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Research Brief

Cross-border Solidarity versus National Capacity Markets: Risk of Inadequate Capacity Procurement

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Who should pay to keep Europe's lights on? National capacity markets are gaining momentum, and capacity costs are borne domestically. However, the reliability benefits spill across borders through an increasingly interconnected grid and the single wholesale energy market. This creates a misalignment: each country does not pay exactly for the capacity it eventually benefits from. We find that this misalignment can encourage free riding and lead to underinvestment in capacity at the regional level. To address this gap, we propose regulatory solutions to better align capacity procurement costs and benefits, such as sharing capacity costs at regional level.

Non-cooperative risk with national capacity markets

When capacity markets are operated nationally, each country might adopt a procurement strategy which maximizes its national welfare, rather than the regional welfare. Arises therefore a risk of non-cooperative behavior.

To evaluate this risk, we modeled a stylized electricity system of two interconnected countries, inspired by the approach of Lambin & Léautier (2019). Both countries are symmetrical, operate a common regional wholesale energy market, and a national capacity market. We verified whether the optimal regional capacity level is a stable Nash equilibrium. In other words, we checked that no country can increase its national welfare by unilaterally increasing or decreasing its capacity demand.

Non-cooperative risk depends on how capacity market costs and benefits are allocated across the region

First, the national capacity market benefits—reduced likelihood of consumers curtailment—depend on how curtailment is allocated across the two countries during common scarcity periods. We identified three possible allocation options:

- Curtailment-local, where domestic generation is allocated in priority to domestic consumers,
- Curtailment-reservation, where generation capacity (be it domestic of foreign) is allocated to the country which procured it
- And Curtailment-sharing, where curtailment ratios are equalized across the two countries. This is currently the prevailing rule, as implemented by default in the EU single day-ahead market coupling algorithm EUPHEMIA.

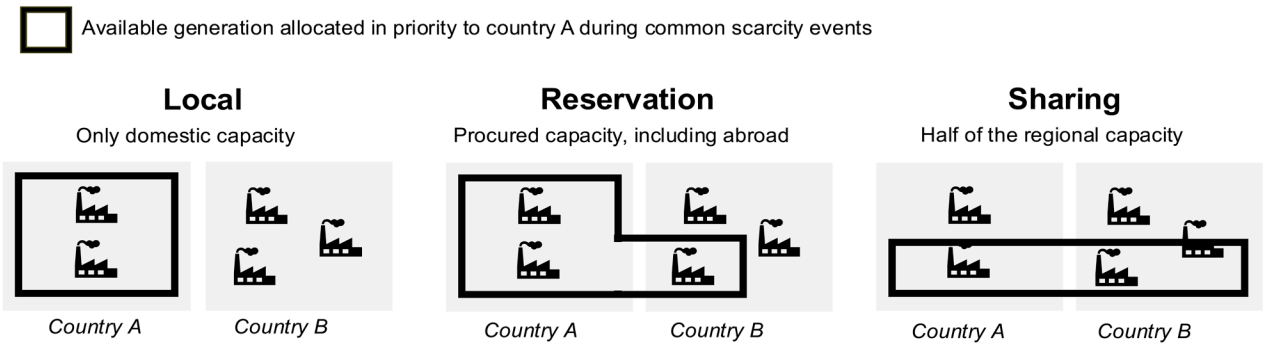

Figure 1. Curtailment allocation rules.

Second, the national capacity market costs depend on how capacity costs recovery is allocated across consumers of the two countries. We identify three possible allocation options:

- Costs-local, where domestic consumers pay only for domestic capacity,
- Costs-reservation, where consumers pay for the capacity reserved (be it domestic or foreign). This is currently the prevailing rule, as the EU Electricity Regulation mandates Member States to allow for explicit cross-border capacity participation into national capacity markets.
- Costs-sharing, where domestic consumers pay for half of the regional capacity.

Combining these different curtailment and cost allocation options, we evaluated their compatibility, which is summarized in Table 1.

The current EU framework is prone to free-riding

We found a risk of non-cooperative behavior with the current EU regulatory set-up. Sharing is the prevailing curtailment allocation rule in the day-ahead market clearing algorithm EUPHEMIA. In case of common scarcity periods, curtailment ratios are equalized, as much as physically possible, across the two countries. Moreover, capacity markets costs are allocated at national level with either explicit cross-border participation (Cost-reservation), or implicit cross-border participation (Cost-local).

In such a configuration, the optimal capacity level is not a Nash equilibrium. Because the benefits (reduced consumers' curtailment) of capacity procurement are shared at regional level, both countries have an incentive to reduce their capacity demand to reduce their capacity costs. Injecting numerical values in the equilibrium condition, we find that we can expect capacity under procurement reaching around −1.4%. Though this relative change appears quite low, it increases the annual loss of load expectation by +54% and unserved energy by +60%.

Additionally, the capacity each country can access during scarcity does not match the capacity it procured. Therefore, EU countries don't have an incentive to procure capacity abroad, i.e. to implement explicit cross-border participation as mandated the EU Electricity Regulation.

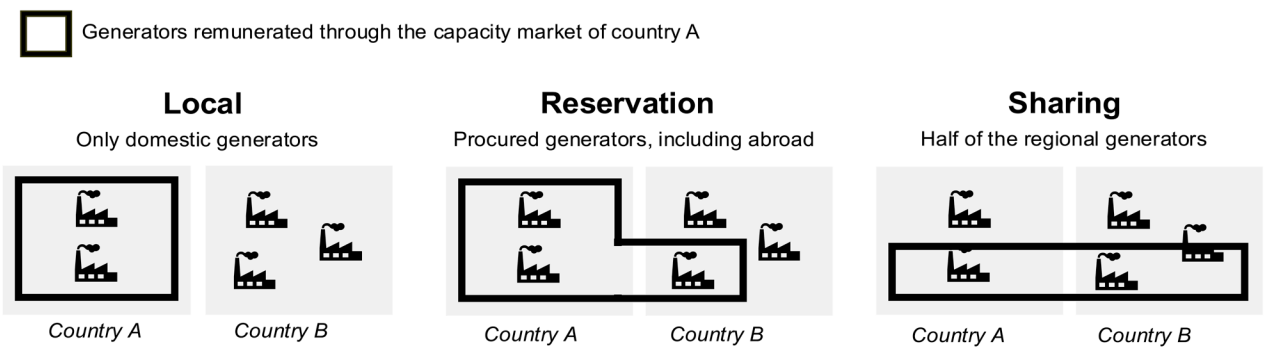

Figure 2. Capacity Costs allocation rules.

Not a solution: purely domestic approach

An alternative approach would consist in letting countries a full responsibility over their national security of supply. Domestic consumers would only pay for domestic capacity (Costs-local). Additionally, domestic consumers would get the available domestic generation in priority during scarcity periods, which corresponds to minimizing cross-border trade (Curtailment-local).

The problem with such an approach is that it distorts capacity procurement towards domestic generation. If foreign generation is cheaper to build, then it would be more cost-efficient from the regional point of view to procure it abroad and import it during scarcity. The domestic approach would result in procuring generators in the wrong location, and higher capacity costs from the regional point of view.

First solution: changing cross-border energy allocation during scarcity

What if we maintain national capacity markets with explicit cross-border participation (Costs-reservation)? In such a case, the allocation of curtailment during scarcity periods should be based on the capacity procured. This ensures that each country gets exactly what it paid for, and eliminates the risk of non-cooperative behavior.

This solution might be difficult to implement in practice, considering time-dependent interconnectivity constraints, non-perfectly correlated scarcity events, and flow-based market coupling (see Elia, 2022). Additionally, "Curtailment sharing" in the day-ahead market clearing only takes place once supply bids are exhausted and market prices reach the common cap. Before that, cross-border flows would be directed towards the country in which consumers submitted most high price bids, which might not be the one which actually procured most capacity.

Second solution: sharing fairly capacity costs ex-ante or ex-post

What if we maintain the current day-ahead market clearing algorithm with "curtailment sharing"? Then, we should ensure that each country pays for the capacity that it gets. In other words, capacity costs should be fairly shared across the region. This can be done ex-ante, or ex-post.

First is ex-post. Capacity procurement and cost allocation could remain at national level. However, cross-border compensations could be allocated based on the observed cross-border flows during scarcity periods. If a country benefitted from more capacity than it paid for, then it would compensate its neighbors for the corresponding imports (i.e. the savings from reduced curtailment) it benefitted from.

Second is ex-ante. The capacity demand(s) could be defined cooperatively by the concerned countries through, for example, a regional capacity market. Costs could be recovered across the region proportionally to the expected benefits of the measure within each country. We discuss in Menegatti & Meeus (2025) why and how to implement regional capacity markets in the EU. As adequacy assessments and capacity auctions are conducted years ahead with a significant uncertainty, ex-post corrections could also be applied.

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">Curtailment</th></tr>
<tr><th>Local</th><th>Reservation</th><th>Sharing</th></tr>
<tr><td rowspan="3">Costs</td><td>Local</td><td>Incompatible</td><td>N/A</td><td rowspan="2">Incompatible (Underprocurement)</td></tr>
<tr><td>Reservation</td><td>N/A</td><td>Compatible</td></tr>
<tr><td>Sharing</td><td colspan="2">Incompatible (overprocurement)</td><td>Compatible</td></tr>
</table>

Table 1. Compatibility of capacity costs and curtailment allocation rules for the achievement of the optimal capacity level in a non-cooperative scenario.

References

Elia. 2022. Appendix on Adequacy Patch.

Lambin X, Léautier T-O (2019) "Cross-border Effects of Capacity Remuneration Schemes in Interconnected Markets: Who is Free-riding?". The Energy Journal, Vol. 40, No. 6, pp. 79-110

Menegatti E, Meeus L (2025) "Three steps to a Regional capacity market in the EU". EUI, RSCAS, Working Paper, 2025/44.

Link to the full working paper discussed in this brief:

Menegatti, E. and Meeus, L. (2026), "Cross-border Solidarity versus National Capacity Markets: Risk of Inadequate Capacity Procurement," MIT CEEPR Working Paper 2026-08, April 2026

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