can be skipped by the reader acquainted with this kind of CRM. However, it must be highlighted that, even if the remainder of this article will focus on the reliability option contracts mechanism, the discussion outlined until now is valid also for other kinds of CRMs, based on different critical period indicators, the main difference laying in the conditional nomination procedure of the CRM contract.

2.3.1.2. Reliability contracts basic terminology. The reliability contract consists of a combination of a call option, to be backed by physical resources, with a high strike price and an explicit penalty for non-delivery. It entitles the buyer of the option to receive from the seller (e.g. a generator) any positive difference between the short-term market price p and the contract strike price s for each MW purchased under the contract. In exchange for that, the seller receives a premium fee F. From the generator point of view (the seller), selling an option means that it will receive an amount of money F in exchange for limiting to s the price obtained from selling its energy, therefore renouncing to the opportunity of selling at short-term prices that are higher than s. The generator (seller) exchanges an expected volatile income, associated to the part of the spot price above the strike price s, for a fixed payment F. The option is then stabilizing a fraction of the generator's income, therefore reducing its risk. Since the option is linked to a physical obligation to deliver electricity during scarcity conditions, the amount of reliability product that a generator could sell is capped to its installed capacity (usually considering also some availability index).

The mechanism also implicitly identifies the scarcity conditions of the system as the periods of time when the short-term market price p exceeds the strike price s. The strike price should be set high enough for it not to interfere significantly with the functioning of the short-term market.

This paper will use this mechanism because the authors deem it to be the most efficient in terms of reduction of investors' risk, low interference with the short-term market, and overall transparency of the process. However its main advantage concerns the market-based identification of the scarcity conditions. This way to identify scarcity conditions obviously assumes the presence of a liquid reference short-term market in the system, which should be a requisite of all liberalised power sectors.

2.3.1.3. Refining the commitment in the regional context. As mentioned above, the reliability option consists of a financial option plus a physical delivery commitment. The financial option commitment is the same for national and foreign generators. Foreign generators will need to enter into FTRs if they want to reduce base risk exposure (discussed below).

However, the physical commitment is the contract provision that must be carefully defined in the regional context. As analysed in Section 4, the product has to be slightly modified for national and cross-border reliability providers:

- National reliability providers: for the reliability providers situated in the CRM-system, the commitment of delivery of physical capacity within frontiers will be checked any time scarcity is declared in the CRM-system. If those having committed capacity are not producing for the CRM-system when such a situation in the CRM-system materialises, a penalty will apply. To ensure this, it will be checked that national reliability providers have presented a conditional nomination in their own system and that they are actually delivering.
- Cross-border reliability providers: in order to comply and be coherent with the conditions established in Section 3, the commitment for cross-border capacity has to be carefully defined. In particular, the compliance of capacity delivery coming from cross-border agents will only be checked when (1) a scarcity is declared in the CRM-system and (2) the interconnection with the neighbouring system is not congested in the direction towards the CRM-system. When this is the case, the CRM-system will check that the cross-border reliability provider has declared the conditional nomination to the PCR and it is actually delivering.

2.3.1.4. Zonal capacity auction. The previous scheme calls also for a zonal auction, since on the one hand the products they are selling are slightly different in nature, and on the other they are also subject to a cross-border constraint. This way, in the auction different prices may result for providers within the CRM-system and cross-border.

2.3.2. Bilateral contracts in the PCR

As previously pointed out, the consideration of long-term bilateral contracts in the short-term market is not fully clear yet. Apparently, in the pilot phase of the project, bilateral contracts will need to be backed by physical transmission rights, to be nominated in a use-it-or-sell-it approach (PTRs+UIOSI). In this case, part of the interconnection capacity would be auctioned in the form of PTRs and only the remaining part from this process would be assigned through the price coupling algorithm. However, this approach can be modified in a second phase, leaving the entire transmission capacity allocation to the PCR and complementing it through the auctioning of financial transmission rights[8].

In the following discussion, it will be assumed that only two types of long-term contracts are allowed:

- Financial Transmission Rights (FTRs).
- Conditional nominations linked to the CRM as defined in Section 4.

2.3.3. Day-ahead market coupling

The day-ahead price coupling mechanism allows a coordinated congestion management in the region[9]. In broad terms, once the commercial capacities of the interconnections have been calculated (considering also bottlenecks within single national systems), a shared algorithm clears the regional market, efficiently allocating all the limited transmission capacity and calculating different zonal prices whenever the maximum capacity of an interconnection is reached. Additionally, in line with the requirements presented above for the cross-border CRM participation, it will also be supposed that the short-term mechanism takes cross-border conditional nominations into account.

2.4. Terminology and notation

Herewith the discussion will be based on two countries, country *A* (CRM-system) and country *B*, and their power systems, which are interconnected through a transmission line of maximum capacity I_{AB}. Agents in *B* are allowed to take part in the reliability auction of country *A*, but their bids will be obviously accepted up to the maximum capacity of the interconnection. This can be carried out through a zonal auction. It is possible that some agents in *A* do not participate or are not selected in the auction of their own system and therefore have no obligation under the framework of the capacity mechanism.

Thus, for the sake of simplicity, agents can be divided into reliability providers in *A* (agents in system *A* whose bid is accepted in the reliability auction), non-reliability providers in *A* (agents in system *A* whose bid is not accepted or who do not take part in the reliability auction), reliability providers in *B* (agents in system *B* whose bid is accepted in the reliability auction of system *A*), and non-reliability providers in *B* (agents in system *B* whose bid is not accepted or who do not take part in the reliability auction of system *A*). This nomenclature will be used in the dissertation and represented graphically in Fig. 2.

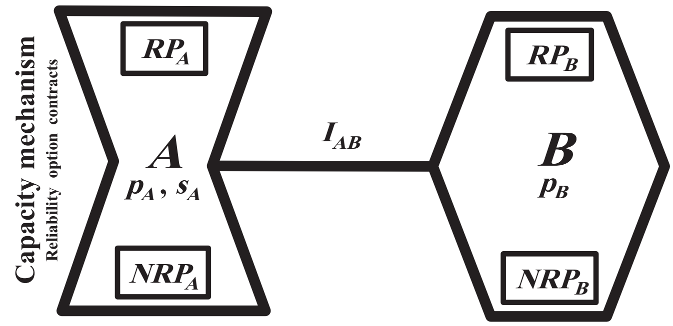

Fig. 2. Graphical representation of the problem under study.

The possible existence of a capacity mechanism in country *B* is not relevant for the purposes of the dissertation, subject to the fulfilment of avoiding over-commitment of capacity. This means that if an agent, located either in system *A* or in system *B*, commits part of its capacity in the reliability auction of system *A*, then it cannot commit that same part of its capacity in any other capacity mechanism whatsoever to which it has access. In a regional market, this can be accomplished by a coordinated accounting of capacity mechanisms contracts between TSOs, without the need of a single regional mechanism.

3. Results and discussion

Assuming the above mentioned context and hypotheses, all the possible relevant cases that can occur as combinations of short-term price in *A* (p_A), strike price in *A* (s_A), and short-term price in *B* (p_B), are analysed, focusing on their impact on the fulfilment of the reliability contracts. The goal is to demonstrate that an effective participation of cross-border capacity to a national capacity mechanism is possible and efficient.

3.1. Case I: $p_A < s_A$

In this first case, the short-term price in system *A* does not exceed the strike price of the reliability option contracts. Therefore there is no scarcity condition in A and consequently there is no obligation to deliver, neither for the reliability providers in *A* nor for the reliability providers in *B*. The market is cleared through the price coupling and the flow through the interconnection depends on the equilibrium of generation and demand bids in the two systems.

As a result, when the CRM-system operates under normal conditions (no scarcity), short-term prices in the two systems and flows through the interconnection are fully determined by the short-term price coupling mechanism.

3.2. Case II.1: $p_A > s_A$, $p_A > p_B$

In the second case, the short-term price in system *A* exceeds the strike price of the reliability option contracts. Furthermore, the short-term price in system *A* is higher than the one in system *B* ($p_A > p_B$), this meaning that there is a net flow of electricity through the interconnection that results in the congestion of the line, i.e., an electric power equal to the maximum transmission capacity I_{AB} is flowing from system *B* to system *A*.

In this case, as explained above, only the physical commitment of reliability providers in A will be checked. If this commitment is not fulfilled, these agents are subject to a penalisation.

Since I_{AB}, the maximum capacity of the interconnection, is also the maximum contribution expected from the reliability providers

[8] The decision between these two different approaches will depend on the consideration that FTRs will finally have in the second Directive on Markets in Financial Instruments (MiFID II). See Batlle et al. (2014) for details.

[9] According to ACER (2013b), the North West Europe/PCR pilot project has gone live in February 4th 2014 (including the Iberian MIBEL) and roadmaps have been set for cross-regional intraday trading, harmonised allocation rules for transmission rights and cross-border capacity allocation methods.

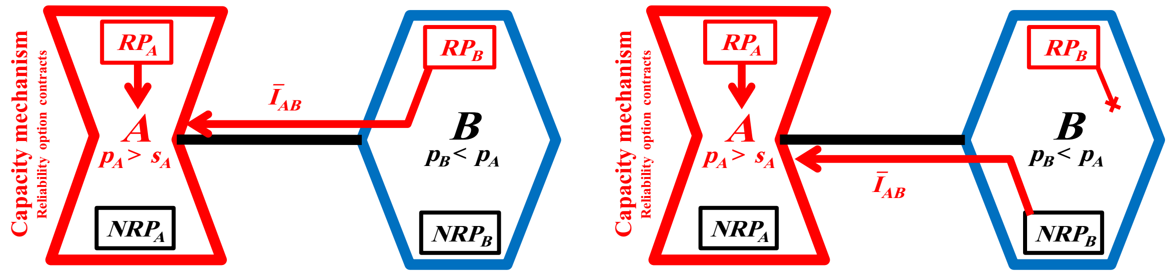

Fig. 3. Graphical representation of two cases when $p_A > s_A$, $p_A > p_B$.

in system *B,* it is not necessary to verify whether these agents are actually producing for *A* or not (Fig. 3). In fact, in this case, it is not important to check whether the flow coming from the neighbouring country correspond to the reliability providers in system *B* (left chart in the Figure) or to other agents in the same system (right chart in the Figure), as long as the interconnection is providing the contracted capacity.

Therefore, under these conditions, the cross-border conditional nominations do not need to activate and they are discarded by the PCR algorithm, because it is already assigning to system *A* the contracted capacity from system B.

Summing up, when the CRM-system suffers scarcity conditions and the neighbouring system does not, short-term prices in the two systems and flows through the interconnection are again fully determined by the short-term price coupling mechanism. The short-term market naturally results in the congestion of the interconnection and in the delivery to the CRM-system of the CRM contracted capacity.

3.3. Case II.2: $p_A > s_A$, $p_A < p_B$

It will be assumed in this case that, always under scarcity conditions in system *A* ($p_A > s_A$), the short-term market price in system *A* is lower than the one in system *B* ($p_A < p_B$). This means that the interconnection between system *A* and system *B* is congested, but this time by a net flow, as determined by the PCR, is going from *A* to *B*. Note that this situation is likely to represent scarcity conditions both in system *A* and in system *B*.

This is probably the most interesting scenario, since in this case the market coupling algorithm is assigning the available cross-border capacity in a way whose results may go “against” the CRM commitments. It must be underlined how this affects not only reliability providers in the neighbouring system but also the national reliability providers, since the algorithm could result in the export of electricity, either from reliability or from non-reliability providers (see Fig. 4 for an illustration of this situation). From a purely economic point of view, this would be the short-term optimal solution. However, when scarcity or near scarcity conditions

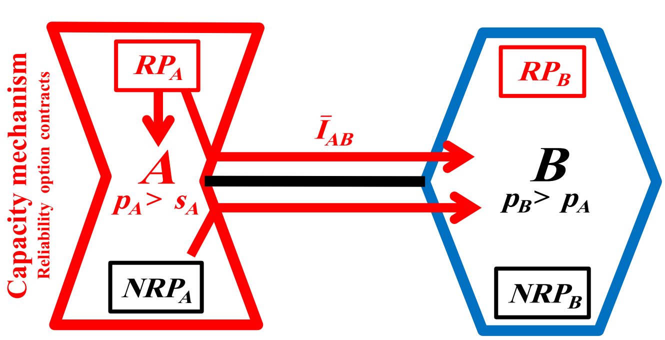

Fig. 4. Graphical representation of the national resources “slipping out” as a consequence of the PCR.

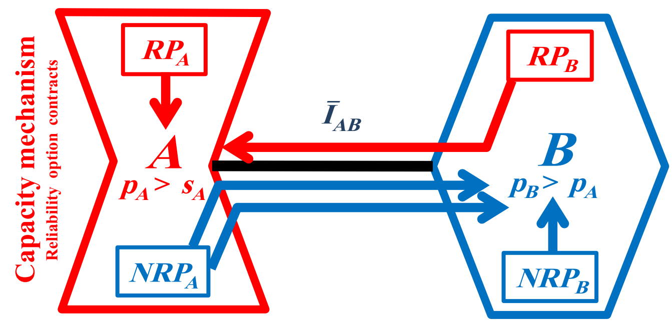

Fig. 5. Graphical representation of case II.3: $p_A > s_A$, $p_A < p_B$.

are reached, there is a lot to discuss on the efficiency of electricity prices as short-term signals.

Therefore, it is in this situation when the conditional nomination plays a key role. In this case the CRM-system has to verify that both reliability providers in *A* and in *B* have declared a conditional nomination in the PCR, and that they are also delivering. This is coherent with the approach presented above in Section 3, where it was said that physical delivery would only be checked when the flow from the interconnection with the neighbouring system does not reach the expected contribution.

If the condition above is fulfilled, and all the reliability providers are delivering as committed in the auction, the resulting situation is only possible if there are so many non-reliability providers in system *A* cleared in the short-term market in order to economically “export” to system *B* that they cause a flow through the interconnection not only capable of balancing the flow deriving from reliability providers in system *B* who are economically exporting to system *A*, but also to result in the interconnector congestion in the other direction, i.e., from *A* to *B* (Fig. 5).

3.3.1. Is the short-term efficiency affected by the conditional nominations?

In this case, an issue related to the economic efficiency of the operation could be raised. Besides some other issues, price caps are a key factor affecting this efficiency[10]. Reliability providers in *B* are economically exporting electricity to a market where the short-term market price is lower. However, when the short-term market prices are defined through the activation of price caps, as it is likely to be the case when scarcity conditions arise, it is arduous to make any reasoning regarding the utility of the demand. Commonly the determination of price caps is more the outcome of a regulatory agreement than the result of a process aiming at calculating the real value that the demand assigns to electricity. Actually, the price cap could only be a rough approximation of an

[10] Short-term to very short-term regional markets can fail to allocate efficiently electricity due to other reasons, as for example a lack of well-functioning coordinated regional markets after the spot or direct out-of-the-market interventions of TSOs (and or regulators).

average value of the demand utility, because different consumers assign electricity a different utility at different times. Since price caps cannot be regarded as accurately reflective of the demand utility, the economic export of electricity from a system with a higher to a system with a lower price, if the latter are the result of price caps activation, does not represent an economic inefficiency.

Indeed, short-term market efficiency is already distorted because of the existence of price caps, since price caps do not allow to fully express the willingness to pay for electricity in the short-term. The conditional nomination proposed in this article can act as an effective safety valve to this imperfection. Therefore, these conditional nominations actually do not worsen the market efficiency, but, on the contrary, they improve it. When market agents pay to hold the physical right under these extreme circumstances, they are reflecting precisely their utility.

On the other hand, if prices are correctly representing the actual value of the energy in each system, then theoretically the demand in system *A* (or the Regulator on its behalf), which is covered by the reliability option contract and is the actual owner of the electricity produced by reliability providers in *B*, with this price combination, should sell this electricity in system *B*. In fact, its utility is represented by the short-term price and, if the price in system *B* is higher than in system *A*, the demand should prefer to sell the electricity in system *B* and retain the revenues from the sale, since the latter are higher than the utility value it is assigning to electricity.

This scenario could be feasible, thus the mechanism does not avoid reaching the ideal optimal outcome if scarcity prices were representing the actual utility of the demand in the two systems. However, it is obvious that this efficient scenario is not realistic, due to the activation of price caps.

The discussion above does not mean that the demand which is actually able to react to price changes through short-term decisions could not be allowed to follow different strategies. However, the correct approach would be to leave to the consumers the possibility of opting out from the auction for reliability option contracts, either requiring the regulator not to consider their demand in the auction, or by selling in the auction itself demand-response products.

Thus, when the CRM-system suffers scarcity conditions and the price as determined by the PCR is higher in the neighbouring system than in the CRM-system, the fulfilment of the CRM contracts may not be naturally met by the PCR, as it is defined now. This is the scenario in which physical CRM commitments have to prevail over PCR results and this is proposed to be obtained through the application of conditional nominations.

Although it can be claimed that a flow from a system with a higher to a system with a lower price is inefficient, it must be underlined that, during scarcity conditions, short-term prices are far from being efficient signals.

3.4. Case II.3: $p_A > s_A$, $p_A = p_B$

It will be assumed in this case that, always under scarcity conditions in system *A* ($p_A > s_A$), the short-term market price in system *A* and in system *B* is the same ($p_A = p_B$). This implicitly means that the interconnection between system *A* and system *B* is not congested.

This case can be formulated and solved following exactly the same reasoning as the one followed for case II.2. Again, if the market coupling algorithm is assigning all the available cross-border capacity and only FTRs are available, it is not possible to ensure that CRM contracts are fulfilled. Therefore, in this situation it is essential again to apply the conditional nomination presented above. Also in this case the the Regulator of system *A* has to check that both reliability provider in system *A* and *B* have presented the conditional nomination in the PCR, and that they are delivering.

Note that in this particular case there is not any type of arguable inefficiency in the short term dispatch, for the conditional allocation would only be solving a tie situation in which the prices in both countries are identical.

This price combination is of particular interest, since it could be also the result of concurrent scarcity conditions in system *A* and system *B*, potentially related to the occurrence of non-served energy, that provoke the activation of price caps in the two short-term markets. In fact, under the framework of the PCR project, and in particular of the NWE/PCR (North West Europe PCR) pilot project, consensus is being gathered around the necessity of harmonising the price caps of the short-term markets coupled by this mechanism[11]. If this design were implemented, a situation where both the harmonised price caps are activated would belong to this case ($p_A > s_A$, $p_A = p_B$), because the short-term capped price at the two sides of the interconnection would be the same.

So, finally, when the CRM-system suffers scarcity conditions and the price as determined by the PCR is equal in the two systems, the fulfilment of the CRM contracts may not be naturally met. In this scenario, physical CRM commitments have to prevail over the PCR results and this is proposed to be obtained through the application of conditional nominations. In this case, the conditional nominations only solve a tie situation and do not hamper the short-term market efficiency.

3.5. Consideration on FTRs and locational signals

It may be argued that agents in system *A* and agents in system *B* do not compete on the same basis in a reliability auction launched by system *A*, through its system operator. In fact, a reliability provider in system *A* and the buyer of the reliability option (in system A) are natural risk counterparties, while this is not true for a reliability provider in system *B*[12].

In the framework of market coupling, a likely scenario is that, when scarcity conditions arise in system *A*, the short-term price in *A* will be higher than the one in *B* ($p_A > p_B$). In this case, the remuneration of the reliability provider in *B*, i.e., $p_B - p_A + s_A$ (in fact the agent in B receives the short-term price of system B, but has to settle the reliability option contract, by returning $p_A - s_A$), can be significantly lower than the one of the reliability provider in *A*, i.e., s_A, or even negative. In order to hedge this risk, the reliability provider in *B* can strategically buy financial transmission rights which assign it the congestion rent of the line, thus providing it too with the status of natural counterparty with respect to the buyer of the reliability option. Nonetheless, it has to pay for these financial transmission rights and the expense, in theory, will be exactly the expected short-term price deviation between system *A* and system *B*. The result is that the reliability provider in system *B* will have to internalise this expense in its bid to the reliability auctions and therefore it will have a disadvantage with respect to a reliability provider using the same technology, but located in system A[13].

However, this is not an undesirable effect. In fact, it represents an efficient locational signal for agents willing to invest. A similar

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[11] ACER (2013b), regarding the harmonisation of floor and ceiling prices in the framework of the PCR project, states that "a consensus emerged around the values +3000 € and −500 € (per MWh) and this range is to be implemented with the NWE market coupling go-live".

[12] See Rivier et al. (2013) for a detailed explanation on transmission rights and on the "natural counterparties" concept.

[13] That said, there are other relevant reasons that can make cross-border capacity more competitive than domestic one, among others the fact that capacity can be cheaper in neighbouring systems (competitive advantage to strategic resources) or, for instance, that existing foreign capacity can compete against new investments in the domestic system.

situation occurs when a large demand is concentrated in a first node which is linked to a second node, where several generators are connected, and the line between them is usually congested. Obviously, generators in the “load node” have a commercial advantage in comparison with the generators in the “supply node”, but this happens because the former are better located than the latter. The same occurs with a capacity mechanism: reliability providers in a node with a high demand for reliability will always have, in a reliability market, an advantage in comparison with reliability providers located in a node with no reliability demand and connected to the first node through a line subject to congestion.

4. Conclusions

Several European countries, albeit committed in a harmonisation process of their national short-term markets, are independently and separately designing the long-term capacity mechanisms. While the implementation of different capacity mechanisms is acceptable from a regulatory point of view, this should not be translated in the creation of national energy autarkies.

This article, by means of examples based on the reliability option capacity mechanism and on the price coupling market coordination approach, demonstrates that it is feasible to eliminate the current regulatory barriers to the participation of foreign agents in the capacity mechanism of a system in the same regional market, while not affecting the short-term market efficiency. The assumptions under which this can be achieved can be resumed as follows.

- Capacity mechanisms must be based on contracts to be exercised during scarcity conditions in the system. The spot price is the best critical period indicator and this is likely to turn to be more valid in the future, in a scenario of increased elasticity of the demand.
- Countries in the regional market must always fulfil article 4.3 of the Security of Supply Directive, which states that “Member States shall not discriminate between cross-border contracts and national contracts”. This requirement should be accomplished through the modification of the operation procedures of several system operators.
- If an agent in the regional market commits part of its capacity in the CRM of one system, then it cannot commit that same part of its capacity in any other capacity mechanism whatsoever to which it has access. This can be accomplished by a centralised and coordinated accounting of capacity mechanisms contracts.
- If a system implements a capacity mechanism open to all the agents in the relevant regional market, it will procure reliable capacity from abroad only up to the maximum transmission capacity of the interconnection, by means of a zonal auction[14].
- The performance assessment of cross-border reliability providers has to be carried out only when the interconnection is not saturated in the importing direction (towards the system implementing the CRM).
- In case all the transmission capacity is assigned through the market coupling, a conditional nomination rule must be included in the clearing algorithm, which ensures the fulfilment of reliability contracts during concurrent scarcity conditions on both sides of the interconnection. Such conditional nomination enhances the firmness of the cross-border reliability contracts. At the moment it is not contained in the current procedures of the PCR project, but the authors of this paper claim for its inclusion, as it would increase the confidence in foreign reliability providers in the framework of capacity remuneration mechanisms. It does not represent an actual transmission capacity reservation, but rather a rule to make this reservation superfluous. The non-necessity of cross-border capacity reservation has been demonstrated in the dissertation for the different price combinations. The conditional nomination rule is only needed to ensure the fulfilment of the reliability contracts during scarcity conditions when, due to the activation of price caps, the short-term prices do not allow the proper consideration of bilateral contracts.

[14] Actually, zonal capacity auctions are already in place in some power systems in the United States (PJM), where the transmission constraints within the system do not allow a single-node auction.

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