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Abstract

This article addresses the functioning of capacity remuneration mechanisms (CRMs) in an integrated European electricity market featuring a high share of intermittent renewable energy sources. We first highlight the close ties between flexibility provision and generation adequacy, and explain why these two issues must be considered concomitantly when developing CRMs. We then show that while Member States have different needs, addressing security of supply in a purely national way will be expensive. We finally identify three prerequisites for a workable Europeanization of national generation adequacy mechanisms: a consistent assessment of adequacy needs and cross-border resources, a dedicated method to allocate risks and remuneration of cross-border resources contribution, and a definition of rights over the system resources at times of extreme scarcity.

Keywords

Capacity remuneration mechanisms, Security of Supply, Flexibility, Integrated Energy Market

1. Introduction[*]

The ability of energy-only markets to provide an attractive revenue stream to investors in generation assets has recently been questioned in Europe. The debates on "energy-only markets vs. CRMs" or on the comparative advantages of the different broad options (strategic reserves, capacity payments, capacity markets…) have already been the object of extensive work in the literature, but this old debate is now taking place in a new context. We identified two specific issues requiring more investigation. First, a large share of the resources remunerated will have to operate in a flexible way so as to cope with the variability of intermittent RES. In this context, generation adequacy is not only about delivering an abstract adequate volume of "capacity", but also about delivering an adequate flexibility mix for the system. Part of the incentives to flexibility might be embodied in short-term energy prices, but it is clear that the issue of generation adequacy cannot be decoupled completely from the issue of flexibility. Second, the implementation of national CRMs in Europe challenges the slow convergence towards an integrated European electricity market (Glachant and Ruester 2013). Different needs, different resources, and different priorities have led to the emergence of a patchwork of CRMs, and it is likely that it will not be possible to conceive a European mechanism that would fit the needs of all Member States. Yet, it doesn't mean that national schemes must lead to an autarky that will be all-the-more costly if it is impossible in practice to confine the impact of CRMs to generation adequacy.

The objective of this chapter is therefore to introduce the question of CRM implementation in the particular context of integrated electricity markets featuring a high share of intermittent RES. The first section focuses on the relationship between flexibility and generation adequacy and explains why these two conjoined issues cannot be separated in a system featuring a high share of intermittent RES. The second section lists the costs of autarkical CRM, taking into account the pervasive impact on flexibility remuneration. The third section describes the requirements for euro-compatibility of national generation adequacy policies.

2. The pervasive impact of CRM on flexibility remuneration

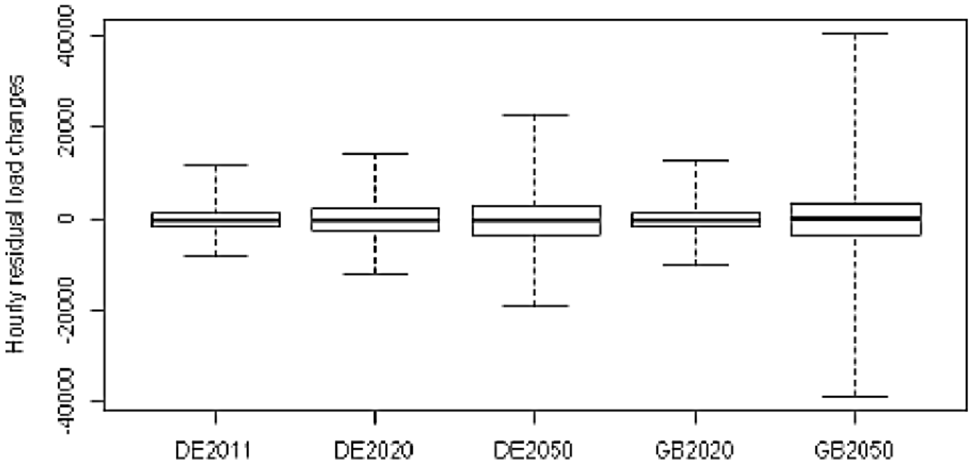
2.1 Ensuring generation adequacy will require flexible resources…

In a system featuring a high share of intermittent RES, generation adequacy is not only about capacity margin. As the output of these resources is variable and not perfectly predictable, more flexibility will be required, where flexibility is defined here as the capability of a given resource to adapt production or consumption within a given timeframe (whether these variations were expected or not). Flexibility therefore refers among others to the ability to start-up and ramp-up quickly power units, to cycle frequently, and to operate at low minimum loads.

The needs for flexibility are specific to a certain power system. These needs will vary with the generation mix, the load pattern, the nature of RES, and interconnections to neighbouring countries. The case of hourly changes in residual demand for both Great-Britain (GB) and Germany is illustrated by Bertsch, et al. (2013). Their simulations up to 2050 show that the maximum hourly change in residual load (up and down) will increase as RES constitute a higher share of the generation mix (See Figure 1). They also show that these results will vary a lot across countries with different resources and generation mix, as for instance between GB and Germany.

[*] This work is a preliminary version of a chapter to be included in the book: Hancher et al, EU Energy Capacity Mechanisms: Law, Policy, and Economics, Oxford University Press 2015 (forthcoming).

Figure 1: Hourly changes in residual demand: actual and model simulations (Bertsch et al. 2013)



Flexibility is hence needed in power systems, but flexibility is costly. Increased wear and tear leads to higher costs for generators, while maintenance contracts must be renegotiated to operate in a flexible way (Pérez-Arriaga and Batlle 2012). Plants will operate in a flexible way provided they receive incentives to do so, through energy prices or specific incentives. Note that another interesting result of the study by Bertsch, et al. (2013) is that maximum hourly variation of residual load will increase much more than the standard deviation of these hourly variations. Concretely, it means that we will be confronted to issues of low load-factor of flexibility capacity and uncertain remuneration, similar to the challenges employed to advocate the implementation of CRM.

2.2 … which implies that CRM will remunerate flexibility

It is widely acknowledged that flexible resources will be needed in the future to cope with the development of intermittent RES. However the issue of flexibility remuneration is sometimes presented as decoupled from the generation adequacy issue. Some long-term mechanisms would be implemented to ensure generation adequacy, while new short-term signals would ensure flexible operation of generators.

In practice however, it is difficult to see how a pure generation adequacy policy could be implemented. It is clear that a properly designed generation adequacy policy should ensure the availability of capacity where and when needed. It is also clear that such remuneration for availability will then have to be associated to penalties in case of unavailability. The opportunity cost for the generator of not being available when needed will include this penalty and hence be higher. However, hourly variation of residual loads can be quite fast in a system featuring a high share of renewables, as seen in Figure 1. In order to be available at times when RES output drops quickly to low levels, inflexible units have to start generating earlier. For a thermal unit with relatively high variable costs, it may imply generating at a loss so as to be available when needed. Investment in flexibility will avoid such losses, as a unit able to start-up and ramp-up quickly will be available when needed without incurring such losses. The incentives to invest in flexibility will then be determined by the (high) value of generating when needed as intermittent RES are not available and the corresponding prerequisite of generating when prices are low (or negative) as intermittent RES are available. The incentives to invest in flexibility will then be higher as the penalty in case of unavailability is higher. Flexibility will be at least partly remunerated through any generation adequacy policy.

One might argue that penalty for unavailability could be reserved to situation when flexibility is not needed: inflexible generators would be excused for not being available in such situations. Yet, the relevance of such clauses is highly questionable in a system featuring fast and significant variability of the residual load. It seems obvious that those clauses would then reduce strongly the guarantees provided by such generation adequacy policy.

Even the simplest CRMs will therefore reward flexibility. Of course, some more complex design can deliver even more incentives to deliver flexibility. Special technical requirements can for instance be imposed to some or all of the resources remunerated for generation adequacy. Note that according to the theoretical analysis developed by Joskow and Tirole (2007), the more states of nature featured in a power system, the more complex a capacity mechanism will have to be to restore efficiency. This conclusion is highly relevant in a system featuring a very variable residual load with a wide range of probable states of natures. More complex CRMs will then increase further the remuneration of flexibility through this channel.

2.3 The impact of CRM will hence not be limited to "capacity"

There are different ways of remunerating flexibility. Flexibility can be remunerated implicitly, by embodying its remuneration in energy prices. Its value must then be accessible via adequate fluctuations of energy prices, as well as trough arbitrage between day-ahead, intraday and balancing markets. This approach is for instance defended by Bertsch, et al. (2013), who show that there is no need for explicit remuneration of flexibility. In their simulation, participants receive sufficient incentives to be flexible in order to benefit from high energy prices when possible. Alternatively, flexibility can be remunerated explicitly through the definition of new flexibility products, or by setting new technical requirements matching the flexibility needs.[1]

In practice, remuneration is often a mix of these two options, as part of the flexibility needs are expressed through energy prices, while a complementary part is expressed through the definition of specific products established by the transmission system operators (TSOs). However, in a stable long-term equilibrium, there is no free lunch. If the need for flexibility is constant, additional remuneration for the same service through a channel will be compensated by a lower remuneration in another channel (for instance a lower differential in energy prices). A consequence of flexibility remuneration through generation adequacy policy is that it will hence mechanically reduce the remuneration of flexibility in other markets such as the energy markets and ancillary services provision.

Flexibility can be delivered by a wide set of resources, both in terms of technology and location. The optimal set of resources to meet future flexibility needs is still not fully identified. The distribution of remuneration for flexibility across the different markets is not relevant as long as each market remains accessible to all potential flexibility providers. However, in practice, the scope (in terms of technology and location) of resources allowed to bid in CRMs is reduced compared for instance to energy markets. Some resources can be excluded from CRM as a result of direct requirements: no participation of intermittent RES, exclusion of demand-side resources, no remuneration of cross-border resources. Some resources can also be excluded as an indirect consequences of other requirements: the timeframe can be incompatible with the development of transmission assets, availability requirements can be incompatible with demand-side resources or intermittent RES, limitations on the minimum size of bids might prevent the participation of smaller participants, and the way the contribution to generation adequacy are assessed may discriminate against some resources.

As the value of flexibility is reallocated from energy markets and ancillary services to a CRM biased towards a given set of resources, the scope (technology and location) of resources able to deliver this flexibility will be reduced. This impact will be higher when the share of flexibility remuneration delivered through CRM will be higher, and for more exclusive CRM. This could be

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[1] There are for instance ongoing discussions in California to establish flexible ramping products.

especially costly in a context of uncertainty regarding the best set of resources required to meet future flexibility needs.

3. The costs of autarkical CRM

3.1 Conceiving national CRMs in a purely national way is expensive…

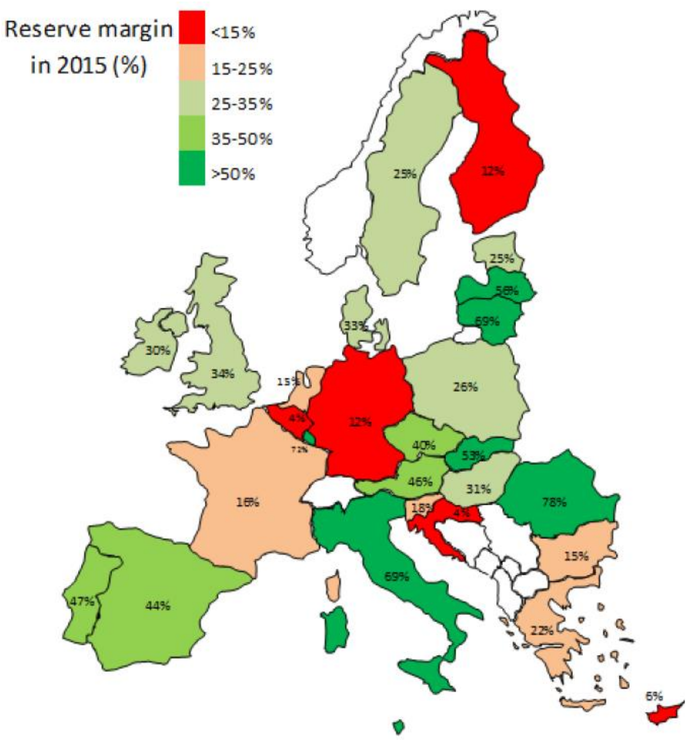
The needs, the resources and the objectives of Member States differ substantially. France aims at dealing with a high peak demand and electrical heating when temperatures are low. Germany wants to phase-out nuclear plants and must take into account the North-South architecture of its grids. The Spanish CCGT fleet is currently unprofitable as a result of overcapacity. Such specificities have resulted in a wave of heterogeneous proposals for CRMs, from centralised, targeted strategic reserves in Belgium, to decentralised, market-wide capacity obligations on suppliers in France.

Yet, the difficulty to conceive a unique scheme fitting all Member States is certainly not a reason not to look after consistency across nationally specific scheme. The benefits of a multi-lateral (or regional) approach towards security of supply are indeed obvious by comparison to a national autarkical approach.

Autarky leads to excess capacity

First, current level of reserve margin and future needs vary across different Member States. Some of these states experience large amount of surplus capacity, while the reserve margins are shrinking in some neighbouring countries. This is illustrated in Figure 2, established in a report by THEMA consulting group (2013) for the Directorate-General Energy of the European Commission. A multi-lateral reserve margin will therefore be better than the smallest national reserve margins, even with constraints coming of limited interconnections.

Figure 2: Reserve margin trends in the short-term in Europe (Source: THEMA consulting)



Second, stress events across neighbouring countries are not perfectly correlated, which means that the surplus capacities will generally not be needed at the same time by the different national systems. Of course the stress events are also partially correlated: weather correlations between neighbouring countries can result in similar hourly load among different systems as well as correlation of weather-driven output from intermittent RES among these systems. An analysis of historical levels of capacity margin from 2005 to 2011 in Great-Britain (GB) and other member States (France, Ireland, Spain, the Netherlands, and Germany) has shown that there was indeed a correlation between low (less than 20%) hourly capacity margins in GB and Ireland of France (Pöyry 2013). Yet, there was no correlation between GB and any other system at times of very low capacity margin (less than 10%) in GB. While a majority of stress events with low capacity margins occur in winter, they are rarely coincident (Pöyry 2013). Similarly, the regional analysis undertaken in the ENTSO-E Scenario Outlook & Adequacy Forecast 2014-2030 aims at identifying groups of countries requiring simultaneous imports for different reference points in time. The only case identified in the study is the block of Denmark, Germany, Czech Republic and Switzerland requiring simultaneous import in the winter period in 2025. Yet there is then sufficient import capacity available on the external borders of this group to cover these needs. Resources can therefore effectively been shared at the regional scale to cope with non-coincident stress events. Autarkical policies will require a higher level of investment in generation capacity.

Excluding the activation of cross-border resources from generation adequacy policies will therefore lead to higher overall costs, as the potential to share capacity resources available at a multi-lateral scale is lost. The costs of provision aiming at ensuring national self-security were estimated to 3.0 to 7.5 billion euros per year from 2015 to 2030, reducing the benefits of an integrated energy market by more than 20% (Booz & Company, et al. 2013).

Generation adequacy policies will also impact energy markets

Generation adequacy (the availability of sufficient resources capacity when needed – including activation of demand switching) and flexibility (the ability to adapt production or consumption to the system needs within a given timeframe) are two cornerstones of a reliable power system hosting a high share of intermittent RES. However the issue of flexibility is sometimes decoupled from the generation adequacy issue. One assumes some long-term mechanisms would be implemented to ensure generation adequacy on the one hand, while looking at other short-term signals from day-ahead to balancing horizon to ensure an optimal dispatch of generation and activation of flexible system components (generation, demand or storage).

Such a partition between long term adequacy building and short term flexibility activation seems however misleading, as explained in section 0. The ability of system resources to start-up and ramp-up quickly, to cycle frequently, and to operate at low minimum loads becomes inevitably critical in a system hosting a high share of intermittent RES. For a thermal unit with significant variable costs, it may imply generating at a loss so as to be available when needed. Generation adequacy incentives end inevitably impacting prices and flexibility remuneration in the "short term" markets. If the generation adequacy policy is biased ex ante towards a given set of resources (by technology and location) further distorted conditions are introduced in the short term markets acting ex post. This pervasive impact of capacity remuneration on other deliverables will be a source of additional costs.

3.2 … and will not be accepted by the European Commission

Member States have a unilateral right to influence the general structure of their energy supply. They also have a legitimate right to define the conditions and operation of security of supply within their boundaries. They also bear the complementary national regulatory frames and authorities. These strongly national foundations of the EU power systems are reflected in the diversity of national balancing arrangements and reliability standards. The Electricity Directive 20009/72/EC (article 7) allows Member States to implement '*a tendering procedure or any procedure equivalent in terms of transparency and non-discrimination*', in the interests of security of supply.

All of this said European Commission also has solid weaponry coming from internal market's freedom for trade or competition policy for state aid. That is why Commission will not let national schemes tearing into pieces the integration of internal energy market. In Commission's guidance on public interventions, it is clearly stated that '*mechanisms to ensure generation adequacy should be open to all capacity which can effectively contribute to meeting the required generation adequacy standard, including from other Member States*'.

In order to prevent distortion of competition and trade, Commission has two powerful weapons. First energy is legally a good and as such, the dispositions of the Lisbon treaty regarding free movement of goods apply. It prevents unilateral restrictions of energy imports and exports. Second even for a legitimate state intervention the guidance states that '*Member States, when intervening to ensure generation adequacy, should choose the intervention which least distorts cross border trade and the effective functioning of the internal electricity market*'. The Commission will use its State Aid strong powers to prevent or cure any public intervention that would unilaterally harm or discriminate cross-border trade.

4. A frame for a workable Europeanization of national generation adequacy mechanisms

It is now clear that national generation adequacy mechanisms must take into account the contribution of cross-border resources, either to avoid the extra costs of autarky or to ensure compatibility with the guidance of European Commission. We propose in this section a set of tools ensuring a minimal Europeanization of national generation adequacy mechanisms. A first tool is a methodology allowing an assessment of the adequacy needs and a measurement of the contribution of cross-border resources. A second is a frame of legitimate remuneration and allocation of responsibilities for services delivery at activation. A third and last tool is a multi-lateral frame to coordinate this activation of services at times of general and multilateral scarcity.

4.1 A consistent assessment of adequacy needs and measurement of cross-border resources

The agency for the cooperation of energy regulators (ACER), in its report on capacity remuneration and the internal market, underlines that '*the contribution from cross-border capacity to security of supply is often not taken into account sufficiently well when addressing national or local adequacy concerns*'(ACER 2013). CEER in its own 2014 report reminds the remaining difficulties to assess regional security of supply (CEER 2014). It states that national generation adequacy outlooks are established with no consistent definitions, methods or scenarios, and in most cases with no identification of the impact of correlated events at regional level on security of supply. It highlights an urgent need for harmonisation of methodologies within Europe. It calls for a more robust and comprehensive methodology to assess security of supply at a regional scale, as the direction and the volume of flows through interconnectors are the result of partially correlated conditions such as load and output of intermittent RES in the different Member States. The main harmonisation and assessment challenges are presented in Table 1.

Table 1: Harmonization and assessment challenges identified in methodologies for assessment of generation adequacy (source: own categorisation based on CEER 2014)

Type of challenge	Parameter	Main variants
Harmonisation Challenges	Reliability standard	- No standard - Probabilistic assessment of generation adequacy - Capacity Margin
	System stress	- No reference - N-1 rule - System states (normal/alert/disturbed) - Resource unavailability
	Peak-load	- Statistical - Model-based
Assessment Challenges	Treatment of variable generation	- Historical data - Fully unavailable - Percentage of firmness - Detailed modelling
	Domestic network modelling	- Copperplate approach - Optional transmission constraint analysis
	Interconnection	- Isolated system - Interconnection modelling (historical data mostly)
	Correlations	- No impact of simultaneous severe conditions in different systems
	Scenario consistency with ENTSO-E scenarios	- Sometimes weak or no consistency - No strong connection with load forecasts

There are two ways of including the contribution of cross-border resources in national generation adequacy policies. A first "explicit" approach is to allow cross-border resources to participate by themselves (hence "explicitly") in the process, in conditions objectively non-discriminant vis-à-vis domestic resources. A second approach is "implicit" because it bases the procurement process on the domestic resources, while taking into account the statistical contribution (hence "implicit" contribution) of all the cross-border resources to national generation adequacy.

The explicit approach is more demanding and was judged too difficult to implement in France, Italy, or the UK. The Department of Energy and Climate Change (DECC) proposal for instance clearly states that the government '*is keen to find a way for interconnected capacity to be able to participate [explicitly] in the Capacity Market*', but that implicit participation will be considered until a practical solution can be found to ensure physical delivery of contracted cross-border capacity (Department of Energy and Climate Change 2013). It is also planned that ways to further improve the participation of cross-border capacity will be developed by RTE (RTE 2014). The new Irish Single Electricity Market has developed an explicit approach based on a mark-up on imports, and a mark-down on exports. On the continent, the widespread "market coupling" makes it difficult to identify the resources imported and the ones exported. Moreover, the mark-ups currently include a component calculated ex-post, which is in contradiction with the implicit allocation of transmission capacity. The implicit approach is therefore the only easy option currently available in coupled electricity markets.

The implicit approach is the one currently developed in the proposals of CRMs in France and in the UK. In France, the contribution of cross-border resources is taken into consideration by employing a multiplying coefficient ('coefficient de sécurité') initially equal to 0.93 but revised annually (RTE 2014). The size of the obligation is equal to the estimated peak demand multiplied by this coefficient. In Great-Britain, the expected contribution from interconnection at times of stress in Great-Britain will also be withdrawn from the amount of capacity auctioned in the capacity market (Department of Energy and Climate Change 2013). A panel of experts asked by DECC to scrutinise proposals made by the TSO national Grid felt that some reliance could be attributed to interconnectors, and that current evidence points at an average contribution of interconnectors equal to 50% of their nameplate capacity (Department of Energy and Climate Change 2014).

Yet the implicit approach is not simple either: even a basic assessment of the overall contribution of cross-border resources remains challenging. Indeed, despite high availability factors of interconnector, the availability of flows through interconnectors cannot be easily guaranteed until real-time. The contribution of interconnectors is actually highly variable and influenced by concomitant conditions across several European systems, making it difficult to foresee what to get from the interconnectors at times of stress. In a study analysing the correlation of stress periods in the electricity markets in GB and interconnected systems Pöyry (2013) showed that the historical net interconnector flow to GB had not been driven by system parameters in GB or in another of the included system. The authors of this study concluded that the contribution of interconnectors is highly variable and influenced by concomitant conditions across several European systems, making it difficult to rely on the contribution of interconnectors at times of stress in GB. For instance, while net flows on interconnectors reduced the number of hours with very low (less than 10%) capacity margin in 2005, net flows on interconnectors increased the number of hours with very low capacity margin in 2007 (Pöyry 2013).

In the absence of a sophisticated probabilistic methodology, Member States might have to exclude the participation of resources committed in another generation adequacy mechanism, which is referred to as "No double-counting". However, even in neighbouring systems, scarcity events are rarely concomitant. Some resources will actually contribute to generation adequacy in several systems, and at different times. The "no double-counting" policy therefore overestimates the probability of concomitant stress events in different systems, leading to multi-lateral overcapacity and extra costs. Mitigating double-counting might come from refining the adequacy products, allowing the time-periods of commitments to match more accurately the needs of different systems.

4.2 Risk allocation and remuneration of cross-border resources

Allocating the risks of non-delivery by committed cross-border resources is challenging. The actual contribution of committed cross-border resources entails three prerequisites: the resource itself must be available, the interconnector must be physically available, and energy must flow through the interconnector. The risks related to physical availability of the interconnector and resources can be allocated respectively to the interconnector operator and the resources operator, who are best able to manage these risks. However, the direction of the flow and the maximum available capacity of the interconnectors are driven by concomitant conditions in different Member States, as illustrated in Pöyry (2013). Predicting these market conditions over the long-term is problematic, and the associated risk can therefore not be managed by any entity in the absence of a regional system operator.

Allocating unmanageable risks to actors who cannot handle the risks linked to the direction of flows might result in a reduced participation of cross-border resources. It is likely that national TSOs will for instance tend to be conservative in their assessment of external contribution. This is indeed illustrated by the different levels of reliance on interconnectors expressed in Great-Britain by National Grid (0% reliance compared to nameplate capacity of interconnectors) and the panel of experts consulted by DECC (about 50% reliance compared to nameplate capacity of interconnectors). As no national entity is able to manage the risks of non-delivery by cross-border resources, a multi-lateral frame to allocate responsibilities for services delivery at activation will hence be a prerequisite to an efficient contribution of cross-border resources to generation adequacy.

Another issue is the remuneration of cross-border resources. The implicit approach described in section 0 allows taking into account the contribution of resources at the regional level, thus avoiding the costs of excess capacity. However, it implies that the contribution of interconnectors and cross-border resources is not remunerated directly, nor directly competing with domestic resources. It also implies that these cross-border resources are not responsible for their contribution to generation adequacy. Remunerating the contribution of local resources through a CRM while only providing the scarcity rent to cross-border resources will lead to distortions. Insufficient remuneration of interconnections could also lead to local addition of generation capacity pre-empting network infrastructure solutions. The contribution of interconnectors to security of supply is admittedly taken into account in the cost-benefit analysis performed at times of investment, but it might not be sufficient.

4.3 Definition of rights over the system resources at times of extreme scarcity

Generation adequacy policies aim at coordinating the different actors of the system vis-à-vis extreme scarcity cases. The emergence of national CRMs aiming at insuring consumers within a certain system against extreme scarcity can become a source of conflict as Member States do not live in isolation. The many interdependencies between European power systems make it difficult for a single system – or certain consumers- to ensure their "own" adequacy. This will become an issue at times of extreme scarcity, when energy prices might be unable to keep energy flowing towards the "better" insured consumers. The development of a regional approach to generation adequacy (including solidarity principles) requires that a set of rules to determine curtailment level at times of extreme scarcity is established before extreme events happen. Current rules in the market coupling algorithm Euphemia for instance impose identical curtailment ratios in all bidding areas (Price Coupling of Regions 2013):

> For those markets that share curtailment, if they are curtailed to a different degree, the markets with the least severe curtailment (by comparison) would help the others reducing their curtailment, so that all the bidding areas in curtailment will end up with identical curtailment ratios in line with all network constraints.

It is clear that solidarity in the electricity sector at times of scarcity matters as much as it matters in the gas sector, and that generation adequacy is partly a transnational public good. But it is also clear that everybody has to take responsibility in interdependent systems to ensure a minimum reliability level. As some Member States are willing to insure more (at a higher level) their constituency against extreme scarcity than the neighbouring countries, it becomes crucial to measure the efforts made by these Member States under heterogeneous generation adequacy policies and the quantity of energy that consumers are entitled to at times of scarcity. If a common frame cannot be found to allocate fairly the rights to consume energy at times of scarcity, there is a danger that Member States will turn towards autarky so as to avoid cross-border socialisation. Solidarity principles should not prevent those who paid for a higher level of insurance from enjoying the higher level of adequacy they contracted for.

The contribution of cross-border resources will only be reliable if the priority of foreign demand with contracted system adequacy is ensured over domestic demand without similar adequacy commitment. Pérez-Arriaga (2013) for instance argues that '*a true security of supply for electricity at EU level will only happen when import and export physical contracts have priority over any domestic demand without such contracts'*. According to Pérez-Arriaga, this is in direct line with Article 4.3 of the Security of Supply directive stating that in emergency situations, member states should not discriminate between cross-border and national contracts. Yet, in most of the member states, explicit clauses in electricity laws allow to interrupt exports in case of domestic scarcity, which has been applied whenever necessary.

Finon (2013) develops a few methods to limit capacity leakages, focusing on priority issues between domestic demand with contracts and cross-border demand without contracts. A first method would be to change the market coupling rules that determine the level of curtailment between interconnected countries in scarcity situations. While current rules tend to equalize the level of curtailment, the level of curtailment could be adjusted to reflect the efforts made by each country to achieve generation adequacy. A second method ("freezing") would be that TSOs adjust calculation of available transmission capacity when they anticipate scarcity, therefore retaining domestic capacity. Both methods suppose an adaptation of the free trade rules on energy exchanges (Finon 2013).

By confronting these arguments, it is clear that the dichotomy between domestic demand and cross-border demand is not sufficient in the context of generation adequacy policies. There is then a clear risk that arrangements allowing country A to rely on imports from cross-border resources in country B (by preventing suspension of exports from country B at times of joint scarcity) will also symmetrically prevent country A from retaining the benefits of regional generation adequacy (by preventing suspension of exports from country A at times of joint scarcity). A regional security of supply will only be possible if the priority of demand with contracted generation adequacy is ensured over demand without contracts, which implies that national generation adequacy policies should be coordinated at a larger regional scale (through bilateral or multi-lateral agreements).

A first option is to make sure that the actual level of physical rationing of systems (or of their consumers) reflects the efforts made ex-ante to be insured against curtailment. An alternative option is to put into place a financial compensation from systems –or consumers- (being de facto benefiting ex-post from the activation of the generation adequacy policy but having not contracted for it ex-ante) to systems –or consumers- (having contracted ex-ante for such a policy but being not benefiting ex-post of the activation). In any case, there is a need for consistent agreements on both the volume of resources that the systems –the consumers- in each Member State are entitled to in the various possible cases and the value scale of the necessary financial compensation. It comes back to valuing -at time of high scarcity- the efforts made by some systems –some consumers- to ensure adequacy.

5. Conclusion

The introduction of CRM in many Member States in Europe has revived the old debate on "energy-only markets vs. capacity remuneration", that has already been the subject of many contributions to the economic literature. However this chapter focuses on two new issues that are specific to the current context of power systems in Europe. First, as the share of intermittent RES has become significant, "capacity" is not sufficient to ensure generation adequacy: an adequate level of flexibility is also needed. Second, exchanges between European power systems and allocation of cross-border transmission capacity are made efficient by market coupling algorithms. Generation adequacy policies should not lead to a costly move away from the path towards an internal electricity market.

This chapter first explains that it is illusory to try and separate long-term signals for resource adequacy from short-term signals for flexibility. In a system featuring a large share of intermittent resources, ensuring generation adequacy is not about securing a certain adequate level of installed capacity, it is about providing an adequate flexible mix of resources. It implies that even the simplest CRM will not remunerate only "capacity", but also lead to a redistribution of the remuneration for "flexibility". Therefore, excluding some resources (by technology or location) from CRM will also determine the providers of flexibility.

This is one of the reasons why ensuring participation of cross-border resources in national CRM is crucial. The second part of this chapter argue that while it is unlikely that a harmonised CRM could fit the needs of all Member States (who tackle different issues with different resources and aim at different objectives), national CRM should not lead to autarky that would lead to excess capacity and impact energy markets. The European commission is hence determined to use legal provisions on State aids and free movement of goods to mitigate the impact of national CRMs.

The last part of this chapter identifies three prerequisites to euro-compatibility of national CRMs. At the very root of any European policy we need a coherent assessment of the EU and each Member State actual generation adequacy (taking into account interdependencies and the true contribution of cross-border resources). We also need to allocate responsibilities for energy delivery of the committed cross-border resources, which could prove particularly challenging in the absence of a regional system operator. Physical delivery of energy across interconnection assets is indeed the result of concomitant and not perfectly-predictable conditions in different Member States. Finally, solidarity principles should be reconciled with the willingness of some actors to insure against scarcity at higher level than their neighbours. For a regional approach towards generation adequacy to emerge, it is necessary to recognise the higher efforts made by these actors when allocating the corresponding rights to consume energy at times of scarcity.

It is clear from this chapter that the EU debate on the Europeanization of generation adequacy policy is not going to end abruptly or too soon.

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