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CAN WE RECONCILE DIFFERENT CAPACITY ADEQUACY POLICIES WITH AN INTEGRATED ELECTRICITY MARKET?

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SUMMARY

In the present European Union debate, many consider capacity remuneration mechanisms (CRM) as useless and, if they are eventually considered as useful, there is a necessity of total alignment of capacity adequacy policies in time. We develop an opposite position. The adoption of CRM is a necessity because the market and regulatory failures to invest in peaking units, which are amplified by the large, scale development of intermittent sources by out-of-market policies. Then, provided that some minimal harmonization is sought by regulators and TSOs, each member state should have some freedom in the adoption of his capacity adequacy policies.

Our main findings are fivefold.

- *First, beyond the need for a clear alignment of principles in matters of criteria of adequacy and reliability, Member States are legitimate to decide their means of action to maintain the long-term reliability insurance of their electricity system. In particular they should be allowed to choose between keeping "energy only" market architecture or adding a capacity mechanism, and also to choose the type of CRM design, provided that they target a minimal probabilistic criteria of outages and that short term competition on the energy market is not altered.*
- *Second we propose the adoption of minimal criteria of adequacy and reliability in relation to the nature of hazard events which could alter the system reliability and which are specific to each system (seasonal hydraulic hazardness, weekly thermo-sensibility of the peak load, daily and hourly variability of intermittent renewable, unplanned thermal plants outages). In a system in which the regulator and the government are totally confident in the ability of the market to reveal the level of protection desired by the consumers in a system, the absence of precautionary approach could in fact alter the supply reliability level targeted by the respective TSOs in the neighboring markets which they are integrated with.*
- *Third the CRMs which are quantity instruments rather than price instruments – that is the bilateral obligation, the auctioning of forward capacity contracts or the auctioning of reliability options -- are the most efficient to limit the distortive interactions between markets with different adequacy approaches. We show that they present two advantages in this respect: first their impact on other energy markets which are targeted to be integrated is limited and second they allow us to limit redistributional effects whereby the consumers of the system with the most efficient CRM could pay for the increase of reliability in the other systems.*
- *Fourth the CRM of strategic reserves which are composed with new equipment and eventual old existing equipment is perceived as the cheapest capacity instrument, but in fact in a long term perspective it has distortive effects on investment decisions by the market (sliding slope, opportunistic behavior of postponing investment in waiting for TSO's call for tenders).*
- *Fifth, provided that a quantity instrument and a minimal probabilistic criteria is adopted, there is no frontal opposition between the absence of complete harmonization of adequacy policies and adoption or not of CRMs with respect to completion policies principles, in*

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particular in matters of location of equipment and cross-border trade alteration, compared to a counterfactual scenario of perfect harmonization with either no CRMs at all, or strictly harmonized CRMs.

Sixth there are few advantages from trade in capacity rights as such trade will impose a very complex and harmonized set of rules to homogenize the capacity rights between systems, and will generate important transaction costs (for the certification and the checking of the reliability of foreign committed equipment, for the eventual limitation on the interconnection capacity to allow flows of reliability rights and energy during scarcity periods). We identify a social efficiency gain only when in some systems, there is a long standing situation of overcapacity beside systems with tight situations during peak periods, but the TSOs of the first systems should keep the power to forbid capacity rights exports as soon as they anticipate disappearance of their overcapacity and new situations of tightness. This means the definition of common criteria and vesting power of control to ENTSO-E.

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1. INTRODUCTION

We defend here a position different from the conventional wisdom. In the actual momentum of definition and implementation of the different elements of the target model and network codes, many consider capacity remuneration mechanisms (CRM) as useless and, if they are eventually considered as useful, there is a necessity of total alignment of capacity adequacy policies in time. This conventional view is based on different arguments (see for instance Eurelectric report, 2011; European Commission, 2013). First, there is no clear evidence of missing money and we should wait for evidence of market failure if there is a lack of investment in capacity, with recognition by European coordination instances (ACER, CEER, ENTSO-E, etc.). Second, in the future it could be shown that, after the implementation of market rules, improvement in the day-ahead, intraday and reserves markets, and the integration of these different submarkets that will follow the present process, new revenues for new equipment will be sufficient to trigger investment. Third, the use of capacity remuneration mechanisms should not been recommended, given that they could distort energy market integration in different ways: by changing the cross-border exchanges on the long term, by orienting some locations of equipment in an inefficient way (with eventual new congestions between systems) and by reducing the value of market integration if interconnections are not well incorporated in the design of some CRM. Our three counter-arguments are the following.

a. First, we argue that, whatever the improvement of market rules for the intraday, reserve and balancing markets which can help to give an economic value to flexibility services and the back-up of the increasing intermittent generation, a capacity adequacy approach will remain a necessity, given the increasing share of intermittent producers and the risk of their low production during extreme peak. Idem for the better integration of these energy markets which will help to re-enforce solidarity between systems and the mutual statistical contribution of each one to the reliability of the other ones during scarcity periods.

The market failure to invest in peaking units is also related to the very capital intensive nature of the investment, with a recovery of fixed costs on a very short and hazard period of price spikes. It is also the case for other resources such as demand response programs. So, depending on the initial situation of total capacity related to peak load at the moment of the reform and the local beliefs in the ability or inability of the market to determine the optimal level of precaution (despite the inactive and inelastic real time demand), a member-state should have the freedom to choose a precautionary policy, because it would support the political cost of any black out or any vast brown out.

Even without a large scale development of intermittent sources of energy, a vast literature (for example Cramton and Stoft, 2006, Joskow, 2006; De Vries 2007) shows that there will be a missing money problem for investing in peaking units and reserve capacities. It is not so much because some price caps exist on the different electricity markets for technical or political reasons: if a price cap is set at 3000 €/MWh, it is not in itself the major source of the missing money problem, but it could become a problem if it is set respectively at 180€/MWh, 500€/MWh and 1000 €/MWh as in Spain, Italy or Ireland. The missing money problem comes also from the premature interventions of the TSO in periods of scarcity and exceptional events when he anticipates a large risk of decrease of the power frequency and calls contractual reserves, rather than to wait for the real time manifestation of scarcity to call these reserves.

The introduction of large-scale intermittent renewables production magnifies the missing money problem, in addition to the need for back up and flexibility services throughout the year, which should not be confused with the need of adequacy. It magnifies the missing money problem because of the correlation between wind generation and peak load in winter. So it erodes the price spikes and the scarcity rents most of the years. But at the same time, the windpower variability hazardly increases the needs of reserve margins of the system because of the risk of absence of windpower generation during some occurrences in winter.

b. Second, concerning the necessity of full harmonization of adequacy approaches, we do refer to the subsidiarity principle for letting Member States (MS) act on their own in matters of adequacy which is a long term insurance for the supply reliability in due time: in particular for the choice of the level of precaution above a minimal level and the instrument to reach the long term insurance goal. It is so provided that this CRM acts by the quantity as the obligation or the auctioning of capacity contracts because it guarantees to reach the forward capacity target. On the one hand it is much less the markets than the Member-states' policies which determine the technology mix and the different types of hazard factors arising from generation equipment fleets and loads, these hazard factors (thermal plants outages, renewable generators variability, thermo-sensibility of load) which affect supply reliability in times of scarcity and exceptional situations. So it should be up to their government, their respective regulators and the TSO to act first in the matter of precaution to control and limit the supply reliability risks in the long run.
   On the other hand member-states tend to consider themselves politically responsible for the supply security in their country because electricity is an unusual commodity for assuring the running of economic activities and social welfare and because electricity is not storable and easily transportable as could be any material commodity and good. The 2006 Electricity SoS directive and the 2004 and 2009 Electricity Market directives do not deny to Member States their right to act on their own. So, beyond the European Treaty and legislation principles, every MS has the right to choose between trusting or distrusting the energy market by staying or not in the "energy only" architecture, in order to achieve adequate reserve margins, after having taken into account the possibility of electricity exchanges during scarcity periods with neighboring systems. [2]

[2] The first communication of the Commission "Making the internal energy market work"(EC, 2012) considers that adequacy falls in the field of Public Service Obligation, and justifies a control of conformity with the

c. To complement this perspective, we should relativize the problem of interaction between markets with different adequacy approaches by remembering major distortive effects of the members states' own energy policies on electricity market functioning and integration. There exist in each system specific policies which could alter and distort the market functioning in the neighboring countries both on short term and long term. This is the case from the German nuclear phase-out policies and also the case from the priority given to RES-E policies implemented by some MS beyond the mandatory objectives of the RES directives. Indeed these differences result in the development of large-scale production at low variable costs and with fatal intermittent production which has large negative externalities on the neighboring systems in terms of new balancing needs, price variability and wholesale price decrease. It also alters the profitability and fixed cost recovery of recent generation investments in conventional technologies.

So we could consider that such interferences between markets coming from different MS policies choices are de facto admitted by the European Commission, provided that, in principle, it does not alter competition inside and between countries. But in fact the Commission does not encompass all the issues in the same approach, even if there are interdependencies between them. It tends to separate the problems without hierarchizing the issues and without taking into account their interdependencies.

In this paper, in order to simplify, we only address the effects of the differences of adequacy approaches between member-states, but with always keeping in mind that problems raised by the differences of adequacy policies chosen by regulators can be less important than those raised by the RES-E policies and their difference of results.

The criticism addressed to the unharmonised adequacy approaches between a number of MS is based on two arguments:

- The need to minimize interference between the difference of capacity adequacy approaches and the CRMs with the integrated energy market
- The impact on long term competition of the potential of CRMs to alter equipment location and production decisions within the internal market.

The answer will be in the assessment of the first causes of distortive effects of MS' own adequacy policies, which are the differences in adequacy and reliability criteria on one side and in the regulatory restriction on the energy price by a price cap on the other side (Section 2). Then we consider the distortions related to the difference of approaches (energy only versus adoption of a CRM; or else difference of the nature and design of CRMs) (Section 3). Thus we can then explore the minimal conditions of harmonization necessary to minimize the remaining distortive effects, and we assess possible tensions with competition policy principles (Section 4).

Then we develop a cost-benefit analysis of exchanging capacity rights between systems (Section 5), because a strict reading of the 2006 SoS directive and the Treaty leads the

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directivesAs economists, we could contest this point, considering that the different directives (in particular the 2006 electricity SoS directive, do not consider electricity as a composite of several goods which includes long term insurance of supply reliability. Electricity is not a commodity like the other ones which are storable and have an active demand which reacts to price in real time. There is no expression of the consumers 'willingness to pay for reliability'. Electricity is a complex product which combines not only energy, but ancillary services for voltage and frequency stability, transmission access rights, and also "long term insurance of reliability" which is a collective good non excludable and partly non rival, the so-called "reliable capacity" formerly theorized in the peak tariff theory (Boiteux, 1953).

majority of experts to believe in the virtue of capacity rights exchanges between systems. But we will need a lot of harmonization efforts in matter of designs of the different CRMs, while the social benefit of exchanges will remain quite poor.

Before developing these five points, we present in Box 1 a useful conceptualization of the property rights underlying both the supply reliability -- the collective good managed in real time by the transmission system operator (TSO)--, and the capacity adequacy, -- the collective good co-managed by the government and the regulator and the TSO--, knowing that each of these two collective goods interacts with their respective ones in the neighboring markets.

Box 1

Reliability rights and capacity rights

To apprehend the advantage of building solidarity between systems by exchanging different products during scarcity periods –energy, reserves, ancillary services- and also how it reinforces long term insurance of supply by mutual exchange, we define "reliability rights" in a system as the property rights on the reliability of the supply system, the collective good managed by the TSO. These reliability rights cover both the energy exchanged bilaterally and on the day-ahead market as well as the infraday exchanges between balancing responsible entities –in this case they are implicit property rights --, and various reserve services and ancillary services bought by the TSO to assume its responsibility in last resort during the operational window.

Capacity rights and reliability rights are property rights on two collective goods which are temporally nested.

Reliability rights are offered by every generation unit which produces and can adjust their production, or which is in reserve, ready to produce energy, to offer the balancing services and ancillary services sold to the TSO which is in charge of guarantying the system reliability to every producer and consumer. As energy can be exchanged up to the gate closure of the infraday, the reliability rights cover not only the different types of reserve and balancing services bought by the TSO but also all the energy which is forward exchanged between producers and loads which are "balancing responsible" for a delivery hour in bilateral transactions, on the day ahead and the intraday markets just before the "real time" during which the TSO takes the complete physical control of the system. So any kWh injected in the system also includes an implicit "reliability right".

We define "capacity rights" as property rights on the long-term reliability insurance of the system to which all the dispatchable equipment, and to a much lesser extent variable generators, contribute. This is a collective good under the responsibility of the government, the regulator and the TSO. The capacity rights associated with a generator's unit can be vague or heterogeneous as it is respectively with the capacity payment and with the strategic reserves mechanism. But they could be clearly defined with the mechanisms based on a quantity principle with the forward capacity obligation, the forward capacity contracts auctioning and the reliability options when they represent in fact a forward promise of equipment reliability in times of scarcity. In this case these rights correspond to forward commitments to be able to deliver power on the energy markets, or if they have preferred to be in reserve, to deliver operating reserve or balancing service to the TSO in scarcity situations. The capacity rights which will be defined by the certification in the CRMs generate *de facto* reliability rights on the delivery dates.

A capacity right is related to the capacity adequacy of a system, "collective good" which is a long term insurance of supply reliability during scarcity periods obtained by targeting a reserve margin calculated in relation to the hazard situation of the system. This helps the Transmission System Operator (TSO) who is in charge of managing the system reliability, to be sure to have sufficient reliability rights in the system. These capacity rights are attributed to existing units as well as new generation units installed under the incentives of the CRM, which both commit to be reliable during peaks on the delivery date by signing the forward certification contract. So a capacity right is a promise of reliability in scarcity periods. This promise is submitted to the incentive of a penalty. Bilateral capacity obligation (BO) or forward capacity contracts central auctioning (FCM) create such capacity rights which in turn will contribute to generate reliability rights during scarcity periods at the delivery date.

As the TSO is in charge of the system reliability in any annual period and in particular in tight capacity periods, he should have the exclusivity of reliability rights purchases in last resort or at least he **should have the total control of their use in last resort in scarcity periods in his own system**. But, with the dominance of bilateral markets in the EU internal market beside some pool market architectures, it is not possible to retain energy and the implicit reliability rights associated with it in the system with a CRM during scarcity periods, unless there are some derogation rules to free exchanges (see section 4 where we discuss the free riding of systems without CRM)

Following

At the end the European logic would also lead us to envisage the trade of capacity rights between neighboring systems whenever they have a CRM of a different type, or else whenever they have no CRM at all. The question is: could we exchange capacity rights of different natures between different countries with different capacity adequacy approaches, and even different levels of precaution? (See the discussion in section 6 on the exchange of capacity rights).

2. DO SOCIAL INEFFICIENCY AND DISTORTIONS PRIMARILY ARISE FROM THE ADOPTION OF DIFFERENT PRICE CAPS AND ADEQUACY CRITERIA?

The issues addressed in this section are related to the differences of price cap and adequacy criteria between markets, before we cover the issue of differences of adequacy approaches in section 3.

Even if energy markets interact between systems and can constitute a single market with a unique price during a number of hours, the responsibility of reliability and long term supply security remains with the TSOs and the regulators by national laws through the subsidiarity principle. In economic terms they manage the collective goods of system reliability and capacity adequacy. But these collective goods are not independent from the respective ones of the neighboring systems, Via the day ahead and intraday energy exchanges, as well as the trade of balancing services between TSOs, there are exchanges of reliability rights, in particular in tight periods; each system contributes in a hazard way to the supply reliability of others, up to the interconnection capacities between them. In consequence in a long term perspective, each system could be considered as a contributor to the capacity adequacy of the other ones and vice versa.

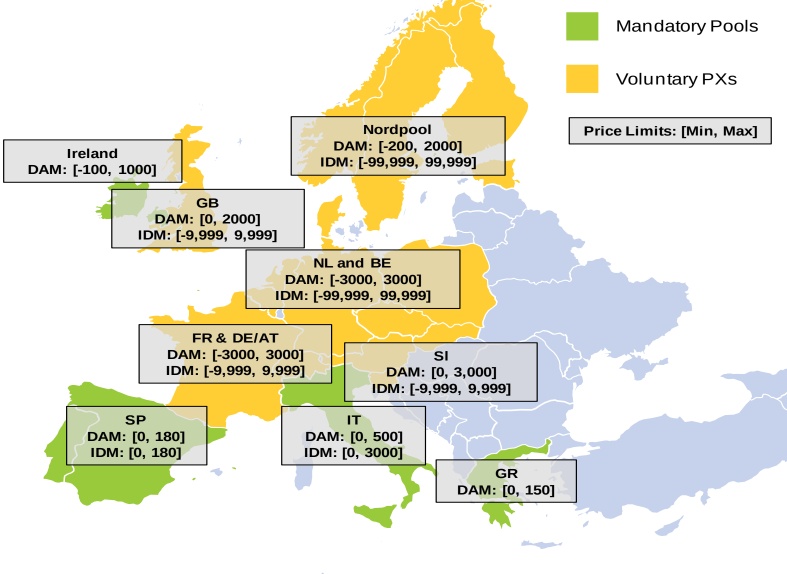
But the interdependencies could play in two different directions, solidarity between systems and free riding of some vis-à-vis the other ones. If every market remains in the “energy only” architecture, differences of regulatory restrictions on market price by price cap could first create differences of incentives to invest in peaking units (or demand side management programs) and to reach a target of reserve margin. This also occurs if there are differences in the TSOs’ respective precautionary approaches in terms of reserve margin and adequacy criteria, whatever the means they adopt to respect this criterion. In any case large differences in price caps or in criteria of precaution could lead to a situation in which the consumers in a system could benefit from the higher criteria of adequacy and reliability.

2.1. *Differences between price caps*

In an integrated set of "energy only", markets in which the collective goods of adequacy and reliability can interact between systems, the main challenge of harmonization should be to make each system self-responsible in the matter of long term security insurance in relation to two drivers: first the incentives to invest in peaking units (because they could be limited by different levels of price caps which determine the possibilities to extract scarcity rents during peaks) and second the adequacy criterion defined by the TSO in agreement with his government.

First the following figure shows the differences of price cap on the day ahead and the intraday markets between countries. It points to the fact that mandatory pools have low price caps (respectively 180 €/MWh in Spain, 500 in Italy and 1000 in Ireland) because they are designed to integrate a capacity payment with modulated value depending of the situation of the system. Nevertheless the other markets based on bilateral contracts show some divergences (2000 to 3000 here and there on the day ahead[3]).

Différence of price caps on day-ahead and intraday markets between markets (source CERA-IHS)



NB: Traditionally the pool design has a lower price cap because a capacity payment is added.

2.2. *Necessity of alignment of adequacy criteria on probabilistic principle*

The adequacy criteria are also quite different (see the next figure). They differ in nature (deterministic or probabilistic) and in level. For instance among those who choose the probabilistic criteria of LOLE (loss of load expectation), we observe some differences: 3h/y for France to 16h/y in Belgium with the Ireland in the middle with 10 h/y. The harmonization should concern the nature of the criteria, and this choice should aim to make countries responsible for their negative externalities on the other systems.

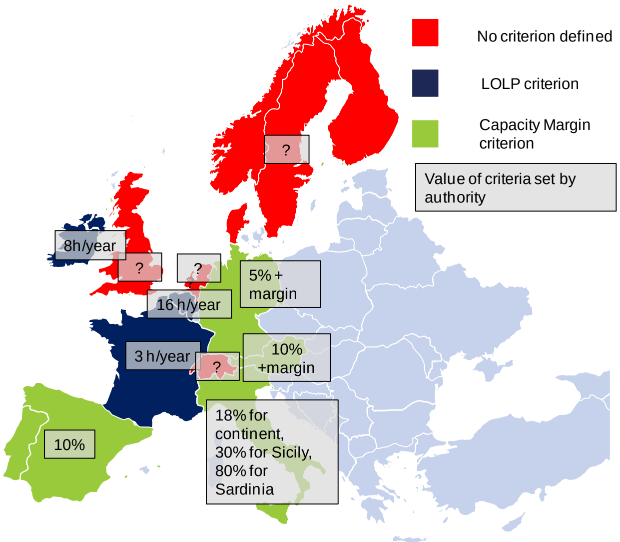
Each system bears specific hazards which result from the type of resources and technologies (seasonal hydro-reservoir, thermal equipment, intermittent windpower, etc.) but also the types of

[3] **Note that the pice cap of the infraday market differs also in another interval of very high price (10,000 to 100,000), because these prices are much more volatile, given the lower liquidity of the infraday.**

electricity use development (for instance, after a long lasting promotion of direct electrical heating in France, there is a very important thermal gradient of peak load of 2.3 GW per minus degree under zero Celsius). When countries succeed in windpower and PV generation development, they should take into account the high specificity of their seasonal, daily and hourly hazards of these generation units. If they do not, they spill their problem of supplementary need of reserve margin onto neighboring systems. A country with 50 GW of RES-E intermittent as presently Germany is, should have to develop the corresponding supplement of reserve margin. If countries do not adopt the same nature of criteria of adequacy, there will be long-term negative externalities between systems.

The negative externalities related to the differences in precautionary policies and adequacy criteria are probably more important than those which will result from different choices of adequacy approach or types of CRMs. As another side of the medal, it is also noteworthy that, if there is consistency in the approaches, equivalent efforts in matter of reliability and adequacy of each country will play a positive role in decreasing the efforts needed in the other countries because of the mutual contribution of each one to the adequacy of the others, which can be statistically assessed and foreseen.

Figure : Differences of criteria of reliability between some European countries
Source : CERA-IHS and table in annex



Whatever a regulator chooses between installing a CRM or to staying in an “energy only” market architecture, it is necessary that each one adopts minimal criteria for both adequacy (long term) firmness (quarterly term) and reliability (very short term) that lead each system to carry its own long-term and short term responsibility vis-à-vis the long term supply security of the systems with which they are physically and commercially integrated. It should be done in relation to the nature of hazards and which are specific to each of them, and the extent of associated risks. In the same vein, it will be necessary to define common rules of forward declaration of close down of equipment aligned more or less on the delivery date of the capacity rights.

The quite common idea that market integration could justify differences in precaution because the day-ahead and intraday energy trades will solve the respective reliability problem is highly open to criticism because they would justify any Member-State free-riding in the long term. In this respect the probabilistic criteria under the form of LoLP (loss of load probability) or LoLE (loss of load expectation) appears to be the most relevant for this empowerment, better than the deterministic criteria which will arbitrarily impose a reserve margin of 5% here, 10 % here, or else 15% where there is much windpower and PV generation.

In the deterministic approach (which is used in a number of countries and until recently by ENTSOE, generation margins are equal to a fixed percentage of the peak demand and operating margins sufficient to cope with the most likely contingencies. One of the drawbacks of this method is that it does not take into account the stochastic nature of supply and demand. Indeed, hazard events such as uncertainty in customer demand load, forced outages of generating units, and intermittent production have an impact on the adequacy capacity need. On the other hand, probabilistic methods provide more meaningful and realistic information about the hazard events that affect supply and demand (Prada and Ilic, 1999).[4]

3. WHICH SOCIAL INEFFICIENCIES ARISE FROM THE ADOPTION OF DIFFERENT APPROACHES TO CAPACITY ADEQUACY?

Public economics theory is not clear about the second best solutions to manage a collective good which is co-produced with private good, as capacity adequacy and electrical energy are by dispatchable equipment. Then, when different policy instruments are chosen to offer adequacy in each neighbouring systems, necessarily you would have different types of interferences between the CRM and the energy in each system. This also creates distortive effects if the energy markets are integrated. A fortiori this makes tricky cross-border exchange of capacity rights between markets with different CRMs.

In this section, after a brief overview of the different capacity mechanisms (3.1), and the usual criticism to the adoption of different capacity adequacy approach including the energy-only architecture (3.2), we consider different situations of asymmetrical cases with no congestion on the interconnection: first a market with CRM besides an energy only market (3.3.), second a market with capacity payment besides a market with an capacity obligation or a FCM, or a market with an obligation besides a market with a FCM (3.4). Then we consider the situations with different market designs in an initial situation with congestion on the interconnections during extreme peak (3.5). Then we sum up main findings (3.6).

3.1. *The variety of design options of capacity mechanisms*

A capacity mechanism can take several forms, ranging from decentralized price or quantity instruments to centralized monitoring through auctions of capacity contracts or options with the system operator. In each case, the regulator anticipates and defines the level of capacity needed to guarantee supply security by a certain date, but with real differences in the ways targets can be met.

- **Capacity Payments**: All generators, incumbents and entrants are paid for being "available" during every period. Bid prices should be aligned with marginal cost even in scarcity periods with a bid cap. In the most socially efficient design, the level is set administratively, by aligning the sum of energy and capacity revenues with long-run marginal prices of peaking units.[5] Under this efficient outcome, the capacity payment is calculated as the expected value of lost load (VoLL) per MWh during the curtailment hours multiplied by the loss of load probability (LoLP) targeted by the regulator. This is added to the short-run marginal price. One drawback of this mechanism

[4] Note that the methods of ENSTO-E, which, in the so-called Scenario of Adequacy Forecast to 2030 (see for instance, ENTSO-E, 2012) was dominated by the deterministic approach, are evolving to probabilistic methods , based on the simulation of exchanges between systems in several annual periods and Monte Carlo simulation.

[5] This is one of the main rationales for the adoption of the pool market architecture in Ireland. See IEA (2012) and Lawlor J. (2012).

is that there is no guarantee that the capacity target will be reached.

- **Capacity Obligation:** An obligation is established 3-4 years in advance for suppliers to sign contracts with new and existing generators. At the delivery date, the suppliers must submit a required number of capacity certificates equal to the peak load of their customers' portfolios, plus a surplus corresponding to the reserve margin needed for system reliability. It is defined a number of years in advance by the system operator in order to give time for investors to install new peaking units. As a result, suppliers may comply by developing vertical arrangements, either by building their own capacity units or by long-term contracts with independent producers or entrants. A secondary market is implemented for marginal adjustments by the obliged suppliers and the committed producers to ensure reliability.

- **Capacity forward auction** is a capacity payment where the price is set by a centrally conducted auction in which generators bid for capacity contracts. The auctions are conducted a number of years in advance (four to five years before delivery). Both existing and new capacity providers may participate. Forward contracts might be differentiated between new units (for which capacity revenues could be guaranteed in some way or another for several years), and existing units (for which revenue is only guaranteed for the year of delivery).

- **Reliability option auction** is a forward auction like the Capacity Auction, but the generators who effectively offer a "call option" receive the option premium in exchange for a guarantee that their generation capacity will be available during peak periods. It balances this guarantee against a capping of the revenue by the option strike price when wholesale price exceeds the level of the latter, which is also a way to protect the consumers against the price variability and the price spikes. It is a financial instrument with forward coverage rather than a physical instrument. It aims to guarantee stable revenue strands with energy revenues capped by the strike price and the fixed premium per MW.

- **Targeted mechanism for strategic reserves** requires some new reserve units (or demand-side response) to make up for any shortfalls foreseen by the SO. Payments which are contractually guaranteed for a long period are made only to specific generators and technologies. They are called on only as a last resort to prevent distortion of the energy market price signal. They are well adapted to systems with hydraulic dominance or small systems with some very large plants (such as the Finnish system). However, the targeted mechanism which may be effective in reaching the adequacy objective in the short-run, could deter investment in peaking units through the market, given that market players can anticipate the SO decision to call for tenders if reserve margins decrease too much.

Notice that the capacity rights are more or less clear, in relation to the double objective to have enough capacity resources during peak in a next year and to have a guarantee of reliability performances from them. With capacity payment mechanisms, these rights are vague. With strategic reserves, they are heterogeneous, because they are only explicit for the new strategic units selected after the call for tenders. It is not the case with the other instruments: in the bilateral (forward) obligation and the forward capacity (contracts) markets, the definition of capacity rights is really improved by the forward certification and the contractual commitment of producers to be available; with the reliability options auctioning, the rights are forward defined and in a financial way. So it is not exactly physical rights, but the incentives to create new equipment for the system's reliability and to be reliable in system stress period are quite the same.

Most of the issues addressed in this section are related to market architectures dominated by bilateral relations (complemented by PX), which have been adopted in most the European countries except Ireland, the Iberian peninsula and Italy (About institutional consistency of CRM design and overall market architecture, see box 2). In these bilateral markets in times of scarcity we must emphasize the impossibility of controlling exports of energy and reliability rights and to retain a flow of energy to another system both for legal reasons - the European Treaty guarantees the free exchange of energy - and for reasons related to the market design dominated by bilateral trade. Indeed on the opposite of a pool market architecture, a TSO is not allowed "to recall energy exports"[6] and the present market coupling algorithm increases the way that scarcity is shared between systems with different adequacy policies (criteria, CRM or not, designs of CRM).

Box 2

Influence of general market architectures on the choice of CRM designs

Before talking about interference of different adequacy policies between markets on integrated energy markets, we have to observe that preeminently distortive interference could exist between mandatory pools and bilateral markets (i.e. bilateral relations + PX). The products offered on the pool are not the same as the energy exchanged on the PX (the bid in the pool includes also different reserves and ancillary services for the system balancing. Moreover the pools are designed in a logic of controlling the bids and impose a quite low price cap (180 €/MWh in Spain, 1000 in Ireland), on the opposite of the bilateral markets with PX in which the price cap are quite high (3000 on EPEX), what create different levels of missing money.

The choice of general architecture differs also on another aspect: the influence of the choice of the CRM type. In Europe in systems with the pool design, a capacity payment had been or has been chosen (in the UK it was with a sophisticated ex-post calculation depending on the scarcity situation). In other systems as the US ones, the pool structure helps to choose centralized design of CRM as the forward capacity auction or the reliability options auction. Bilateral obligation as the one chosen in France appears a priori to correspond more closely with the general market architecture.

But in fact auctioning could be chosen also in bilateral markets. But there is a problem of consistency: most of the energy trade is bilateral either by internal contracts in vertical companies or by external contracts (in addition to the exchanges on the PX for the adjustments of the balancing responsible entities). In these cases vertical integration predominates, as for instance in the UK for reasons of risk management related to the balancing mechanism BETTA, installed after giving up the pool system. But in fact the two « philosophies » could be reconciled by making possible bilateral capacity contracts (mainly contracts internal to firms) beside the forward capacity contacts which are signed with the TSO, as it is envisaged in the future capacity market design in the UK (OFGEM, 2012; Elforsk, 2011).

Indeed, in the British project of CRM design, the TSO is in fact the residual buyer of capacity certificates beside the more or less vertically integrated companies' internal exchanges. But companies long in capacity as well as IPP and aggregators of demand response resources will contract with the TSO, via auctioning if they want to make money with their surplus of dispatchable resource*. Moreover capacity certificates could be exchanged in confidence between TSOs in two systems getting the same type of FCMs if the two auctions are synchronous and with homogenous

[6] On mandatory pool markets managed by an Independent System Operator like in the systems of PJM, New England and New York in the USA, the ISO is also the market operator and when it receives all offers day ahead, and the requests for notification to export, it has the opportunity to check the sufficient availability of energy and reliability rights in times of scarcity in order that all the electricity and reliability rights produced in the system are only used by the home retailers and by the SO' s needs for the balancing of the system.

products.

*It is also noteworthy that even in the different US forward capacity mechanisms; it is also possible for the vertically integrated companies to have internal exchanges. But in the most current designs they are obliged to formally bid at zero price on the auctioning as soon as their capacity resources are certified and included in the calculation of the reserve margin by the SO.

3.2. The usual criticism of non-harmonized CRM adoption

Two critical arguments against non-harmonized adequacy policies and asymmetrical situations of markets with or without CRMs are focused on the distortions of long term effects on energy market price, long term choices of location of their investment by competitors and beyond, cross-border trade[7].

First, in situations without congestion, the introduction of a CRM in a country could lead to the development of lower marginal cost equipment running during semi base load and peak periods than in the system without CRM (or with a less favorable CRM). Consequently this new equipment will be able to offer electricity on the integrated market at a lower price and will reduce the load factor (running hours) of some of the existing equipment in the other system without a CRM (or a less favorable one) in different periods. This could lead to premature mothballing or retiring of the plants and create stranded costs for the existing equipment. In this case new investment could be needed in the second system to maintain the same level of reliability when congestion tends to appear on the interconnection during scarcity period because the units of the first system are not sufficient to maintain the same level of reliability in the two systems which formerly were perfectly integrated. [8]

Second, the mere absence of a CRM in one of the integrated markets (or the difference in the CRM designs) could change entrants'preferences for an investment location between the two systems, compared to a situation without CRMs or with identical CRMs. Investment in new peaking units (or other adequacy resources) in the system with CRM (or in the one with the most favorable CRM) will change the annual price profile during peak. So the trade flows will be changed in comparison to the counterfactual during this period. A previously non-congested interconnection could become congested and it will restrict competition between generators of the two systems during congestion periods. So it clashes with the EU-wide objectives of price convergence[9]. We shall develop a criticism of this view in the next subsection, pointing that it will only last during a temporary period while.

In order to clarify the problem raised by the difference of adequacy approaches, we shall consider different cases of relations between two systems which have the same criteria of adequacy and

[7] See for instance the Clingaendel report on the CRMs in Central Western Europe (Clingaendel, 2012), p. 48-49 and the EC communication draft on guidelines (EC, 2013).

[8] Even if we choose cope with this issue without considering other market distortions coming from national public policies and their divergences, we can observe that the differences in RES-E policies (target of development, types of instruments, share of RES energy in total production, administrative barriers, regulatory uncertainty, etc.) have already created much more important distortions in the functioning of integrated markets and in the influence of the systems with the most ambitious objectives on the other ones. Moreover it is the introduction "out of market" of large scale variable RES-E generators which has incited to contemplate the implementation of CRMs here and there.

[9] Conversely previously congested interconnections could be decongested during this period if the CRM is implemented in the country with the previous high SRMC cost marginal resource in peak, and so with the highest price. So in this case, that goes in the EU's wished objective of better integration and higher competition.

reliability and which have the same size and load growth in order to focus on the main drivers of potential distortions. First we elaborate around a reference case of a country with a CRM beside a country which has no adequacy policy, but trusts the ”energy only” market to send long term signals via scarcity rents during price spikes. Then we consider some cases with different CRMs respectively in the two markets. In this approach we distinguish a situation with initially integrated markets and a situation in which there is an initial congestion between the two markets.

3.3. What happen in the asymmetrical case of a market with a CRM beside an energy only market? [10]

We consider two interconnected systems initially equivalent in peak load, capacity level and tech**n**ology mix. The reason for which the first one has adopted a CRM is the existence of a price cap (eventually as low as 1000 €/MWh) while the second, an energy only market, is without price cap to allow investment in peaking units by the market players' anticipation of scarcity rents.

We distinguish two initial situations of market integration:

- One in which the systems are perfectly integrated in times of scarcity
- A second in which congestions on the interconnections separated the two systems during such periods before the CRMs implementation.

In the first context, the respective collective goods that are the two systems' supply reliability are pooled in one collective good. Accordingly, if different approaches of capacity adequacy are adopted between the two systems, it does not affect this pooled collective good during a quite long period. Similarly, the capacity adequacy which is also a collective good proper to each system is pooled as a long term forward insurance for reliability in the near future. That said, this situation produces asymmetrical effects as a consequence of the different structures of income between producers in each market: the producers in the energy only markets earn the energy prices as revenues while those in the market with a CRM earn both the energy price and the capacity revenue. If there is no congestion in scarcity times, the difference in adequacy policy choices will inevitably affect the functioning of the integrated energy markets in terms of energy prices to be paid by the second market's consumers, but not in terms of reliability performances, up to the moment of the apparition of congestion on interconnections. But, depending on the type of CRM implemented in the system A, the story will be different after this moment.

3.3.1. In the system A, a capacity payment (CP) as CRM

We note that in a first step there is no short-term impact of the installation of a CRM in one of the markets on the pricing on the integrated energy market. In a former period, the price on the integrated market is only altered during the short periods of scarcity, because additional generation investments, in particular in peaking units but also in semi-base units, have been made in the market with a CRM as a consequence of the supplement of revenues it brings. Prices are therefore lower in peak in the energy only market, triggering less investment, mainly in peaking units and CCGTs in this system, but this leads consumers to benefit from cheaper electrical energy coming from the nearby market that has a CP.

These differences do not affect the social efficiency of the sum of the two markets, because the reliability performance of the two systems remains the same. There are not, strictly speaking, any

[10] This example has been developed in detail on the case of a CRM designed as a FCM, in Cepeda M. et Finon D, 2011, "Generation capacity adequacy in interdependent electricity markets" , ***Energy Policy*****, Volume 39, Issue 6, June 2011, p. 3128-3143.**

"capacity leaks". There is just a redistributive problem. Indeed, consumers in the system with a CP pay more than those in the neighboring energy only market. At the same time, the producers profit both from the capacity remuneration and the potential spillage of excess electricity, with peak units built beyond the needs of the reserve margin of the system with CRM able to supply the other market during scarcity periods.

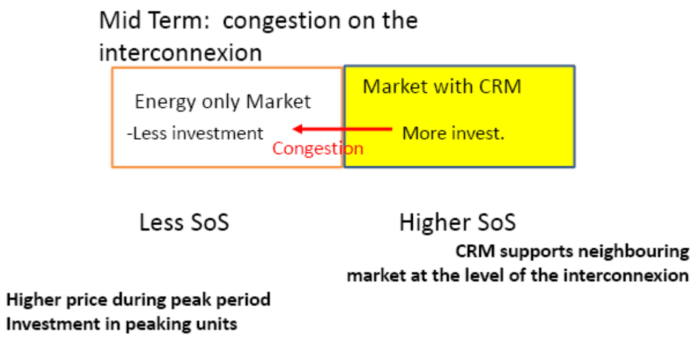


Figure 1. Stage 2 of the relation between the two systems: the period of congestion

However there is a dynamic effect in a third period: the flows from the market with CRM to the other occur without increased installations of peaking units in the other market, because price spikes have been erased on their integrated market and thus do not allow scarcity rents during peak load in this market. After having been physically integrated in earlier periods, the markets will be separate during some hours of the extreme peak within a few years. In each one during this period there will be consistency between the revenue structures of the producers and the separate need for investment in different technologies to meet energy and capacity needs.

It should be noted however that in the post-separation years, the reliability performances on the energy-only market will fall during a couple of years during which price spikes occur more frequently, the time to have sufficient “scarcity rents” during these current price spikes to trigger investment decisions in peaking units for reserve margin.

It is noteworthy in parallel that the neighboring system with a CP continues to contribute to the reliability of the energy only market during scarcity periods of the latter with energy flows at the level of the interconnection capacity.

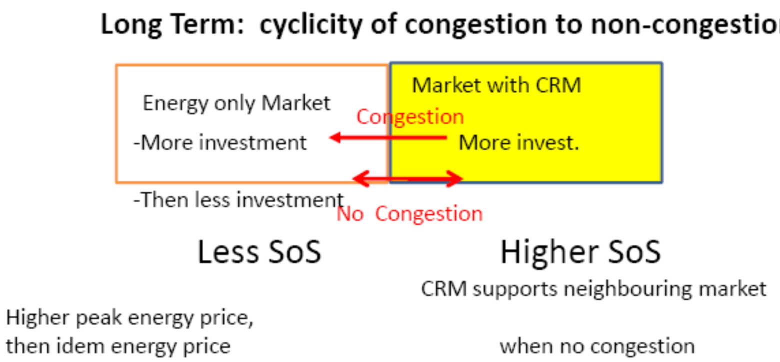


Figure 2. Successive periods of congestion and no congestion on the interconnection

3.3.2. If the CRM in market A is a quantity instrument (obligation, centralized auctioning) beside energy only market in system B

In this situation there is a way to control some of the distortive effects. Let us take first the problem in theoretical terms. In a context of uncertainty on the cost curve with a flat benefit curve, the theory shows that an instrument based on an obligation will never lead to the same quantitative result as an instrument by price which aims to guarantee revenues (Weizmann, 1974)[11].

In our case of a centralized or decentralized obligation the difference of nature of the instrument in comparison to a capacity payment will have a further effect. Indeed with the obligation or the FCM, the TSO defines a maximum probability of shortages in peak to be reached by targeting a total capacity covering the total system load, plus a reserve margin, less the statistical contribution of the other systems (calculated by the concerned TSO or by ENTSO-E for the delivery year). So the TSO has the possibility to limit over-installation of semi-base load and peaking units which would be assumed to supply the neighboring market without CRM. This could avoid what numerous experts fear about the adoption of heterogeneous adequacy approaches: an unfair competition between countries and markets in the installation of new equipment. [12]

Box 3
The particular situation of a strategic reserve mechanism in one of the markets

We set apart the situation in which a country adopts a strategic reserve mechanism while its system is integrated inside a regional market. This mechanism can directly influence the functioning of the energy market and the balancing mechanisms of the neighboring markets with which its own market is integrated, whatever the way the latter ones are designed (energy only markets, markets with other CRMs).

In fact the call for strategic reserves by the TSO in the market with this CRM could be too premature at the beginning of exceptional events or scarcity periods and it will depress the energy price on the integrated market in comparison to a counterfactual situation without strategic reserves. In order to avoid this situation, the regulatory rule concerning the call of these reserves shall be very restrictive. Imperatively reserve units should not be called by the TSO to bid on the energy markets or to complement its operating reserves before the marginal resources clear the energy market or the balancing mechanism (as is the case in the Swedish system).

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[11] Weitzman, M.L, "Prices vs Quantities", *The Review of Economic Studies,* 41 (4), pp. 477-491, October 1974.

[12] A recent exercise, realized in the Netherlands, could contradict our position by its alarmist conclusion. Indeed this exercise of market simulations to 2020 show that a small system without CRM (the Dutch one) will be de-optimized by the installation of a CRM with a 15% reserve margin target in the much larger neighboring system (the German one) with which it is perfectly integrated. The German system will attract investment in CCGTs and peaking units which will compete unfairly with the old equipment of the small system and deter new entries. But more importantly, it is noteworthy that the reliability of the two integrated systems is not degraded in 2020, and the Dutch consumers free ride by benefiting on a lower annual average price as well as on the German investment effort in reserve units.
See Özdemir, de Joode, Koustaal (2013) *Generation Capacity Investments and High levels of Renewables: The Impact of a German Capacity Market on Northwest Europe,* May 2013, working paper ECN—13-030.

3.4. Effects of differences in CRM design between two systems with no congestion on the interconnectors

As above, between a system A with a CRM more favorable in terms of revenues and risk management than the CRM in the neighboring system B, there are the same dynamic interactions as between a system with CRM and a system with an energy only market. There will be more peaking units (or “demand response”) investment in the first system, and so more energy flows from the system A to the system B in scarcity periods up to the year the congestion will appear during this period. However, as long as the CRMs are quantity instruments, the TSOs are able to control forward the reserve margin when they define the reserve margin target to be reached by the system, but some minimal harmonization of rules and design is necessary up front) when they adopt quantity instruments. The problem is completely different if the two CRMs are respectively based on two different principles, as we shall see in the following section.

3.4.1. Effects of difference of CRMs based on different principles

This is the case of a market with capacity payment beside a market based on a quantity instrument (Bilateral obligation, FCM or RO). The first market generally has a market structured in a mandatory pool on which the hourly revenue is composed by the marginal bid price aligned on the variable cost and a complementary payment, with a limit imposed by the regulator to the differences between the hourly energy price and the marginal cost of the marginal unit which clears the market: so there is little or no scarcity rent during scarcity periods on the energy market. Hourly revenue is in fact defined in relation to the long run marginal cost of the marginal technologies at each moment. This is the explicit philosophy of the Irish pool, and it was also the one of the first British pool.

The second type of market, based on bilateral relations, needs capacity revenue in exchange for commitment to be reliable during scarcity periods, in order to complement the energy revenue because limitations on scarcity rent by regulatory rules (price cap) or premature TSO intervention.

In this situation the exchanges between the two markets deal with products of different natures, and there is a need for transformation of the products when they are exchanges between markets. In the case of the exchanges between the Irish pool market (on which two products, energy and capacity, co-exist) and the present British bilateral one (without yet a CRM) on which the product includes energy and implicit reliability rights, the exporters from the Irish market have to bid on the pool and if they are selected, to buy back their electricity from the pool if they choose to arbitrate with a sale to British retailers or on the organized market BETTA (provided that they gain to these sales after paying the transport by the interconnectors). On the other side, the British producers bet on the fact that the sum of energy and capacity prices on the Irish pool will be higher than the energy price on the BETTA.

So when a CRM of FCM or RO design is implemented in a market (such as in the British market architecture in a close future) beside a pool market with a low price cap and a CP (as the Irish one), on the first one there will be a revenue composed by an hourly energy and reliability revenue per MWh and an annual capacity price for the equipment selected by the forward auctioning revenue. And beyond the border, the same equipment could win revenue which has a different structure: an hourly energy price restricted during peak by a price cap and an hourly capacity price per MWh when it runs during peak period. Another difference is that the installed capacity in the first system could be limited to the capacity target, while in the second system, there is not a capacity limit ad well as it could a deficit of capacity. In such a situation, this system could free ride.

3.4.2. Difference of incentives between bilateral obligation and auction of forward capacity contracts.

As said above, we suppose here that there is the same reserve margin between the two systems and in order to simplify, that there is no legal possibility of exchange of capacity rights between the two systems.[13]

1. First of all, incentives are not the same: in the bilateral obligation, there is one penalty on the certified producer if he is not reliable during the period of supply guarantee, and another one on the retailer who does not respect his obligation, while in the FCM there is only one penalty which is on the side of the producer, and in the RO this penalty is only implicit (payment of the difference between the very high energy price and the strike price to the SO). These differences in penalties create differences in the risk structures for the investors in new units.

2. The capacity contracts between producers and their counterparts do not have the same nature and therefore have different attractiveness to investors. The bilateral obligation (even formulated in relative terms, i.e. in percentage --109% for instance -- of their load at the delivery date) is exposed to the eventual lack of retailers' capacity contracting because of their risk aversion in face of their volume risk related to the possible switching of a share of their customers portfolio to more favorable competitors. Their risk aversion is not compensated by the possibility of reselling their surplus property rights on the secondary market. Conversely central auctioning of forward capacity contracts or reliability options creates better incentives to invest for two reasons: the credibility of the counterpart who acts as a central buyer and is not exposed to volume risk; and the standardized character of the contracts, which limits transaction costs.

Less investment in peaking units on the side of system A with a bilateral obligation to the benefit of the second system B with an FCM or an RO would mean that the TSO of the system B would account for a lower % of reserve margin coming from the statistical contribution of the other systems (and vice versa concerning the TSO of system A). So the overall reserve margin of the two integrated markets will remain at an efficient level during a certain period, up to the year of congestion could appear from B to A during scarcity episodes, unless the SO of system A decides to give more guarantee to investors in peaking units.

3.5. Situations with markets separated in scarcity times by congestion on interconnections

If there is congestion on interconnections between the two systems in times of scarcity, both the "reliability" and "adequacy" collective goods of each system are separated. The issue of social inefficiency which could result from the divergence of capacity adequacy approaches in their respective market architectures only arises in relation to the market integration during peak load. We should recall first that if there is congestion on interconnection capacities, the divergence of adequacy approaches does not affect the functioning of energy markets because the markets are structurally separated in times of scarcity. Marginalist hourly price is set during these periods in a way which is specific to each of these markets, depending on different marginal units to clear each market.

It is noteworthy that, if in this case we imagine the establishment of a single capacity market on these two energy markets in this type of situation, it would be completely inefficient. In Public Economics theory, it is a classical counter-example of inefficiency of the price unicity of a public good

[13] This raises fundamental problems of product difference as will be seen below.

which is related to two private goods which have separate markets. It could be the case between the regional markets as the Central Western European one and the peninsula ones (Iberic, UK-Ireland, etc) with numerous hours of congestion on their respective interconnections if the same integrated capacity mechanism would cover these different markets.

In any case, it is worthwhile to also observe that differences in CRMs could help to resolve a problem of congestion between two markets. If systems are initially separated by a congestion during peak periods because one system is in a relative deficit of capacity and asks for a lot of energy from its neighbor during these periods, the implementation in this system of a CRM (which has greater incentive power to help investment triggering than the CRM in the other system) could limit the demand for imports and so suppress congestion and allow alignment of marginal prices. The processus is quite the same when systems which are initially integrated with large interconnections between them, become separated by a congestion during some hours in peak periods because the more performing CRM in one of the systems.

3.6. Controlling the free riding between markets with different adequacy approaches

How to ensure that the capacity adequacy of a system which is paid for by national consumers benefits only to them, instead of benefiting to consumers of neighboring systems without CRMs?[14] Why should they have to pay for better reliability which benefits not only to their system but also to the other system?

In order to simplify the approach, we still consider two similar systems without congestion on the interconnections between them and we add two other hypotheses. First the two markets being fully integrated, they have adopted a similar price cap which is quite high (for instance 3000€/MWh) and which leaves a quite high scarcity rent in the system which remains with an energy only market. So we do not cope with a situation where the units built in a system with a CRM could benefit via some energy exports to other higher priced markets. Second systems which adopt a CRM are supposed to adopt a quantity instrument which is the best effective to reach the reserve margin target related to its anticipated peak load.

3.6.1. The issue of free riding between two integrated systems in scarcity periods

If the regulator and the TSO of system A have decided to establish a CRM while the one of the system B are confident in the energy only market incentives, it is in order to only allow their system to be sure that it reaches a target of reserve margin which is only related to the needs of system A and its peak load. It is because they are more risk adverse and have less confidence in the market's ability to reach the reliability level that they wish for their system A on behalf of their customers, than the regulator and the TSO of the system B. So they strictly focus onto the requirements for the reliability of system A, even though both markets are perfectly integrated. But the two systems implicitly share a long term insurance of reliability, despite their differences of efforts.

Nothing guarantees that in system B, incentives relative to the energy only market with the same high price cap as the market in system A, would allow a level of reserve margin in adequation to the specific hazards in system B. So it profits more from the efforts in A than the opposite, because the energy only market does not guarantee the same level of adequacy in B as the CRM implemented in A. Moreover procedures of market coupling *de facto* establish an arbitrage between the two systems and organize the trade of energy from A to B in periods of synchronous scarcities.

The TSO of system A cannot control the *de facto* pooling of the capacity adequacies of the two

[14] See this question mark in the Clingaendel report, p. 49.

systems and will find himself in a deadlock in a situation of synchronous scarcities, in future years when adequacy in B becomes much less important than in A. When there are arbitrages on energy and reliability rights in period of synchronous scarcities between A and B, it will be to the advantage of B with energy flows from A to B much larger than they would be if it uses a similar CRM. This could be viewed as a "capacity leakage" from A to B. In this case this TSO should be worried about ways to counter the arbitrage logics between the two systems during these periods. To correct this free riding which appears to be a surplus transfer from the consumers in A to the consumers in B because the risk of loss of load is higher, the energy arbitrages of market players located in A should be limited only to situations in which system A with CRM has some surplus, when the system without CRM is in a period of scarcity. But how to control the possibilities of “capacity leakages”? Are they compatible with the European legislation?

3.6.2. Ways to limit energy arbitrages between integrated markets with different adequacy approaches in times of scarcity

In fact we argue here in favor of the subsidiarity principle invites us to analyze this issue of capacity leakages and the possibility to restrict arbitrages on energy and reliability rights in the day-ahead and in the infra-day markets, from a country who preferred to install a CRM beside a country who prefers not to have such a precautionary approach and which stays with an energy only market, eventually with a quite low price cap.

A first and simple method between markets coordinated by a market coupling arrangement could consist in an agreement between the members of ENTSO-E to change the market coupling rules. Indeed, in the software of the market coupling, there are rules of curtailment in time of scarcity, which tend to equalize the level of curtailment between the markets in scarcity situations, whatever the differences of precautionary approaches in matters of reserve margin (See Vassilopoulos, 2013). So the first solution could be to differentiate the criterion of curtailment in relation to the severity of efforts made in matter of reserve margin and adequacy target. This means that these efforts should be recognized as contributing to an own collective good which is a distinctive and legitimate feature of this system.

A second method is already used by some TSOs under the name of “freezing”,. In periods of scarcity, a TSO could adjust its day-ahead calculation of Available Transmission Capacity (ATC) when scarcity is anticipated in its system. It turns back to the free trading principle but it is tolerated. The method could be legalized in an ENTSO-E agreement: countries with a CRM will be allowed to calculate ATC along with more restrictive criteria which should be clearly defined by the ENTSO-E comitology.

A third method, more market-oriented**,** is to increase the demand of reliability rights of the market players of the system with CRM (see box 1 about reliability rights). This could be done by imposing an operating reserve obligation (1-2%) on producers and retailers, in addition to their balancing responsibility, as well as to all other market players (importers, exporters, traders) able to arbitrage with other countries during the intraday period before the gate closure[15]. This obligation could concern windpower and PV producers above a certain size, (or under the mandatory aggregation of the smallest one in a “cooperative” structure to reach this size).

In this way reliability rights generated in the market with CRM should tend to stay in this system under the pressures of the obliged buyers' demand as well as the TSO’s requirements of reliability rights during the operational window (real time). Indeed in times of scarcity, this new obligation (combined with a significant penalty aligned on the VoLL for instance) increases the demand of reliability rights and can discourage arbitrage on energy and reserve services between systems that

[15] **Producers already support some obligation on secondary reserves in some countries, such as Spain.**

have adopted a CRM and those with an energy only market. Arbitrages of the former systems with CRM with the other systems will correspond to the surplus of reliability rights remaining in them after their use. In the same way limitations on the number of arbitrages will limit the influence of systems with CRM on the lowering of prices of neighboring systems with energy only markets.[16]

But this approach will impose a control on the trading activities of each player (producer, trader) during peak periods and their notification on the market. A factor plays in favor of a possibility of such a control: *on the intraday market coupling*, injector and receptor are identified, which could be a way to overcome the issue of individualized control if the obligation is defined as an intraday one. This change could be combined with the change in *the rules of curtailment* in the day ahead market coupling software. To conclude on this third way it is noteworthy that this way is more compatible with the rules of free trade than the two former ones.

3.7. To conclude on the differentiation of adequacy policies between markets

First, when the energy markets are fully integrated at the moment of implementation of CRMs here and there, and provided that a quantity instrument and a minimal probabilistic criteria is adopted, there is no frontal opposition between the absence of complete harmonization of adequacy policies and adoption or not of CRMs with respect to completion policies principles, in particular in matters of location of equipment and cross-border trade alteration, compared to a counterfactual scenario of perfect harmonization with either no CRMs at all, or strictly harmonized CRMs.

Second the problem is not the same at all when the markets are initially separated by congestion during scarcity periods. If a well-designed CRM is implemented in the more stressed system which tends to import up to the saturation of interconnections during scarcity periods, a mid-term effect will be the suppression of the congestion and it plays in the sense of better market integration.

Third, the capacity payment is the CRM which is the least adequate to mitigate the effects of differences between adequacy policies, in particular if the capacity payment in one system is over-dimensioned and attracts investors to their system rather than others. Moreover as capacity payments are generally associated to mandatory pool architectures, this adds to the complexity of exchanges of energy between these market architectures.

Fourth the indirect effects of differences between adequacy approaches, in particular the “capacity leakages” from the most precautionary countries, are the most manageable when the implemented CRMs are quantity instruments (bilateral obligation, auctioning of forward capacity contracts or reliability options).

Fifth, in case of differentiation of adequacy approaches, there are some possibilities to limit the free riding between systems and to control the “capacity leakages “from the most precautionary systems. Two of them (revision of market coupling rules, freezing of ATC) suppose an adaptation of the free trade rules on energy exchanges under the common governance of the regulators and the TSO. The third way which relies on national governance-- the obligation of operating reserve put on any market player -- does not need any European supervision, but would imply to reinforce the obligation and the control on every local player (generator, supplier, trader, etc.).

[16] By the way we should note that the mechanism of reliability options could potentially allow us to limit arbitrages. We prefer to focus on the much simpler tool based on a physical obligation on operating reserves, which is analyzed in the main text.

4. THE MITIGATION OF INTERFERENCES BETWEEN DIFFERENT CAPACITY ADEQUACY APPROACHES IN INTEGRATED ENERGY MARKETS

Differences in adequacy approaches create interferences by the influence of the differences of adequacy criteria on the functioning of energy markets, and the choice to whether or not create a CRM (or else by the different CRM designs). We should seek first to align the adequacy criteria before considering the differences of adequacy approaches. It is only after this prerequisite in a relevant political agenda that we can cope with the issue of mitigation of distortive interactions between markets of type A with CRM and markets of type B without CRM (and between markets with different CRMs with more or less stable capacity revenues).

4.1. Priority to the harmonization of price caps and criteria of adequacy

Following the analysis of section 2, it appears that the priority should be the adoption of quite similar price caps in order to align the level of incentives to invest in capital intensive capacity resources such as peaking units and demand response programs on one side, and to harmonize the level of precaution decided in each system by the regulator and the government, with the definition of minimal criteria of adequacy and reliability in order to avoid free riding between systems.

In this respect the probabilistic criteria is the most relevant to reflect the responsibility of each system in relation to the hazard factors which are specific to the supply reliability of each system in scarcity periods. This includes homogeneity of methodology of calculation, as well as the way the mutual statistical contribution of each system to the other ones is taken into account. Probabilistic methods should take into account the probabilistic contribution of other systems to the reserve margins of each one. They should not assume independence between each reserve margin, and thus should not neglect correlations between the generation margins of interconnected systems, in particular the non-correlation (or low correlation) between intermittent productions (and respectively between peak loads) in different systems.

Interdependencies between systems, which are characterized by their mutual interconnections' statistical contributions, need to be uniformly assessed with the same method. This should be the role of ENTSO-E, the European organization of TSOs, to define a common methodology and eventually to get control of the assessment of the evolutionary mutual contribution of other systems to the reliability in each one.

The harmonization of these criteria and these method around a probabilistic approach is more important than a harmonization of adequacy approaches and the choice of CRM designs because this approach is able to responsabilize each member state. Note in passing that the imposition of a minimal criterion which makes each TSO empowered on an equal basis (as the probabilistic criterion does) could incite a Member State originally in favor of the energy only architecture, to choose to install a CRM, as might be the case for Germany. Indeed due to the development of intermittent generation sources on a large scale, the probabilistic criterion should lead us to define a reserve margin that is much higher. It should also be noted that throughout we begin to admit that the "market" alone will not be able to reach the high reserve margin necessary to cope with the problems created by large-scale intermittent production on the system during peak and extreme peak.

4.2. *The need for adaptation of the SoS directive: which methods and which possible alignment of criteria?*[17]

The methodology of assessment as well as the analysis of the statistical contributions of the interconnections should be standardized under the coordination of the working group of ENTSOE. A crucial aspect of the assessments is that the interdependence between the systems could be very evolutionary, depending on the level of RES-E deployment, the success of the interconnector reinforcement policy, and the macroeconomic situations.

Generation adequacy standards should be harmonized across the EU, but should be developed taking into account potentially diverging preferences regarding security of supply. We need to adopt probabilistic criteria but it is politically difficult to adopt the principle of a strict harmonization of probabilistic criteria. The main option which seems to be the most in line with the "Community modus operandi" would be that a probabilistic criteria floor should be adopted, but each Member State may choose to go further in their precaution level. They may do so, despite the fact that their effort could be as useful for their neighboring systems as for them if there is no congestion, because more dispatchable equipment could thus be built in their system because of their more prudent criteria or else their more secure capacity mechanism. But we have seen above that some measures may be taken in order to avoid "capacity leakages" towards less precautionary systems and the *de facto* free riding of the consumers of these systems.

About reliability criteria, these concern the loss of load by one of the major equipments in a system (rule N-1). But development of large-scale wind power capacity changes the issue and makes necessary a rule taking into account the fading-out of all the windpower or PV capacity of a system. This issue of management of reliability rights for the needs of a given system is made even more complex by the differences of the curtailment rules in market coupling and also the price caps in the same market coupling, as it would be for instance if Italy would be integrated to the CWE market coupling. It is important to underline that, in a market coupling mechanism, if market A (Italy) has a price cap of 1000€/MWh while the neighboring system (France) has a much higher price cap of 3000€/MWh, it is possible for the generators of market A to bid on the market coupling at 1500 or 1800, with the possibility of being called by the market in market B, even if market A is in a situation of scarcity. The main question becomes to a question of changing the rules of the market coupling: at which level might the less precautionary TSO decide to curtail some loads when the most precautionary one (to reach a reserve margin by the help of a CRM) has to take the same type of decision because his system is also in a scarcity period?

A metaphor can be made with the Monetary Union inside the Eurozone. The creation of the Euro was accompanied by the definition of criteria of convergence in terms of budgetary deficit, even if each MS budget relies on national sovereignty. So nothing has impeded some MS to be more virtuous than the rule of 3%. But at the same time, the compliance with the rule was fictitious for most of the Eurozone members, in particular after the financial crisis when the MS have tried to save their banks. But at the end of the day, the virtuous countries feel slighted as they consider they have to participate in the deficits of the others via some new Common funds managed by the European Central Bank. If we transpose that to the issue of adequacy and reliability, that means that it should have a minimum adequacy rule establish on the same basis and a stringent survey of the national plans to respect this criteria. And in the calculation of the rule, the evolving statistical contribution of each system to the others should have to be taken into account, but with common rules of calculation.

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[17] **We support the introduction of mandatory risk assessments or generation adequacy plans at national levels similar to those required under the Gas security of supply regulations.**

4.3. How far can we go in accepting differences between adequacy approaches?

How far can we go towards accepting differences in rules between systems, for reliability remuneration and capacity mechanisms, if this leads to major tension with the principles of market integration? Before considering this issue, two remarks should be made.

A first remark is simply related to the differences of rules of TSO's contracting for the operating reserves and ancillary services, because this interacts with the role of CRM to give a complementary remuneration to reliable capacities, as these services do in relation to reliability rights. The current process of improving the integration of day-ahead and infra-day markets, for balancing mechanisms as well as network codes, will certainly result in a homogenization of reliability rights.

A second remark concerns the need of compatibility of energy market design and CRM design in each system, and for exchanging energy and capacity rights. The majority of EU energy markets are bilateral markets complemented with exchanges. Their integration proceeds from the same cross-border principles: coordination of facultative exchanges via market coupling and cross border bilateral transactions. In matter of adequacy, we could intuitively consider that the bilateral/decentralized obligation *à la française* could be the most compatible with this energy market design and, by extension, we could deduce that, if this type of decentralized energy market could be integrated, why not the capacity markets associated to the bilateral obligations because they should help also bilateral cross-border exchanges of capacity rights? In fact there is no need for such concordance. Decentralized energy markets could also be compatible with central auctioning of forward capacity contracts or reliability options in a system, and for exchanging capacity rights. But the issue here is mainly an issue of homogeneity of capacity rights to be exchanged.

An important problem is raised by the differences between market architectures: mandatory pool-type markets, such as in the Iberian market or Irish market, versus bilateral markets with facultative exchanges. On one side the price caps are much lower in the former market architecture than in the bilateral markets. On the other side capacity payment is generally added in the pool architecture to mimic long run marginal cost pricing in a long run market equilibrium perspective. The co-existence of such intrinsically different market architectures *de facto* result in different products that we wrongly supposed to be exchangeable on an integrated market of energy as we point out above. It must be underlined that these differences already impede integration of mandatory pool markets in the regional perimeter of market coupling which can only integrate systems based on bilateral relations and facultative exchanges. A fortiori the co-existence between a market with a pool architecture and a capacity payment in a system, and a market with bilateral exchanges and decentralized obligation or a FCM in the neighbouring system, would have *a priori* unforeseen distortive effects, because the impossible difficulties to homogenize the products energy, reliability rights and capacity rights. The least to say is that this makes cross-border exchanges of capacity rights and interconnections participations to respective heterogeneous CRMs, an economic non-sense.

A corollary of this later remark concerns the differences in price cap regulation between market architectures. Energy and capacity products, in the market rules of a mandatory pool, are designed more in a logic of long run marginal cost pricing (indeed the bids should be aligned on the variable costs even in scarcity periods with a bid cap near to 200 €/MWh). It is the opposite of bilateral market architecture which is run on logic of short run marginal costs, with constant betting on future revenues from hourly scarcity rents to trigger investment in peak plants. On the EPEX market the price cap can be quite high (3000€/MWh), leaving open some opportunities to extract scarcity rents during peak periods. Then if we want to reduce interference between energy markets and eventually to allow exchange of capacity rights and interconnection participation, should we have to impose the same price cap, as well as an alignment of the CRM designs on the same one?

4.4. Do differences in adequacy approaches tend to oppose competition policy principles?

In this subsection we cope with the issue of differences in adequacy approaches in the perspective of competition policy criteria by using the previous findings. The main argument against differences in adequacy policy is that they will influence the location of new equipment between systems and change cross border trade compared to a counterfactual scenario without CRMs or with strictly harmonized adequacy approaches.

4.4.1. Controllability of the effects on competition in integrated markets

If we consider the simplest case of two inter-related and identical systems without congestion between them, the previous developments show that there could be some influences but they are transitory and controllable if the CRM is a quantity instrument. Indeed, there will be a difference in revenues for the same type of equipment between the two systems (energy + capacity prices in the system with CRM, only energy revenue in the system with an energy-only market).[18] So generation investment in one country will be favored in comparison to the other country. In fact one CRM suppresses the level playing field, not in a short term perspective, but in a long term competition perspective. However we could argue that there are few distortions to competition if the CRM is a quantity instrument for several reasons.

First, if we contemplate the relative share of capacity revenues in the total revenues for each type of equipment, the problem concerns mainly peaking units and much less mid-merit and base-load units, in particular in systems where the price cap is quite high, as it is in the European bilateral markets of the CWE zones (3000€/MWh).

Second, it is true that the difference in revenues between the two systems incites to preferably invest in new capacities in one of the two integrated energy markets, the one with CRM. But with energy markets being completely integrated and the circulation of capital totally free, the market players of the "energy only market" could invest in the market with CRM, to export towards their "energy only system" during price spikes by making their own arbitrages.

But as said before, we have to distinguish between the CRMs based on quantity and the CRMs based on a price instrument. With a CRM based on quantity, the TSO has the possibility to limit over-investment in semi-base load and peaking units, which are attracted by the CRM revenues but which aim to supply the neighboring markets without CRM. CRM based on obligation or centralized auctioning could avoid the impact feared by numerous members of the expert community from a heterogeneous CRM approach: unfair competition in the installation of equipment between countries and systems. Central auctioning can be the most transparent in this respect. A market design with capacity payment does not offer the possibility to control opportunistic installations in

[18] We would have similar arguments with different CRMs in the two systems.

the system if this payment is overestimated.

Third, whatever the CRM design, the surplus of investment by local producers and entrants in the system with a favorable CRM would not be at an excessive order of magnitude. The reason is that, beyond a certain level it would be risky investment because the exports from new units in excess of the local needs would be exposed to the risk of new congestion on the interconnections with other systems in period of scarcities. With the extension of market coupling, which is based on anonymous transactions, there will be no guarantee that these new generators could succeed in their arbitrage with the other systems.

Fourth they could have some situations in which CRMs would have a positive effect in terms of trade. Certainly there are situations off differences in adequacy policies and CRMs adoption which lead to some changes in cross border trade during peak periods and generate transitory congestion when the systems were perfectly integrated before CRMs implementation, conversely the adoption of a CRM in a system which formerly imported much energy during peak but with a restriction by the interconnections capacity, could help to suppress this congestion.

4.4.2. Difference of adequacy policies does not change competition inside each system

Inside the system with the CRM, all the competitors received the same revenues: the energy price and the capacity remuneration. It is the same as for the differences between RES-E support policies: no difference inside a Member State, but differences of revenue and guarantee level between MS. Curiously, the tenants of no CRMs at all, or fully harmonized CRMs in the name of competition policy principles, make no reference at all to the jurisprudence coming from some recent examples of DG Competition decisions which allow national policies which are opposite to market integration. We take the example on the recent decisions concerning the French law NOME, which creates a regulation in price and in quantity of 80 % of the French wholesale trade corresponding to the nuclear production on which up to 25% should be sold at a low regulated price to the Historic operator's competitors.

It is on such a basis that the DG Comp reports on June 2012 on the French law NOME and the calculation of the price of nuclear drawing rights (called ARENH) which are attributed to the EDF's competitors up to 25% of its total nuclear generation, considering that it allows competition inside France (cf. European Commission, 2012a). And yet the NOME law is in total opposition with two competition principles: First, it creates a barrier to arbitrage on wholesale nuclear electricity exchanges between the French and the other MS markets by deterring it by a penalty. Second, as just said, it obliges EDF, the nuclear producer, to align its market retail price on the ARENH tariff for the share of nuclear electricity in its overall supply to its customers[19] ; it is also the way the default tariffs to households will be calculated. In the two cases it is typically Sate aid. The result is that it deters entrants from investing in new capital intensive equipment in the French system. So we can conclude that, referring to the Brussels competition authority's decision, the impact of differences of adequacy policies, or of CRMs between systems should be considered as secondary, provided that the competition in a country is not altered.

[19] In other wordssEDF should define its market price by aligning its internal price of nuclear electricity between its generation division and its commercial division on the regulated price of nuclear drawing rights. There will be regular supervision by the regulator on this point, along a provision of the NOME law.

4.4.3. Relativization of the problem of distortive location of equipment by difference of adequacy approaches.

We shall add three elements of relativization:

- First, the structure of revenues from new equipment installed in two systems with different market architectures (pool versus bilateral markets) and with different levels of price cap is already different (180-500-1000 €/MWh in the Spanish Italian and Irish pools versus 3000€/MWh in the bilateral markets of the CWE zone), and these differences have an effect on the location of the new units to be installed.

- Second, the systems in which the regulator and the TSO do not consider as important the respect of minimal criteria of adequacy and reliability could be considered as free-riders as they provoke differences in installation of new peaking units between systems, given that peaking units investment are much more risky in an energy only market.

- Third, differences of RES-E supports and barriers between systems have important effects on the location of these RES-Eequipments and they have progressive disturbing effects on the exchanges between systems and energy markets, which come from the fatale production of variable RES-E. At the limit, CRMs could correct these inter-systems effects by inciting the development of new peaking units or demand response in the systems with important capacities of intermittent CRMs.

To sum up, when the issue of competition policy principles is brandished, we can counter that the adoption of different adequacy polices is not in opposition to competition on the integrated energy market between the different systems if some precaution in matter of harmonization is contemplated. In particular when a CRM is a quantity instrument (decentralized obligation or centralized auctioning) , the TSO is in a position to control the installed capacity surplus in relation to the needs of his system, after having taking into account the statistical contribution of the other systems. Moreover inside countries with a CRM, competition is not altered by the installation of the CRM, given that any entrant can come and invest, in particular operators coming from neighboring "energy only" markets or with a less favorable CRM.

5. THE RATIONALE TO ESTABLISH EXCHANGES OF CAPACITY RIGHTS BETWEEN SYSTEMS

Cross-border participation with bilateral exchanges of capacity rights is often considered as the solution that is most consistent with the improvement of integration of the successive energy markets up through real time. The E.C. document accompanying the communication of the Commission on the "Generation Adequacy in the Internal Market" (E.C., 2013) considers in this way that "*a mechanism which excludes cross border participants could result in new generation capacity displacing imports. This would undermine the financial viability of generation in other member states and could have a negative impact on regional security of supply"* (p.25). This position on cross-border trade of capacity rights is backed on an interpretation of the Article 4.3 in the 2006 SoS Directive: *"(... Member States shall not discriminate between cross-border contracts and national contracts"*) of the 2006 SoS Directive, which refers itself to the provision of free trade of the European Treaty. Such a presentation of the cross-border participation issue, which is quite common among electricity market experts, is erroneous for three immediate reasons.

- First, this approach does not distinguish energy and the other goods attached to the electricity as reliability and long term insurance of supply. It does not define property rights on capacity and reliability. So we may consider that it does not deal with the freedom to trade on capacity rights but only on energy.

- Second it ignores that, along the rules that should be chosen by ENTSOE and the TSOs to assess the capacity adequacy in interdependent systems, the contribution of the foreign systems to the supply reliability in the local one is taken into account in the calculation of outage probability and the reserve margin target in the quantity based CRM designs, whatever cross border participation on a bilateral basis is allowed or not by the local regulation. So there is no displacement of imports by new generation capacity because the adequacy target is calculated by statistically taking into account energy imports during scarcity periods. There will be imports and trade flows from foreign systems with revenues addressed to the exporters during scarcity periods, and they will be paid at the quite high peak price of the common energy markets in scarcity period.

- Third, the regional security of supply is certainly not altered by the preference of some systems to prefer to take into account the statistical contribution of the other systems rather than allowing bilateral cross-borders transactions because each system will also seek to reach a minimal criterion of adequacy and reliability, even those which stays with the energy only market architecture.

Moreover, to promote bilateral capacity rights trading between systems is questionable in terms of transaction costs and social efficiency improvement. We argue that, even if these exchanges are feasible if there are common criteria of reliability and adequacy and CRMs based on quantity instruments, they involve property rights which are difficult to be clearly defined measurable in order to be exchanged between systems. Moreover, if we refer to the social efficiency criteria, they only bring forward clear economic gains in very specific and temporary situations of overcapacities in some system.

In this section we first analyze the reality of the benefits that the trade on capacity rights, which are only a "promise” of a reliability rights exchange at a delivery date, would bring to the integrated systems. Then we shall point out the difficulties in trading capacity rights between systems that are inherent to the nature of this product. Finally we examine an ideal situation of total harmonization of criteria and CRMs designs which would really allow exchanges and complete participation of interconnections, but for that with the merger of all the similar CRMs in the same CRM.

5.1. Low economic stake of inter-system exchanges of capacity rights

The stake of increasing liquidity and integration in energy and reliability rights markets is much more important than the stake of capacity rights trading which would justify harmonization at any cost for easing trade of capacity rights. It should be noted first that the need for additional back up and “flexibility services” due to the rise of intermittent production in a system should not be confused with the need for additional reserve margins in extreme peak due to the same rise. Answers to the first need, in particular by the better integration of day ahead, infra-day and balancing markets, reduce the stake of a total harmonization of capacity adequacy approaches. Indeed the achievement of the Target Model on energy and reliability rights markets by the help of the new network codes will enable the sharing of flexibility service resources to cope with the intermittency variability. This pooling of flexibility resources will help to cope with the respective hazardness on generating units and peak loads of the different systems, within the limits of interconnection capacities between countries.

By comparison the economic stake of capacity rights trading is quite modest. Assuming a situation where countries have the same adequacy approaches and there is no congestion in times of scarcity between the two systems, economic gains from trade in capacity rights will emerge in two types of situations. First type of situation: we find advantages in situations of transitory overcapacity in one or more systems. Then an exchange of forward capacity rights allows us to postpone the construction of new reserve units in neighboring systems which are close to capacity scarcity during peak or exceptional situations, while they could give some revenues to the equipment about to be closed in the systems in overcapacity (as we observe presently in number of countries) . But we should not forget that these situations are temporary and that they could also be shortened by private decisions to close some equipment or by resumption of growth.

Second situation, in a longer run perspective of market equilibrium (the only one that really matters when capacity creation is at stake for the sake of the long term supply security), there would only be long standing gains from trade in a situation where one country was much more efficient in building new capacity in peaking units. So firms in this country would decide to build such units to sell energy to other markets having a capacity mechanism during peak periods and to sell capacity rights by committing forward to be reliable in scarcity periods, and thereby have double revenue which makes these investments profitable. But this hypothesis of comparative advantages on peaking unit costs is not realistic because these techniques (gas turbines, combustion turbines) are standardized technologies with the same cost from one system to another.[20] In other words there is no long term comparative advantage in the trading of capacity rights, only occasional advantages due to overcapacities here and there.

Whatever it would be, if there is a general wish to have a treatment of capacity rights conform to a strict reading of the Treaty and the SoS directive, the exchanges of capacity rights should be strictly limited to exchanges between systems in overcapacity above their reserve margin and neighbored systems near the level of precaution in matter of reserve margins. If not there will be ”capacity leakages” from systems with precautionary policies to systems with market-confident regulators, but which implicitly free ride.

By comparison, better integration of day-ahead, intraday and real time energy markets, mutually reinforces the reliability in each system, and beyond the long term supply reliability insurance, the so-called adequacy of each one. Pooling the flexibility resources via the extension of balancing zones should indeed moderate the expense of new back up of large scale wind and solar productions. The more the area of reliability rights is important, the less the balancing need of each system will need internal adjustment and operating reserves services and – as an effect on capacity adequacy – the less reserve margins for the long term will be necessary, provided that interconnection capacities are there. Nevertheless, in system s with large scale windpower and PV capacities, these developments in “flexibility services/reliability rights” markets do not suppress the need for a capacity mechanism for the attribution of a complementary economic value to each dispatchable capacity in extreme peak, given the possibility of weak windpower generation (Bradbury, 2013, p.15).

[20] We could consider the particular case with hydro-dominant countries with seasonal or weekly storage capacities (Austria, Switzerland and now Norway for The Netherlands and Germany), but these assets already exist and there is not a stake of new developments. In this case exchange of capacity rights from these systems to other systems would depend on the existence of water inflows over the statistical average in the dam during peak periods. But this does not allow firmness of forward commitments with the neighboring systems.

The case could be different for countries endowed with sites allowing the development of new pumping storage equipment. But this technology is more dedicated to answer to flexibility needs than forward capacity needs. Moreover the present experience show that the effect of large scale PV development in a region on the spread day-night prices deters investment in such equipment in the neighboring regions.

5.2. The possibilities of capacity rights trading

If a priori the principle of trading capacity rights between systems stems from the principles of the European treaty and the SoS Directive of 2006, the likely heterogeneity of adequacy approaches requires us to question the feasibility of such exchanges and, if feasible, the importance of new market rules to establish. Indeed we need third sets of stringent conditions, most of which are unattainable to reach exchangeability of capacity rights in a number of situations.

a) ***The first set of conditions* is related to the homogeneity of property rights. First, in principle, we should ensure the existence of explicit capacity rights in each market, and when they exist, they should be homogeneous. To respect these two conditions we need:**

   1 / That TSOs have adopted an uniform minimal criterion of adequacy (probabilistic nature, minimum level of precaution), as well as the same method to assess the statistical contribution of other systems to their need for reserve margins;

   2 / That each market has a capacity mechanism so that there is an explicit capacity right which has an economic value in its home market to be compared to the value of similar rights in the other markets;

   3 /that the CRM designs have the same nature (all CRMs acting by the quantity and physical capacity rights for instance) in order to give an economic value of equivalent nature on both sides of interconnections.

In other words we need to get the same product, or at least quite similar products, to be exchanged between markets with different CRMs.

- But between a system with capacity payment and a system with quantity instrument (bilateral obligation or central auctioning), there is no possibility of exchange because there is no explicit capacity right associated with equipment in the capacity payment system, even if the payment is related to the observed reliability of the existing and new equipments.
- But, even if, between a system with a bilateral obligation and a system with a central auctioning, the situation of capacity rights is clearer because the capacity rights explicitly exist (A producer in one system with the BO could contract with a local retailer or could bid to the TSO's auctioning and vice versa), the rules should be homogenized to level the playing field a minima. The forward time of the obligation should be the same as the forward time of the auctioning in order to avoid a producer escaping from a contract in one of the CRM and making arbitrage with an arrangement in the other one where the forward term is shorter. Nevertheless the contracts linking reliable producers and their foreign counterparts between respectively a decentralized mechanism (bilateral obligation) and centralized ones (FCM auctioning or RO auctioning) would remain different between the two types of CRMs and they imply different risks for investors.
- But, it is the same between CRMs with physical capacity rights (BO and FCM) and those with financial capacity rights (the RO) because there is no direct equivalence which is reflected in particular in matter of revenues during peak periods: indeed the generators received the capacity price and the wholesale price in the former ones (BO and FCM) while he received the premium and no more than the strike price when the wholesale price goes up during peak hours.

So it will never allow us to create a perfect level playing field for exchange of capacity rights, even if some convergences of rules could make close the revenues by CRMs in the same situation (for instance the strike price of the RO mechanism is aligned on the energy price cap in the market designs with a BO or a FCM).[21] We could imagine a sort of exchange rate between the two systems.

Second, if *a priori* it seems impossible to have capacity rights exchanges between a market with CRM and an energy only market (as suppose above), it is noteworthy that in fact exchanges could make more sense if one of the systems stays in a "energy only" architecture and would export capacity rights than between markets with different CRMs. If could be sold from this system to a system with a CRM if the TSO of the importing system with CRM would create property rights in it which are aligned on those in its system. This trading would need a strong intervention of the two TSOs who would have to narrowly cooperate for the capacity certification, the checking of the compliance of the exporter unit (with its commitment to be reliable during scarcity periods), and the eventual reduction of marketized interconnection capacities.

b) *The second set of conditions* deals with the identification of situation in which capacity rights would be allowed to participate to the CRM of other in a way compatible with the social efficiency criteria. If exports of property rights are allowed in every physical situation of each system, this means that, given that there are some chances that units will export of capacity rights and so commit to export corresponding reliability rights at the delivery date, the TSO of each system is forced to give up his total control over the use in last resort of the reliability rights generated by the local capacities in periods of scarcity in it system. This is the reason for which, as said before (section 3.5), the exchanges of capacity rights should be strictly limited to exchanges between systems in overcapacity above their reserve margin and neighbored systems near their level of precaution in matter of reserve margins, in order to let the former TSO all the margins of maneuver in periods of tight capacity.

Concretely this means to define three rules. First the capacity rights exported to the other systems could only be sold by the units which have not been selected by the CRM of the system in overcapacity (either by the auctioning in the case of FCM or the RO; or by the purchase of the obliged suppliers in the bilateral obligation). That means that there is no common market, but a timing of successive markets, with transactions firstly on the CRM of the system in overcapacity, and then participation of the non-selected units to the CRM of the other systems. Second a complementary rule is that the total capacity allowed to export capacity rights should not exceed both the statistical contribution of this system to the other system, (as it is assessed by ENSTO-E, and a fortiori by the interconnections capacity from the exporting system to the importing one. Third a TSO should have the power to forbid capacity rights exports as soon as they anticipate disappearance of their overcapacity and an approaching situation of tightness, as well as the right to reduce the export of energy associated to exported capacity rights in case of an exceptional unanticipated situation of scarcity in his system (with the maximum of imports possible). This means definition of common criteria to decide a suspension of trade on forward capacity rights from one system towards the other ones, as well as vested power of control for ENTSO-E.

If this condition is not acceptable by the different stakeholders in the UE to the detriments of the TSOs' functions, a TSO should get the short term possibility (different from the former forward possibility) for a TSO to stop the energy exports associated with a capacity right deal with the neighboring systems during periods of tightness in his system. This condition is related to the

[21] Bilateral contracts in the bilateral obligation will never present the same transaction costs and the same guarantees as contracts between an entrant and the SO in the FCM system of the RO system. With second and third one the contracts are standardized and the SO is a much more credible counterpart that a private retailer in the bilateral obligation. An independent investor in system A with a bilateral obligation would prefer to bid on the SO auctioning of system B with FCM or with a RO auctioning. Moreover some independent existing producers would do the same rather than search for contracts with a retailer short in capacity in his own system.

temporal imbrication of “capacity rights”, and “reliability rights".[22] As said, a TSO should have the exclusivity of purchasing reliability rights in last resort for guaranteeing the stability of his system, given his legal responsibility to ensure its supply reliability. If there is a legal possibility of exporting capacity rights, he must give up this exclusivity because these sales by a local player rely on the commitment to export the associated reliability rights (under the form of energy deliveries) in times of scarcity. If it could be acceptable in a period of overcapacity, it would certainly not be in a period of scarcity.

c) *A third set of conditions* concerns the "transferability" of the capacity right from a system to another system. This transferability is submitted to the possibility of firm reservation of access rights to interconnection capacities in advance to allow the transfer of the corresponding reliability rights at the delivery date because of the possibility of congestion in times of scarcity. The commitment of the capacity rights export is only valid with this firm reservation because the risk of congestion of the interconnection: the reliability rights of the external capacities in the neighbored CRM may have to be mobilized by the other system during scarcity periods. But, market coupling cancels the firm booking of access rights, as well as it does not guarantee at all that the energy bid price of the units committed in the neighbored CRM will be sufficiently competitive to be selected. Firm booking will not also be possible with the forthcoming adoption of the "Financial transmission rights" on interconnections presently governed by physical transmission rights auctioning.

So it appears that the priority given by the Target Model realization to the increasing liquidity of the energy markets and their integration, (especially through market coupling, and in the future, through extension of financial access rights), is contributing to hinder the development of credible commitments of capacity rights exchange. Indeed between two systems the market coupling makes it impossible to ensure the realization of a firm reservation of rights of access to interconnections and beyond, the realization of the commitment to deliver physical energy in the other system during its scarcity periods. Beyond these traits of cross-border exchanges, there should be a robust agreement between TSOs based on clear reciprocity.

Nevertheless, as it is current in market design in the electricity markets, which de-connects physical flows and commercial flows, a principle could be that it is the units committed in CRM contracts with the other systems which are in priority considered by the market coupling software, as if they implicitly have a share in the interconnections, provided that have bought forward transmission rights.

5.3. The ideal-type of capacity rights exchange: full harmonisation for the implementation of one single CRM?

The ideal-type solution for organizing of capacity rights exchanges between systems could be the adoption of a unique capacity mechanism managed by a strict coordination of TSOs on the model of "locational" forward capacity contracts mechanism applied in the PJM markets in the USA.

This mechanism takes into account the main congestions between the systems which are integrated in the PJM and also inside each system in times of tight capacity, and the auctions help to reveal different values of capacity rights (PJM ISO, 2012, Brattle Group, 2008). It is a signal for installing new

[22] We explain in box 1 this temporal imbrication of “capacity rights”, (which, as said, are forward promises to be reliable at the delivery date), and “reliability rights" (which, when explicit, are short term or real time non-energy products, and when “implicit”, are related to energy sales or transformation of non-energy products (reservation) in real time energy) .

generation equipment or better yet, new transmission lines. But, such a solution involves many institutional conditions to be feasible in the context of the European Union. In particular it requires very close coordination of TSOs, an integrated energy and reliability markets, as if they would be a unique TSO and unique market in the same way as there is a unique ISO and unique pool energy market between the different companies of the three jurisdictions of the PJM. This “utopia” could be envisaged in the EU in certain regional perimeters as the CWE zone, or more widely in some years, given that important benefits could result from (Zachmann, 2013).

Moreover it supposes that major internal congestions in each TSO are taken into account, that is congruent with the nodal pricing applied in the PJM and its short term incentives, while in the EU, the enlargement of market coupling --which is a zonal pricing between systems—ignores internal congestions (which could increasingly result from loop flows coming from windpower inflows in the interconnections from other systems) and thus does not help to create short term incentives inside systems.

Another fundamental difference is that in the EU, the TSOs are owners of the infrastructures while it is not the case of the ISO in the PJM. That means that there is a clear stake to create incentives to develop transmission lines by way of the price signal of the locational capacity price (and not only by the nodal pricing), while incentives of other nature exist in the EU member-states, in particular via the zonal tariff for building new interconnections.

6. CONCLUSION: SOME MINIMAL HARMONIZATION PRINCIPLES IN MATTERS OF CAPACITY ADEQUACY

We argue that harmonization of adequacy approaches at any cost makes low sense, knowing that the improvement of intraday and reserve markets (including balancing and ancillary services) and their homogenization which are improved by the Target Model implementation, allows better real time market integration and much more important social efficiency gains. This will allow a better solidarity than now. It does not solve in itself the problem of interferences between systems when adequacy policy and CRM designs are different.

6.1. *Some conditions to avoid negative externalities between systems*

So it appears necessary to give priority to a number of measures of homogenization much simpler to adopt that measure of harmonization of CRM approaches.

- To adopt a homogenous probabilistic criteria of adequacy and reliability (among which the criterion of load curtailment) by taking into account statistical mutual contribution to the reliability of the other systems, because it is the best criteria for making systems responsible for their own risks in face of their specific hazard factors during peak periods;

- To adopt a minimal probabilistic criterion of outage for the adequacy target of reserve margin to reach;

- To adopt similar rules of forward control of private decisions of close down, in particular by alignment with the horizon of TSO anticipation (the delivery date in the BO, FCM and RO);

- To adopt a similar high price cap to avoid differences in incentives to invest in peaking and reserve units, even if the general market architectures (pool design versus bilateral market) remain different.

In short the Member States (MS) should converge on the same target of adequacy and on the energy price regulation which conditions to invest in order to reach the same minimum level of probabilistic precaution during peak load periods. Member States are free to go beyond the minimum criteria but it is necessary in this case to amend some rules of exchanges in order to avoid capacity leakages from precautionary systems towards less precautionary systems. In this sense it is worthwhile to underline that if the part of the algorithm of the Market Coupling software on the curtailment rules de facto creates short term solidarity between systems by equalizing the ratio of curtailment of total load in each system, this is done at the detriment of the most precautionary systems. It is an example of some simple amendments that appear to be needed.

6.2. The adoption of a set of minimum principles in the design of adequacy policies and CRM designs

These minimum principles should aim:

- To avoid direct influence of the capacity mechanism on the successive temporal markets (day ahead, intraday, balancing), in particular in the case where a regulator chooses the strategic reserves mechanisms;

- To prefer quantity instruments (BO, FCM or RO) to price instruments (capacity payment), given that they allow us to control the effectiveness to reach the reserve margin target, to statistically take into account the contribution of interconnections and eventually to limit the "capacity leakages" between systems with different adequacy approaches in a mid-run perspective;

- To rely on market-based mechanisms: auctioning of forward capacity contracts or reliability options or else decentralized obligation (with certificates exchanges on secondary markets);

- To search for symmetry of the treatment between supply options and demand options (load shedding, etc.) in each CRM design.

These minimum rules will never suppress the long term impacts on investment in the markets with the CRM which gives better incentives to invest than in its neighboring markets with other CRMs, or else with no CRM at all. But this is mainly at the detriment of consumers of the more precautionary systems in terms of costs. Nevertheless, as said above, the major effects of this flaw (in terms of free riding of the other systems, and of long term change of energy trade between systems) could be controlled by a TSO when a quantity instrument is adopted by limiting excessive location of equipment in its system.

Finally differences of adequacy approaches are not in opposition to competition principles in the way that the EC applies these principles. In particular they do not distort competition inside each market, a principle which has been highlighted concerning the acceptation of the regulation of the major part of the wholesale trade in France designed by the French law NOME.

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