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Towards a regional approach for capacity remuneration mechanisms in Europe

A discussion paper for Eurelectric

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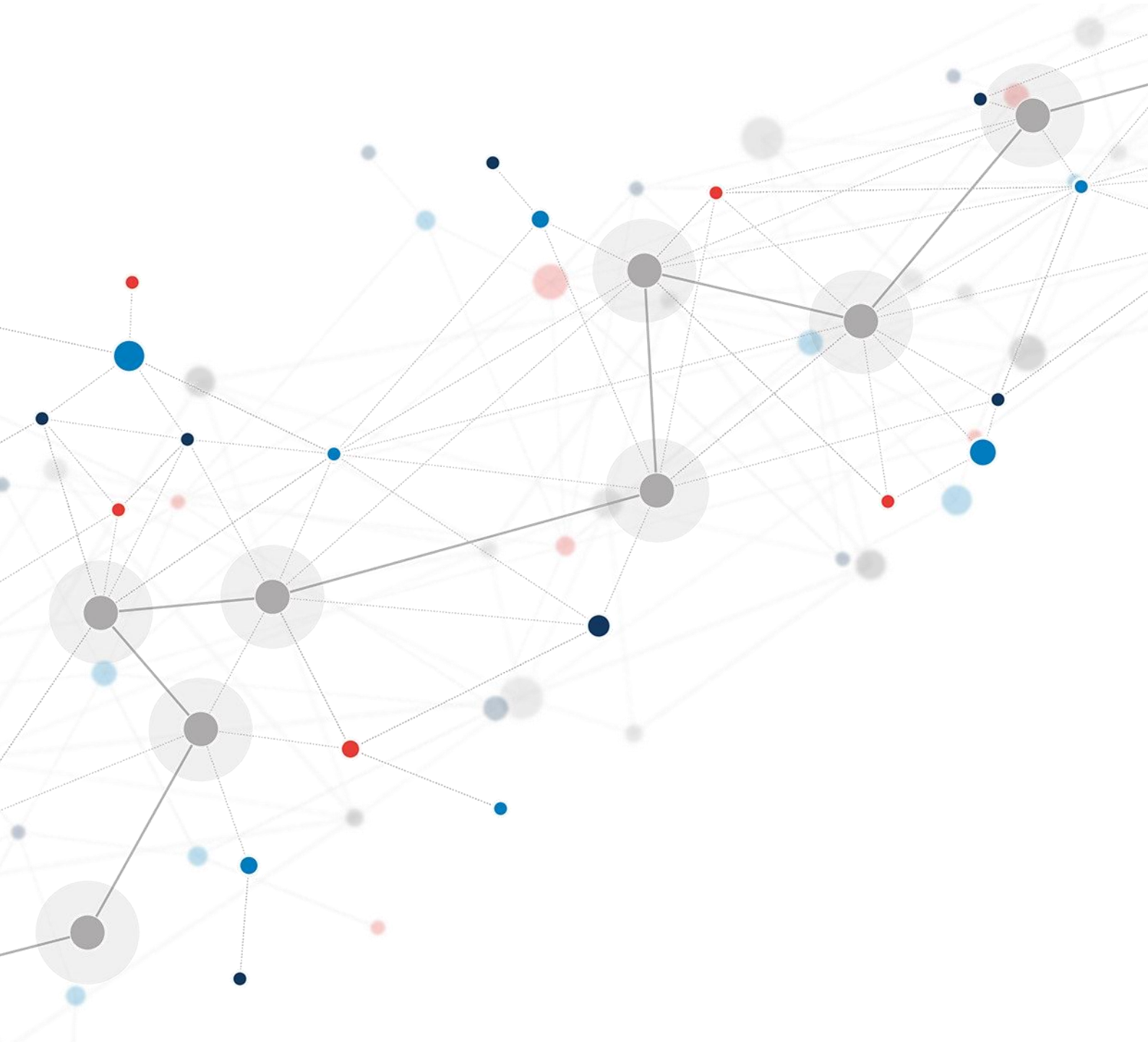

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Introduction

1 In the past decade, many European Member States have introduced capacity remuneration mechanisms (CRMs) in response to concerns over resource adequacy. Depending on their local needs and specificities, Member States have implemented different types of CRMs, in particular:

- Strategic reserves, in which Member States keep certain generation capacities outside the electricity market for operation only in cases of emergencies. The German, Finnish and Swedish strategic reserves hold a reduced portfolio of thermal power plants, preventing them from closing and keeping them as backup in case of unusual episodes of high electricity demand and insufficient power generation.

- Market-wide capacity markets, in which capacity providers can obtain a payment for being available to generate electricity, or, in the case of demand response operators, for being available to reduce electricity consumption, subject to obligations and penalties. Such capacity markets like the ones in Belgium, France, Italy, or Poland are open to all technologies and provide complementary revenue to the energy markets. In other words, all power generation and demand-response units can simultaneously partake in capacity and energy markets, subject to eligibility rules.

2 These differences in the type of CRMs, but also in the detailed design of these mechanisms, can be justified by intrinsic differences between national power systems, such as electricity mix, regulatory frameworks, degree of interconnectedness, internal network constraints and need for locational investment signals or wider national prerogatives such as decarbonisation policies.

3 The State aid guidelines and the Electricity Regulation defined key design principles and features in order to avoid inefficiencies or distortions to the level playing field in the Internal Energy Market,[1] including amongst others cross-border participation in capacity markets (step 2 of Figure 1 below). In 2025, the Clean Industrial Deal State Aid Framework ("CISAF")[2] defined specific features of CRM design that would streamline the State aid approval process, enabling a swifter adoption of CRMs. The level of detail provided in its design features would also foster a degree of harmonisation in CRM design, as Member States seeking a smooth and fast approval process would adopt the CISAF baseline.

4 Given the structural differences that exist across Europe, the full harmonisation of approaches to adequacy or the implementation of a single pan-European capacity mechanism may not be achievable nor desirable. Moreover, given that security of supply is a national prerogative,[3] any European or regional capacity mechanisms would rely on a voluntary approach. On the other hand, stronger regional coordination to adequacy approaches could generate gains for consumers if adequate requirements are met. These potential gains originate in the short term from the pooling of capacity resources to minimise cost of procurement across borders, and in the medium to long term through more efficient dimensioning of needs and investment on a regional basis.

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1 See the EU Electricity Market Design (available here) and Electricity Regulation Art.22 (available here).

2 CISAF Communication, Annex I (available online).

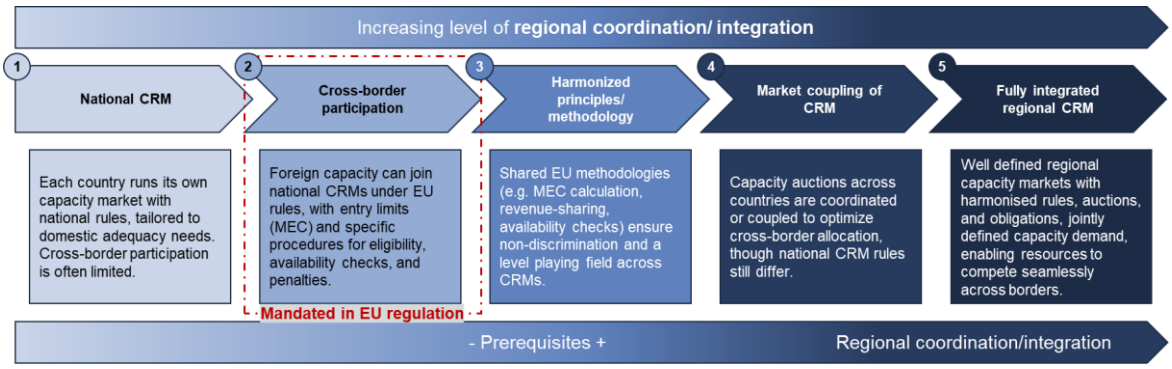
3 Article 194.2 of the Treaty of the Functioning of the European Union. Available here.

5 Several steps can be envisaged from the current national CRMs with cross-border participation in only a few countries, to a more systematic cross-border participation based on enhanced coordination and harmonisation of the underlying design principles, towards potentially market coupling of CRMs, or even a regional CRM covering several countries as shown in Figure 1.

6 As recently pointed at by the JRC, locational investment signals could be beneficial to the European market and at the national level, and provide substantial benefits, estimated to 12-29 bn euros/year in 2040. Without prejudging the choices made by policy makers, stronger regional coordination on CRMs should be compatible to the introduction of such locational investment signals in CRMs if decided so.

7 Figure 1 below presents different levels of regional coordination for capacity mechanisms, and adequacy more generally.

Figure 1: Different levels of regional CRM coordination options



Source: Compass Lexecon.

8 The purpose of this paper is to assess to what extent and under which preconditions increased cooperation on adequacy assessments and contracting mechanisms at regional level deliver higher benefits in terms of costs and security of supply. This paper builds on the existing literature on CRM design and cross border participation,[4] and focusses in particular on the potential steps towards the implementation of regional CRMs (steps 4 and 5 of Figure 1 above), i.e. a mechanism that enables the coordinated procurement of capacity at the regional level, including cross-border exchanges.[5] The paper does not aim to provide a detailed analysis of whether CRMs need to be implemented, nor which features of these mechanisms would need to be harmonised.

The structure of the paper is as follows:

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4 See for instance: Roques F., Verhaeghe C., (2025a), 'Electricity Market design to ensure Security of Supply', March 2025, Available here. Roques F., Verhaeghe C., (2022), 'Different Approaches for Capacity Mechanisms in Europe: Rationale and Potential for Coordination?', Capacity Mechanisms in the EU Energy Markets, Oxford University Press, 2022, Available here. Roques F., Verhaeghe C., Bourcier F., (2025) 'Electricity market design to support the development of flexibility in EU power systems - an analysis of best international practices', Compass Lexecon report financed by Amazon Web Services, Available here. Roques, F. (2008). "Capacity Mechanisms and Institutional Context: Healing Symptoms or Causes?", Utilities Policy (2008), Vol. 16(3): 171-183. Available here. Roques, F. (2019). Counting on the neighbours: challenges and practical approaches for cross-border participation in capacity mechanisms. Oxford Review of Economic Policy, Volume 35, Issue 2, Summer 2019, Pages 332–349, Available here.

5 This can range from the coupling of distinct national capacity mechanisms to a fully integrated regional capacity procurement mechanism.

- *First*, the paper introduces the **context and key issues underpinning the debate on a regional approach towards CRMs**, recounting the emergence of national CRMs into a set of mechanisms with different designs.
- The *second* part lists and analyses the **theoretical benefits** of a regional approach towards CRMs through a series of illustrations comparing national CRMs with regionally pooled capacity procurement schemes.
- *Third*, after recognising that differing system needs have led to divergences in CRM designs, the paper delves into the prerequisites of regional CRMs as well as the **technical, operational, and political challenges** that they would face in their implementation.
- *Lastly*, the **conclusion summarises the main findings of the study** on the emergence of different CRM designs, the benefits of incremental steps towards regional CRMs, prerequisites to meet and challenges to tackle, and puts forward on a voluntary approach based on short-term and low-regret actions to pave the way for further coordination of CRMs and adequacy more broadly at regional level.

1 Context: The current patchwork of national capacity mechanisms with limited cross-border participation

9 In this section, we set out the status quo regarding the implementation of CRMs in different countries across Europe, the different approaches across Member States, and the limited progress to date regarding cross-border participation despite the existing legal obligation.

1.1 A patchwork of capacity remuneration mechanisms have been implemented across Europe

10 In the past decade, capacity remuneration mechanisms have been implemented in a number of countries in Europe, as a response to rising concerns about security of supply and resource adequacy. On the demand side, the push for electrification is expected to raise total electricity consumption and peak load. On the supply side, the decommissioning of thermal power plants, due to aging fleets, decarbonisation policy and/or economic reasons, tends to restrict the relative size of the fleet of dispatchable power plants. This dual demand expansion and dispatchable supply contraction potentially create a growing firm and flexible capacity gap. This gap is what capacity remuneration mechanisms (CRMs) aim to address, by rewarding capacity providers for their availability in times of scarcity.

11 As of May 2025, 9 EU MS have capacity remuneration mechanisms in place (10 with GB) and another 6 are in development (Figure 2). The European Commission scrutinises the implementation of these mechanisms against State aid rules, and more specifically the associated guidelines.[6] The EC approved the first capacity market in 2014 – the GB one – and approved several capacity mechanisms in following years, e.g. the German strategic reserve and 5 other CRMs in 2018.[7]

12 A stronger impetus for CRMs came through the 2021-2023 energy crisis, in which Russian gas supply throttling caused major power price surges. The rippling effects of this supply crisis across consumer prices brought security of supply to the centre of the EU energy agenda. As a range of tools aimed primarily at safeguarding security of supply by filling the adequacy gaps in the electricity system, CRMs naturally came back into focus.

13 Moreover, capacity mechanisms are also part of a broader evolution of the market design reflecting the changing cost structure of the industry to meet decarbonisation objectives (with fixed costs technologies set to dominate capacity additions in the next years), with the development of a two-step approach with planning of system needs followed by the contracting of the corresponding capacity. Capacity mechanisms are part of this evolution towards ‘competition for the market’ driving

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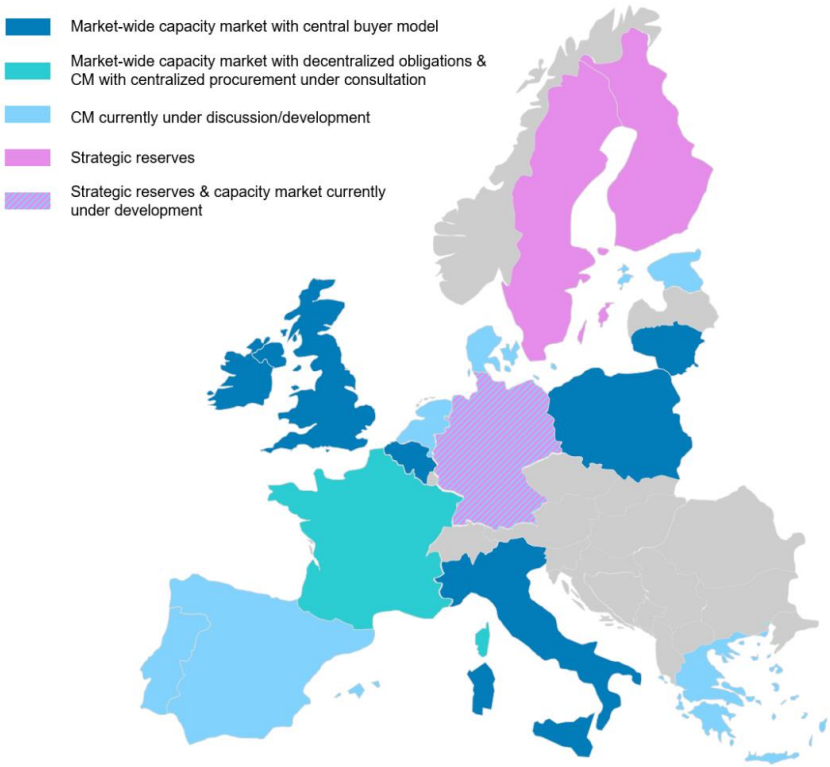
6 Formerly, the *Guidelines on State aid for environmental protection and energy (EEAG) 2014-2020* (available here), and today the *Guidelines on State aid for climate, environmental protection and energy (CEEAG) 2022* (available here).

7 EC (2018), *State aid: Commission approves 6 capacity mechanisms*. Available here.

competitive forces where most efficiency gains can be obtained, that is to foster efficient investment decisions.[8]

14 These evolutions led to the decision in the EU Electricity Market Design reform (EMDR) of 2024 to define CRMs as an integrated feature within the wider framework of system needs assessment, valid for up to 10 years upon the EC's approval of the corresponding State aid case.[9] Today, a consensus is emerging in Europe on CRMs being a necessary part of the electricity system's toolkit to ensure security of supply.

Figure 2: Map of CRM types as of May 2025 across Europe



Source: based on ENTSO-E's *The role of Capacity Mechanisms to enable a secure and competitive energy transition* (Figure 2 page 19) and on complementary desk research from Compass Lexecon. For the Netherlands, see this 2025 discussion from the Dutch TSO about security of supply.

1.2 Despite some degree of harmonisation promoted through EU regulation and the CISAF target model, significant differences remain in CRM design

15 The **EU framework** defines CRMs as State aid (i.e., requiring an EC explicit approval before implementation), and provides general requirements through the **CEEAG** and **Electricity Regulation** as such:

- The EU Guidelines on State aid for climate, environmental protection and energy (**CEEAG**) outline general requirements for CRMs to pass the EC's review. Under the CEEAG, a CRM must

8 See e.g. Roques and Finon (2017) 'Adapting electricity markets to decarbonisation and security of supply objectives: Toward a hybrid regime?' Energy Policy, Volume 105, June 2017, Pages 584-596. Available here. Roques F., Verhaeghe C., Cartry C., (2025b) CATF and Compass Lexecon report with research funding from CATF, 'Accelerating the deployment of clean power technologies to reliably decarbonise Europe through enhanced planning and contracting mechanisms', 2025, Available here.

9 See (EU) 2019/943 Article 21.8. Available here.

(1) have an incentive effect, i.e., induce participants to provide capacity that they would not otherwise provide, and (2) minimise distortions of competition and trade, i.e., be necessary, appropriate, open to all technologies, proportionate to the issue, such that the benefits it generates outweigh the distortions it creates.

- The **Electricity Regulation** sets general implementation (Art.21) and design principles (Art.22) for CRMs, and requires capacity markets to allow direct cross-border participation of foreign capacity (Art.26). The regulation calls for ENTSO-E and ACER to co-design common calculation rules for the maximum entry capacity (MEC)[10] of foreign capacity into a CRM, and for the sharing of cross-border participation revenue and burden[11] across neighbouring TSOs. These methodologies have since been released and are being implemented by TSOs.

16 Member States have been free to implement and design their CRMs as they see fit within the general principles of the EU framework. Indeed, **national CRMs differ** by type (e.g., market-wide capacity markets vs strategic reserves) and design (e.g., obligation and penalty regimes). These differences are due notably to:

- **Differences across geographies.** Consumption profiles, production mixes, interconnection levels and other factors shaping adequacy needs can vary across countries. For instance: some countries seek to incentivise new investments to compensate for the closure of old existing power plants.[12] For countries with a thermal fleet at risk of decommissioning for economic reasons, the goal is to keep sufficient critical units online[13] to reach reliability standards. Other countries may have a production mix dominated by hydropower, causing a need for back-up power generation capacity in case of droughts.

- **Differences in the timing** of implementation. Member States initially had more freedom to set their own CRM designs and more EC guidance and requirements were progressively introduced (e.g. in the Electricity Regulation and in the CISAF for fast-track approval in 2025). Thus, a CRM that entered operation earlier could present less sophisticated or less uniform design features.

- **Differing views on the design features best suited given local specificities**. A well-designed CRM carefully balances multiple goals: reaching the adequacy standard set by authorities, preventing the decommissioning of existing power plants necessary for security of supply, attracting investments in new capacity (in generation, demand response, or flexibility and storage), minimising costs, mitigating distortions to competition and trade, and ensuring a smooth interplay with the wider framework. For instance, longer contracts may attract more investments and competition into the auctions but could create a risk of locking in capacities and of higher costs for consumers. As such, there is no one-size-fits-all CRM design. Consequently, each country adopted the set of design features it deemed most suitable at the time to solve its own adequacy issue.

17 **The implementation of direct cross-border participation of foreign capacity is mandatory** in accordance of the Electricity Regulation as its effective implementation should **generate significant benefits**. Indeed, it could reduce capacity procurement costs in the short term through

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10 ACER Technical Specifications (available here) define MEC as "the maximum entry capacity on a given CM border for a given delivery period", i.e., in system stress periods, and propose two methodologies to compute it:
- *Net positions* (art.7) which account for exchanges at the border concerned and net flows at each border, in order to provide a flow-based representation of the contribution of each border to the CRM
- *Commercial cross-zonal exchanges* (art.8), which accounts for exchanges at the border concerned

11 Including availability checks, non-availability payment enforcement, common capacity provider registries.

12 European Commission (2019), SA.35980 - 2019/C – UK Capacity Market. Available here.

13 European Commission (2022), State Aid SA.55604 (2022/N) – Finnish strategic reserve. Available here.

the efficient pooling across borders and contracting of available foreign capacity when it is economic to do so, and in the longer term through investment incentives that stretch across the border. Direct cross-border participation could also widen the pool of capacity providers and foster competition in auctions.

18 Nonetheless, direct cross-border participation is **not yet implemented** uniformly across EU capacity markets. So far, only Belgium and Poland have fully implemented it. Italy set up a simplified variant with no physical delivery or availability obligation.[14] France and Ireland have so far awarded interconnectors, not foreign units, but plan to adapt in their CRM overhauls.[15] Lithuania's CRM, though not active yet, is also expected to enable direct cross-border participation.[16] A probable cause of this incomplete implementation is that **direct cross-border participation requires a high degree of coordination and trust** with neighbouring countries – both of which may be hampered by political reluctance or unnecessary red tape. The cost of direct cross-border participation and the allocation of said costs may also be a concern. Such costs include e.g., performing availability checks domestically on behalf of a foreign TSO, or setting up the required common registries and data sharing processes.

19 The Clean Industrial Deal State Aid Framework (**CISAF**) introduced in 2025 a new "**target model"** specifying a range of capacity market design features that would **streamline** the State aid process, enabling a swifter adoption of CRMs (Table 1).[2] The level of detail provided in its design features would also foster a degree of **harmonisation** in CRM design, as Member States seeking a smooth and fast approval process would adopt the CISAF baseline. Notably, the target model reaffirms the obligation to implement **direct cross-border participation** in capacity markets as per the Electricity Regulation. ACER specifications apply regarding implementation details, like the methodologies to compute the Maximum Entry Capacity (MEC) of foreign bids per border.

Table 1: Non-exhaustive list of design features for future CRMs in the CISAF target model

Characteristic	CISAF target model
Scope	Open to all technologies with size > 1 MW, delivery duration > 1 hour, and under the applicable emission thresholds.
Procurement	One main auction for 75%-90% of the estimated demand 4-6 years ahead, and adjustment auctions up to 1 year ahead.
Contract duration and CAPEX threshold	Default duration is 1 delivery period (year). An additional year may be added for every incremental capital investment step of 25€/kW, up to 15 years maximum for fossil-fuel generation.
De-rating factor methodology and rules	De-rating factors must be set at least every 2 years for eligible resources and for each bidding zone. They can be taken from the ERAA, or, if not available, be based on the availability of the resource during scarcity. Participants can deviate up to 15% from the default de-rating factor, or face penalties.
Cross-border participation rules	Direct cross-border participation according to the Technical Specifications of ACER. Maximum Entry Capacities must be set based on ACER rules.

14 See ACER (2023), Security of EU electricity supply 2023, (available here): "Foreign resources only need to be registered with the Italian power exchange, for financial purposes, to be allowed to participate in the Italian capacity mechanism. They are also subject to the payback obligation, but otherwise have no further obligation".

15 More precisely, France defined a framework to switch to direct cross-border participation, but this framework is not yet applied due to a lack of inter-TSO agreements to concretise it.

16 Lithuanian Ministry of Energy (2023), Capacity Mechanism. Available here

Cross-border capacity obligations	Follow ACER Technical Specifications, i.e., common rules for carrying out availability controls, unavailability payments, data registers, transparency requirements, etc.
Cost recovery	CRM costs must be fairly allocated between network users, representing their real contribution to the stress event periods.

Source: CISAF Communication, Annex I (available online).

20 Finally, without prejudging the choices made by policy makers, the design of CRMs could incorporate locational investment signals adapted to local situations to guide investment and decommissioning decisions to take into account grid constraints and local needs.

2 Subject to adequate coordination and interconnectedness, regional approaches to coordinate CRMs could bring additional benefits and foster cross-border participation

21 As explained before, current capacity mechanisms were introduced gradually in Europe to address national concerns upon security of supply, and with limited coordination. As the European regulatory framework has been strengthened, direct cross-border participation should be implemented and allow for a more efficient capacity procurement and level playing field across Europe. Where relevant, further harmonisation could also reduce costs and facilitate coordination amongst CRMs.

22 In this section, we explore a range of possible steps towards regional approaches to coordinate capacity remuneration mechanisms and the potential benefits that more coordinated regional approach to adequacy could bring.

2.1 Different levels of regional coordination for CRMs can be envisaged, depending on the alignment on key principles and degree of harmonisation

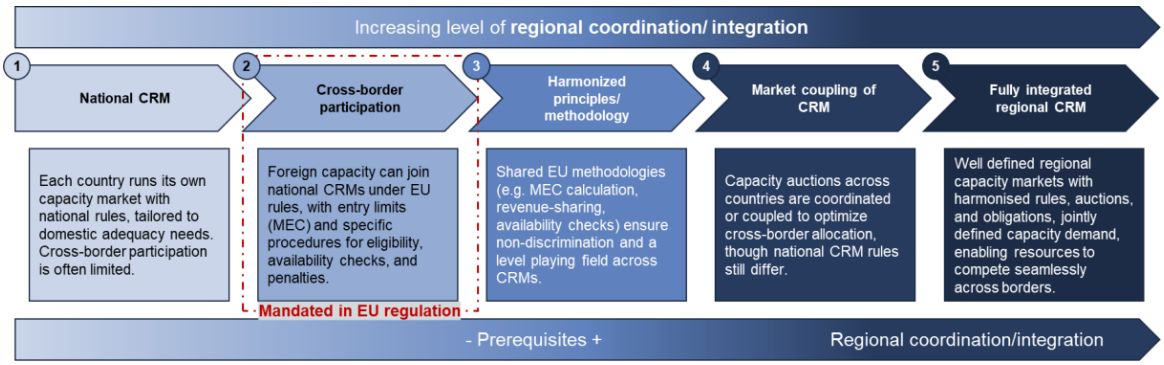
23 While current CRMs are national in scope – except for the Irish mechanism covering the Republic of Ireland and Northern Ireland – there are gradual options to coordinate and integrate them further, as Figure 3 below depicts.

24 The existing EU regulation already provides a framework for the initial coordination steps, as it mandates the participation of foreign capacity providers (cross-border participation) in market-wide CRMs and aligns some features of their design.

25 Through the CISAF, harmonisation could even be further accelerated insofar as Member States strive to get a faster approval of their new CRMs or the reform of their existing CRMs and follow the minimum requirements set out in the Annex 1 of the CISAF.

26 The implementation of CRMs in all countries within a region, based on aligned principles ensuring sufficient compatibility, could also facilitate and make cross-border participation across these mechanisms more efficient.

Figure 3: Different levels of the regional approach towards CRM



Source: Compass Lexecon.

27 To go further, an **agreement on a sufficient level of harmonisation and on the necessary coordination and governance features** (step 3) could allow Member States to further integrate their CRMs through bilateral / multilateral approaches or even at regional level.

28 Indeed, the level of coordination and harmonisation in the design of national CRMs or of the regional CRM could vary. Specifically, there would be trade-offs between Member States' desired degree of control and tailoring to their system needs and the overall benefits of regionalisation and harmonisation, and how costs and benefits are shared at regional level. These trade-offs need to be discussed and agreed upon by MS before the implementation of the regional CRM, and would be settled in the details of the design of the regional CRM and of its underlying adequacy assessment. In particular, insufficient harmonisation may impede the materialisation of expected theoretical benefits from regional coordination, especially regional CRM, or create barriers to it.

29 However, even if a high degree of coordination and harmonisation would be necessary to unlock some of the benefits of regional CRMs, differences between national CRMs justified by local specificities may remain and would still allow for further integration and benefits.[17] This is key insofar as structural differences between countries may justify different CRM design choices and parameters. Indeed, as we explain in more detail in section 3.2.1, complete harmonisation is neither necessary nor desirable to deliver regional CRMs. Nonetheless, specific items will need to be harmonised to unlock regional CRMs. These may include, e.g., product design (availability periods, obligations, penalties…) or de-rating factor methodologies.

30 Depending on this degree of coordination, we envisage two main archetypes of a regional approach towards CRM: (i) a market coupling of CRMs or (ii) a fully integrated regional CRM (see steps 4 or 5 in Figure 3).

31 ***The market coupling of CRMs*** (step 4) would be a joint procurement of capacities in the different participating countries, including the allocation of maximum entry capacity (MEC) – solely based on transmission constraints – to allow for cross-border exchanges of capacities. This would follow the integration and coupling of day-ahead energy markets, transposed to capacity procurement. Each CRM could retain its own specific design and rules – provided that a minimum viable level of harmonisation is reached to enable coordinated (yet separated) procurement.

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17 To draw a parallel with energy markets for instance, differences remain today between national wholesale electricity markets, such as local products, participation obligations, etc., despite efforts to harmonise their design. Although these residual differences affect the functioning of the internal energy market, the degree of harmonisation across MS is sufficient to harvest significant benefits from market integration. See for instance ACER (2024), *Progress of EU electricity wholesale market integration*. Available here.

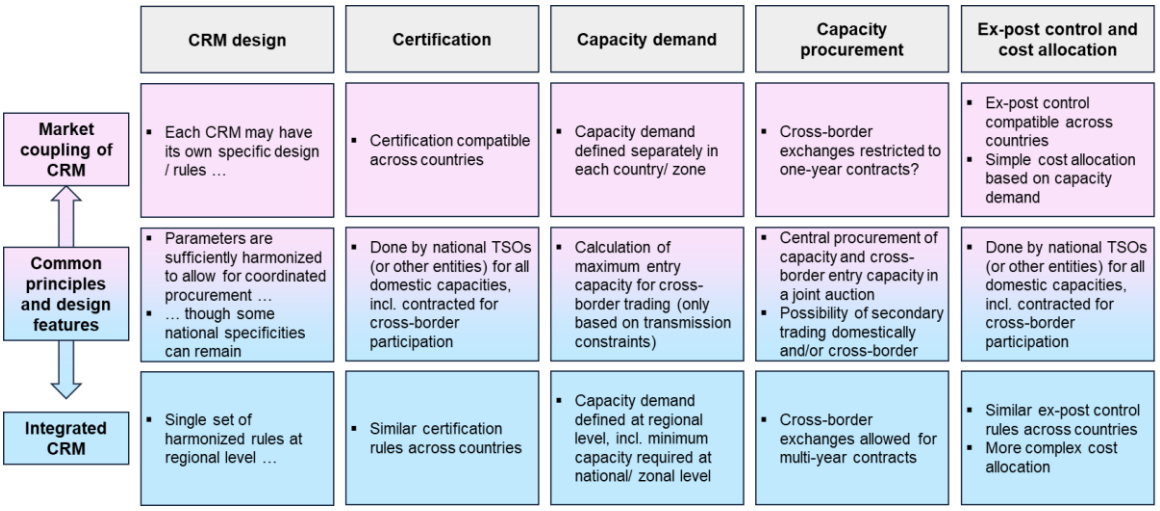
32 More specifically, though full CRM rules harmonisation would not be necessary, the market coupling of CRMs would require compatible rules applicable to capacity providers across participating countries. These include certification, participation requirements and commitments (availability-based obligations) or ex-post controls and penalties. Moreover, auction timings will need to be aligned to enable the joint auctioning. Again, a parallel could be drawn with the existing energy market coupling, where the procurement of energy and the allocation of capacity are performed jointly, even though national differences may remain with regards to imbalance settlement, scheduling rules etc.

33 ***In an integrated CRM at regional level*** (step 5), the most significant difference would be the joint definition of the capacity demand, coordinated at regional level. While in a CRM market coupling, we would assume capacity demand being defined at national level, the capacity demand in a fully integrated CRM could be defined jointly, e.g. based on a detailed regional resource adequacy assessment, to better take into account synergies and complementarities in the consumption patterns (and possibly the variable RES infeed). Based on the local needs, the available interconnection capacity, as well as the complementarities between countries, the capacity demand assessment would define the total capacity to be procured as well as the minimum capacity to be procured in the different zones or countries, taking into account the interconnection capacity, in order to meet reliability standards in all countries covered by the CRM. Unlike for the current approach based on the MEC calculation, the cross-border capacity could directly account for the expected available interconnection capacity in this case: it should not be based on the expected contribution of neighbouring countries (i.e. no longer for the expected positions - net import or export margin - at stress events), as this will be embedded in the auction.

34 The CRM design could be further harmonised, with similar certification, ex-post control and cost-allocation rules, all of them resulting in efficiency gains, although a full harmonisation would not be necessary. Some local / national specificities could remain, e.g. de-rating factors or reliability standards could be defined at national level based on a common methodology.

35 Although there is a spectrum of nuances to define these coordination approaches, Figure 4 below describes the main features of these two archetypes, highlighting their key differences. In particular, the two approaches share common principles and design features, including a minimum viable level of harmonisation in CRM design that allows for national specificities, but the level of alignment increases in step 5, and the capacity demand would be defined jointly in the region in step 5.

Figure 4: Main features and key differences of two CRM coordination archetypes



Source: Compass Lexecon.

2.2 Regional approaches to coordinate and integrate CRMs can deliver theoretical additional benefits, if the right prerequisites are met

36 There are incremental benefits to further coordinate and integrate CRMs at regional level, depending on the approach and on whether the necessary prerequisites are met.

2.2.1 Some first steps towards harmonisation and cross-border participation could already yield benefits

37 Compared to a national CRM designed and operated in isolation of neighbouring countries, cross-border participation (as currently mandated by the EU regulation, corresponding to step 2 of Figure 3) can already provide significant benefits.

- First, cross-border participation can yield **cost reductions** through competitive pressure as foreign capacities compete with domestic units.
- Second, it **reflects better the contribution** of foreign generators and interconnectors to adequacy, thus reducing the total capacity needed within the EU. This rewards them for the role they already implicitly play in maintaining adequacy and reinforces incentives to be available at times of potential need and to invest in foreign capacity or cross-border transmission capacity.
- Third, it can ensure **a more level playing field** between foreign and domestic capacity providers. Subjecting foreign and domestic capacities to the same payments and obligations erases discriminatory distortions.

38 The EU regulatory framework also provides for coordination in setting the maximum entry capacity, through the regional coordination centres, i.e. the maximum expected capacity that foreign capacities could provide in a national CRM through a given border or set of borders. The MEC takes into account the expected available transmission capacity to the CRM country as well as the ability of neighbouring countries to supply electricity to the CRM country beyond their needs (i.e. the availability of a capacity margin for export) during stress situations in the CRM country.

39 The harmonisation of the designs of national CRMs (step 3) with direct cross-border participation can bring additional benefits to the ones described above. Harmonised CRM designs, including e.g. the standardisation of procedures and requirements to provide and control capacity availability, can **lower implementation costs** for all participants as well as for organisers (TSOs, regulators, policymakers). Harmonised products and obligations can also **facilitate cross-border participation**. The harmonisation of underlying methodologies to set the different parameters of the CRMs could also foster a level playing field at regional and European level; this does not imply similar values in each Member State as these may not reflect local situations or needs, and may not be efficient or desirable overall.

2.2.2 A regional CRM could in theory provide significant benefits by sharing adequacy resources if a number of prerequisite conditions are met

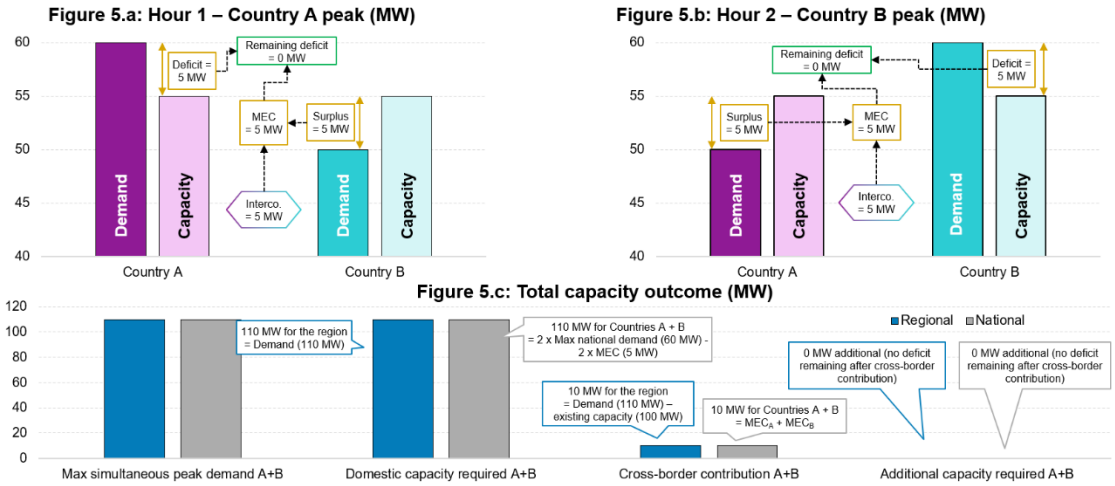
40 The regionalisation of CRMs could in theory create savings compared to uncoordinated national CRMs by (i) potentially reducing total capacity demand (valid in step 5 only) and (ii) optimising capacity procurement thanks to the expansion of the pool of available capacities and their mutualisation to address adequacy concerns (valid for both steps 4 and 5). In what follows, we consider an integrated regional CRM in comparison to separate national CRMs with direct cross-border participation.

On the total capacity demand reduction

41 Today, capacity requirements to meet adequacy needs are typically calculated on a national basis, leveraging analyses from the European and National Resource Adequacy Assessments. They are based on peak demand (generally netted of variable generation) and reliability standards, and should take into account – or be partly satisfied by – the contribution of capacities across the borders.[18] These capacity needs are then procured within national CRMs.

42 However, the underlying patterns that determine these peaks vary across countries: national-level peaks do not necessarily translate to regional-level system stress as they may not occur simultaneously. For instance, peaks typically occur in France at the end of office hours in the winter,[19] whereas they tend to take place during *Dunkelflaute* periods in Germany[20] – i.e., not always at the same time. As a result, capacity contracted in CRMs based on national needs, even with coordination in the adequacy assessment and with cross-border participation, could be higher than if total capacity demand was coordinated through a regional CRM. This is illustrated in Figure 5 below.

Figure 5: A case of sufficient capacities[21]



Source: Compass Lexecon.

43 In this illustrative example, if the capacity demand is defined – together with minimum requirements at national levels to account for transmission constraints – at regional level, only 110 MW would need to be contracted. Compared to separate national CRMs with direct cross-border participation (as required by the EU regulation), this may differ in two ways:

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18 In case of implicit participation or to determine the need and capacity for strategic reserves, the capacity demand would be netted off cross-border contribution. In case of explicit participation, i.e. the solution in compliance with EU regulation for market-wide CRMs, the capacity demand would be based on national need, but could be satisfied by direct participation of cross-border capacities.

19 RTE (2025), *Analysis of consumption peaks and thermosensitivity*. Available here

20 ENTSO-E (2025), *The role of Capacity Mechanisms to enable a secure and competitive energy transition*. Available here.

21 This example and the next ones are simplified and meant for illustration purposes. We assume that interconnection and capacities are already de-rated to account for their likely availability and that peak demand is predictable (countries have different consumption patterns) and needs to be satisfied to meet the reliability criteria.

- Thanks to cross-border participation, existing capacity in A would participate in the CRM B and therefore contribute to adequacy in A in the period H2 and in B in the period H1, and conversely for existing capacity in B. In that case, there would not be over-procurement of capacity overall in the region thanks to cross-border participation,[22] but consumers may pay more, as they would contract in total 120 MW instead of 110 MW. Depending on the specific design of the CRMs (incl. cross-border participation), and on the bidding strategies of the market participants, this could lead to increased revenues for capacity providers. In addition, TSOs may capture part of the revenue through the interconnection and use it to reduce grid tariffs.

- If cross-border participation was restricted for capacities participating already in their domestic CRMs – i.e. cross-border participation's constraints would not properly take into account the non-simultaneity of peaks – then 120 MW would not only be procured but would need to be available at the same, leading to a 10 MW potential overbuilt of capacity. This would result in even higher costs for consumers. This highlights the importance of taking into account cross-border contribution to adequacy, as mandated by EU regulation.

On the optimisation of capacity procurement

44 The mutualisation of resources in an integrated regional CRM could in theory unlock system cost reductions through a more efficient procurement of capacity, optimised across borders, and increase competition amongst capacity providers.

45 Compared to cross-border participation, there are two important factors that fundamentally explain how a regional procurement process can be more efficient:

- Currently, when cross-border participation is effectively allowed, it might be only for shorter-term capacity auctions (Y-1 in Belgium for instance[23]) and/or only for existing capacities, as long-term contracts cannot be attributed to new foreign capacities. This limits the competition, especially when new capacities are necessary to meet adequacy needs.

- Moreover, in case of separate CRMs, the cross-border contribution (with the maximum entry capacity) is limited by the capacity margins of neighbouring countries and its ability to contribute adequacy in the contracting country. This assessment is done ex-ante, and may not take full account of capacity developments enabled by the foreign CRM (if any) and by contracting new foreign capacities, which in practice is not possible in today's CRMs. Indeed, new foreign capacities are not eligible to long-term contracts and the MEC is not calculated over several years.

46 Figures 6 and 7 below illustrate potential cases, where a regional CRMs can bring additional benefits beyond cross-border participation.

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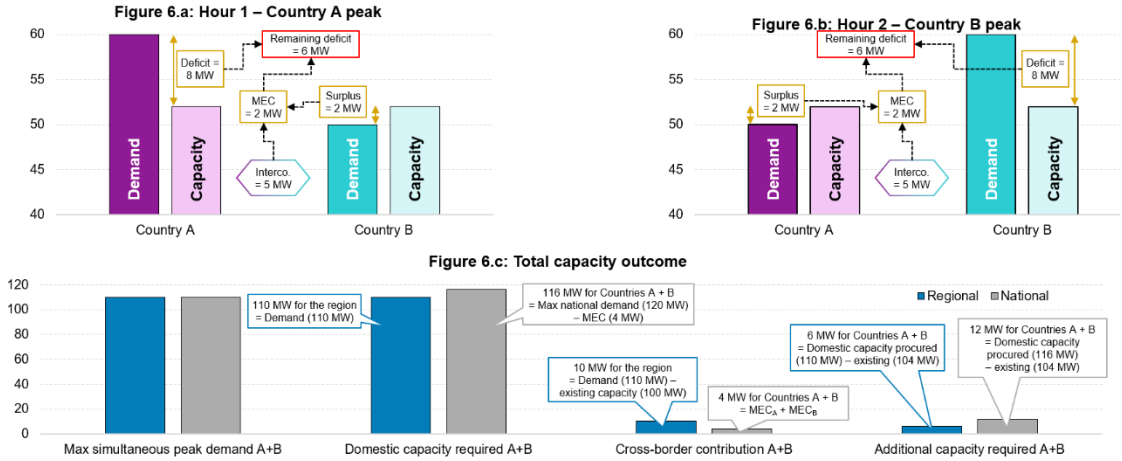
22 In this example, the MEC would be set at 5 MW, i.e. the expected available cross-border capacity, as there are sufficient capacity margins in stress situations to export to the needing country at that level.

23 Elia (2025), *CRM design note: cross border* (available online).

Figure 6: A case of insufficient existing capacities



Source: Compass Lexecon.

47 Figure 6 shows the same illustrative example as before, but capacities in countries A and B are not sufficient to cover national needs, and altogether to cover regional needs. New capacities would need to be developed in both countries.

- In this illustrative example, despite the cross-border being 5 MW, when demand peaks in country A, only 2 MW of existing capacities are available in country B to contribute to meet peak demand in country A (and conversely). In case of national CRMs, the MEC would be likely set at 2 MW (both for CRMs A and B), as it accounts for the maximum expected contribution of the neighbouring country.[24] Each country would therefore need to contract domestically 58 MW, i.e. building at least 6 MW of additional capacity each.[25] This would result in a total capacity in the region of 116 MW and an oversupply of 6 MW in comparison to the total demand of 110 MW, with capacities being crowded out in future auctions as MEC would then likely be reevaluated upward.

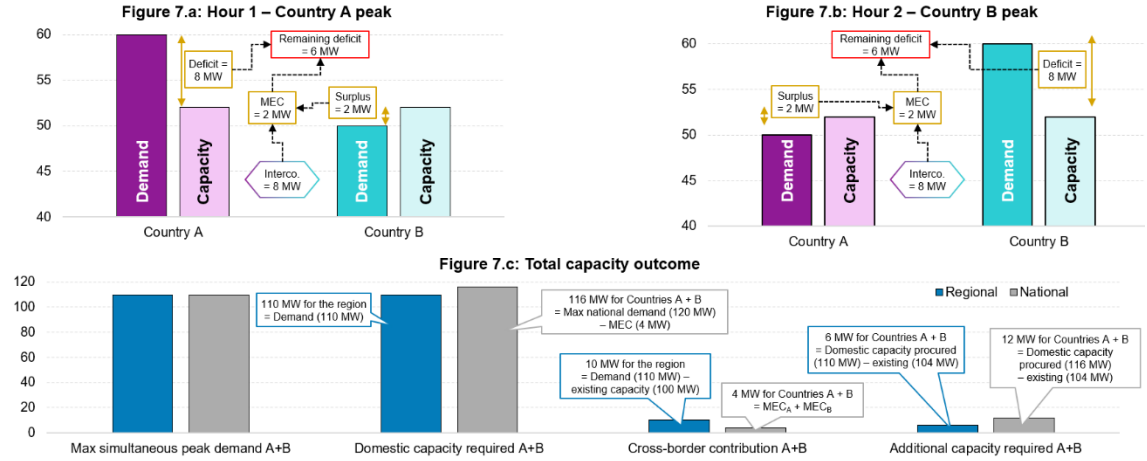
- In case of a regional CRM – assuming adequate coordination both in the adequacy assessment, capacity demand definition and operations – total capacity demand would be set at 110 MW, with minimum requirements of 55 MW both in countries A and B. This is indeed the peak capacity demand at regional level and, given the expected available cross-border capacity, 55 MW in both countries is the minimum value to ensure meeting both regional peak demand and national

24 Setting the MEC at 5 MW would require assuming in the MEC calculation both countries are meeting their reliability standards thanks to their CRMs, with capacity reaching 55 MW or above – depending on how they would take cross-border participation into account – and therefore able to contribute up to the expected available cross-border capacity. This would require high trust and coordination in the development of required capacities in the neighbouring country, as in an integrated regional CRM. For instance, the French MEC to the Belgian CRM auction for 2026-27 was set to 0 MW, due to concerns on the low availability of French nuclear, despite the existence of a CRM in France.

25 For the purpose of the illustration, we assume here that existing capacities are economically viable and missing capacities would be provided by new builds. However, the same reasoning could be applied to existing capacities with the threat of closure due to a negative economic viability assessment. In such a case, in addition, a more efficient cross-border contracting through a regional CRM would not require long-term visibility on cross-border transmission capacity (unless potentially in case of significant refurbishments – and corresponding multi-year capacity contracts – being necessary).

peak demands at all times.[26] The regional CRM would therefore contract 3 MW of new capacities both in A and B, for a total of 110 MW, avoiding over-contracting – and thereby leading to lower overall costs. Nonetheless, ultimately new capacities in A and B are not directly competing as they are separately needed to meet national minimum capacity requirements.

Figure 7: A case of insufficient existing capacities and higher cross-border capacity



Source: Compass Lexecon.

48 Figure 7 shows the same illustrative example but cross-border capacity is increased to 8 MW. New capacities would need to be developed in both countries.

- In case of national CRMs, the MEC would be likely set at 2 MW (both for CRMs A and B) even with higher cross-border capacity, as the MEC would be limited by the capacity margin in the neighbouring country.[27] As before, each country would therefore need to contract domestically 58 MW, resulting in an oversupply of 6 MW in comparison to the total demand of 110 MW, with capacities being crowded out in future auctions as MEC would then likely be reevaluated upward.

- In case of a regional CRM, total capacity demand would be set at 110 MW, with minimum requirements of 52 MW both in countries A and B. At least 6 MW of new capacities would need to be built. Contrary to the previous example, and assuming long-term visibility on cross-border transmission capacity, the higher cross-border capacity allows the location of these new capacities to be optimised. This lowers procurement costs, through development and construction costs, as well as differences in expected revenues in energy and balancing markets, as shown in Figure 8.

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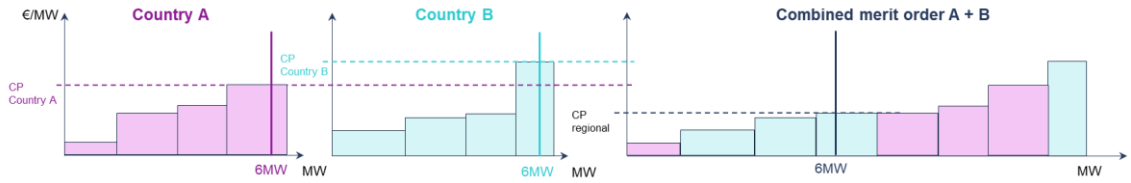
26 Conversely, procuring less than 55 MW in one country would not meet the reliability standard, as the cross-border contribution in stress situations would be capped at 5 MW by the expected available transmission capacity.

27 Setting the MEC at a higher level would require assuming in the MEC calculation both countries are meeting their reliability standards, and where the incremental capacity would be located, as the constraint would not come from the expected available cross-border capacity. This assumption would define the capacity location outcome, instead of leaving the regional CRM optimising their locations.

Figure 8: Impact of merging capacity merit order for new builds



Source: Compass Lexecon. Note: for simplification purposes, the merit order only displays new capacities.

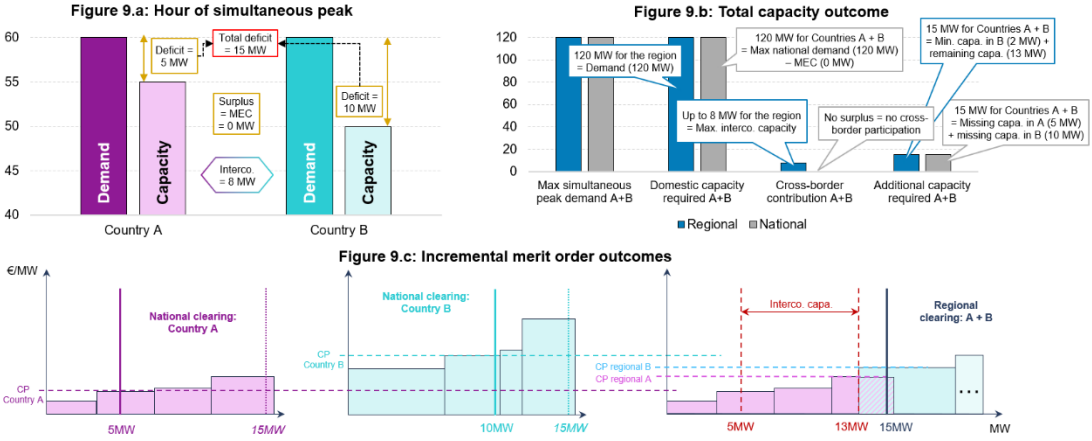
49 This latest example also shows that **potential benefits also depend on the degree of interconnectedness** within and, potentially, between regional CRMs. Without sufficient interconnection capacity, MS cannot optimally mutualise their capacities as physical flows are limited.

50 We finally assess **a situation of simultaneous scarcity risk**, illustrated in Figure 9. Even if demand peaks at the same time, potentially leading to simultaneous scarcity situations, regional CRMs may provide additional benefits. If one country has sufficient available capacity beyond its capacity needs, it could contribute to the neighbouring CRM through cross-border participation. But, in other situations, a stronger coordination could trigger additional benefits. For example, Figure 9 below illustrates a situation where the demand in the two neighbouring countries is correlated and peaking at the same time, and both countries may be facing adequacy concerns in the absence of newly built capacities.

- Unlike previous examples, increased regional coordination does not allow reducing total capacity demand given the correlation of peaks.
- In case of national CRMs, the MEC would likely be set to 0 given both countries are expecting to face scarcity simultaneously. Even assuming both would meet their reliability standards, they will have a priori no capacity margins to contribute to supply electricity to the neighbouring country in stress situations. Both would therefore procure 60 MW in their CRMs, leading to 10 MW of additional capacity in A and 5 in B.
- In case of a regional CRM, and given the available cross-border capacity of 8 MW, the minimum capacity requirement would mandate 2 MW of new capacity in country B,[28] but the remaining 13 MW could be located alternatively in A or B in order to minimise costs, leading to efficiency gains compared to national CRMs.

28 Indeed, 52 MW is the minimum necessary capacity to meet demand in countries A and B, assuming maximum imports to 8 MW as per the expected available cross-border capacity. Depending on the CRM procurement outcome, more capacity may be procured in each country.

Figure 9: A case of simultaneous demand peaks



Source: Compass Lexecon.

51 Importantly, these potential benefits depend on a **number of prerequisites being achieved, in particular sufficient coordination and consistency in the capacity demand and requirements** in the different countries. Indeed, uncoordinated definition of national capacity demands, poorly defined capacity products, long-term cross-border capacity calculations, etc. may prevent participating countries from addressing properly their security of supply needs and may prevent an efficient integration of capacity mechanisms. This will be further detailed in the next section.

2.3 Benefits could also arise from the further coordination of some underlying policies and operational issues on a regional level

52 The implementation of a regional approach for CRMs would require coordination of some underlying policies and operational issues, such as the integration of adequacy assessment and scenario planning, potentially unlocking efficiency gains as follows:

- More coordination to define the capacity demand at regional level, through, e.g., a (joint) **regional resource adequacy assessment** (RAA), could enable the assessment of resource adequacy with more granularity than at European level, while allowing for better visibility and alignment of the evolution of neighbouring countries' power systems than in a NRAA. This would require strong coordination between TSOs, NRAs and Member States at regional level, that could be facilitated by coordination bodies such as the Pentalateral Energy Forum.

- Under a regional approach for CRMs and with a regional RAA, TSOs or potentially RCCs would be incentivised to **develop joint scenarios, notably for crisis management**. As explained later in the report, regional power system crises are a focal point of the conceptual discussion on regional CRMs, as they present a massive coordination challenge whose resolution could also bring major benefits.

- Moreover, a regional approach for CRMs could lead to further efficiency gains by **inducing Member States to further coordinate and align their CRM designs while ensuring their needs are fulfilled.**[29]

29 These potential benefits are based on: ENTSO-E (2025), *The role of Capacity Mechanisms to enable a secure and competitive energy transition*. Available here.

53 These improvements and high coordination could be implemented even without a regional CRM, but the implementation of a regional CRM would be an impetus to drive convergence and alignments further than what is currently legally binding.

54 Also, **regional CRMs do not necessarily entail a complete homogenisation** of CRM design features and reliability standards across MS. Indeed, a potential advantage of the concept of regional CRMs over that of an EU-wide CRM is that it can accommodate the specific needs of different power systems on a national basis. This principle does also cascade into the country or local levels by enabling local differences – which would be lost if all reliability standards and design features were the same across a regional CRM. A regional CRM could therefore have different reliability standards, emission thresholds, or de-ratings factors within its region. The trade-offs between efficiency, level playing field and addressing specific local needs would need to be evaluated and decided upon in conscience.

55 Finally, the regional integration of CRMs could be an additional step towards further EU energy market integration, as it could “couple” national CRMs into a regional market, foster coordination and harmonisation amongst those countries and, more widely, in Europe.

56 As with the rest of the theoretical benefits listed above, the virtuous cycle effect between a regional CRMs and EU market integration depends on **certain prerequisites and on the degrees of (1) interconnectedness and (2) harmonisation**, both within and between regions. The degree of harmonisation will also have to find a careful balance that allows the regional CRMs to address the specific system adequacy needs within each region.

3 However, the implementation of a regional approach for CRMs faces a range of challenges and roadblocks

57 Even though a full harmonisation of the CRMs are not necessary per se, the implementation of a regional CRM (either a market coupling of CRMs or an integrated regional CRM as defined in Section 2) would have significant prerequisites, e.g. a minimum level of alignment on the technical design, a stronger coordination of operations as well as governance and political will.

58 In this section, we assess the different challenges that would need to be addressed in the course of implementing a regional approach towards adequacy.

3.1 Member States' adequacy and system needs differ, leading to diverging approaches regarding the need for and design of capacity mechanisms

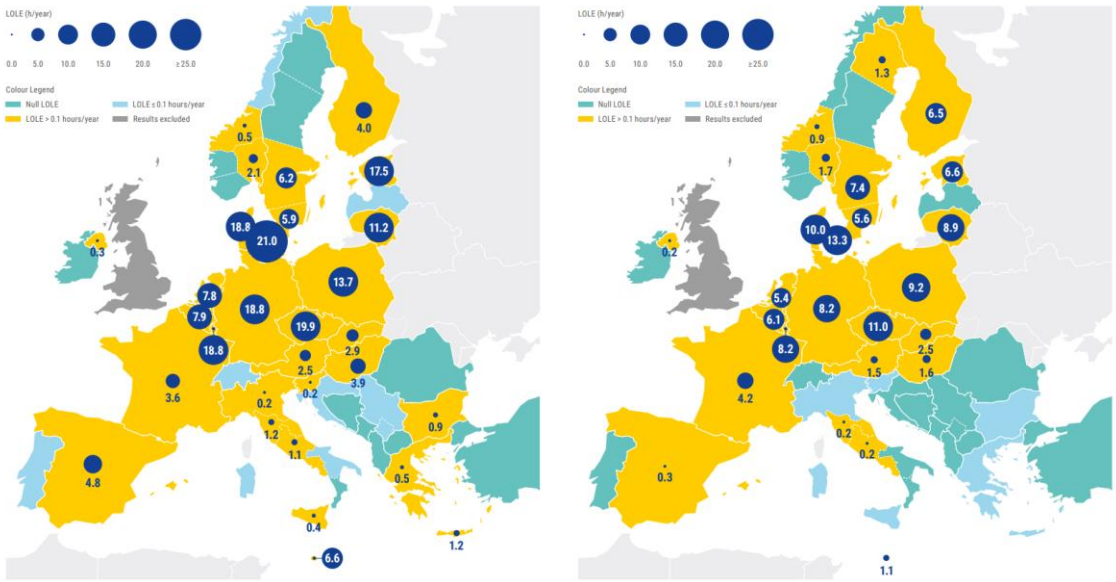
59 At the core, CRMs serve to bolster the security of electricity supply, a national prerogative under EU treaties.[30] National CRMs differ in their design in large parts because MS face different sets of national circumstances and challenges to their security of supply, including:

- High and/or temperature-sensitive winter peak demand,
- Episodes of high demand coupled with low renewable production levels,
- Hydrology impacts on hydro generation availability,
- The rapid closure of existing thermal power plants, due notably to planned retirements, or to decarbonisation-related decommissioning motives.

60 Thus, not all countries face the same adequacy risks, as captured in the Loss Of Load Expectation (LOLE) map of the ERAA (Figure 10).

30 See TFEU Art. 194. Available here.

Figure 10: Adequacy risks in 2028 (left) and 2030 (right)



Source: ENTSO-E (2024), *European Resource Adequacy Assessment 2024 – Executive Report.* Figure 3 page 8. Available here.

61 As stated prior, the complexities involved mean **there may not be a one-size-fits-all CRM design**. The variety of adequacy issues and their causes in Europe means that not all European countries may need the implementation of a CRM and, when a CRM is needed, that different types or designs of CRMs may be better suited to address their needs:

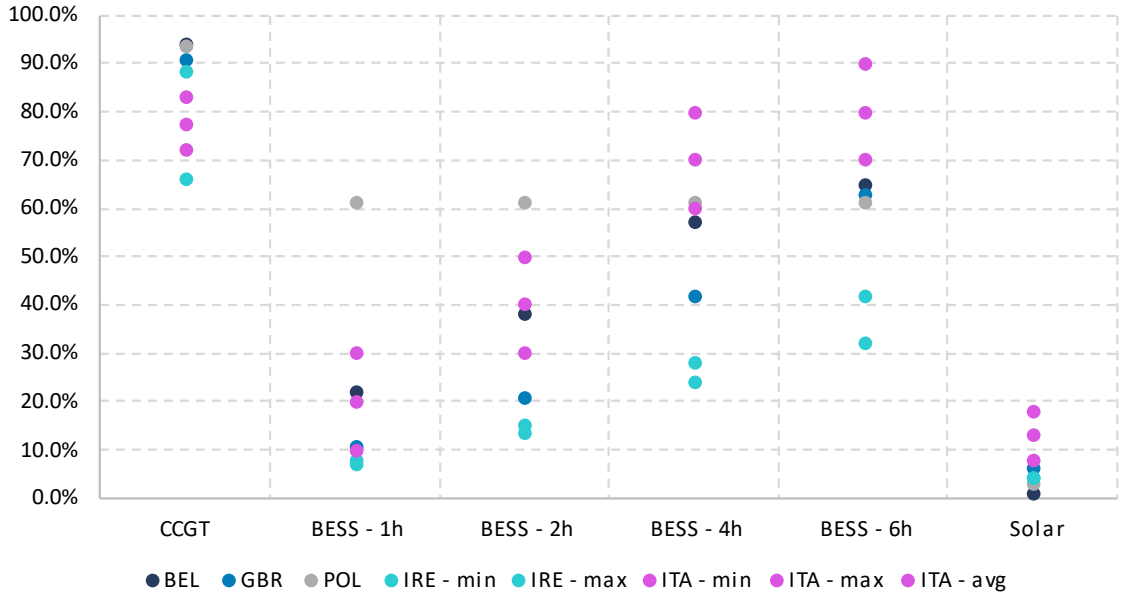
- For instance, some countries may only face adequacy issues under **rare circumstances**, like an unusually cold, cloudy, and windless winter or dry years affecting hydro generation. Such countries could rely on retiring plants as backup and opt for a **strategic reserve** to prevent them from being decommissioned.
- Other countries may have a more **structural adequacy deficit**. Their existing fleet may lack revenues to keep functioning ("missing money") or investment in new capacities is necessary to meet the increase in demand or to counterbalance the closure of old plants. These countries could choose a **capacity market** to select the least-cost capacity providers market-wide and thereby reduce the cost of adequacy, as well as to trigger investment in new capacity.

62 As such, **differences in adequacy risks lead to justifiably different designs** across national CRMs. For instance, Sweden and Finland have strategic reserves while Belgium and Poland set up a market-wide capacity market. Some design features could nonetheless be **harmonised** across capacity markets without raising much challenges. These could include identical or cross-compatible definitions of capacity products, availability control processes, or possibly penalty regimes. This would facilitate direct cross-border participation. Moreover, adequacy needs may evolve and converge in the future across countries. While some countries initially relied upon strategic reserves, gradual retirement of the existing fleet and growing needs may require to change the type and design of CRMs, as it has been observed in Belgium or as it is being discussed in Germany and other countries.

63 However, other design features may be more **difficult to harmonise**. De-rating factors, indicating how much a given resource contributes to adequacy in times of scarcity, would be inaccurate if set equal across CRMs with structurally different capacity mix and adequacy issues. For example, the de-rating factor of solar PV could be higher in a country where AC usage triggers demand peaks on summer days, than in one where demand peaks happen on winter evenings. In practice, the de-

rating factors of the same technologies vary widely across CRMs (Figure 11). This example highlights a practical difficulty of either coordinating national CRMs at the regional level or implementing a regional CRM.

Figure 11: De-rating factors for a selected sample of technologies, countries and infeed durations



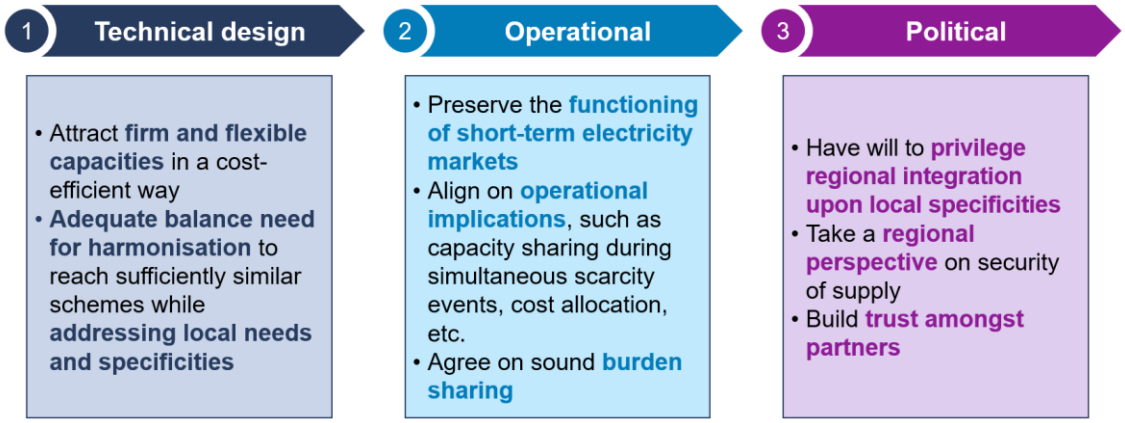
Source: CL intelligence. Note: this chart serves an illustrative purpose. The de-rating factors shown may be outdated as of September 2025.

64 In practice, the implementation of a regional CRM does not require a full harmonisation of all features of the CRM, but it does require an alignment of the specific CRM type and on the main features, or at least principles, of its design. As explained before, the harmonisation of procedures and methodologies could reduce costs for stakeholders overall and foster a level playing field at regional or European level. Differences, including for example in the parameters' values, could remain and be justified by local needs or situations.

3.2 The implementation of a regional CRM would require policy and operational agreements on the design, operational rules and cost allocation

65 As explained above, the implementation of a regional CRM has a series of prerequisites, both in terms of (i) technical design, (ii) operational arrangements to manage the CRMs and to address potential issues and scarcity situations, as well as (iii) to ensure political momentum to align views and regulations, and to agree on an adequate governance, and allow the effective implementation of such regional CRMs.

Figure 12: Challenges to the implementation of regional CRMs



Source: Eurelectric.

3.2.1 Technical design challenges

66 The design of national CRMs is complex and raises many detailed questions. Regional CRMs face even more complex technical design challenges, as they **require a shared definition of key principles and of a minimum level of harmonisation on the technical design** to deliver their expected potential benefits. Such prerequisites include **harmonised and/or mutualised pre-qualification** processes, to save time and resources both for TSOs and NRAs, as well as for market players. To meet these requirements, regional CRMs must strike a careful **balance between the need to harmonise** the schemes so they reach sufficient compatibility, **and the need to address local specificities**.

67 **Complete harmonisation is neither necessary nor desirable** for Member States to work towards regional CRMs. More harmonisation, at least in underlying methodologies and procedures (e.g. certification, availability control, etc.), would make CRMs more compatible pre-regionalisation and reduce the risk of an uneven playing field within regional procurement. However, market coupling in energy markets teaches us that functional aggregation is feasible even while individual markets keep their specificities.[31]

68 The key will thus be to reach the level of harmony that unlocks sufficient compatibility to make regional CRMs work. However, this is easier said than done:

- The dialogue would need to find a minimum viable level of harmonisation in **product design**, to enshrine common adequacy goals and to ensure cross-CRM compatibility. For now, due to local specificities, the components of product design (such as the criteria defining availability periods, obligations, penalties…) vary across national CRMs.
- **De-rating factors** illustrate this tension, as local specificities call for geographical differentiation. They would need to reflect each technology's contribution to the wider regional adequacy – and not only national – depending on their location, while avoiding undue differences that could hamper both the level playing field and effective competition across capacities within the region. As shown above (Figure 11), de-rating factors currently only converge to a degree, with wide variations across countries for the same technology groups. In a regional CRM, the methodology to establish these factors could be harmonised to ensure consistency and avoid undue differences.

31 Single Day-Ahead Market Coupling now covers 26 countries, 32 TSOs, and 18 NEMOs. (ENTSO-E, 2025).

- The ability to procure capacity across the border through the regional CRM, including new capacity, raises the question of **long-term capacity contracts** and hence long-term **visibility on the cross-border capacity** that can be used for capacity contracting. This may require significant change in the way TSOs calculate maximum entry capacity as they will need to provide long-term visibility on available cross-border capacity despite uncertainties surrounding cross-border capacity calculations in such timeframes, including due to the evolution of the capacity mix and of the constraints on the grids.

- The harmonisation of price or bid caps will need to be discussed. On the one hand, the Cost of New Entry (CONE) on which they would base their price or bid caps may differ, and justify differences. On the other hand, differences in price or bid caps may create inefficiencies and distortions. To draw a parallel, in energy markets, there were differences in price caps in the first coupling stages, but they were afterwards harmonised.

- The **CISAF target model will harmonise** some of these design features to an extent.[32] However, **there will remain divergences,**[33] on which Member States will have to find common ground to deliver regional CRMs. This common ground may be found in creative solutions, e.g., cross-compatible capacity products with location-dependent de-rating factors but harmonised obligations and penalty regimes.

- Moreover, the JRC suggests significant benefits in the introduction of locational investment signals, e.g. through CRMs. Regional CRMs can be compatible with such locational investment signals; in such cases though, their design should account for these signals implemented either at national or at regional levels, and make sure it preserves an efficient capacity procurement.

69 Implementing regional CRMs would require a **careful articulation of their interactions, including with respect to cross-(regional CRM) border participation**. A **concerted European-level conceptualisation effort** with frequent and transparent communication could help coordinate the development of regional CRMs. Depending on the choice of regions, RCCs could also partake in or support this exchange of information and facilitate cross-border participation between regional CRMs. This effort would build on the existing Electricity Regulation, CISAF target model, and ACER methodologies (notably for calculating the MEC between regional CRMs).

3.2.2 Operational challenges

70 Similarly to technical design challenges, regional CRMs will face similar operational challenges as national CRMs with direct cross-border participation, but on a larger scale.

71 *First*, parties will need to align on the **operations of the CRM**. Currently, there are mixed responsibilities at national level. Generally, TSOs have a leading role in the operations of the CRM (in terms of managing the auctions, controlling availabilities and certification, managing penalties and imbalances etc.), but NRAs and power exchanges may also play a role. For instance, currently, EPEX Spot operates CRM auctions in France.

72 **Prerequisites** to regional CRMs also include **regional inter-TSO agreement and/or data exchange frameworks**, to coordinate on adequacy monitoring, operations and share costs. Inter-TSO agreements can be challenging to conclude, in part due to the efforts implied to align views

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32 E.g., delivery windows from 1 November of year Y to 31 October of year Y+1 (CISAF Annex 1 req. 18).

33 Especially on the finer details where the CISAF provides only general principles, such as the exact timing of auctions (CISAF says main auction takes place 4-6 years ahead), or non-fossil flexibility requirements.

and risk perceptions or to agree on how to manage operational impacts in stress events.[34] On a more micro level, many of the cross-border or regional TSO projects involve sharing datasets that often do not match easily. Achieving these prerequisites to regional CRMs may also incidentally accelerate the uptake of cross-border initiatives in areas beyond CRMs.

73 *Second*, the procurement of capacity across borders or at regional level raises a tension between how to address capacity sharing during **simultaneous scarcity events**, while **preserving the functioning of short-term electricity markets**. As ensuring security of supply and limiting to the minimum risks of load curtailment is the core objective of CRMs, addressing scarcity situations is of utmost **political sensitivity**.

74 Cross-border participation already raises **tensions over reliability** today. Indeed, Member States award capacity payments to foreign units and expect that these capacities will effectively contribute to reduce risks of load curtailment in scarcity events. Yet, honouring these commitments must not come at the expense of distorting short-term electricity markets. While this would unlikely cause issues in periods of non-simultaneous scarcity, issues may occur when both countries would face scarcity events simultaneously. As cross-border participation within the region would be embedded in the functioning of a regional CRM, there would be a heightened need to tighten rules and operational procedures, and agree, at regional level, how to address these rare but critical situations.

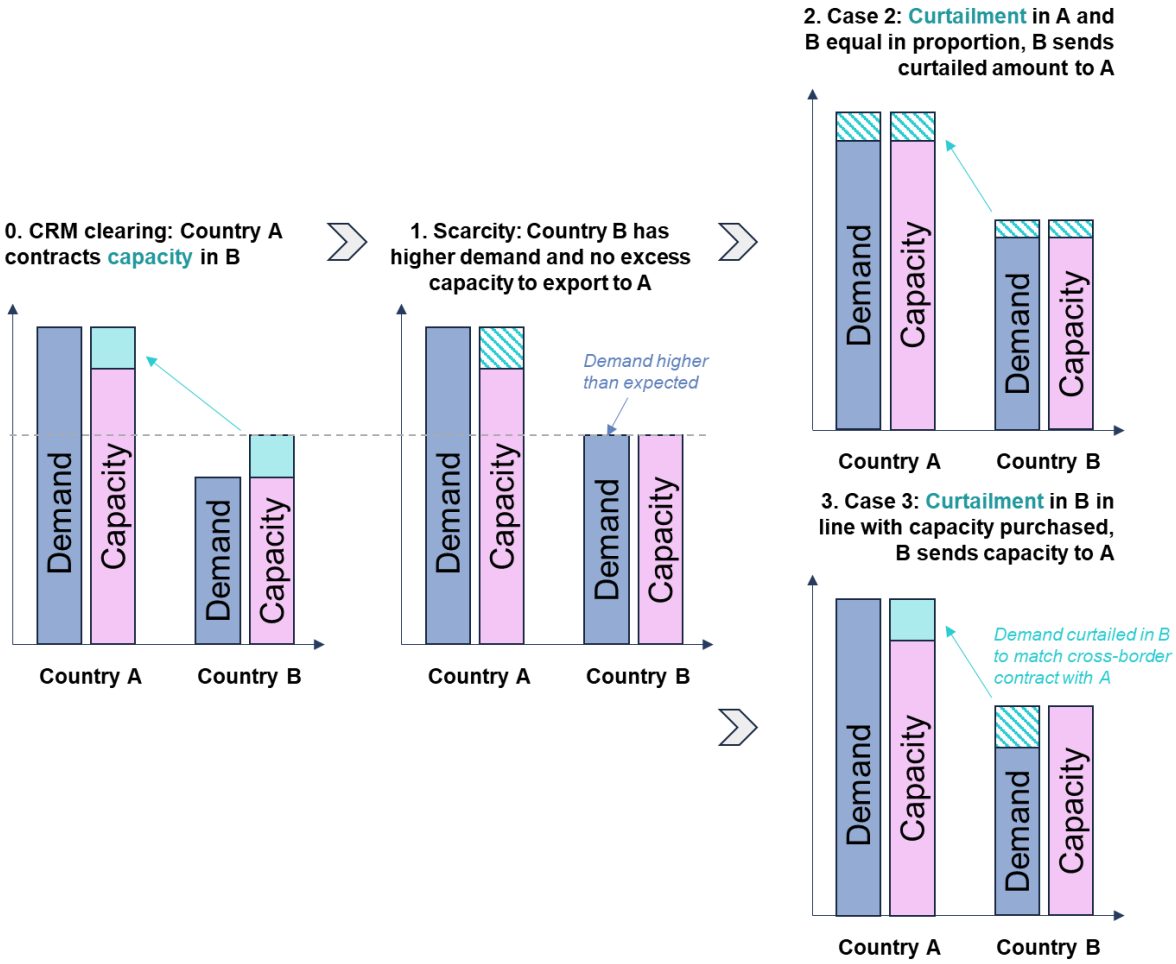
75 These operational arrangements are politically sensitive and will be key to ensure a political buy-in for cross-border participation and regional cooperation. Possible solutions could be to adapt curtailment rules and capacity sharing across borders during simultaneous scarcity events, without tampering with commercial flows between parties, and/or to agree on cost-sharing rules that better reflect these risks and share costs in a fair way with regard to benefits.

76 Figure 13 below represents a situation where scarcity occurs and may raise concerns in terms of capacity sharing and, eventually, cost sharing. This illustrative example assumes that, in the regional CRM, capacity is contracted in country B to meet capacity demand in A, but, in a period of scarcity, while contracted capacities are available and demand in A is as expected, demand in B is higher. This may result in a range of possible outcomes:

- In case 1, country B refuses to curtail its domestic consumers to enable physical cross-border exports. This means in practice that country A does not benefit from the capacity contracted in B, which benefits solely to B.
- In case 2, as currently implemented in the market coupling algorithm, curtailments are applied proportionally in A and B. This means in practice that country A does not fully benefit from the capacity contracted in B, as security of supply benefits are shared B.
- In case 3, cross-border flows are scheduled in accordance with capacity contracts. In practice, this means that curtailment would be defined in line with capacity contracts. Cross-border capacity exchanges could be taken into account by the market algorithm when applying curtailments and scheduling flows in situations of curtailments.

[34] ACER (2023), *Security of electricity supply 2023*. §131 page 46. Available here.

Figure 13: Capacity sharing in scarcity situations



Source: Compass Lexecon.

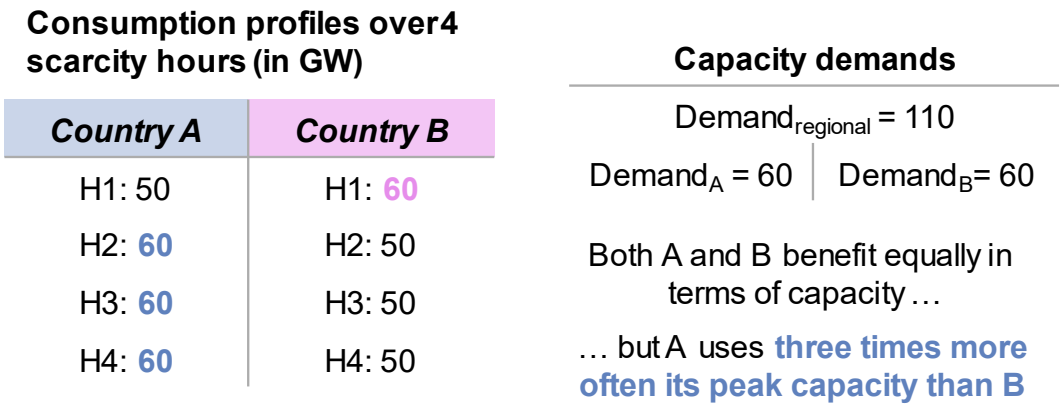
77 The market outcome in such situations would largely be driven by administratively set rules to address curtailments in the market coupling algorithm and/or TSO actions to preserve security of supply and limit curtailment risks. They may however **arouse strong political reactions in case of load shedding**. The design of these features would therefore need political backing.

78 Therefore, capacity sharing agreements and cost sharing arrangements should be defined in a consistent way. As a minimum, cost sharing agreements should account for the different sharing of costs and benefits. For instance, in case 1 above, one may expect that country A would at least receive a financial compensation, although this might not entirely solve the political tensions around such situations. Moreover, in practice, cases might be more complex, and it may be complicated to design capacity sharing and cost sharing arrangements which ensure political acceptability. Trust between parties is also required, especially amongst Member States and amongst TSOs, in order to respect commitments laid out in these arrangements.

79 Cost allocation in regional approaches for CRMs could raise questions beyond joint scarcity situations, as there could be different benefits and methodologies to allocate them. Figure 14 illustrates this with an example. In this example, countries with equal capacity demands but different consumption profiles could benefit differently in capacity vs. in energy terms from the contracted capacity in the CRM. Both countries benefit equally in terms of capacity, but Country A uses three

times more often its peak capacity than Country B. This could trigger discussions on which basis to share costs.

Figure 14: Uneven benefits in energy terms across otherwise equal capacity demands



Source: Compass Lexecon.

3.2.3 Political considerations

80 In the continuity of the technical design, operational, governance and cost-sharing questions outlined above, regional CRMs will also face political challenges as security of supply is a national prerogative under EU treaties. To take a **regional perspective** on security of supply will require fostering **the will to privilege regional integration upon local specificities** and building **trust amongst partners**. Tackling these political challenges would allow Member States to address the root technical and operational issues shown above.

81 *First*, to reach a sufficient convergence and level of harmonisation towards a regional CRM, compromises would have to be struck amongst MS, and strong political commitment would be required to achieve the final goal of a regional approach to adequacy and to be able to overcome the various hurdles. In that sense, the new CISAF target model will promote a degree of convergence and harmony across national CRM designs, both for new CRMs and for those that will seek renewal in the coming years.

82 In practice, the discussion could be structured around the following points:

- **Control on adequacy at national level**: the discussion would focus on how to ensure national reliability standards can be met at national level and to guarantee effective cross-border contributions to adequacy and stress situations. Adequate **operational agreements** for major system stress situations would need to be negotiated, not only from a technical perspective, but also considering the political dimension.
- **Cost-sharing agreements**: notably, to dispel concerns over MS free-riding, from the potential development of a regional RAA, through capacity auctioneering, to market outcomes.
- **Governance**: the decision-making process around regional CRMs will also be crucial for Member States to ensure that they keep sufficient control on the design and evolution of the schemes, including how to ensure adequacy and how to mitigate costs for consumers.

83 Going further, the necessary and useful alignments on national policies outside of CRM design, which could still interfere with regional CRMs, should be assessed. This investigation could focus on policies that could have a major impact on the outcomes of regional CRMs for their MS. The

goal of this voluntary investigation would be to identify solutions to limit distortions and to assess the costs and benefits of individual policies on outcomes for the regional CRM and its MS. Examples of policies worth assessing could include **environmental policy, network charges, aid to industry, support schemes for renewables, and energy taxation** – all MS prerogatives under EU treaties, and susceptible of distorting incentives.

84 To foster further coordination and cooperation, a Regional Energy Forum (REF) could be created – or stem from existing forums line the Pentalateral Energy Forum – gathering ministries, regulators and TSOs, as put forward by ENTSO-E,[35] and involving stakeholders. A key outcome of this forum would be to **define minimum compatibility principles – or a minimum degree of design feature harmonisation – and coordinate design and implementation of a regional CRM** in the region. It could also provide a forum to discuss policy alignment beyond CRM.

85 *Second*, the implementation of a regional capacity contracting mechanism would require MS to **coordinate on their respective system needs**. This shared understanding could emerge from the implementation of a regional RAA, or, at least, the definition of regional capacity demand together with local minimum requirements, in order to harvest the maximum benefits from this regional coordination, as explained in section 2. This would combine the modelling power and local knowledge of each TSO.

86 *Third*, the development of a regional CRM faces practical **implementation challenges** stemming from the current national governance of CRMs. At present, the regulatory frameworks for CRMs are developed at national level, on the basis of different legislative and regulatory structures. In the absence of a unified and unifying EU framework, national laws and regulations across the regions would need to be aligned, with the risks of discrepancies and inconsistencies, based on multilateral framework agreements between Member States.[36]

87 *Fourth*, a regional CRM would be subject to potentially **complex State aid approval** processes due to the number of countries involved. However, **coordinated notifications** could work, as was done with the CRM for the island of Ireland: in 2017, both Ireland and Northern Ireland submitted the same mechanism to the EC for State aid approval in two separate files that were treated together.

88 *Lastly*, the **delineation of regions** within Europe would be sensitive. Regions would need both commonality across CRMs – to start with a compatible set of rules – and differences in adequacy settings – to synergise on uncorrelated scarcity events. The delineation of CRM regions could also **benefit from integrating existing regional structures**. These include Capacity Calculation Regions (e.g., Core) and their respective Regional Coordination Centres (e.g., Coreso), which could replicate some of their key services (e.g., Maximum Entry Capacity for imports outside the region).

89 Moreover, in order to comply with the European State Aid Guidelines and the Electricity Regulation and to avoid distortions of the level playing field in the internal energy market, to include all sources of capacity security and flexibility, regional capacity mechanisms must apply to all contributory interconnections without distinction of financing or regulatory status.

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35 See for instance ENTSO-E (2017), *Power regions for the energy union: regional energy forums as the way ahead*. Available here.

36 And possibly between regulatory authorities and between TSOs.

4 Conclusion

90 Member States have adopted a variety of CRM designs in response to national-level differences in circumstances, electricity system fundamentals, and adequacy concerns. These differences trickle down to design principles, detailed design specificities, and methodologies, causing a lack of cross-CRM compatibility that slows down the progress of direct cross-border participation mandated by EU regulation. This recent EU CISAF's model, published in 2025, provides the grounds for more harmonised designs and could help aligning CRMs and facilitate cross-border participation.

91 There are benefits associated with each incremental step towards regional CRMs. The full implementation of cross-border participation (step 2), though complex, may reduce overall costs via increased competition, better reflect the contribution of foreign generators and interconnectors to adequacy, and level out the playing field. The harmonisation of national CRM designs (step 3) can reduce CRM implementation and participation costs, provided they are still adapted to meet local needs, and facilitate and make cross-border participation more efficient, further alleviating adequacy gaps. Beyond these first steps of design harmonisation and integration, a move towards regional CRMs (steps 4 and 5) could yield additional significant benefits – provided some prerequisites are met:

- The potential benefits of regional CRMs come from the pooling of capacity demand and of procurement across a region. This entails cost reductions through maximising the use of interconnection capacity to reduce total capacity demand, and optimising capacity procurement across the entire region. These benefits depend on the fulfilment of pre-requisites and vary in their amounts with the degrees of interconnectedness and harmonisation. Lastly, wider benefits could arise from the efforts deployed to harmonise CRMs regionally.

- The prerequisites towards the efficient implementation of regional CRMs span a range of measures to ensure sufficient coordination and consistency across jurisdictions. Harmonised and/or mutualised qualification processes will be needed to save time and resources for organisers and participants, and inter-TSO agreements and data exchange frameworks will be crucial to foster operational coordination.

92 However, the implementation of regional CRMs faces significant technical, operational, and political challenges, especially to ensure the abovementioned prerequisites are met:

- The key technical challenges will be to strike the correct balance between harmonising CRM designs until they are sufficiently compatible, and addressing local needs and specificities. The CISAF provides a helpful base, but there will remain divergences and technical details that only Member States, together with regulators, TSOs and market participants, can address. It should also allow, where envisaged, the introduction of locational investment signals at national or regional levels. Although this is perfectly compatible with regional CRMs, this may add a layer of complexity to the design of an efficient regional CRM.

- Operational challenges include the need to find prior alignment on the operations of the CRM, and the politically sensitive tensions related to reliability, more specifically on how to address simultaneous scarcity events while preserving the functioning of short-term electricity markets. Also, at the intersection of the operational and the political, cost allocation issues create further challenges. Indeed, the potential unequal spread of benefits from regional CRMs warrants ex-

ante cost-sharing agreements to dispel any freeriding concerns and reconcile contractual arrangements with cost and security of supply benefits.

- The crux of the political challenges will amount to building and fostering the will to favour regional integration over local specificities to generate the associated benefits, and to build the needed trust amongst Members States. Design and policy compromises will be needed to reach sufficient compatibility, to co-dimension their system needs, to tackle governance-related challenges, and to coordinate CRM State aid notifications. Lastly, the delineation of regions could be sensitive, both politically and practically, with regards to the benefits of integrating existing structures like RCCs.

93 Given the processes involved, it would be essential to ensure that the benefits of regional CRMs outweigh the costs of overcoming these implementation challenges. However, the implementation of regional CRMs will not take place in a single step and would need to be voluntary. Gradual steps, as suggested in Figure 1 of the paper, could be followed for a progressive convergence towards regional approaches.

94 In practice, short-term and low-regret actions taken now could set a course towards a regional approach for CRMs:

- Continue the improvement of national CRMs, including the effective implementation of direct cross-border participation of foreign capacity as mandated by EU regulation (step 2).
- Establish a structured process, with the involvement of Member States, regulators, system operators and market participants, for exchange of best practices with implementation of the legal obligation to include cross-border participation.
- Harmonise national CRMs to the extent possible while still addressing local needs and allowing for different national preferences for adequacy standards, for example by leveraging the principles of the CISAF model; this could reduce substantially costs for market participants, TSOs and regulators.
- Deliver on the prerequisites to make regional CRMs implementation possible and efficient. This includes design harmonisation but also the necessary policy and operational alignments, as well as establishing the coordination mechanisms enabling this practical implementation.
- Start with voluntary, small-scale initiatives towards regional CRMs, such as bilateral projects.
- Strengthen regional cooperation on resource adequacy assessments.

A Appendix

Appendix Table 1: Key concepts and their definitions in this paper

Concept	Definition
Capacity Remuneration Mechanism (CRM)	(EU) 2019/943: "*a measure to ensure the achievement of the necessary level of resource adequacy by remunerating resources for their availability*"[37]
(National) Capacity Market, or market-wide CRM	Also 'market-wide CRM', i.e., open to all suppliers in the electricity market (within a set of eligibility criteria such as minimum size or compliance to the EU's emission threshold) as opposed to e.g., strategic reserves which only include a specific set of strategically relevant power plants.
Regional CRM	A mechanism that enables the coordinated procurement of capacity at the regional level, including cross-border exchanges. This can range from the coupling of distinct national capacity mechanisms to a fully integrated regional capacity procurement mechanism.
EU-wide CRM	A mechanism based on the principles of the regional CRM (described above) but with a procurement encompassing all EU Member States (MS).
Capacity product definition	How each CRM defines the product it remunerates, i.e., the definition of the capacity being sold, such as the availability to generate and deliver electricity over a given period.
Cross-border participation	The participation of capacity units from Country Y into the national CRM of Country X, i.e., across the border from Country Y to Country X.
Multi-CRM participation	The cross-border participation of a capacity unit into more than 1 CRM, i.e., in domestic and foreign CRMs or in different foreign CRMs.
Maximum Entry Capacity (MEC)	ACER Technical Specifications[38]: "the maximum entry capacity on a given CM border for a given delivery period"

[37] "… excluding measures relating to ancillary services or congestion management". See (EU) 2019/943 Article 2 recital (22). Available here.

[38] ACER (2020), Technical Specifications for cross-border participation in capacity mechanisms, Article 2.2 recital (y). Available here.

Appendix Table 2: List of acronyms employed in this report

Acronym	Full phrase
ACER	Agency for the Cooperation of Energy Regulators
BESS	Battery Energy Storage Systems
CAPEX	Capital Expenditure
CBCA	Cross-Border Cost Allocation [framework]
CCGT	Combined Cycle Gas Turbine [power plant]
CCR	Capacity Calculation Region
CEEAG	Climate, Energy, and Environment State aid Guidelines
CONE	Cost Of New Entry
CRM	Capacity Remuneration Mechanism
DSR	Demand-Side Response
EMDR	Electricity Market Design Reform
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
GB	Great Britain
LOLE	Loss of Load Expectation
MEC	Maximum Entry Capacity
MS	Member State [of the European Union]
(N/E)RAA	(National/European) Resource Adequacy Assessment
RCC	Regional Coordination Centre
REF	Regional Energy Forum
TSO	Transmission System Operator
UK	United Kingdom
VOLL	Value of Lost Load

Locations

Europe

Berlin
Brussels
Copenhagen
Düsseldorf
Helsinki
Lisbon
London
Madrid
Milan
Paris

North America

Boston
Chicago
Houston
Los Angeles
Miami
New York
Oakland
Washington, DC

Asia Pacific

Beijing
Hong Kong SAR
Shanghai
Singapore

Latin America

Buenos Aires
Santiago