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European Union Agency for the Cooperation of Energy Regulators

Security of EU electricity supply

2025 Monitoring Report

20 November 2025

Report in PowerPoint format

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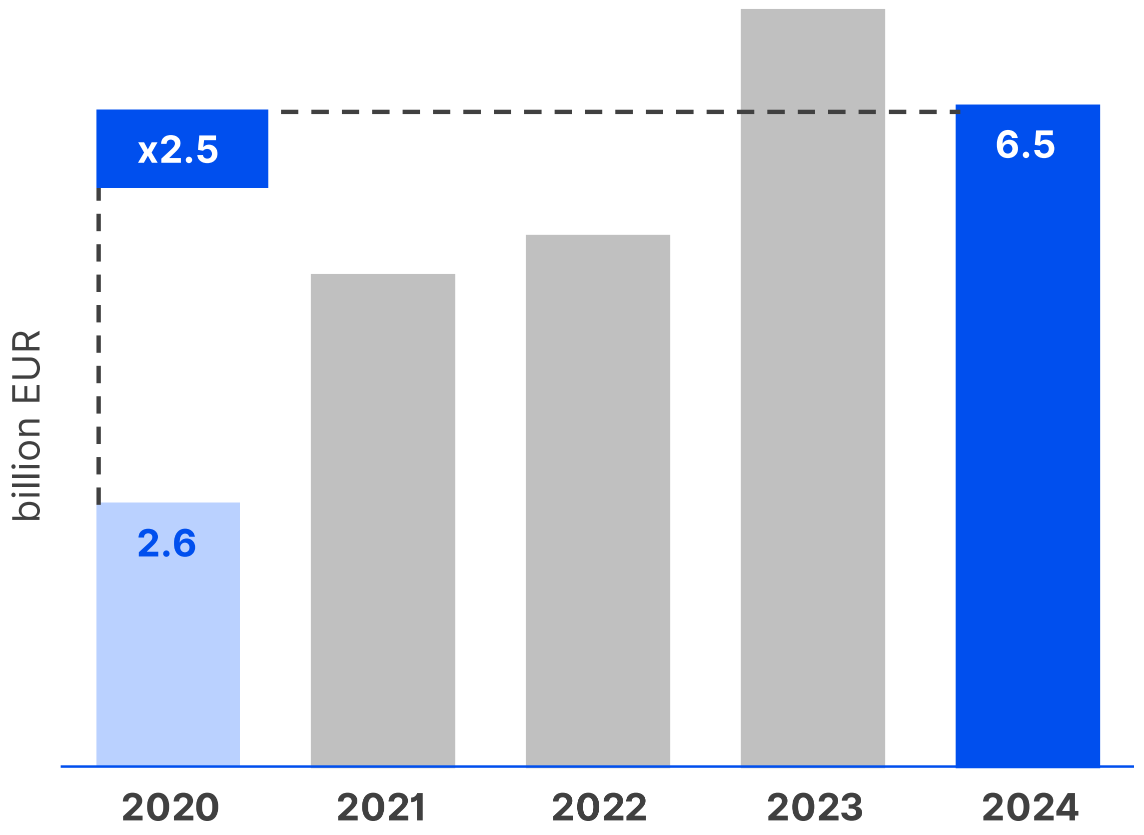
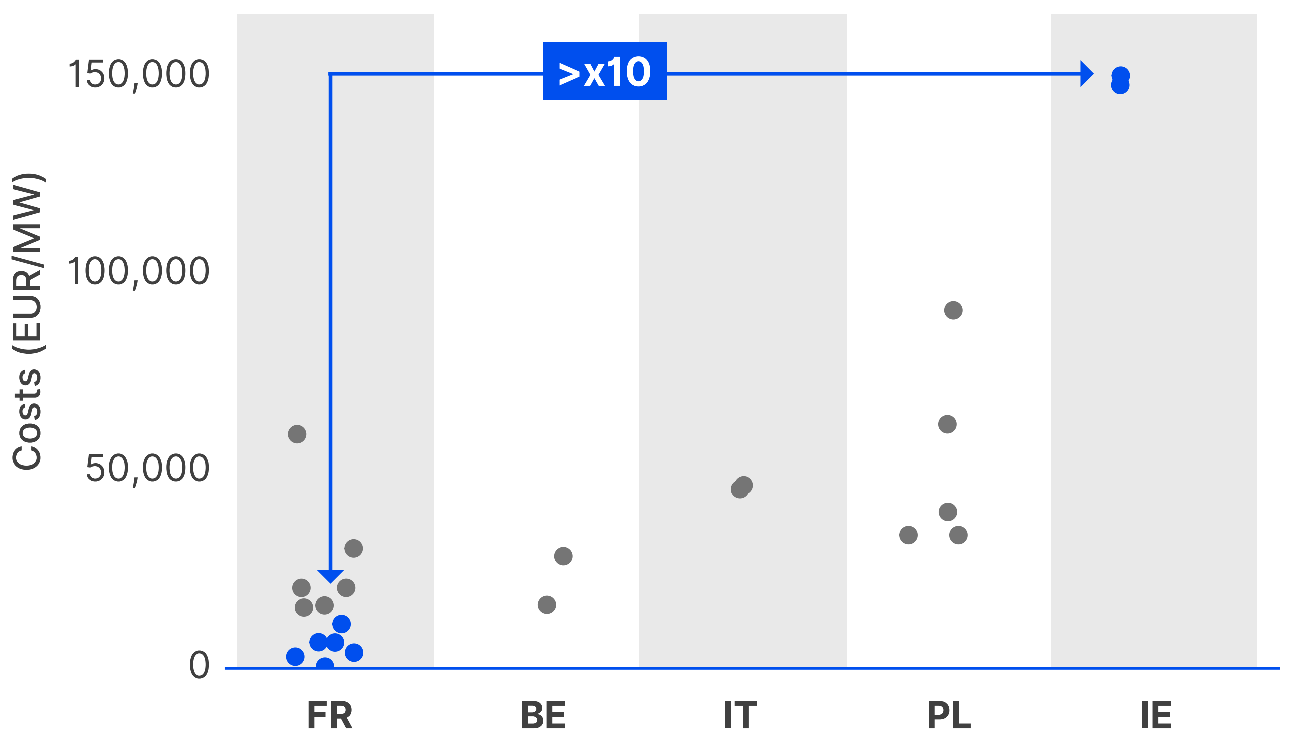
2024 security of electricity supply in 4 charts

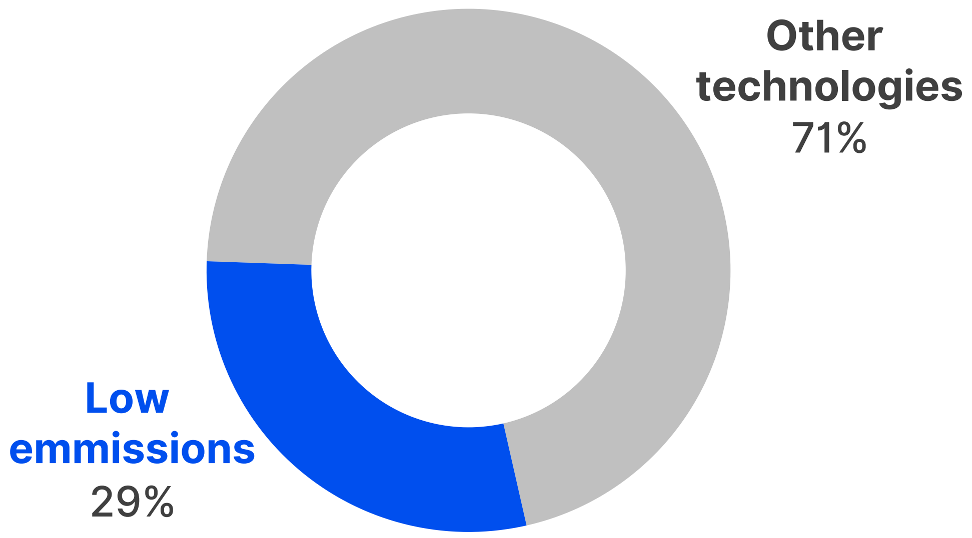
1 Costs of capacity mechanisms more than double since 2020



2 Tenfold divergence of capacity auction clearing prices across the EU suggests inefficiencies

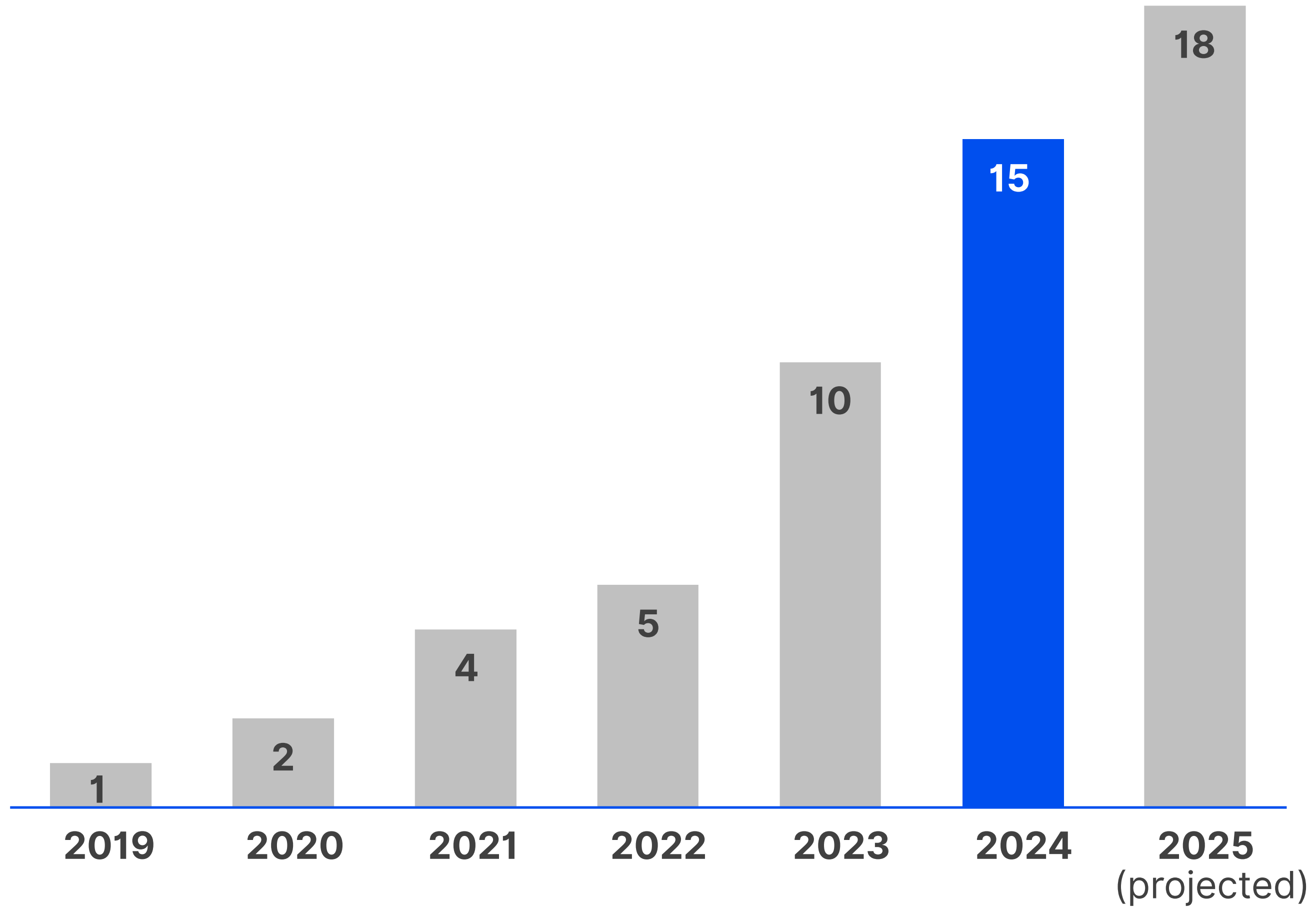


3 Out of 6.5 billion EUR, 29% goes to low-emission technologies, but gas leads in long-term contracts



Capacity mechanism payments

4 Rapid increase in flexibility support, now totalling 15 Member States



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Summary of key findings

1

Capacity mechanisms have yet to become cleaner

- **only a third** of capacity support payments go to clean technologies, gas leads in long-term contracts;
- gas-fuelled power plants remain a crucial safety net, projected to cover **30%** of peak demand in 2035

2

Capacity mechanisms have yet to become more efficient

- **more than tenfold difference** in capacity auction prices across the EU;
- total cost of capacity mechanisms reaches **EUR 6.5 billion** while the number of Member States with capacity mechanisms remains unchanged since 2022

3

Coordination improves efficiency

- enhanced cross-border coordination could decrease the additional capacity to be installed by up to **70%**;
- ACER's estimations indicate potential risks of inefficient procurement due to **limited coordination between support for adequacy and flexibility measures**

4

Regional and cross-sectoral cooperation on risk preparedness crucial for security of supply

- diverse levels of implementation of risk preparedness plans between states and regions, with only **10%** having coordinated measures in place to jointly mitigate the impact of an electricity crisis and assist neighbours;
- limited consideration of cross-sector dependencies between **gas and electricity** in risk preparedness work

Source: NRAs as reported to ACER in the Report Survey.
Report and its findings refer to 2024, unless otherwise indicated

Recommendations to Member States

1

Make capacity mechanisms cleaner

- enable participation of distributed energy resources in capacity mechanisms and implement ACER's capacity-related no-regret actions to remove barriers to demand response
- increase transparency related to support measures going to fossil fuels

2

Make capacity mechanisms more efficient

- ensure a more coordinated approach to capacity dimensioning across Europe, benefiting from the European Resource Adequacy Assessment
- reassess the design of capacity auctions, particularly when consistent high prices are observed

3

Better align capacity mechanisms and flexibility support measures

- identify interdependencies between flexibility and adequacy decisions
- adapt existing measures, striving to co-optimise procurement of capacity and flexibility needs

4

Work closer together on regional risk preparedness

- explore cross-sector cooperation in risk preparedness plans inspired by good practices
- identify outstanding constraints to regional cooperation, share templates, organise joint monitoring of implementation of measures *etc.*

Demand response and other distributed energy resources: what barriers are holding them back? ACER 2023 Market Monitoring Report
ACER proposes 12 actions to remove barriers to demand response

Introduction & Report Flow

Security of electricity supply remains essential for the EU Energy Policy and is closely intertwined with EU's economic competitiveness (Draghi Report).

This Monitoring Report is situated in the context of the ongoing revision of the EU energy security architecture initiated by the European Commission and supported by the European Parliament, as well as in the context of the streamlining of the adequacy framework and other monitoring work by ACER.

Thus, this report takes a broader approach to Security of Supply compared to previous editions, including risk preparedness, the cross-sectoral electricity-gas dimension, in addition to looking at adequacy and flexibility measures.

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State of play in security of supply

Taking stock of recent developments

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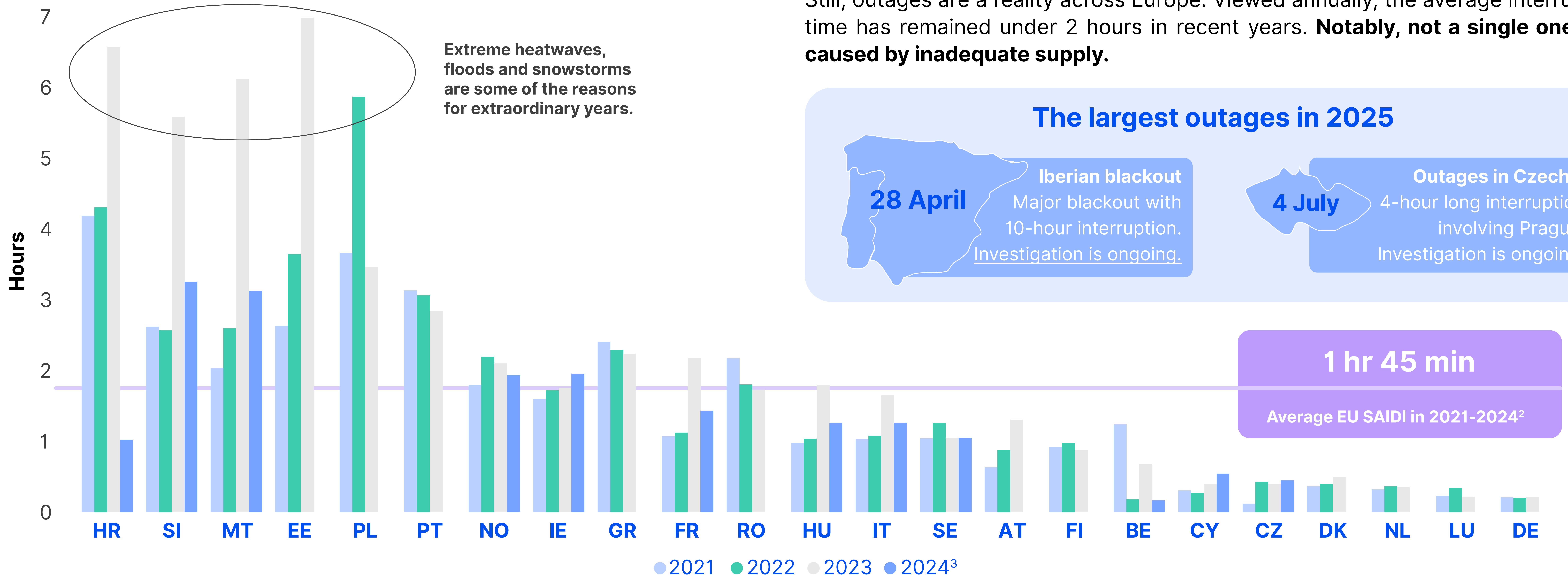
Outages happened, NOT due to the lack of resources

How long were the lights out during the year?

System average interruption duration index (SAIDI), EU-27, 2021-2024 (hr)[1]



The interconnected European power system offers resilience against sudden shocks, largely thanks to its scale. It allows to trade resources efficiently, lowering the costs and provide extra capacity in critical moments.

Still, outages are a reality across Europe. Viewed annually, the average interruption time has remained under 2 hours in recent years. **Notably, not a single one was caused by inadequate supply.**

The largest outages in 2025

28 April

Iberian blackout
Major blackout with 10-hour interruption.
Investigation is ongoing.

4 July

Outages in Czechia
4-hour long interruption involving Prague.
Investigation is ongoing.

Source: ACER based on NRA data. Includes unplanned and planned outages on all available voltage levels. LT, BG, LV data not available. ES does not report SAIDI.

[1] Reliability level 99.98%

[2] Average SAIDI experienced by end-users in the EU (weighed with population) is lower, at 1 hr 23 min.

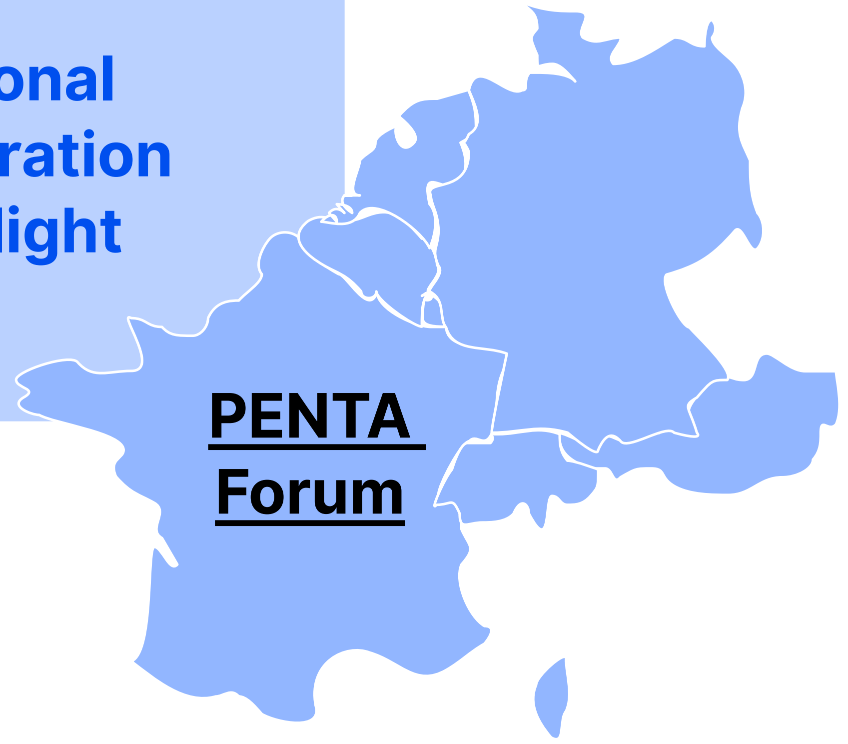
[3] For 2024 multiple Member States indicate either no data available or data incomplete.

Coordination is at the heart of EU risk preparedness

The Risk Preparedness Regulation[1] addresses the cross-border dimension of risk preparedness regarding potential crisis situations in the electricity sector, such as extreme weather conditions, cybersecurity threats, fuel supply shortages and interconnection issues.

Risk preparedness requires cooperation at national, regional and EU levels.

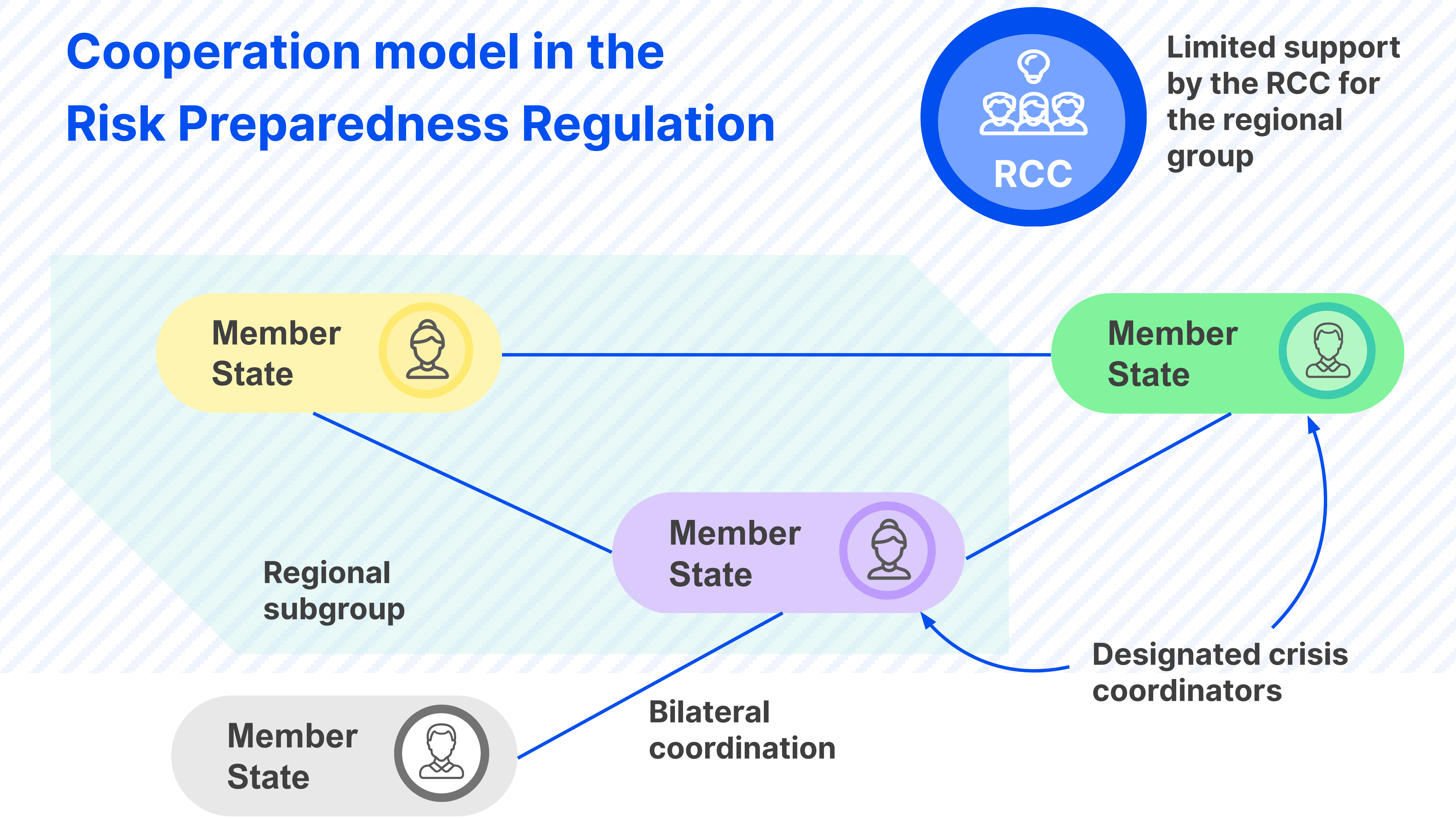
Regional Cooperation Highlight



Frontrunner in risk preparedness cooperation

- regional assessment of cross-border impact of the individual country measures.
- members jointly carry out regular tests of risk preparedness plans.

Cooperation model in the Risk Preparedness Regulation



Sector Coupling Highlight

Both electricity and gas included in risk preparedness work in Germany and Spain.

Each of these two countries has a single Crisis Coordinator for both sectors and develops risk scenarios that include crisis issues in both electricity and gas.

[1] Regulation 2019/941 of the European Parliament and of the Council of 5 June 2019 on Risk Preparedness in the Electricity Sector

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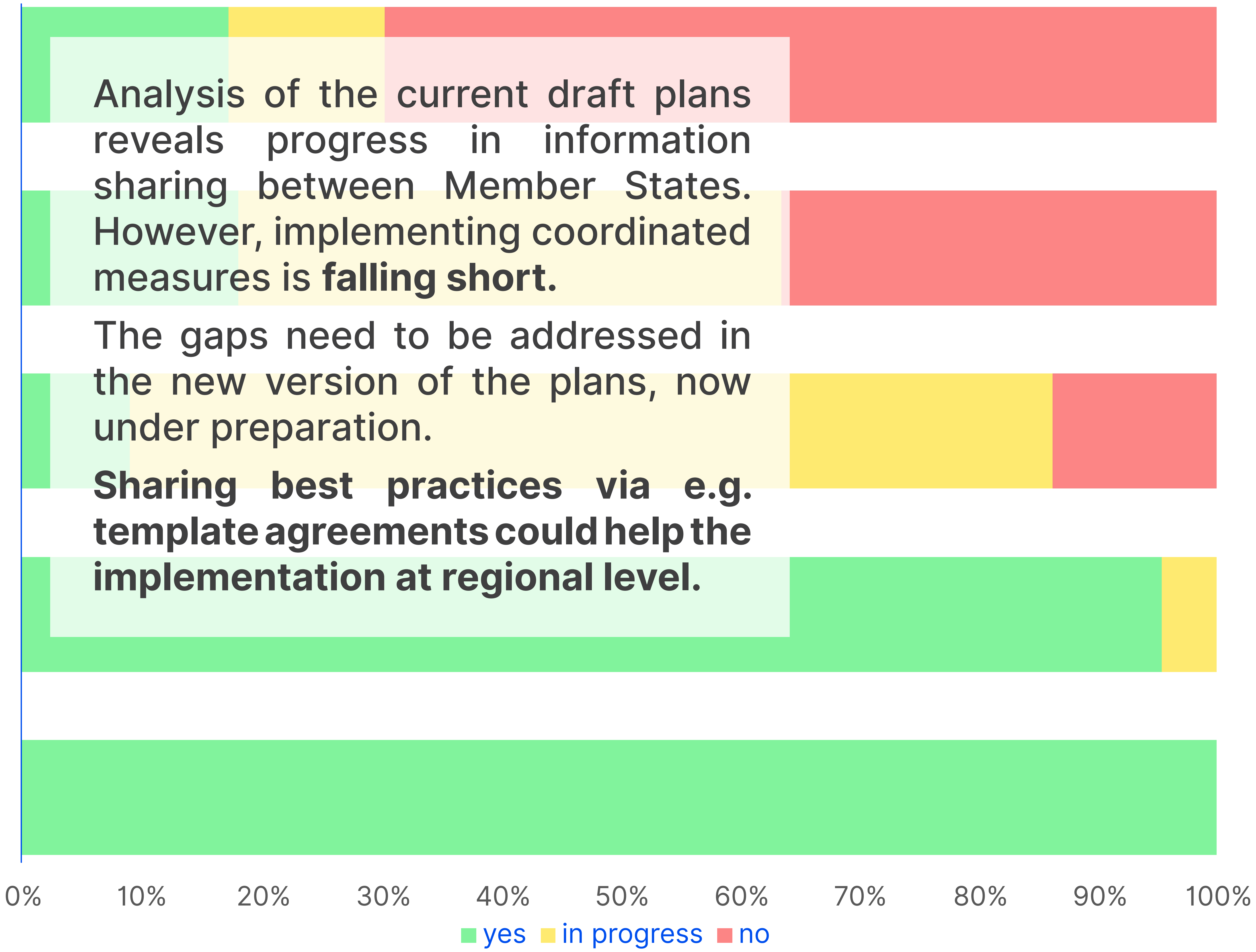
Regional risk preparedness implementation ongoing

The current draft Risk Preparedness Plans by Member States showed diverging levels of implementation in regional cooperation.
The following five actions are key to increasing resilience to eventual energy crises by working together.

1. **Trigger mechanisms for non-market-based measures**
   Only five countries describe mechanisms for activating the out-of-market measures in times of crises
2. **Joint annual / biennial tests**
   20% of countries have –to various degrees – procedures in place for carrying out annual or biennial tests of the risk-preparedness plans
3. **Assistance to neighbours and mitigating crises**
   Less than 10% of countries have clear coordinated measures in place to mitigate the impact of an electricity crisis and assist neighbours
4. **Information sharing and coordination within a region**
   95% have mechanisms for information sharing and coordination within their regions
5. **Crisis coordinators**
   Every Member State has designated a crisis coordinator

Implementation of regional cooperation in Risk Preparedness Plans EU-27, based on draft RPPs 2025 (work in progress)



Analysis of the current draft plans reveals progress in information sharing between Member States. However, implementing coordinated measures is **falling short.**

The gaps need to be addressed in the new version of the plans, now under preparation.

Sharing best practices via e.g. template agreements could help the implementation at regional level.

Source: ACER based on data in draft Risk Preparedness Plans 2025 available on 30 September 2025 (23 draft RPPs available)

Article 12 of the Risk Preparedness Regulation stipulates that: Regional and bilateral measures shall include: (a) Designated crisis coordinator; (b) mechanisms to share information and cooperate; (c) coordinated measures to mitigate the impact of an electricity crisis, including a simultaneous electricity crisis, for the purpose of assistance in accordance with Article 15; (d) procedures for carrying out annual or biennial tests of the risk-preparedness plans; (e) the trigger mechanisms of non-market-based measures that are to be activated in accordance with Article 16(2)

Natural gas remains vital for peak electricity demand

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Electrification and renewables reduce reliance on gas in long-term

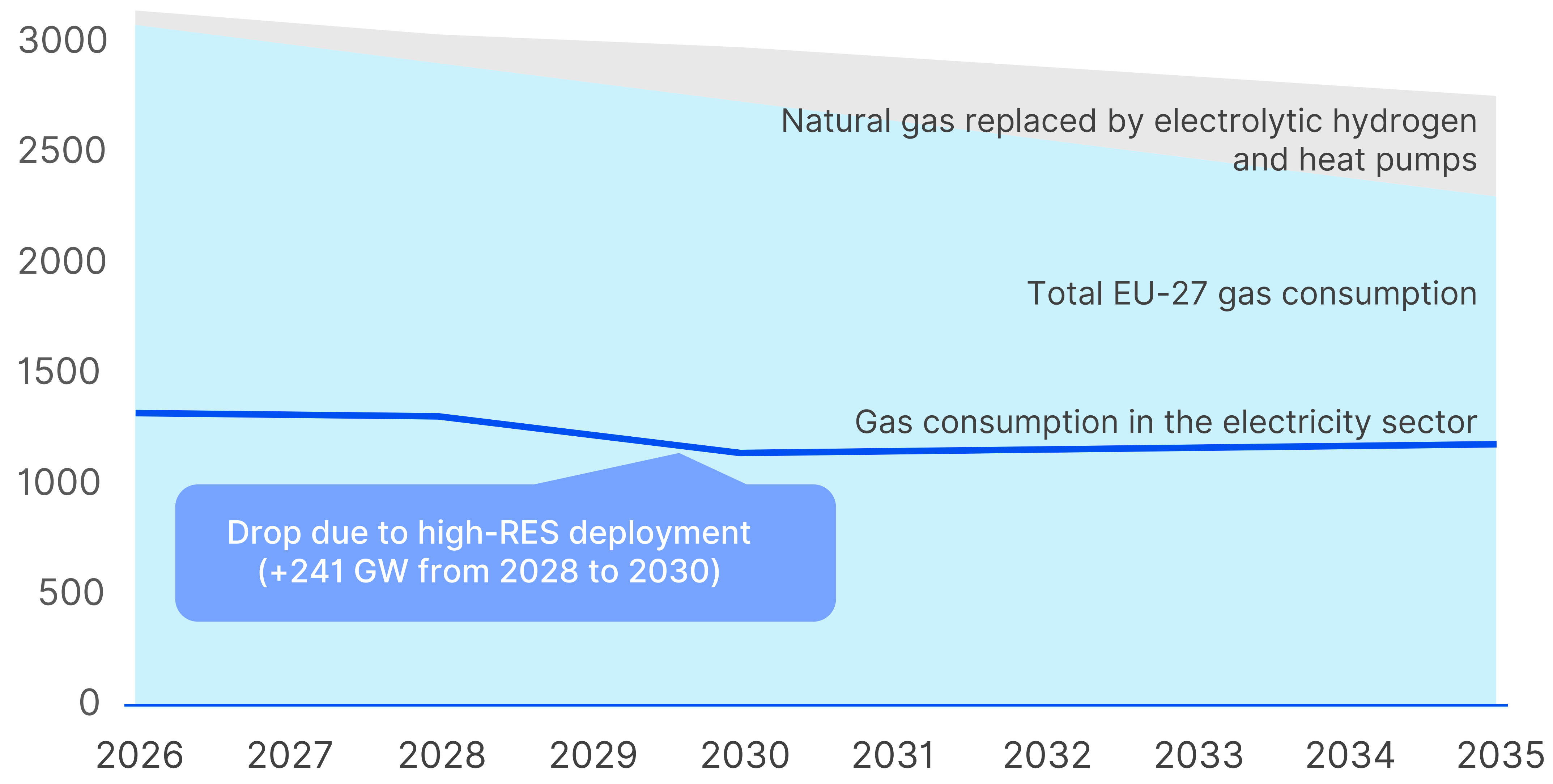
According to ERAA 2024, two emerging technologies in the electricity sector – heat pumps & electrolysers – are expected to reduce the total EU-wide natural gas consumption by 15% by 2035, replacing gas-fired space heating and enabling hydrogen production.

Gas-fuelled electricity generation currently accounts for one-third of the total gas demand[1]. Gas consumption in the electricity sector is projected to decline by 11% in the next 10 years.

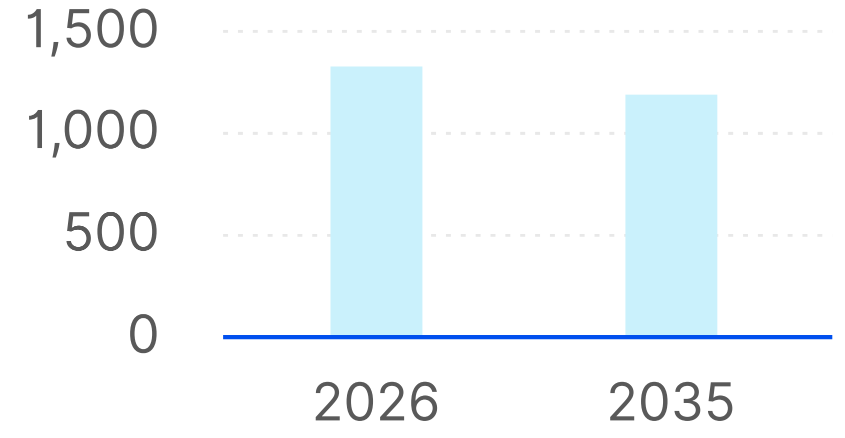
On the other hand, gas will remain essential for electricity peak demand in the coming decade. Gas-fuelled units are **still projected to provide the most significant safety net in the worst hour** across the EU, meeting 30% of electricity peak demand in 2035, down from the current peak-demand reliance on gas of **42%**.

This decrease is mainly driven by the growing deployment of renewable energy sources and energy storage. Flexibility of new electrification uses is essential to reduce the dependency on gas on the medium term.

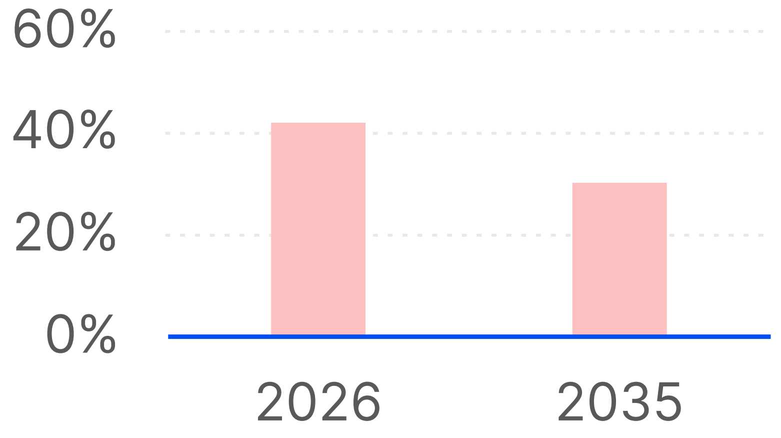
Natural gas consumption in EU-27[2] (TWh/year)



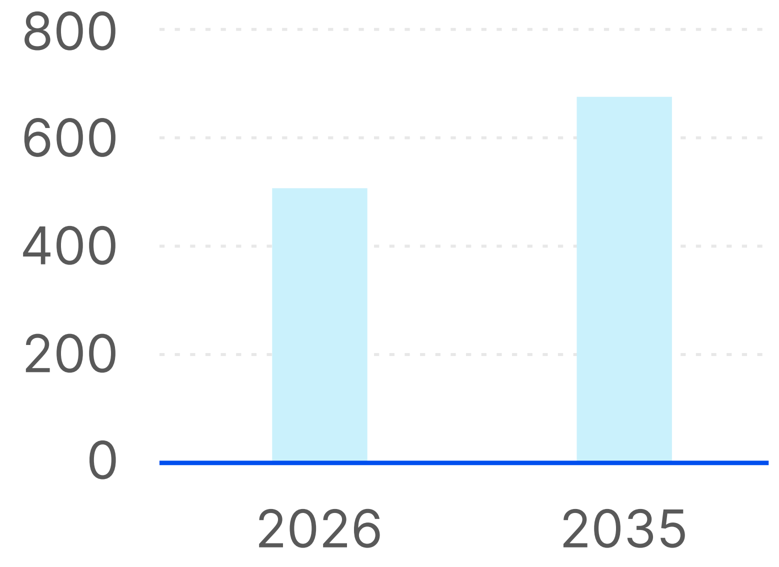
Gas consumption in electricity sector (TWh/year)



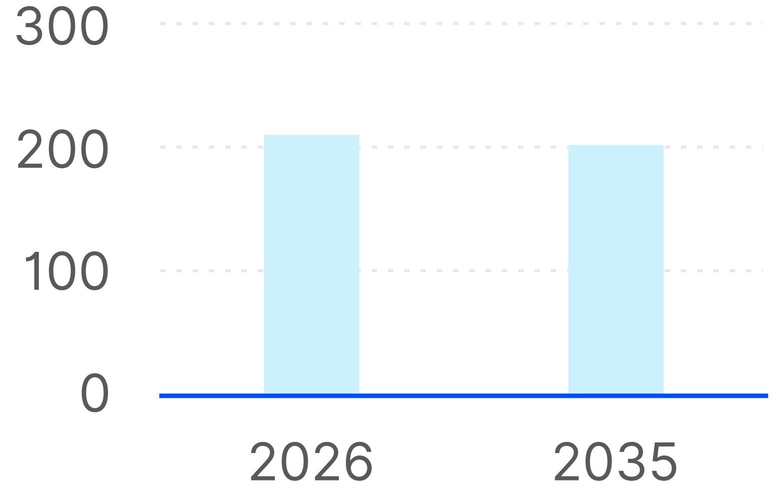
Gas fuelled power plant capacity relative to peak demand (%)



Peak demand (GW)



Gas fuelled power plant capacity (GW)



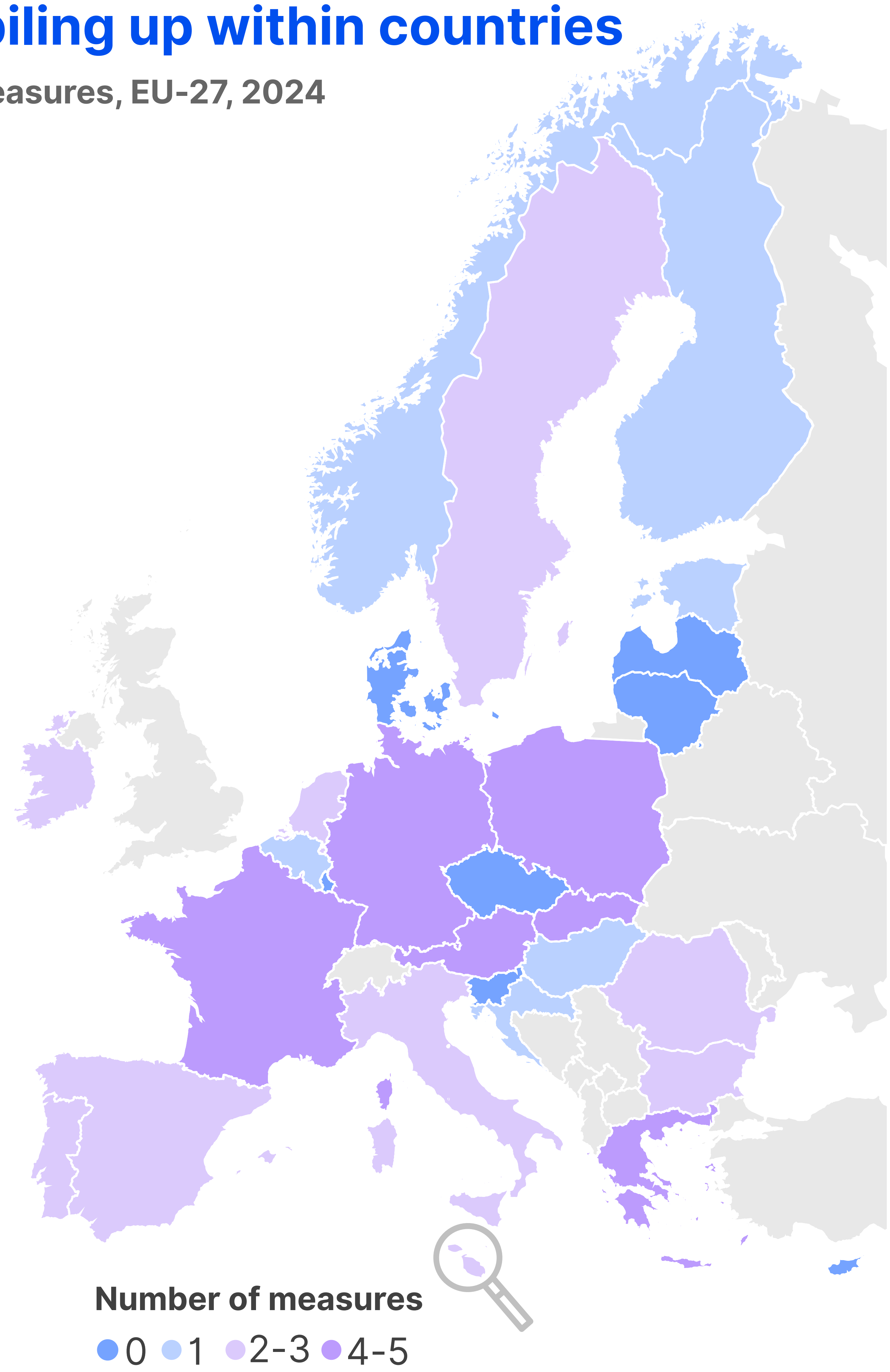
Source: ACER based on ENTSO-E ERAA 2024 and EUROSTAT data
[1] Gas consumption for power & heat generation compared with total natural gas consumption, based on EC compilation.
[2] See Annex II Note (1)

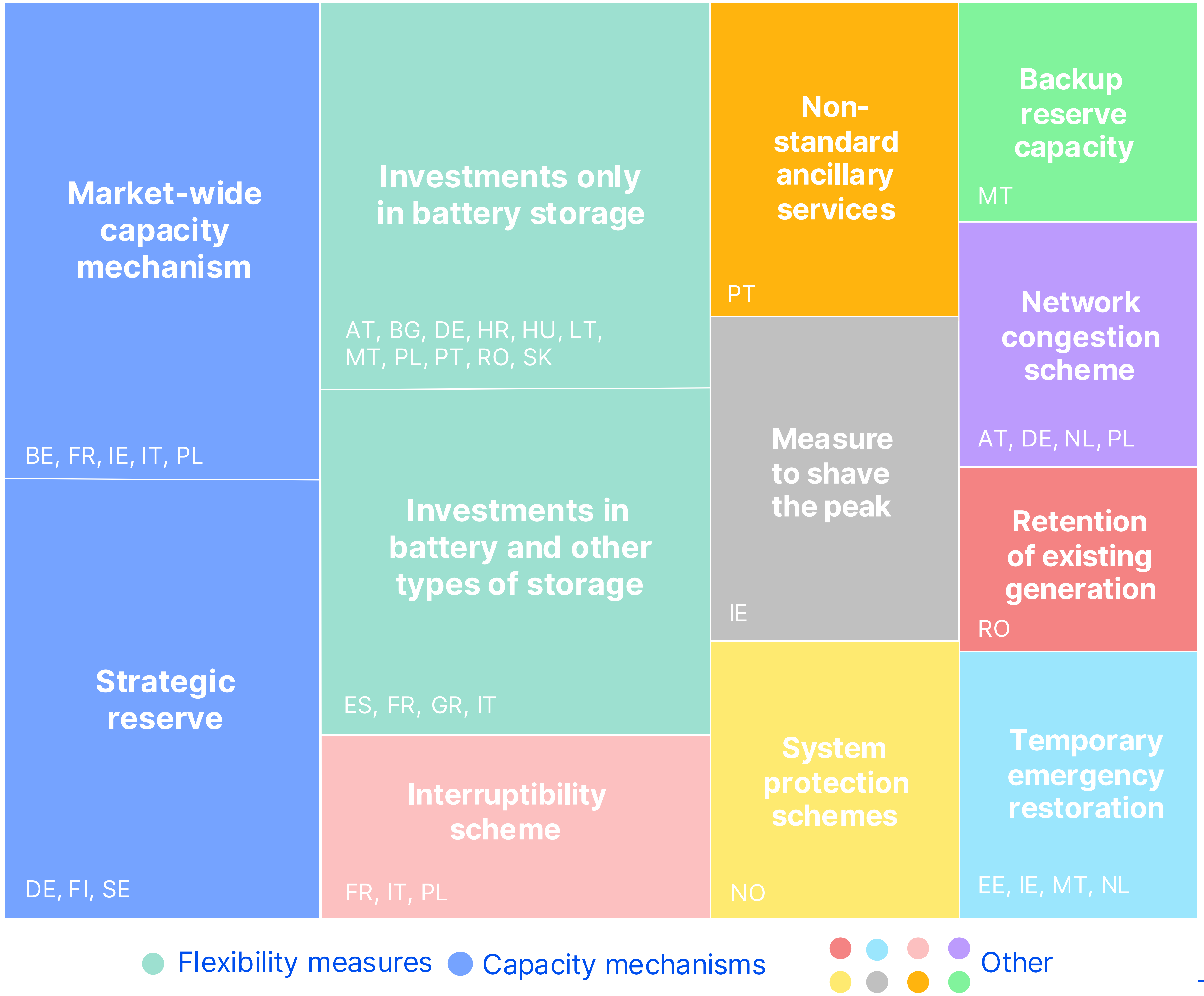
Various measures proliferate, risking overlaps

Support measures piling up within countries

Number of security of supply measures, EU-27, 2024

- **39 support measures** related to security of supply reported in total.
- 15 of which are flexibility measures.
- On average 1.4 measures per Member State, but some have more than 3 measures.





Source: ACER based on NRA data

EU pays almost 11 bn EUR for a plethora of measures

Patchwork of 'other' measures accounts for over a third of the total cost of measures in the EU

Costs of capacity mechanisms in the EU have followed a steady upward trend over the years peaking in 2023.

The main driver of this trend initially was an increase in the number of Member States with capacity mechanisms.

In 2023 the increase in costs was mainly caused by the low nuclear production availability in France, which led to a reduction in available capacity volumes, thus leading to higher capacity costs.

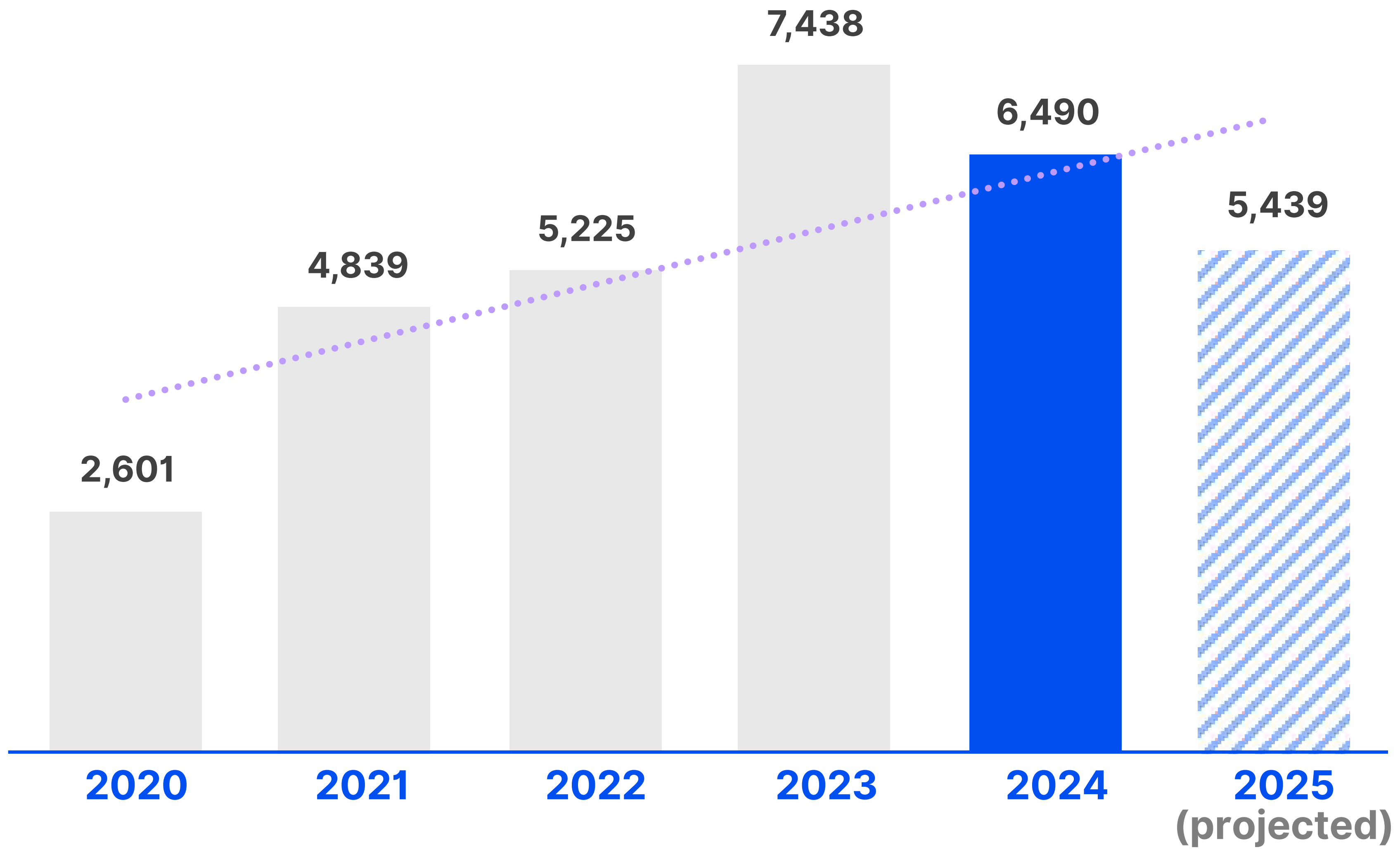
Flexibility measures represent less than 5% of all support costs today but are projected to grow in the coming years.

Multitude of **'other' measures** account for over a third of the total support costs in the EU.

Most frequently used `other' measures by the Member States are network congestion schemes, interruptibility schemes and temporary emergency restoration.

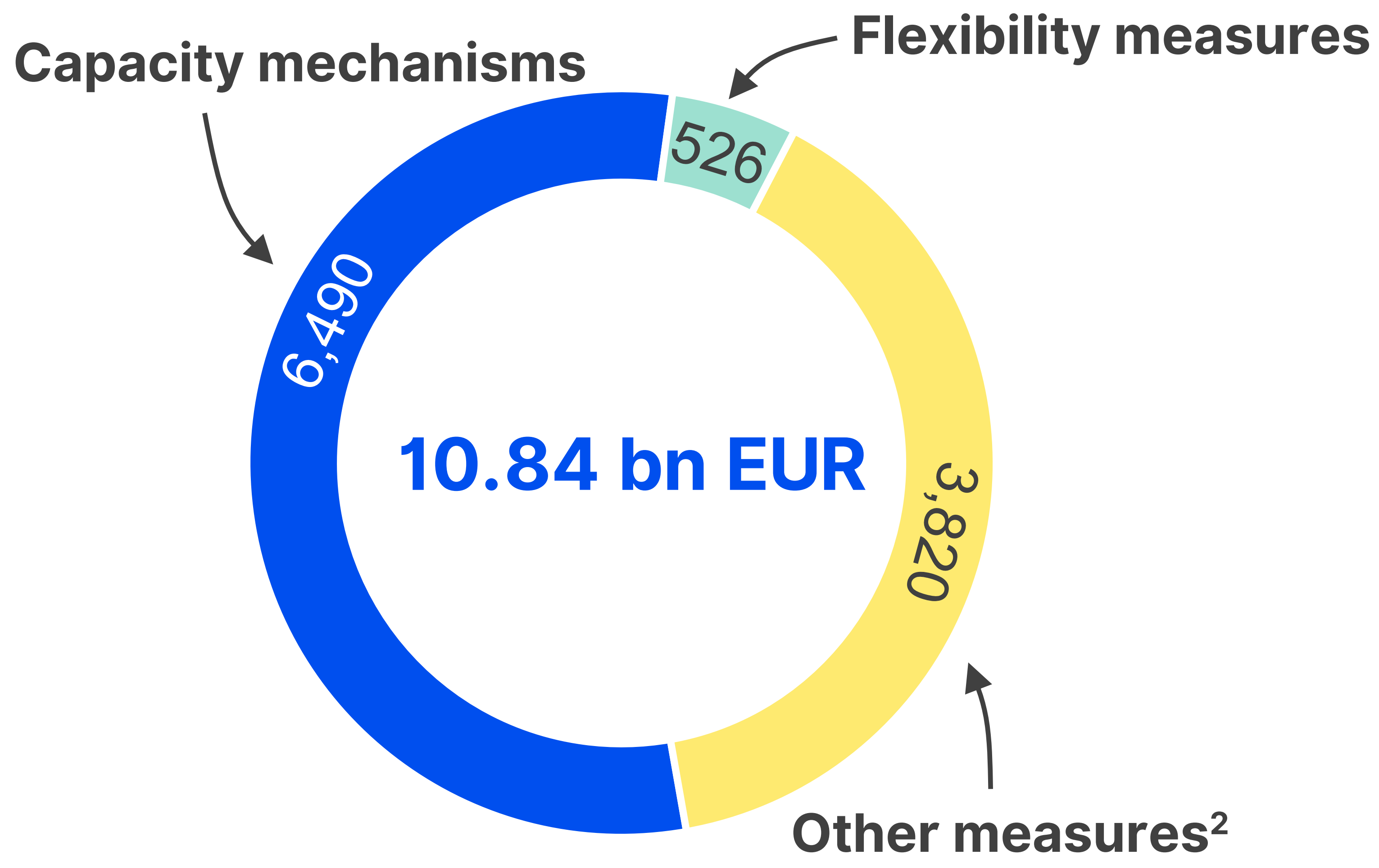
Increasing costs of capacity mechanisms

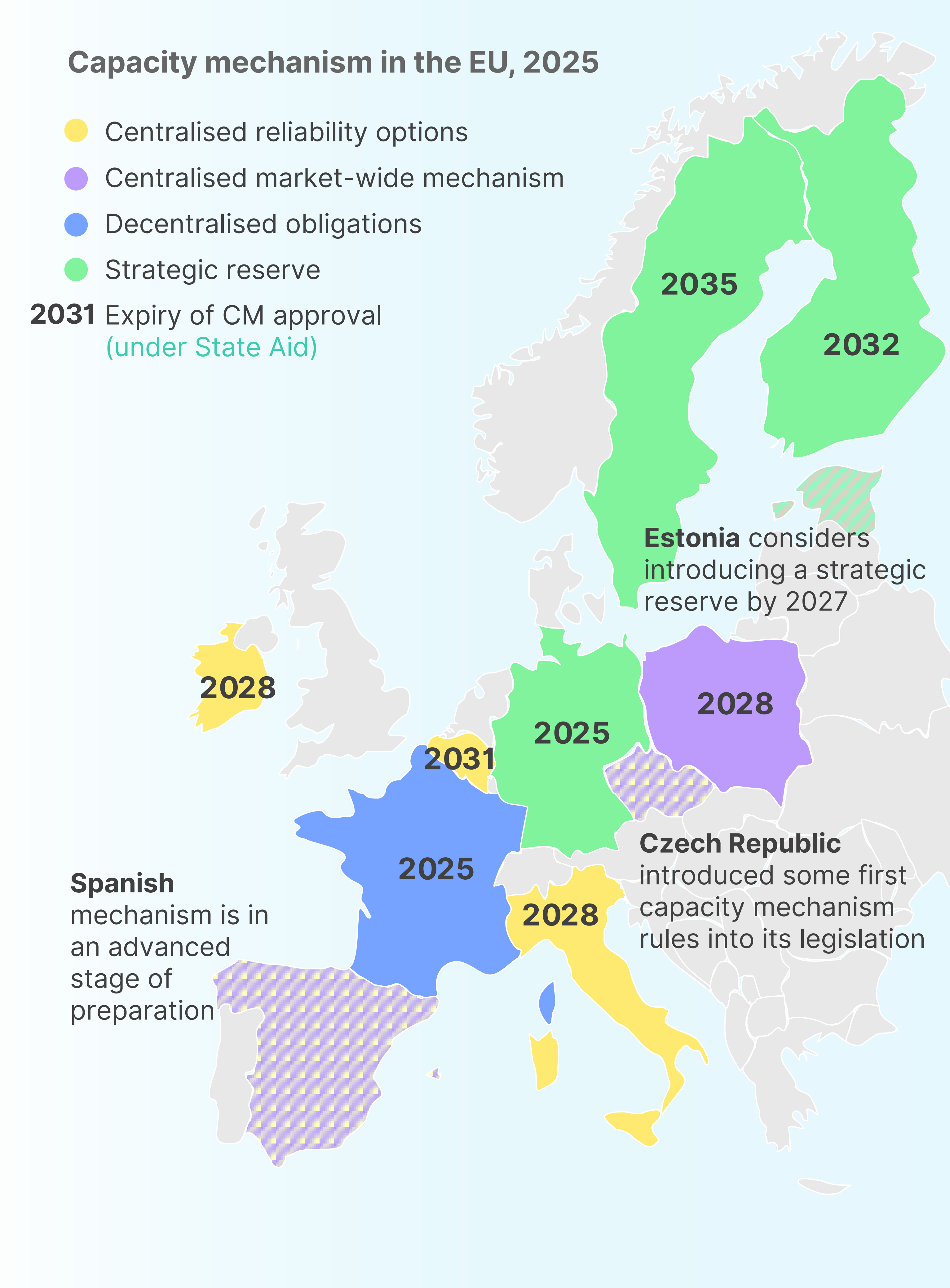
Cost of capacity mechanisms[1], EU-27, 2024 (million EUR)



Support measures are costing the Member States a pretty penny

Cost of all support measures, EU-27, 2024 (million EUR)





Sources: ACER based on NRA data, Estonian market reform plan, Spanish updated market reform plan, amendment of the Czech energy law.
[1] For cost calculation assumptions see note (2) in Annex II.
[2] Other measures refer to support schemes that do not fall under the categories of 'capacity mechanisms' or 'flexibility measures'. These are defined as initiatives that relate directly or indirectly to security of supply and provide remuneration to market participants for capacity outside of balancing mechanisms.

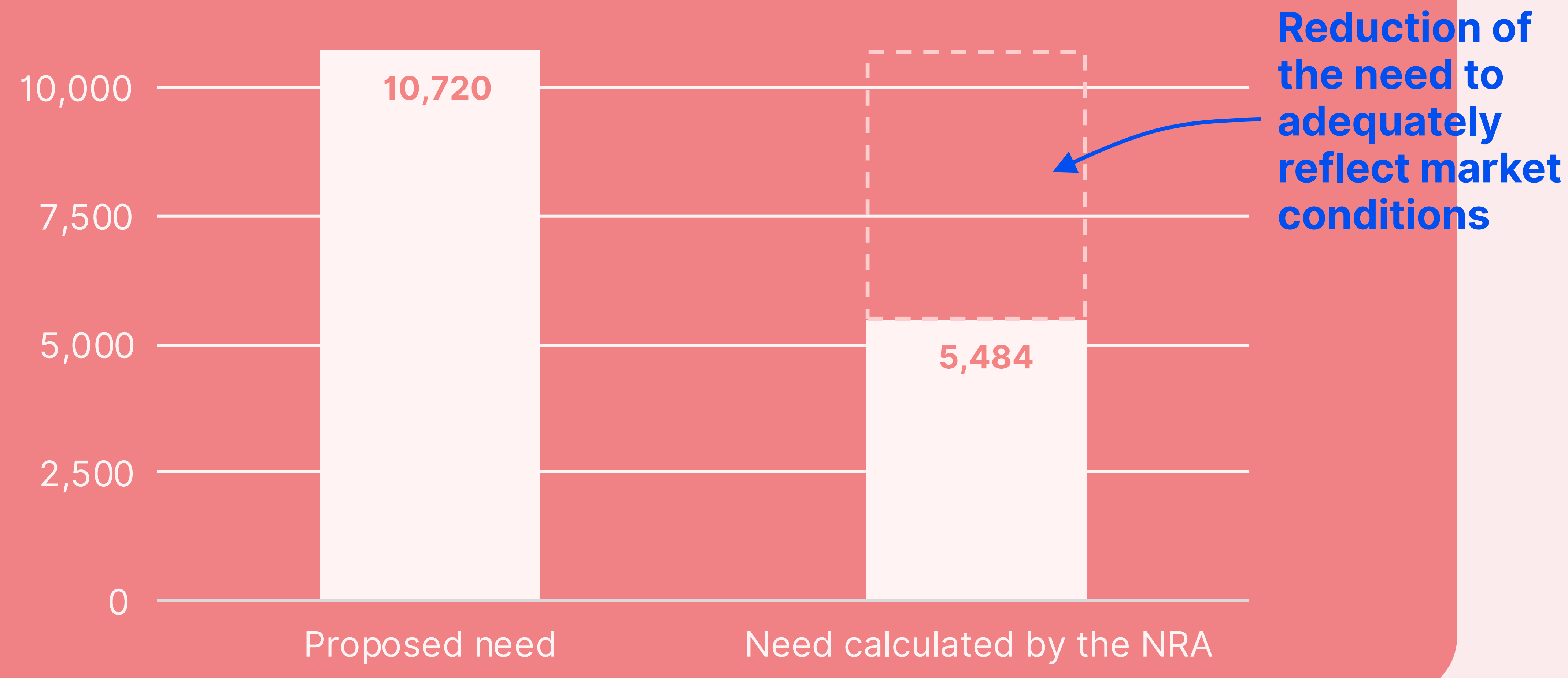
Country Focus: Poland
Skyrocketing costs and needs

Paying for the capacity procurement spree

In 2024, Polish capacity auctions prices were up to 140% higher compared to other continental capacity markets. Part of the problem may lie in the mechanism's design.

When the auction aims to procure more than there are bids, it ends in the first round – and **all bidders get the maximum price**, that would otherwise be reserved for new units only.

The issue of existing plants remunerated as new investments is due to the high dimensioning of the auctions. In June, URE (Polish NRA) reported that the **capacity need for the 2030 auction is nearly double** of what is necessary.



The resources awarded in the Polish capacity market score ever higher remunerations. The assumed cost of new units, which drives the auction prices has been **increasing by over 10% for three consecutive years** now.

Delivery year	2025	2026	2027	2028	2029	2030
Assumed cost (EUR/kW)	73.4	83.7	89.0	99.1	112.2	128.3

These high-cost assumptions were reflected in the actual prices at Poland's capacity market auctions for 2026, 2027 and 2029. The national reports suggest that these auctions aimed to secure more capacity than needed – and seemingly more than the market could offer. With all bids in, the auctions lacked any real competition.

URE reports that the auctions should procure less, pointing to:

- **More dispatchable units**: the thermal plants are unlikely to exit the market en masse once their capacity contracts expire.
- **Less demand**: increasingly responsive demand side and proliferation of prosumers are expected to lower the demand projections.
- **More batteries**: dedicated support for energy storage will bring even more batteries into the Polish system.

The supplementary auctions, triggered by Poland's CO_2 derogation, may only push capacity market costs even higher.

Importantly, a recent decision by the Commission requires a re-assessment of the adequacy gap in Poland, followed by a recalibration of the auctions.

Sources: Auction results for 2026, 2027 and 2029, URE's comments on the draft ministerial order, data from NRAs with ACER elaboration.

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Capacity markets have yet to become cleaner

Capacity mechanisms and emissions

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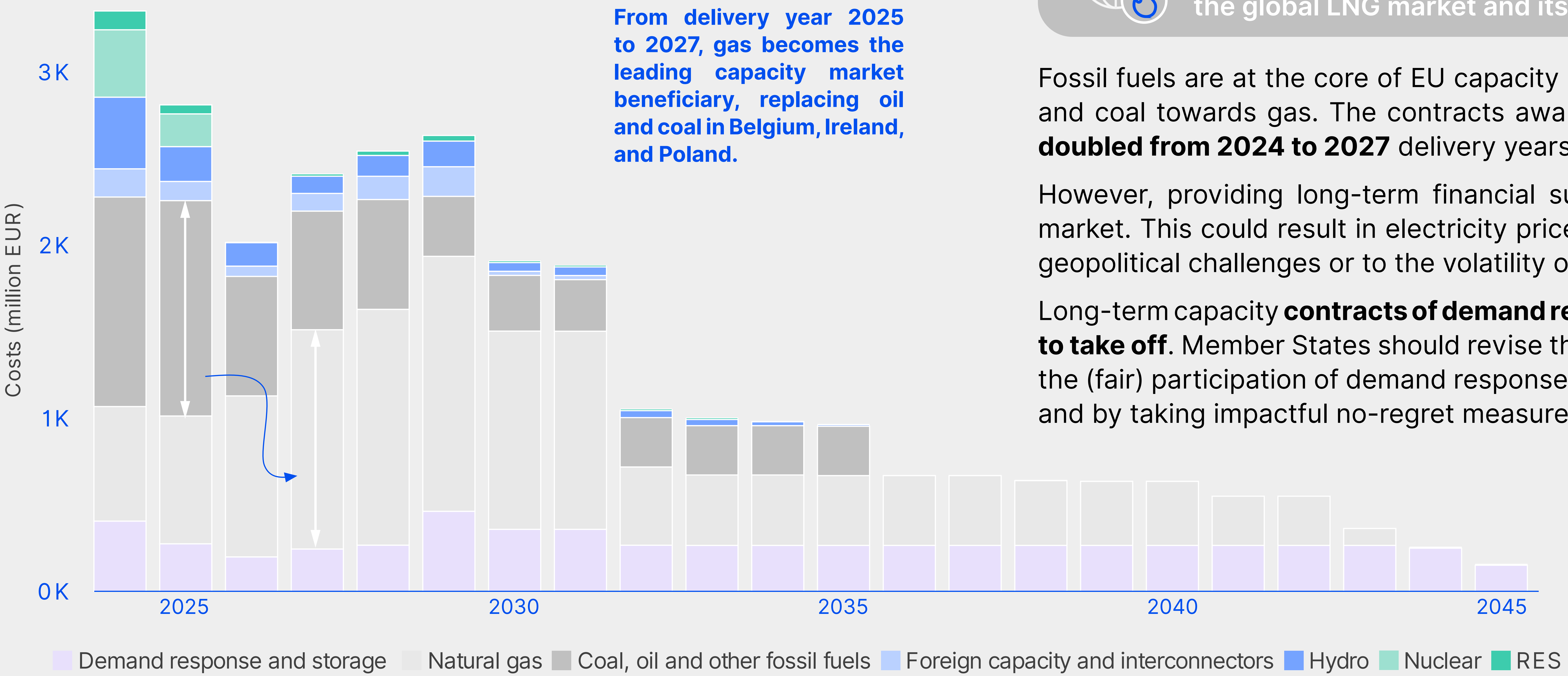
Gas receives most in capacity mechanism payments

In capacity markets, gas takes the lead, as coal and oil decline

Aggregated costs of long-term capacity contracts, France, Ireland, Poland, 2024 (million EUR)



Coal's presence in the power sector is diminishing. Yet, recent price shocks and the flexibility challenge put the rapid coal exit into question. Phasing out polluting coal now faces a new dilemma: natural gas, once a reliable alternative, is increasingly volatile. As the EU moves away from Russian gas, it becomes more exposed to the global LNG market and its intense competition.

Fossil fuels are at the core of EU capacity mechanisms, with a recent shift from oil and coal towards gas. The contracts awarded to gas units have seen their value **doubled from 2024 to 2027** delivery years.

However, providing long-term financial support for gas units locks them in the market. This could result in electricity prices staying exposed to tensions linked to geopolitical challenges or to the volatility of globalized LNG market.

Long-term capacity **contracts of demand response and storage combined have yet to take off**. Member States should revise their capacity market frameworks to allow the (fair) participation of demand response and storage in all capacity mechanisms, and by taking impactful no-regret measures pointed out in ACER's report.

Read now

Apr '25

Source: ACER based on NRA data
Note: Costs for IT and BE are not available with per-technology granularity at the time of drafting.

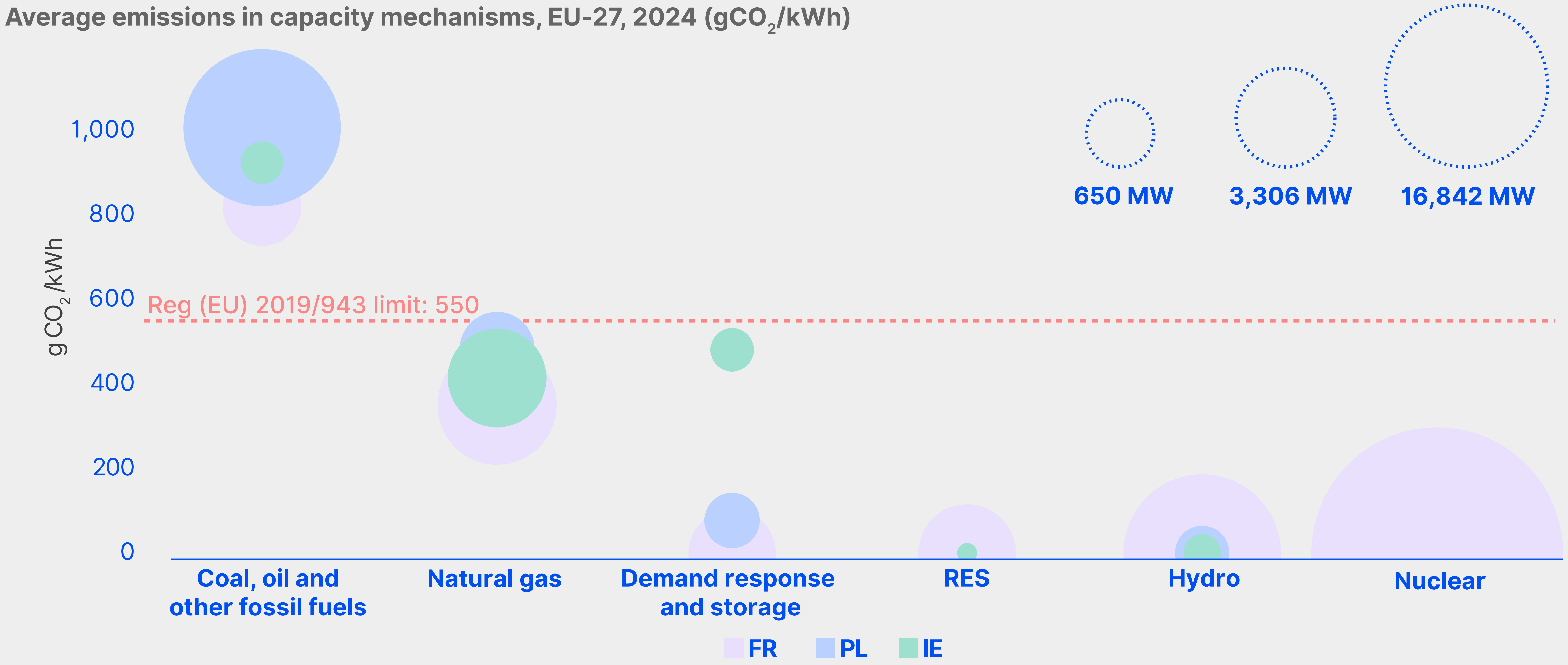
EU emissions limit came into effect in July 2025

Polluters get paid – for now

Fossil fuels plants – coal, oil, and gas – currently benefit the most from capacity mechanisms. This impacts CO_2 emissions, especially in the case of market-wide capacity mechanisms that provide non-targeted support. For strategic reserves, even though they tend to target older thermal units with high emission factors, the rare and short activations limit the overall impact on emissions levels.

The Clean Energy Package introduced an emission limit of 550 gCO_2/kWh that entered into force in July 2025. This limit effectively excludes high emission factor technologies (like coal or oil), contributing to decarbonize capacity mechanisms.

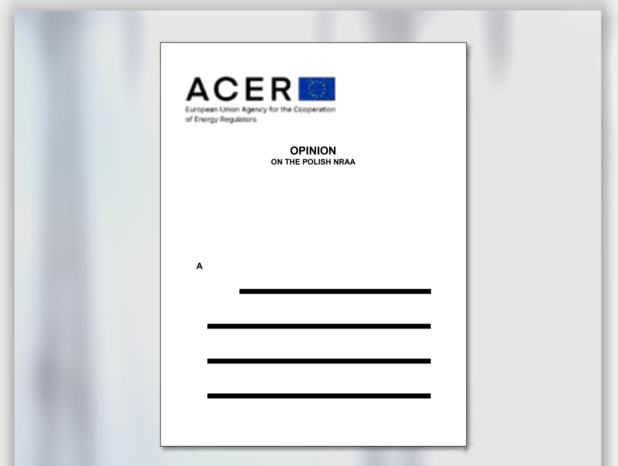
Average emissions in capacity mechanisms, EU-27, 2024 (gCO_2/kWh)



Emissions limit kicks in, with caveats

The amendment of the Electricity Regulation introduced the possibility for derogations from the emission limit. Member States could request a deferral of the emission limit by an additional 2.5 years, provided they met certain conditions. Among them was to demonstrate that cleaner resources are not sufficient to cover the supply needs.

Poland has requested such derogation, relying on the national adequacy assessment (NRAA). In the process, ACER reviewed the assessment and provided its opinion. Finally, the derogation was granted on 11 August 2025.



Read now

Feb '25

Source: ACER based on NRA data. Data for the Belgian and Italian CM is not available.
Note: High demand response emissions in IE stem from industrial demand reduction occasionally being offset by starting up a fossil-fired local (behind the meter) backup generator.

Country Focus: Germany

Coal hangs on as security guarantee despite greening

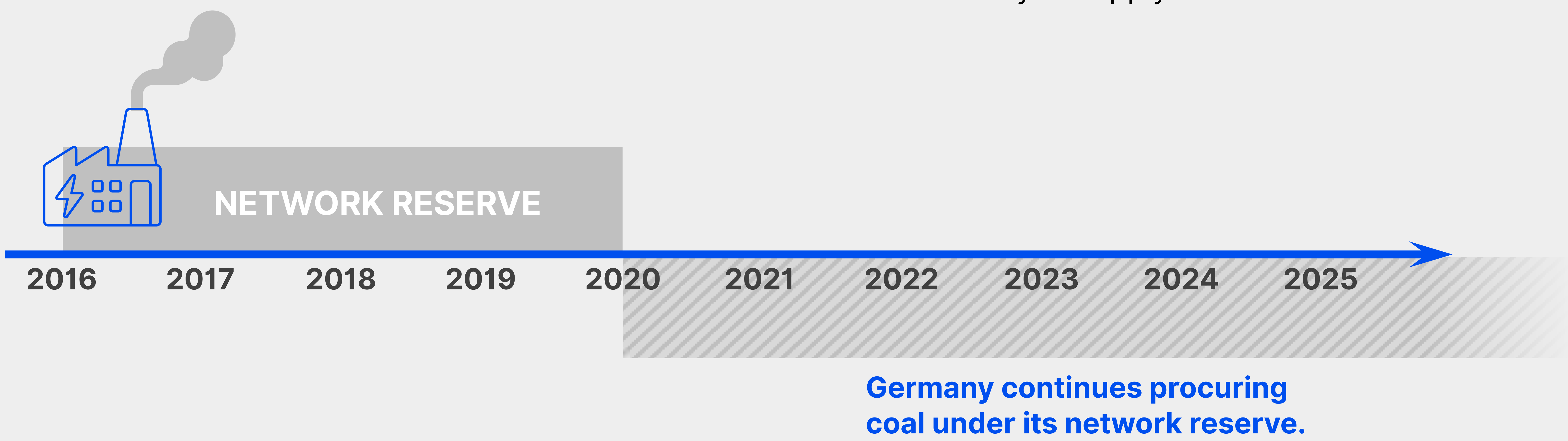
While the share of coal contracted under capacity mechanisms slowly decreases, some Member States still tend to employ it in other security of supply related support schemes. Among them are network reserves applied in Germany.

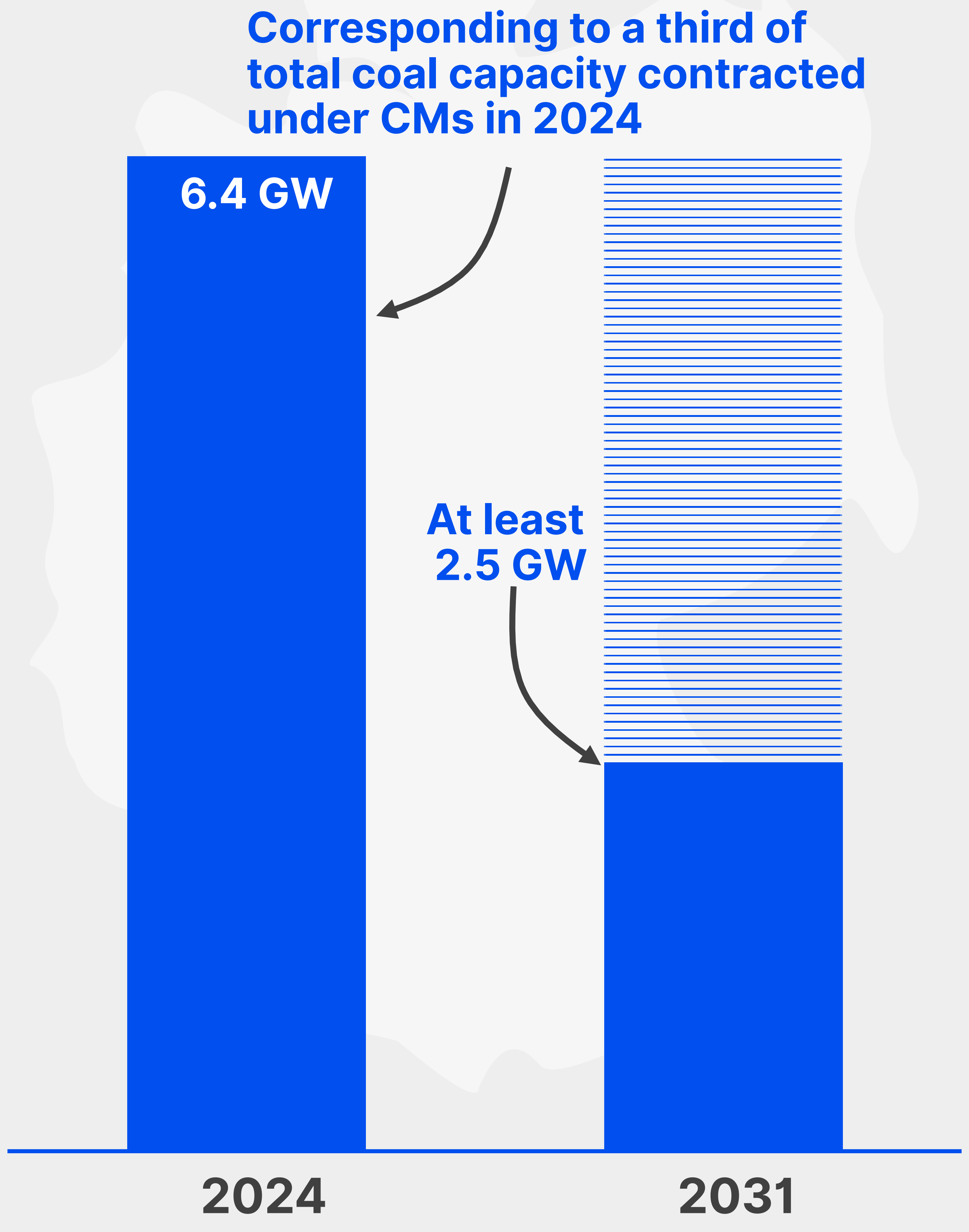
The German measure was approved by the Commission in 2016 as a suitable solution to network issues that should go hand in hand with the network expansion.

Germany keeps the reserve in place. It may support the national network addressing operational challenges, particularly those associated with the integration of renewables.

Currently, the reserve contracts as much as 6.4 GW of hard coal plants. Moreover, at least 2.5 GW have already the contracts signed up to 2031.

This example illustrates the **need to increase oversight** and **ensure coherence** between the different security of supply measures across the EU.





Hard coal capacities contracted under the German network reserve (GW), 2024

Sources: Commission's decision, BNetzA's list of power plants.

Country Focus: Poland
High stakes for the high-emission units

Is Polish energy transition accelerating?

Coal generation in Poland is decreasing in the recent years. In 2024, it **declined by 6%**, building on an even more significant reduction in 2023 (17%), mostly due to rising wind and solar generation accompanied by gas and, increasingly, batteries.

These signals from the energy market suggest desire for investment in clean technologies in the country. At the same time, **14 GW of coal** is still supported by the Polish capacity market.

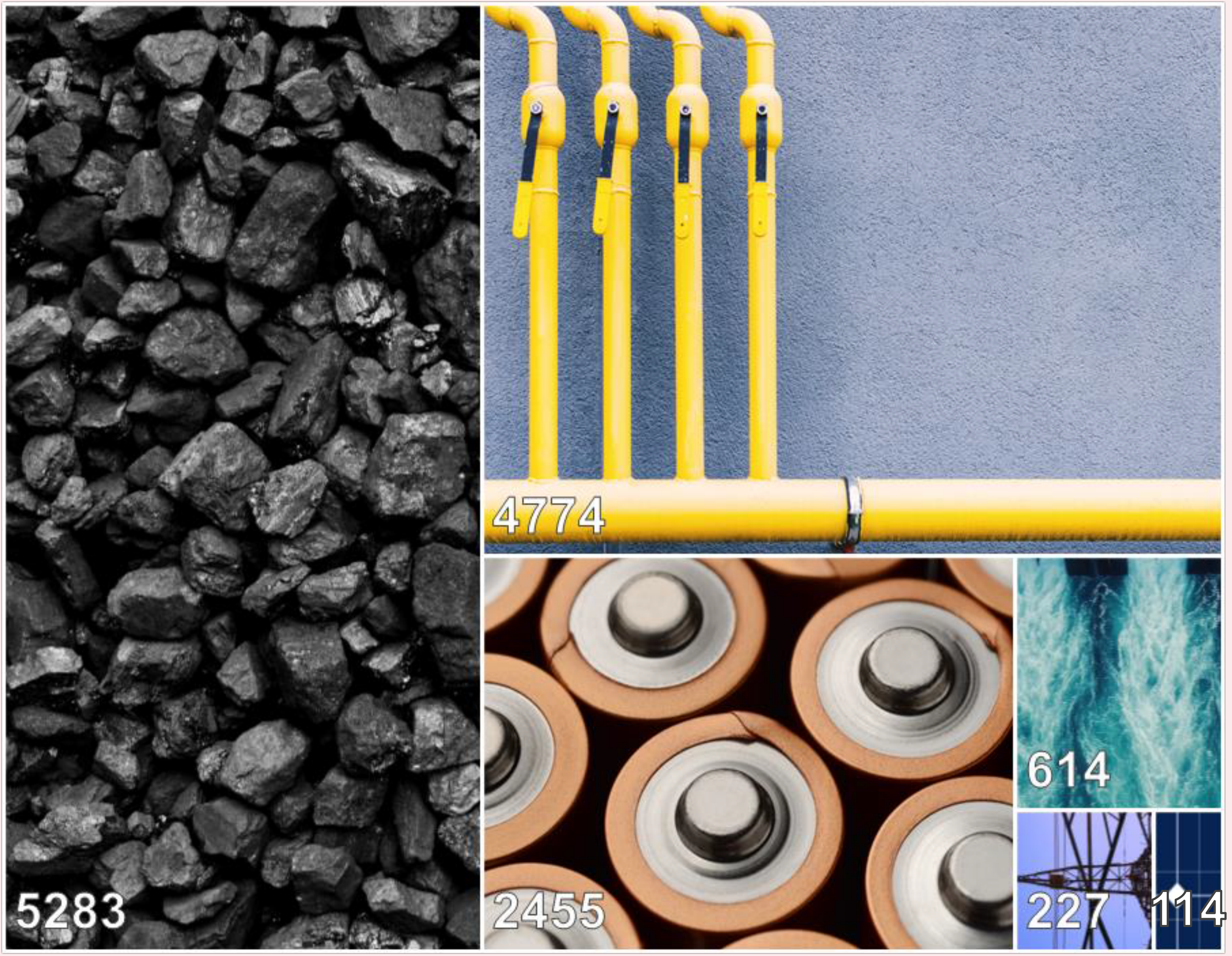
The waiver of the CO_2 emission limits for the Polish capacity market has a strong impact on the Polish energy mix. Today, the energy sector in Poland is largely shaped by the capacity market, since it covers nearly 80% of the country's peak load. The continued dominance of high-carbon resources in the capacity mechanism **limits opportunities for other, low-carbon solutions**.

Capacity contracts in Poland award over 93 EUR/kW a year, nearly double the typical operating costs of gas units ranging from 40 to 50 EUR/kW. **With the market revenues added, these contracts offer strong financial support for fossil-based plants**. The latest auction saw remuneration surge past 125 EUR/kW, further boosting this appeal.

Batteries have outpaced fossils in the recent auctions, rivalling them even before emission limit takes effect. As batteries contracts surged, auction parameters were adjusted, limiting them to bid only up to 12.3% of total capacity (compared to 61.3% half a year ago, which is consistent with the rates calculated by ACER). With a lower capacity factor, batteries lost ground to gas in the July 2025 auction.

Nearly 40% of the Polish capacity payments will go to coal in the next decade

Sum of the long-term capacity contracts costs in Poland, 2025-2035 (million EUR)



Sources: Polish electricity generation data from PSE, auction parameters from the ministerial order, the July 2025 auction results, ERAA 2025 data, data from NRAs with ACER elaboration.

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Capacity markets have yet to become more efficient

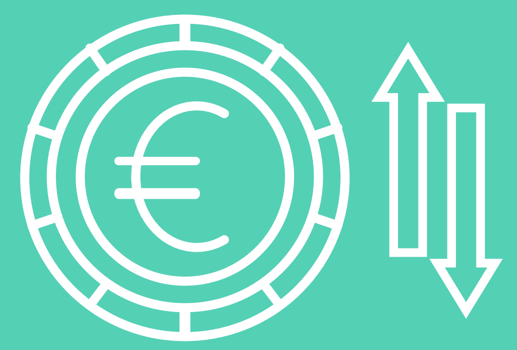
Capacity mechanism design and prices

Scope to improve capacity mechanism design
Highly diverging capacity clearing prices in the EU

Five market-wide CMs, five different clearing price levels

Market-wide capacity auction clearing prices, delivery years 2025 - 2029

Extreme values



Ireland's growing demand for electricity, high construction costs, as well as planning and grid connection delays, has increased risk for new capacity, thus auction clearing prices have reached nearly **150K EUR/MW.**

In the French decentralized auctions, changes in nuclear availability and demand projection brought some clearing prices down to **0 EUR/MW.**

Capacity auction clearing prices exhibit substantial divergences between countries and are characterized by strong volatility:

1. In space - the highest clearing price in Ireland is **10 times higher** than some prices in France.
2. In time - no evident trend on the evolution of capacity clearing prices with each auction.

Although differences in capacity auction clearing prices between Member States are expected due to the inherent differences, **increasing cross-border participation in capacity mechanisms** along with increasing the maximum entry capacity (MEC) **would likely lead to more price convergence**.

In that sense, **further coordination in capacity mechanisms**, with regional mechanisms being the more advanced form of coordination, could increase synergies and lead to greater competition, reducing the cost of these mechanisms.

Source: ACER based on NRA data.

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Scope to improve capacity mechanism design
Capacity markets regularly clear at the cap

Existing vs. New – diverging dynamics

Capacity mechanisms remunerate power plants for being available to generate electricity in times of need. Auction price caps tend to be higher for new than for existing capacity, as price caps for existing capacity only reflect fixed costs, not the investment (CONE) costs.

Existing capacity cleared at the respective price cap (or above) in Ireland and Italy. Such outcomes could indicate, among others, an insufficient amount of prequalified capacity to meet the auction demand, mis-calibrated price cap levels, or a combination of both.

New capacity often stays below the higher respective price cap.

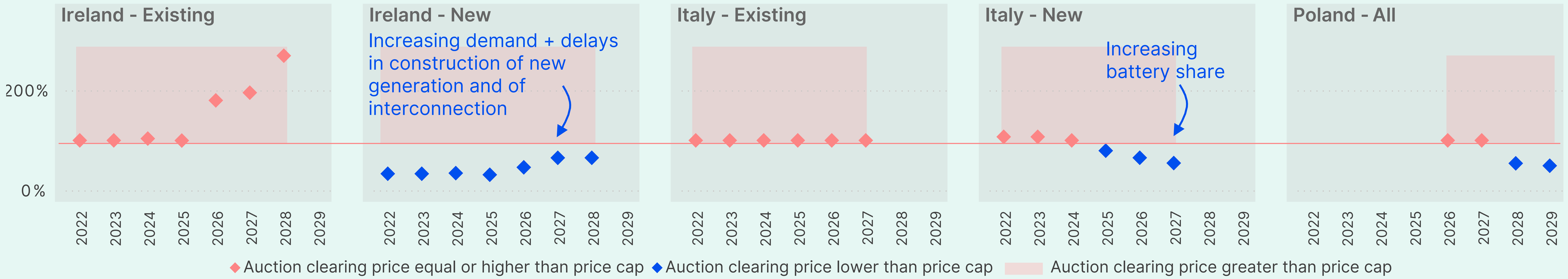
When the new providers, such as storage/batteries and demand response, enter the market, they increase competition and tend to moderate the price clearing levels, as seen in Italy and Poland.

In contrast, a different dynamic in Ireland saw auction clearing prices rise, faced with increasing demand, combined with delays in construction of new generation units and the Celtic Link interconnector not yet being available.

Look into causes

Capacity markets clearing at the cap neutralise the risks for the investor and do not encourage innovation, as fixed costs are fully covered. These price dynamics highlight the **need to investigate the functioning of capacity markets** to shed light on **potential design flaws or non-competitive behaviour**. It is then for **national authorities to take appropriate action** to address the issues.

Capacity market auction prices as a percentage of the respective price caps (values >100% indicate prices exceeded the cap)[1]



Sources: https://ec.europa.eu/competition/state_aid/cases/270875/270875_1979508_218_2.pdf, https://www.terna.it/it/sistema-elettrico/mercato-capacita
Calculated by ACER based on preliminary data from the NRAs
[1] In Ireland, Italy and Poland, both the existing and new capacity is traded in a single auction. In Italy existing capacity has a separate lower price cap. In Ireland, existing capacity also has a separate lower price cap but only for bidding, and thus existing capacity can be awarded the same auction clearing price as new capacity. See Annex II Note (3) for more information.

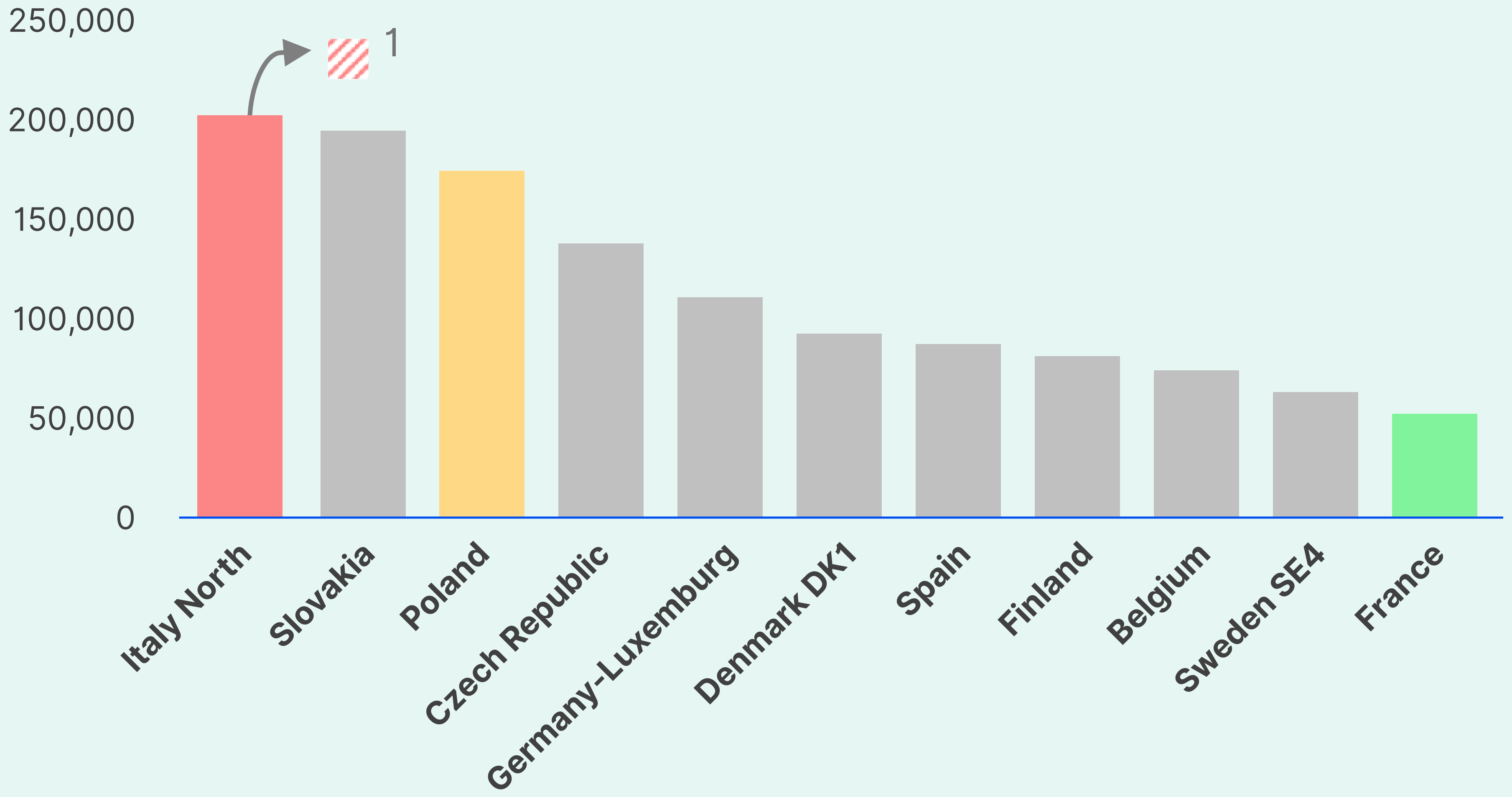
Swedish auctions in October 2025 failed as bids exceeded the price cap – Go to Slide 24

Scope to improve capacity mechanism design

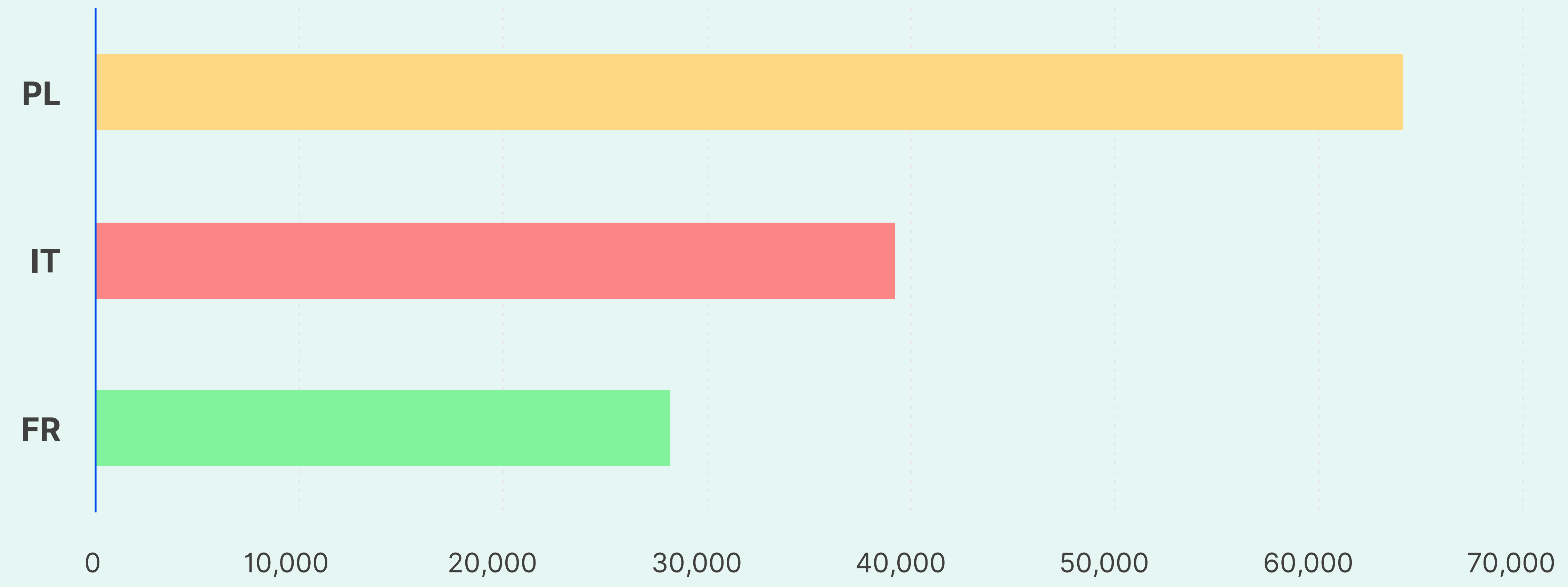
Capacity costs and energy revenues are decorrelated

High revenues on all fronts?

Annual surplus per MW for a gas turbine (EUR/MW/year), 2024



Capacity revenue (EUR/MW/year) for delivery year 2024



In 2024, the estimated annual surplus for gas turbines in **Italy and Poland were higher than those observed in many other Member States**, including those those with a strategic reserve, those without a capacity mechanism and those currently considering introducing one (represented on this graph).

At the same time, the **capacity revenues in Italy and Poland for 2024 were the highest** among continental European market wide capacity mechanisms.

Such observation is non-intuitive. Considering that Italian and Polish gas plants benefit from high revenues on the energy market, their bids on capacity market should be more competitive, bringing down auction clearing prices, hence costs. Yet, this deflating price effect is not observed, and the gas plants benefit from high revenues on both energy and capacity markets.

This raises an important issue for further assessment: **why the market participants that would be expected to realise comparatively high revenues from electricity markets are also securing the highest levels of remuneration through capacity mechanisms**.

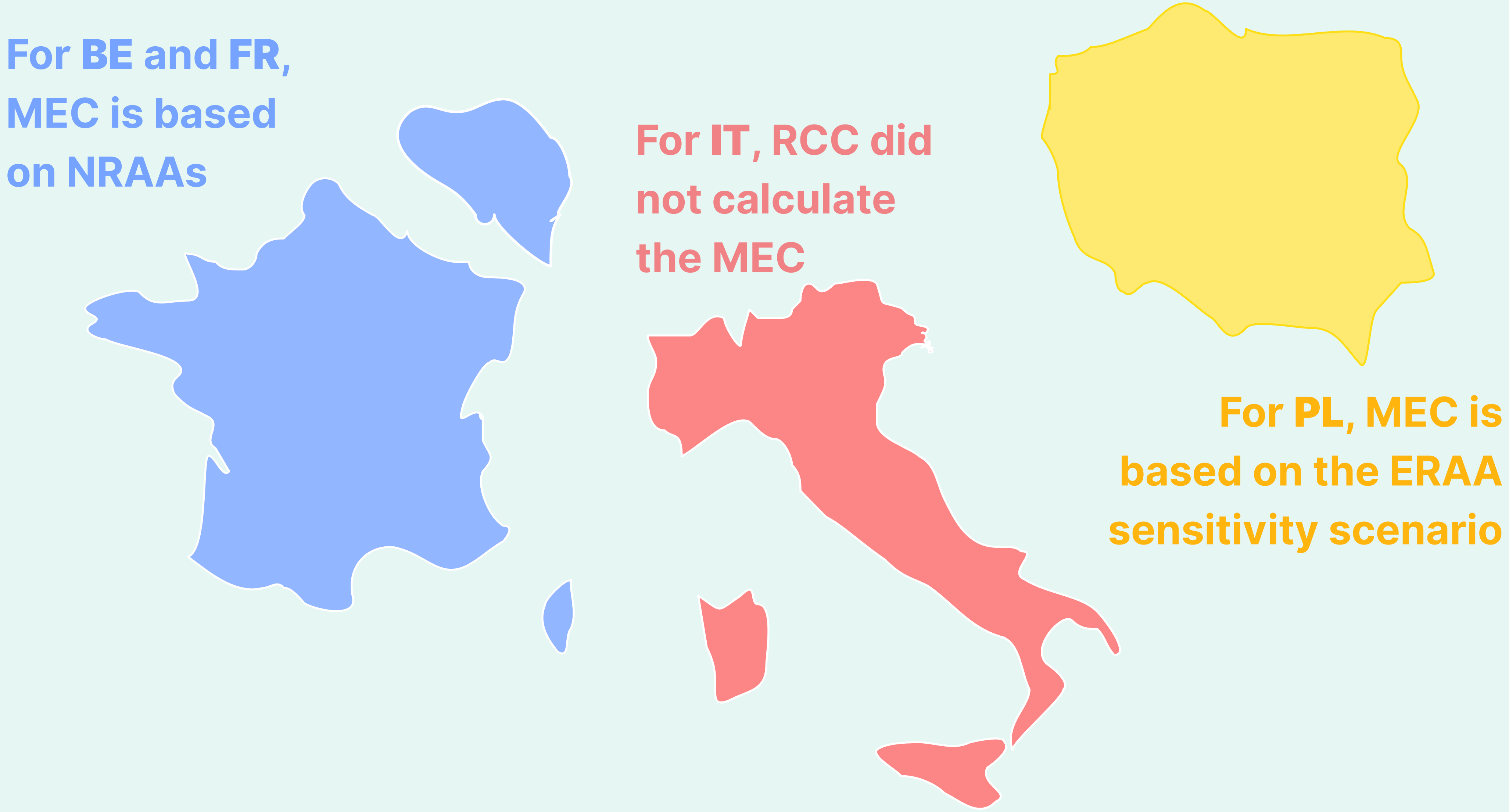
Source for capacity revenues: ACER based on NRA data, updated with recent auction results
Source for annual surplus: ACER analysis based on data from the Transparency Platform
The annual surplus is estimated as the sum of inframarginal rents per MW in the day-ahead market. See Annex II Note (4) for more information.
[1] In Italy, the clawed-back revenues under the strike price mechanism has been taken out of the annual surplus. For 2024 it corresponded to 0.2% of the annual surplus.

Misaligned MEC estimations cause inefficiencies

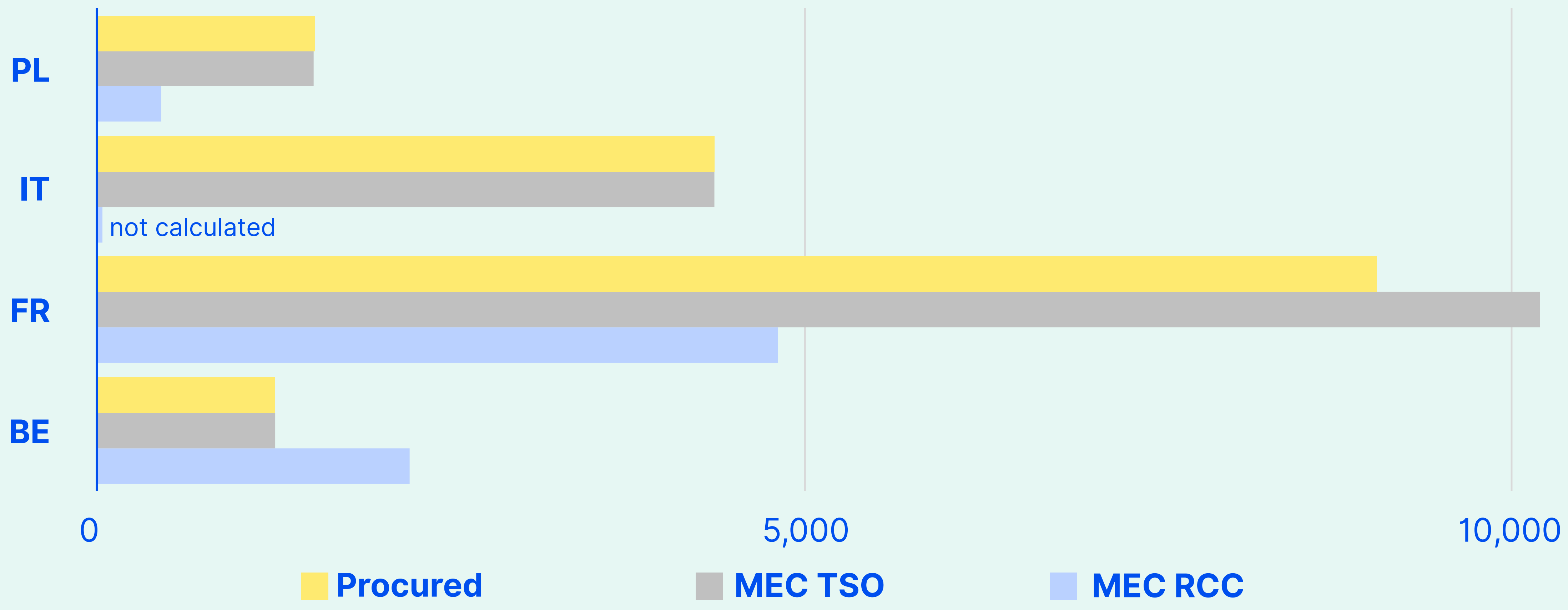
MEC needs to be estimated in a consistent manner

The Maximum Entry Capacity (MEC) defines the maximum volume of foreign capacity that can participate in capacity mechanism. The MEC is a key parameter because reduced cross-border participation limits the ability of foreign (potentially cheaper) resources to reduce the cost of domestic capacity mechanisms.

Regional Coordination Centres (RCCs) should estimate the **MEC** on an annual basis in accordance with the ACER approved methodology. This estimate shall be based on the so called *"central reference scenario with CM"* from the **latest ERAA**. TSOs shall set the MEC based on the RCC recommendation.



MEC and procured cross-border capacity (MW) for delivery year 2026



Large differences are observed between the MEC values computed by RCCs and those ultimately set by TSOs.

These differences stem mainly from using diverging scenario assumptions[1] on capacities available in other Member States. Scenarios that capture the full benefits of cross-border exchanges generally produce higher MEC values, as they reflect the contribution of other Member States to security of supply, whereas more conservative assumptions tend to yield lower values.

Given its strong influence, **it is essential to use the scenario that applies the most realistic assumptions regarding resources in other Member States**. This is the **ERAA central reference scenario with CM**, as it properly reflects the adequacy contribution of capacity mechanisms in neighbouring countries. The RCC estimates, however, are based on the ERAA sensitivity.

Sources: ENTSO-E report on cross-border capacity mechanisms; ACER survey values updated with recent auction results; TSO MEC: Q1 for PL, 6th auction in 2024 for FR; RCC MEC: Coreso 2024 publications and TSCNET MEC report 2024.
[1] For instance, the French NRAA scenario assumes that all other Member States strictly meet their reliability standard. By contrast, the Belgian NRAA scenario yields lower MEC values due to reduced nuclear availability in France compared to the assumptions made in the ERAA.

Country Focus: Sweden
Cost-reflectiveness in cost recovery

New Swedish Strategic Reserve

The new Swedish strategic reserve legislation entered into force in August 2025. The first procurement tender did not succeed in securing reserve capacity[1] for the winter months.

In the new Swedish legislation, the strategic reserve can be activated by the TSO for **national** adequacy concern only, in contrast to the previous one that did not have this limitation.

While capacity mechanisms are support measures to address national adequacy problems, there are **tangible benefits to their cross-border use** to tackle eventual adequacy concerns in neighbouring countries, as has been shown by the earlier use of the Swedish strategic reserve.

The spirit of solidarity in cross-border cooperation

In December 2021, the Polish power system came under stress because of **several units emergency shutdowns**. The short-term adequacy concern has been successfully handled with cross-border cooperation – **the activation of the Swedish strategic reserve**.

This event showcases the benefits of cross-border use of national strategic reserves in the spirit of solidarity.

Cost Recovery

Most adequacy risks in Sweden have been identified in the southern part of the country where electricity demand is highest.

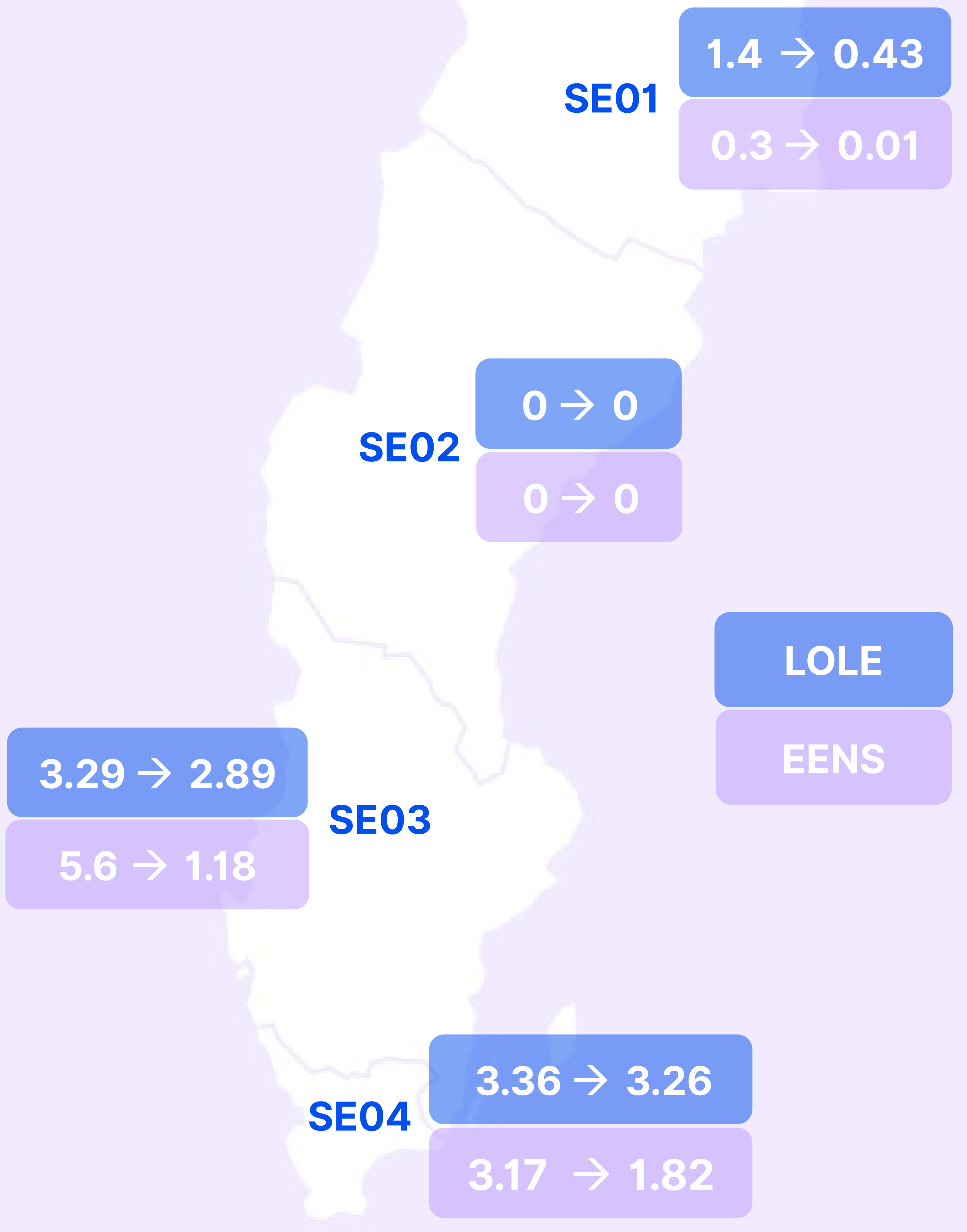
Thus, under the revised rules, the costs for the strategic reserve will be recovered annually from customers located in the southern regions (SE3-SE4), to ensure that those who create a need for the strategic reserve, and benefit from it, also pay for the measure.

As long as the beneficiaries are located exclusively in the southern zones, customers in northern Sweden (SE1–SE2) will not contribute to cost recovery.

While this approach is uncommon in the EU, **it closely follows the principle of cost-reflectiveness** and should be considered in other countries facing similar situation (**see a broader cost recovery discussion** in the previous edition of this report).

Adequacy concerns split between regions

Loss of Load expectation in Swedish bidding zones, 2030 -> 2033, ERAA 2023



Source: ERAA 2023 (used as the decision regarding the new strategic reserve was based on that year's ERAA).
[1] Svenska Kraftnät announced in early October 2025 that they cancelled the procurement of the strategic reserve. Thereafter, Svenska Kraftnät began the work to explore possibility of starting a new procurement of a strategic reserve, which is still the main option. Other market measures are also being considered.

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European coordination improves efficiency

European assessments

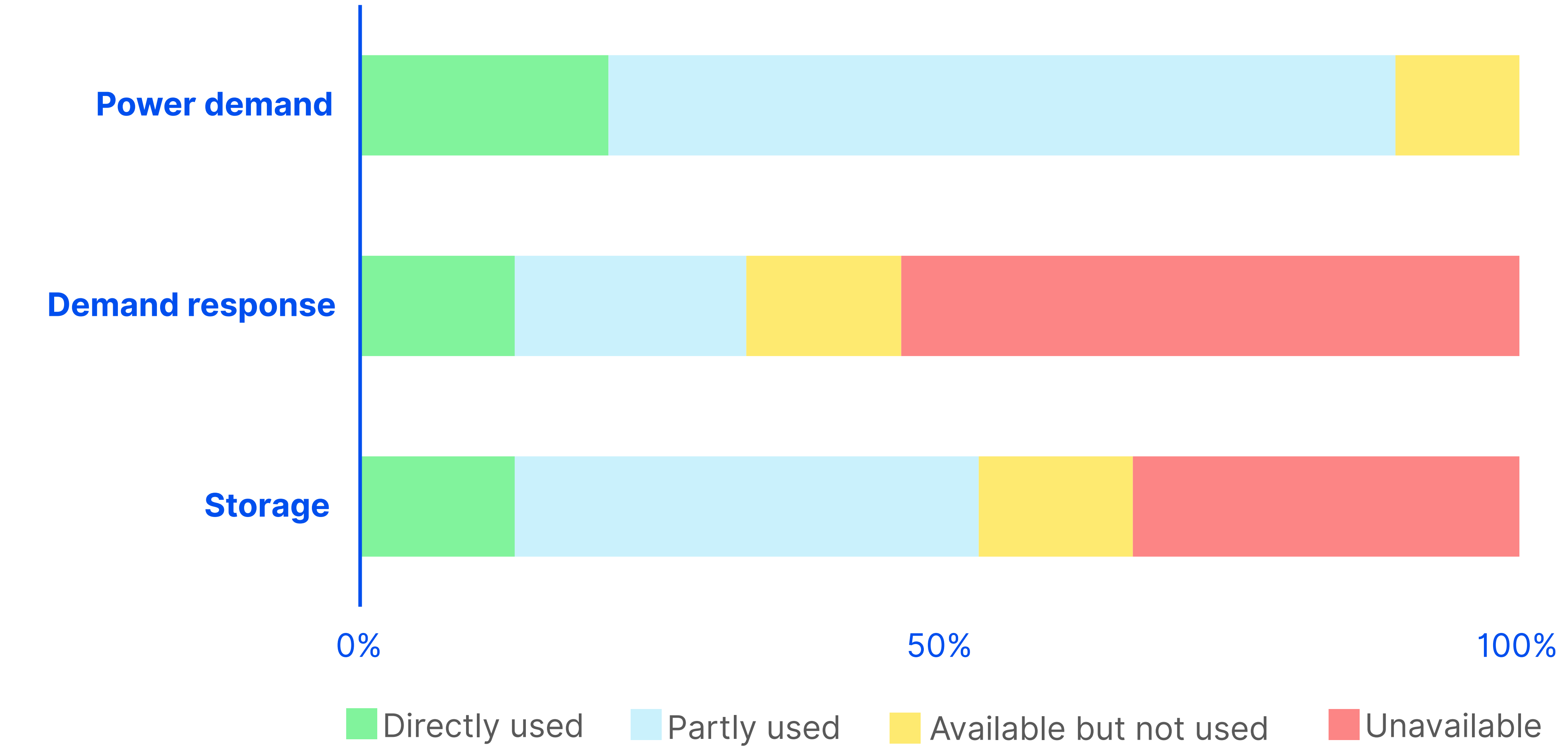
Consistent scenarios for planning system needs

Robust European prognoses start with the national plans

Member States describe their contributions to the European targets in the national energy and climate plans (NECPs). The plans are thus the natural basis for the future-looking power system needs assessments, such as the European Ten-year network development plans (TYNDPs) and adequacy assessments (ERAAs).

Used, but with tweaks – NECPs in the European planning products

Use of NECP data by TSOs for ENTSO's dataset requests

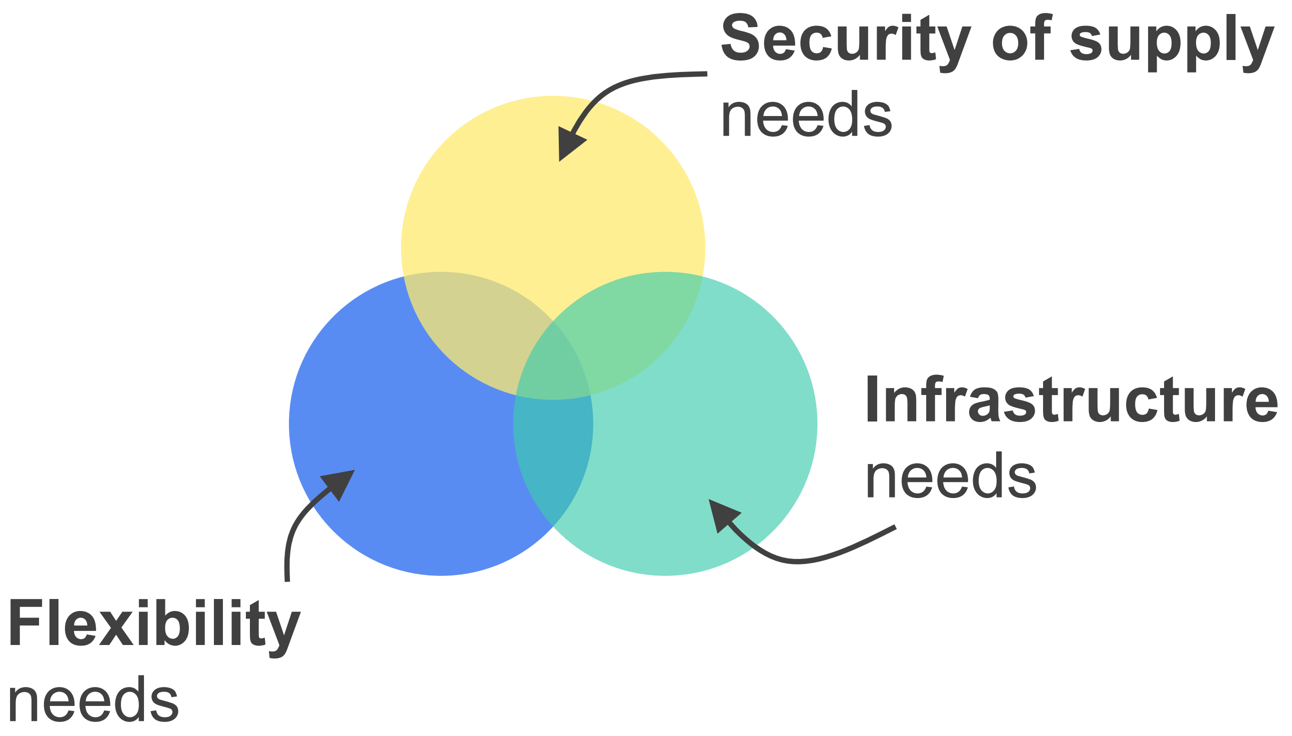


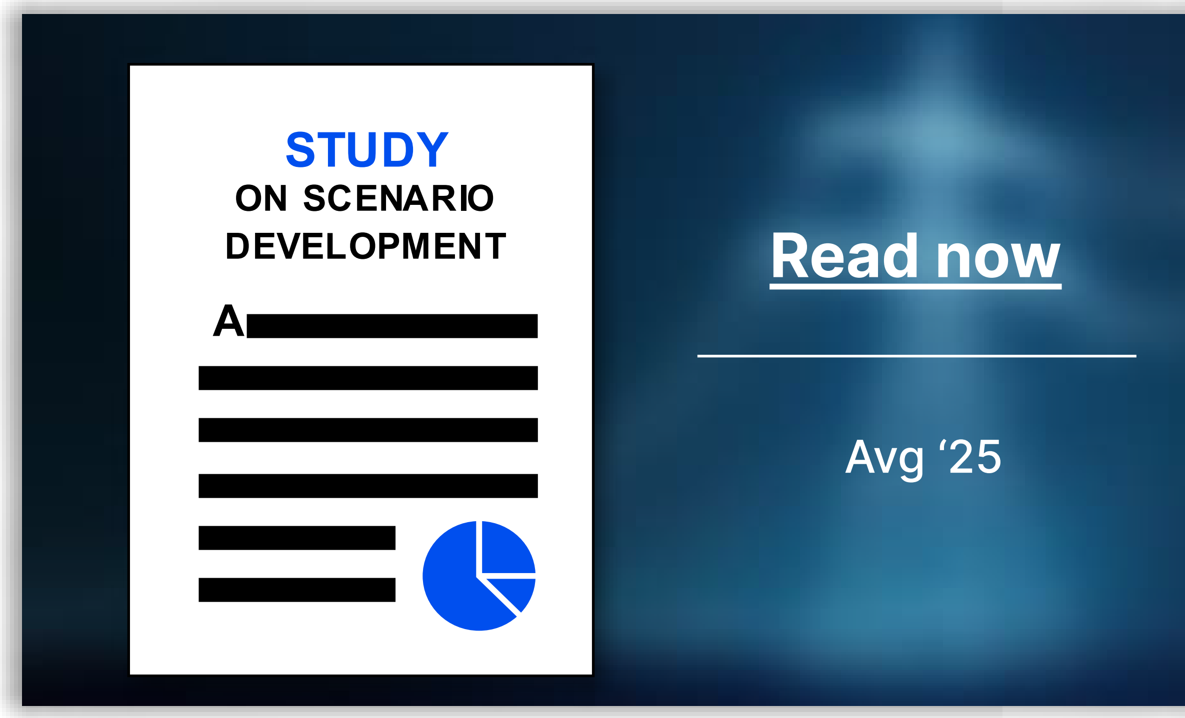
A study ACER recently published reviewed how NECPs are integrated into the scenarios underlying the TYNDP and ERAA exercises.

NECPs often fall short in providing clarity and granularity needed for modelling. TSOs then turn to other sources (mainly in-house projections) to supplement or replace NECP data. Further, there is no formal process in either to validate how NECP data – critical to the results – is used by TSOs.

To ensure the consistency between policy direction and subsequent electricity system needs modelling exercises.

- Consider improving the NECPs` data scope, format and granularity.
- Add oversight of TSOs translating NECPs to modelling scenarios.





Source: Study to support the development of scenarios for EU-wide infrastructure planning and adequacy assessments, August 2025, carried out for ACER by Artelys

Long-term concerns but no short-term risks

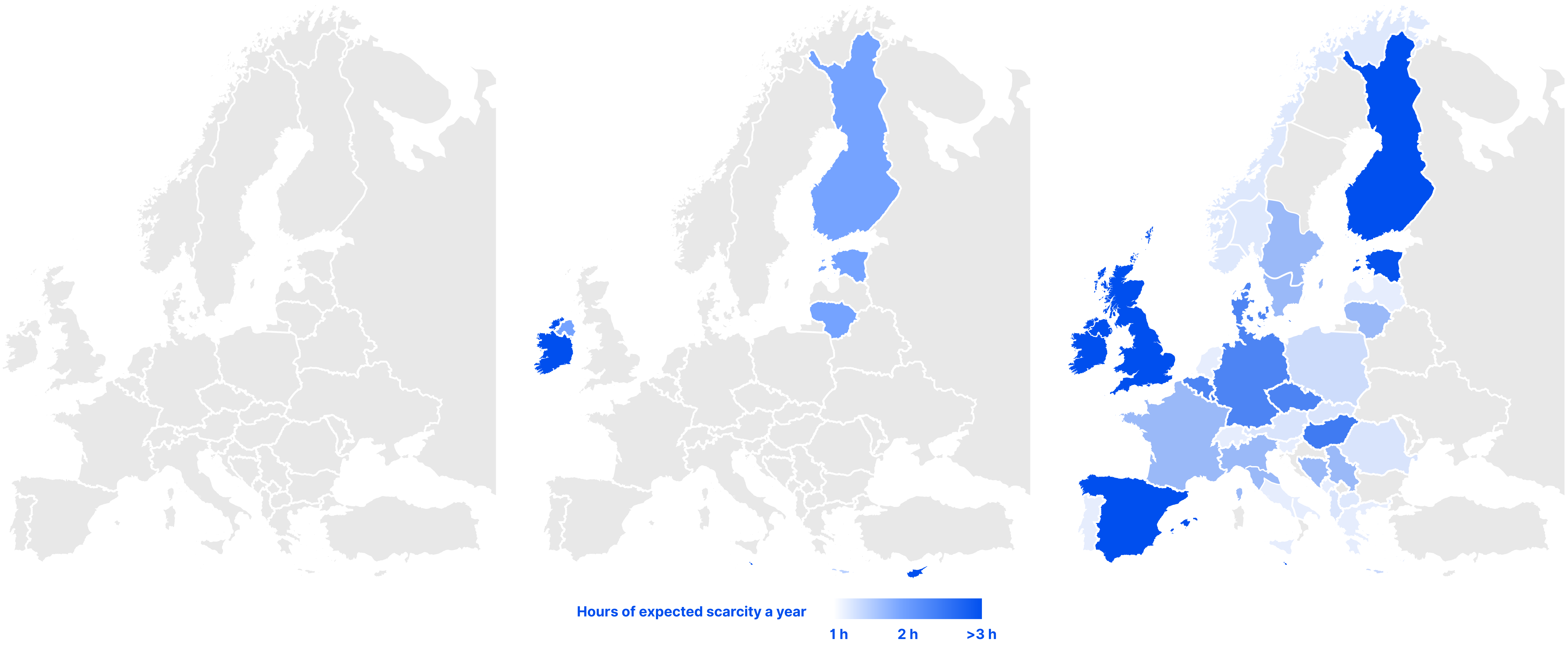
Same year, same winter - different risk estimates

Comparison of projected resource scarcities for winter 2025

Week-ahead
Short-term adequacy assessment

Months-ahead
ENTSO-E Winter outlook 24/25

Years-ahead[1]
ERAA 2023



Although ERAA identifies substantial adequacy risks at a longer-term horizon, **most risks do not show when performing middle to short-term assessments** and also do not materialize.

Such discrepancy reflects the uncertainty related to demand and capacity projections. **The uncertainty increases the farther the study horizon is**. The ERAA results should be approached with this understanding.

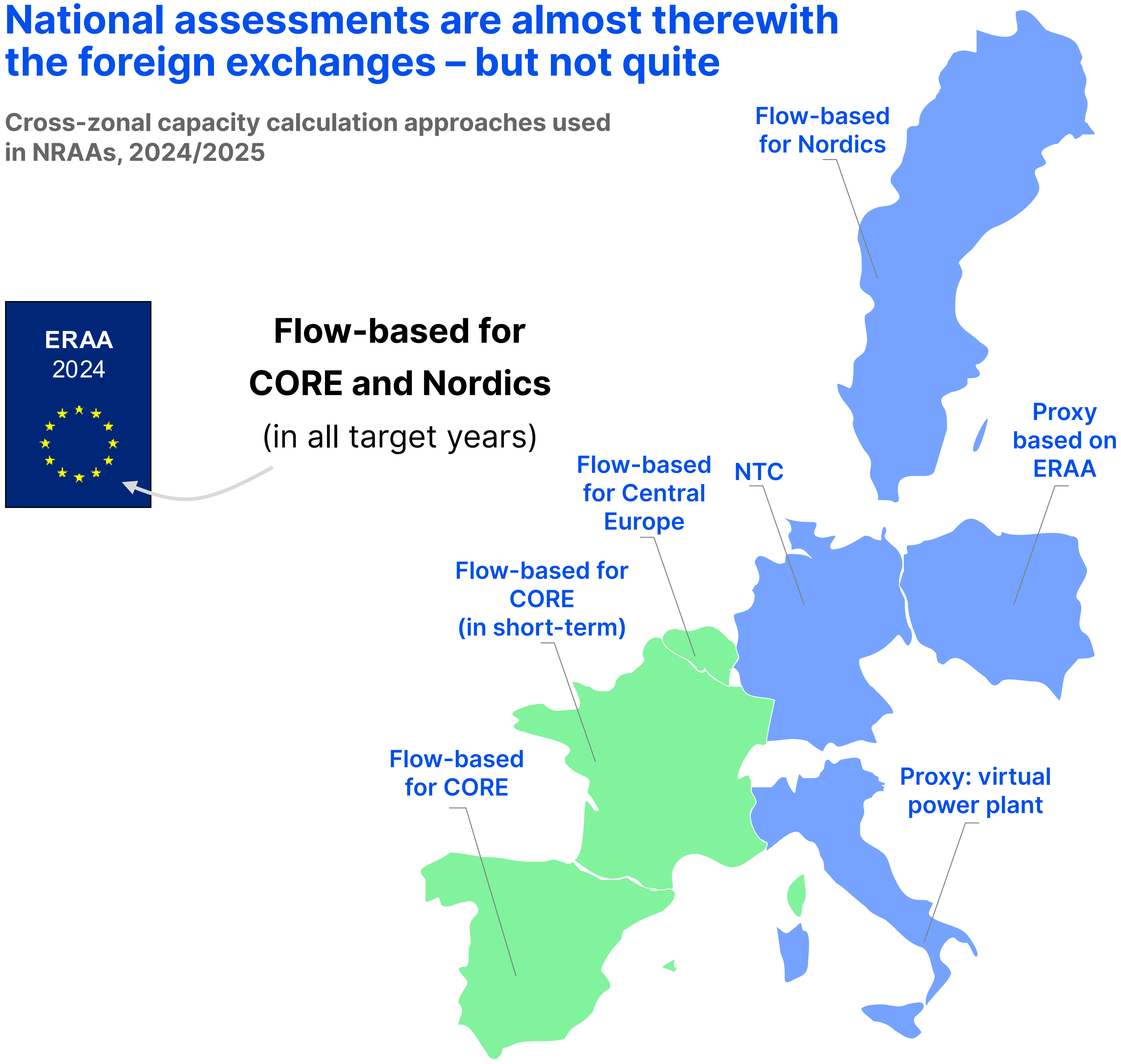
To close the gap shown in the figures, ERAA must constantly improve to remain a state-of-the-art assessment. **The ongoing methodology revision is in line with this objective**, as outlined in ACER's letter.

Sources: ENTSO-E Winter Outlook 2024/2025, ERAA 2023, ACER monitoring
Notes: the ENTSO-E Winter outlook 24/25 covers 18 November 2024 until 31 March 2025. The displayed LOLE in ERAA 2023 covers the same period in 2025, calculated from hourly ENS.
The ACER monitoring of the short-term adequacy assessment performed by RCCs show no triggered adequacy concern in 2024.
[1] See Annex II Note (5) for more information about colour saturation assumption

European study provides input to national ones

National assessments are almost therewith the foreign exchanges – but not quite

Cross-zonal capacity calculation approaches used in NRAAs, 2024/2025



The European Resource Adequacy Assessment, is an annual adequacy forecast by ENTSO-E approved by ACER. As a European exercise, it thrives to capture positive externalities and interdependencies between countries.

Compared to the many national assessments conducted across Europe, **ERAA provides the most comprehensive picture of cross-zonal exchanges**. It models the interconnected internal market with the use of flow-based approach, which is the same method that the operators use in real life for foreign exchanges. On the other hand, most national assessments model smaller geographical scopes and employ simplified approaches, such as net transfer capacities (NTC).

Further, Member States also use ERAA:

- as source of input data for their national assessments (e.g. Poland, Spain, Estonia, Sweden, Ireland, Italy, Slovakia, Cyprus, Portugal, France, Denmark, Romania, Netherlands, Belgium, Lithuania, Czechia, Latvia)
- and also directly ERAA results when justifing the need to introduce capacity mechanisms (e.g. Estonia, Sweden).

ERAA became central to the streamlining effort to ensure timely access to capacity mechanisms. In its recent framework, the Commission has opened a fast-track for capacity mechanisms applications if the demonstration of the need for and the proportionality of the measure is based on ERAA, and the capacity mechanism is designed in line with a target model.

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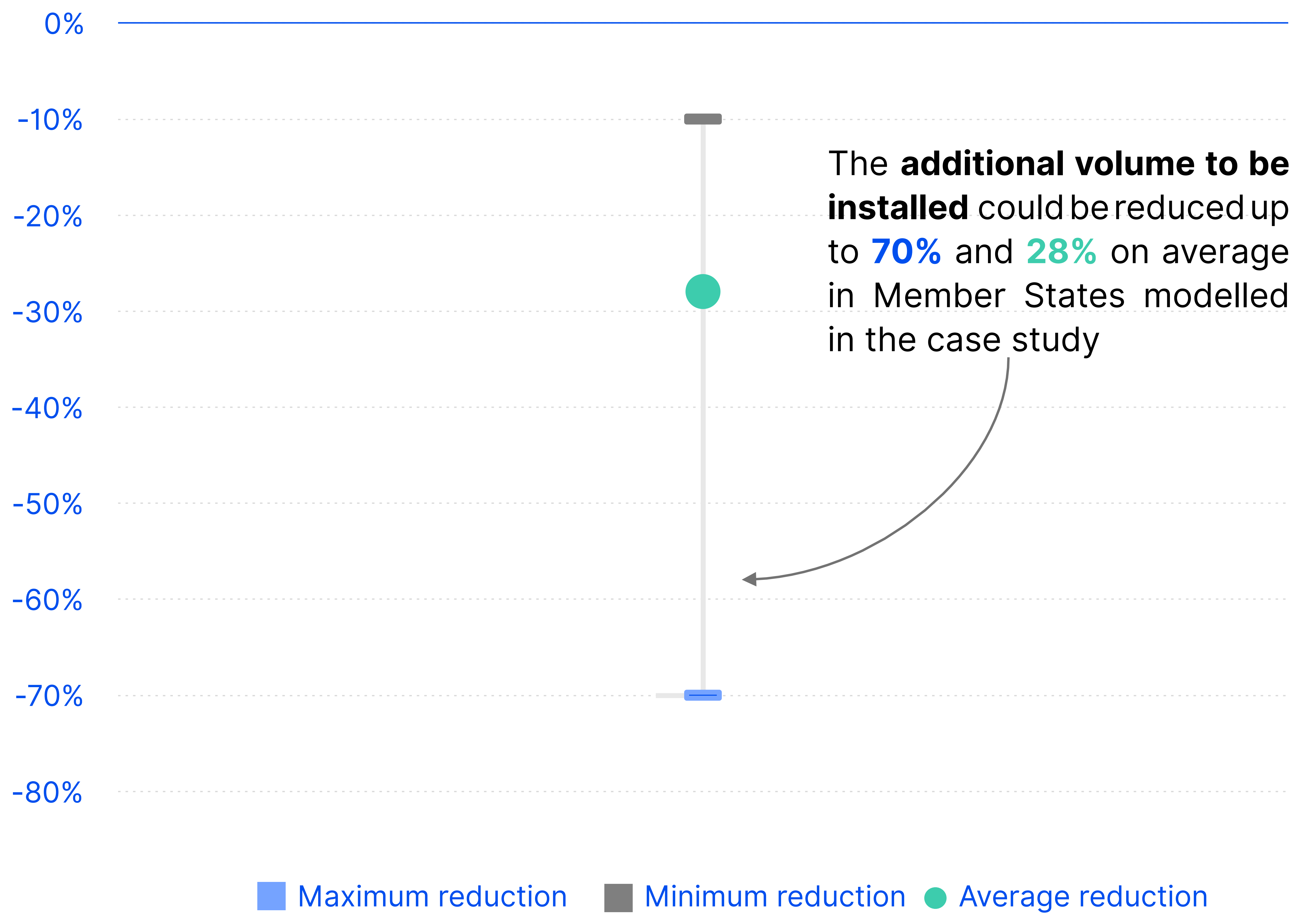
Further coordination would reduce capacity need

Impact of coordinated vs independent dimensioning of capacity mechanism

Percentage reduction in additional capacity required under coordinated dimensioning (compared to isolated dimensioning) on a test case (%)



If Member States considered the full potential of resources in the neighbouring countries - including the capacity procured in other Member States' mechanisms - each individually would need to procure less and hence pay less to ensure security of supply.

When testing this insight, the modelling results confirm that **coordinated dimensioning of capacity mechanisms substantially reduces capacity** to be contracted compared to isolated dimensioning.

These findings highlight the **added value of deriving procurement volumes for capacity mechanisms based on the ERAA Central Reference Scenario with CM** that considers the development of market-based resources as well as the contribution of capacity mechanisms **across Member States**.

Test case defined by ACER and modelled by M. Zampara, D. Avila, and A. Papavasiliou using the ED module tool described in their academic paper: *Capacity Expansion Planning under Uncertainty subject to Expected Energy Not Served Constraints*, arXiv:2501.17484.

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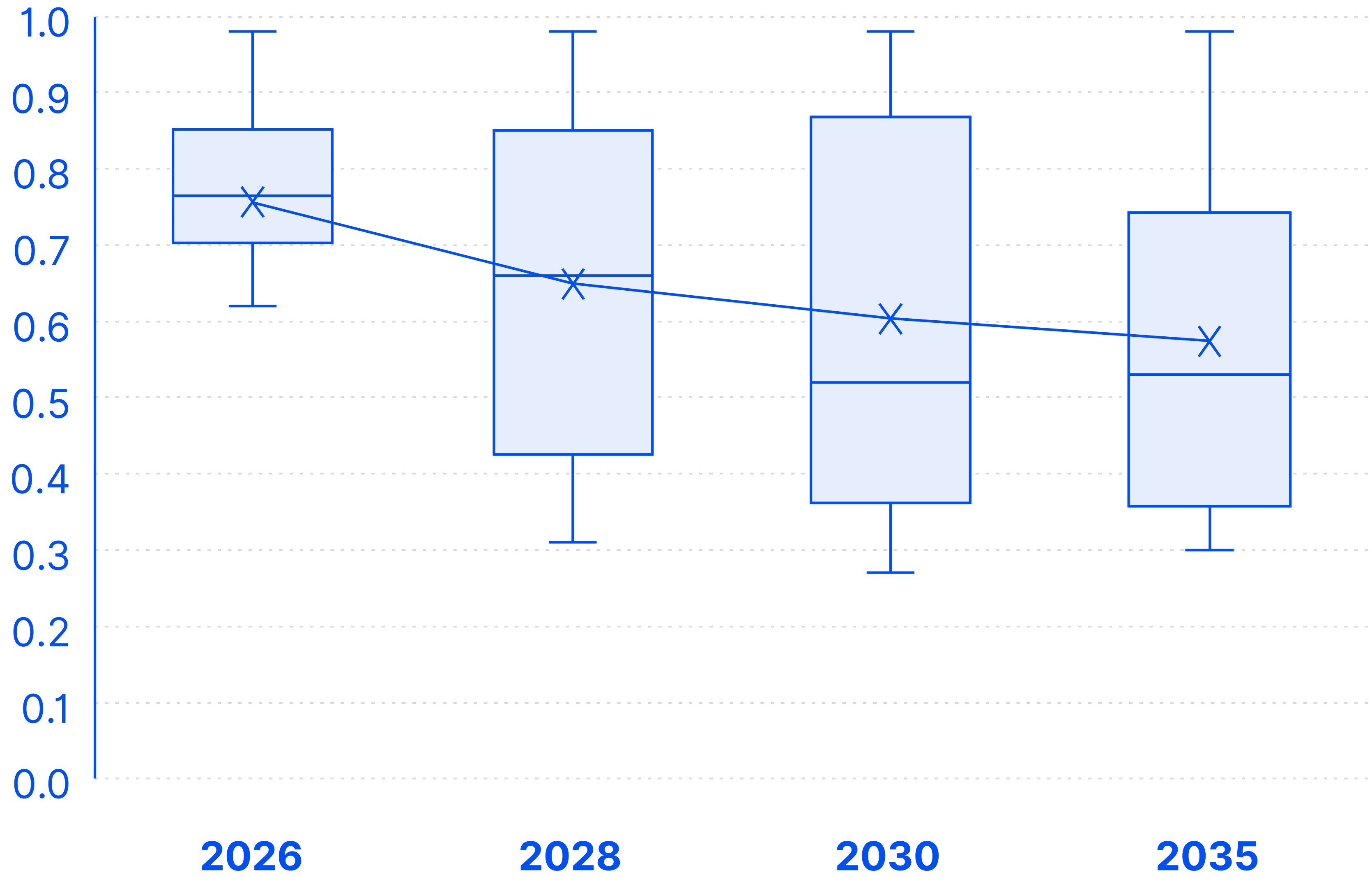
Batteries contribute, but mostly for short-term flexibility

ACER has computed de-rating factors for batteries across different target years and bidding zones. These de-rating factors represent the contribution of a given battery type to adequacy in each Member State.

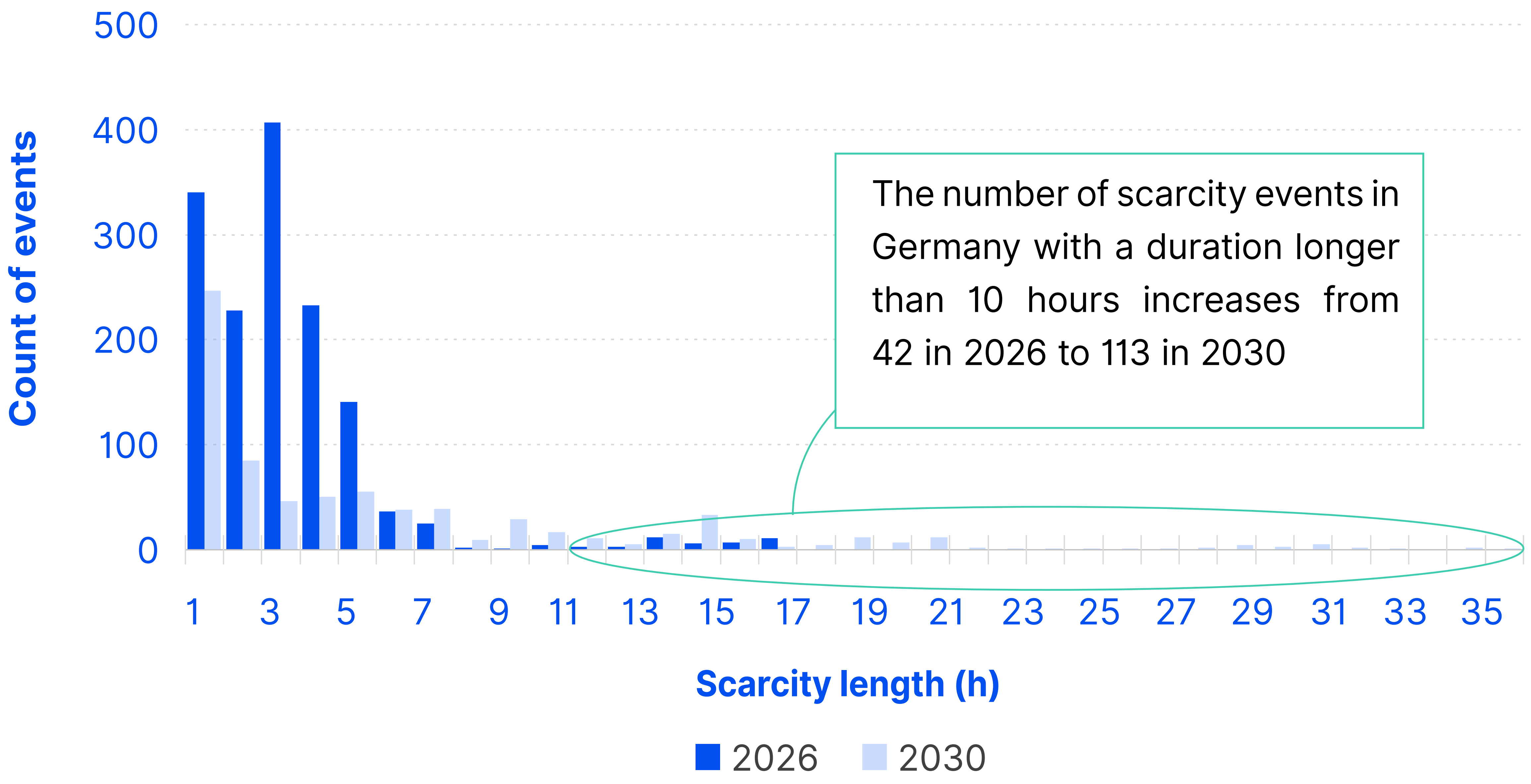
The de-rating factor of a battery depends on its ability to sustain output during scarcity events. Longer-duration batteries provide a higher adequacy value. For example, a **2-hour battery** can deliver full power during a 2-hour scarcity event, but in a **4-hour scarcity event** it can only sustain half power over the full duration.

The **adequacy contribution of batteries is expected to decline over time**, unless battery duration increases significantly, as scarcity peaks get longer and batteries are unable to maintain full output across the entire event. This demonstrates that **current** mainstream **battery technology alone cannot ensure adequacy**; innovation and complementary resources capable of sustaining output over longer periods (e.g. hydro, hydrogen) will also be needed.

Derating factors for 3h batteries[1], EU-27



Duration of scarcity length: ERAA 2024 Germany

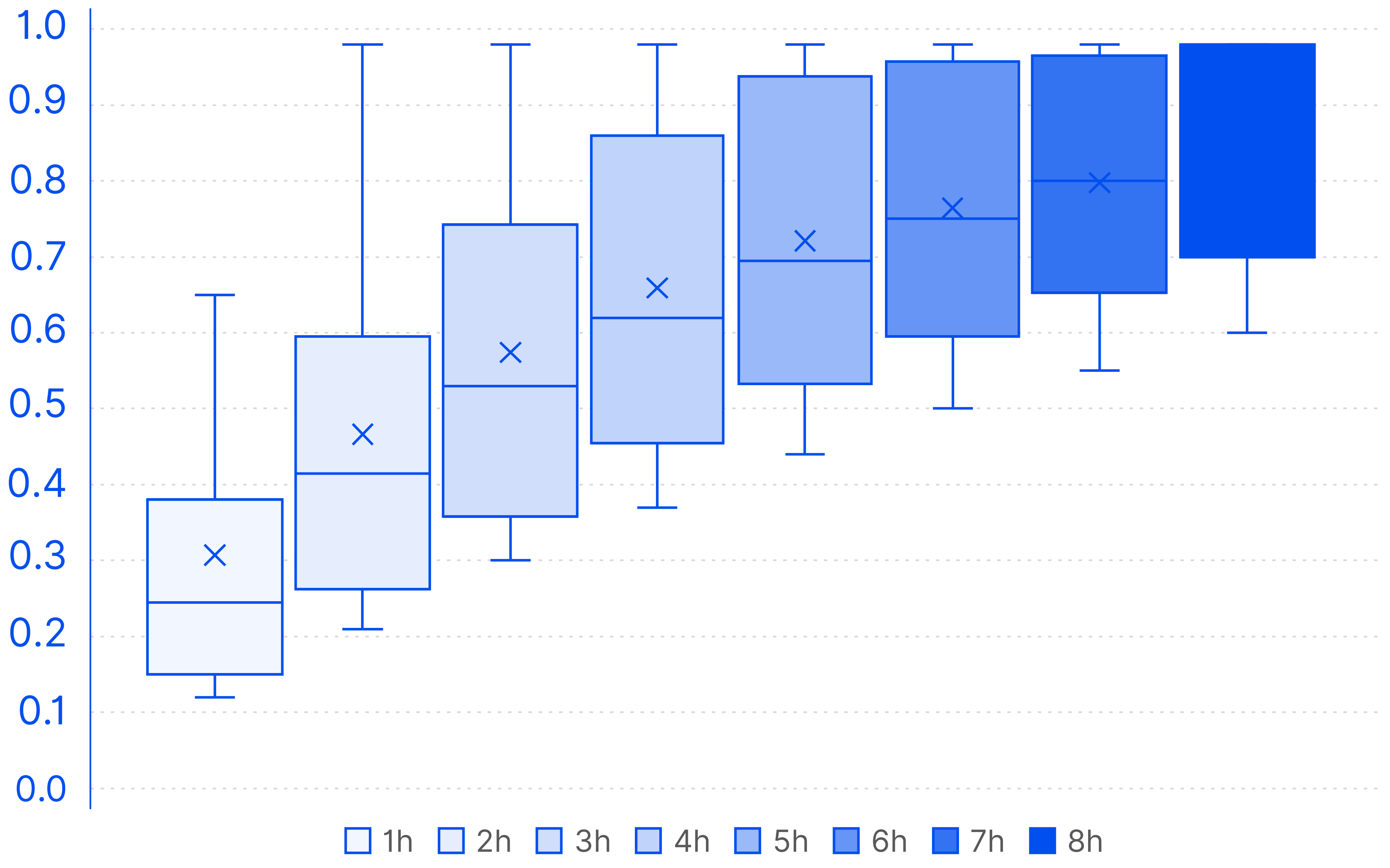


Source: ACER based on ERAA 2024 data
[1] The Derating Factor per bidding zone is estimated for a 1 MW battery, indicating how much such a battery contributes to reducing unserved energy in the ERAA 2024 edition.

Adequacy and flexibility should be co-optimised

Scarcity duration expands with the energy transition

Derating factors for batteries[1] of various sizes, EU-27, target year 2035



De-rating factors for batteries are highly dependent on their storage duration.

Consequently, the design choice on battery duration within a flexibility measure has a significant impact on adequacy outcomes.

For instance, a flexibility measure might identify 2-hour batteries as the most cost-effective option for addressing short-term flexibility needs. However, this choice could still require additional resources to ensure adequacy. By contrast, 8-hour batteries could contribute to both flexibility and adequacy, though they involve higher upfront investment costs. To make an efficient decision, the full contribution of each asset to both flexibility and adequacy should therefore be assessed jointly rather than in isolation.

This illustrates the interdependence between flexibility and adequacy decisions, underscoring that their procurement should be co-optimised rather than assessed in isolation, in line the Electricity Regulation[2] and the newly published CISAF.

Concept of co-optimisation

The concept of co-optimisation is the use a single clearing algorithm that jointly considers market participants' bids for their assets (i.e. the support they require to remain/enter in the market) alongside the system's adequacy and flexibility needs. The algorithm then minimises total procurement costs, while simultaneously ensuring that both adequacy and flexibility requirements are met.

Source: ACER based on ERAA 2024 data
[1] The Derating Factor per bidding zone is estimated for a 1 MW battery, indicating how much such a battery contributes to reducing unserved energy in the ERAA 2024 edition.
[2] See Article 19g of Regulation 2019/943

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Flexibility measures take off sharply, with costs expected to rise

Non-fossil flexibility

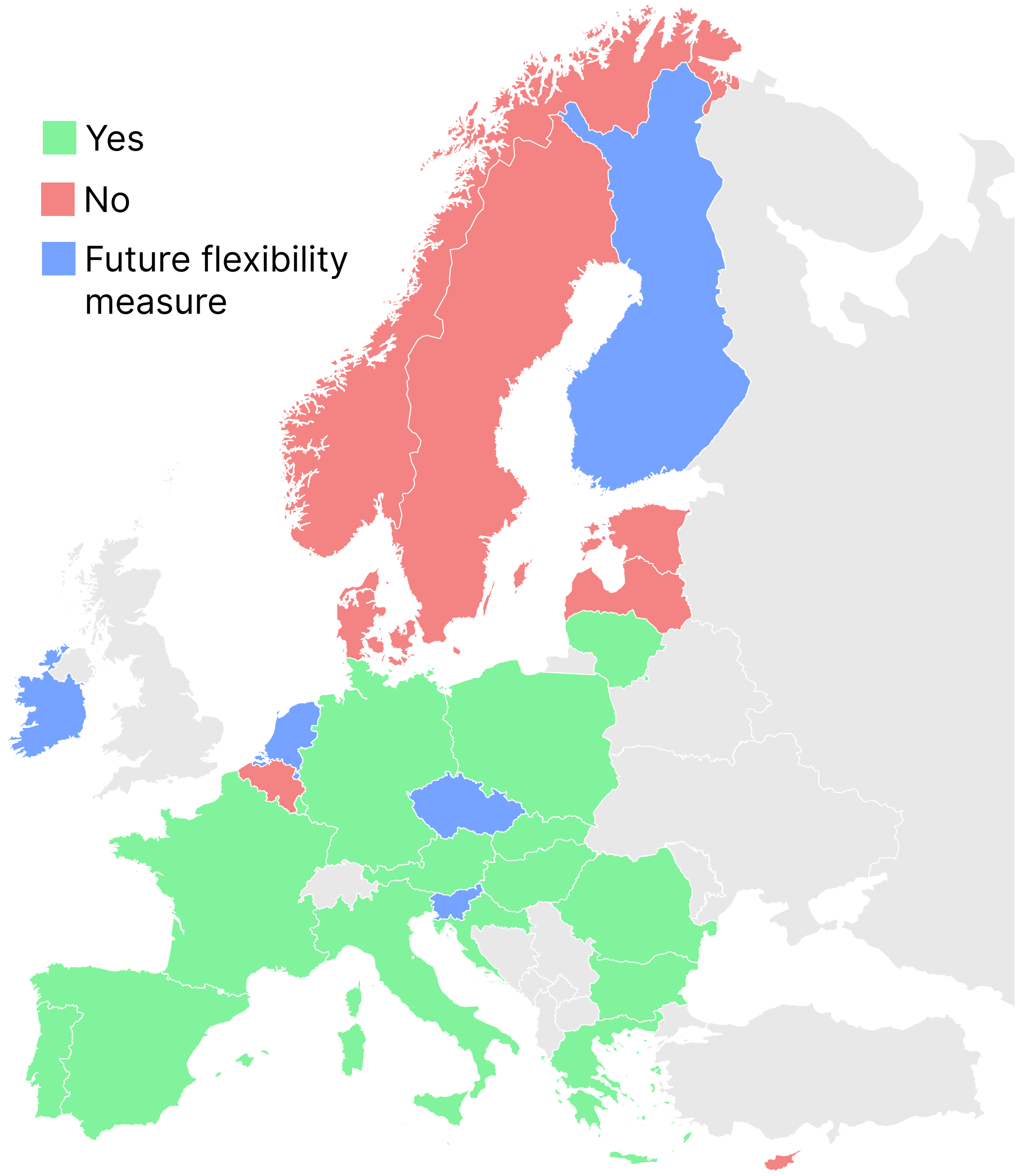
Flexibility measures proliferate across Europe

Throughout the EU, there is an increasing trend in setting new flexibility measures

For this report, ACER defines a flexibility measure as a **subsidy mechanism that aims at incentivising the deployment and utilisation of non-fossil flexible resources**, such as demand-side response (DSR), battery storage and pumped hydro storage. This definition should **not** be interpreted as the definition of non-fossil flexibility schemes provided in Article 19g of the Electricity Market Design Reform Regulation.

More than half of Member States had a flexibility measure in place in 2024

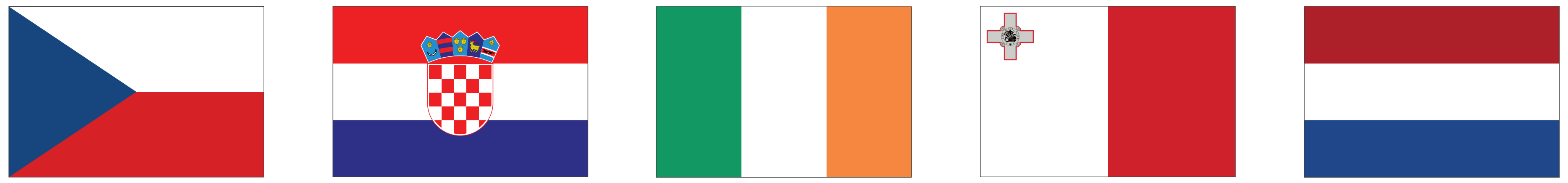
"Future flexibility measure" refers to Member States that will or intend to have one (or more) flexibility measure(s) in future years



Electricity market design reform puts flexibility at the core of renewables' integration

Regulation 2024/1747 introduces a process for Member States to assess their future flexibility needs. Member States shall assess national flexibility needs biannually starting from July 2026, based on the EU-wide Flexibility Needs Assessment Methodology recently approved by ACER. Based on these national assessments, Member States will be able to define targets for flexibility and introduce policies to meet them. Among other policies, Member States will have the possibility to set up non-fossil flexibility support schemes to meet these targets.

Member States that introduced flexibility measures in 2025:



Within these Member States, there is big variability regarding the stage of development of future flexibility measures. CZ, HR, IE, MT and NL have introduced new flexibility measures already in 2025. ES, FI, LU and SI have plans to implement new flexibility measures, but they are still in the preparatory phase.

Note (1) – see Annex III

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Flexibility measures’ costs will surge in future years

Grid-scale battery storage is the main beneficiary of flexibility measures. Out of 15 Member States with flexibility measures, 8 are remunerating grid-scale batteries.

DSR is only eligible for flexibility measures in the Netherlands and France. In **France** the flexibility measure is tied to the Capacity Mechanism, and thus to **security of supply**, and in **the Netherlands** alleviating **grid congestion** is the main purpose of the flexibility measure introduced in 2025.

The **actual costs of flexibility measures** based on contracted capacity **amount to EUR 2.6 billion** as reported for the period 2024-2030, of which EUR 1.1 billion (42%) is directed to grid-scale batteries. **The costs of flexibility measures across the EU are expected to significantly increase** in the years to come, as more Member States establish flexibility measures. For example, national authorities expect the total costs of the flexibility measures to amount to EUR 260 million in the Netherlands and to EUR 230 million in Poland. In Italy, the European Commission approved EUR 17.7 billion in State Aid for deploying centralised electricity storage systems.

The data presented in this report is **based on information available as of mid-2025** for the 2024-2030 period, thus projections are limited and do not include all flexibility asset volumes expected in future years. ACER has analysed data on i) actual costs based on contracted volumes as well as ii) contracted and iii) projected volumes.

Remunerated technologies in 2024–2030

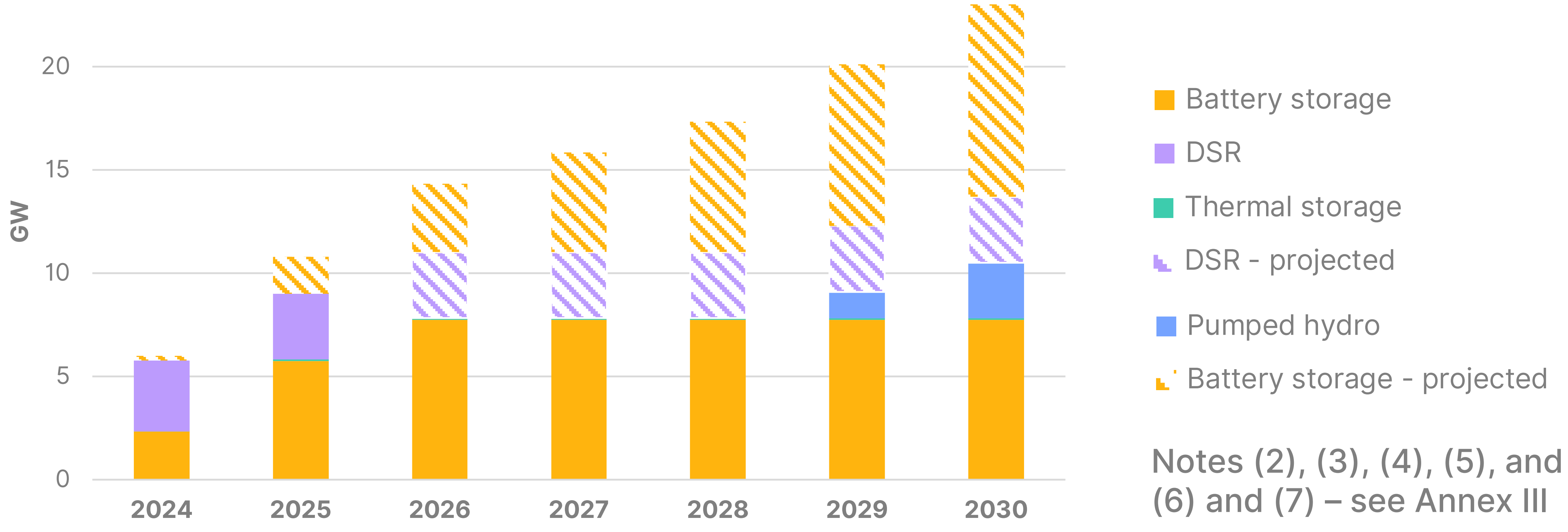
Remunerated flexible assets through flexibility measures in the period 2024-2030, from those receiving most subsidies to those receiving less. Note: cost and volume data comes only from contracted assets’ information available as of mid 2025.

Grid-scale batteries	Co-located storage	Pumped storage hydro	DSR	Distributed batteries	Thermal storage
EUR 1.1 billion	EUR 726 million	EUR 350 million	EUR 260 million	EUR 153 million	EUR 6.5 million
4.1 GW	3.6 GW	2.7 GW	3.3 GW (yearly)	0.3 GW	0.08 GW

Notes (4), (5), (6) and (7) – see Annex III

Installed capacity (cumulative) of non-fossil flexibility assets

Installed capacity of supported flexible assets in EU-27, cumulative, in GW. Note: the plot is made with data available as of mid 2025. The projections shown are therefore limited and do not encompass all flexibility asset additions that are expected in the 2024-2030 period.

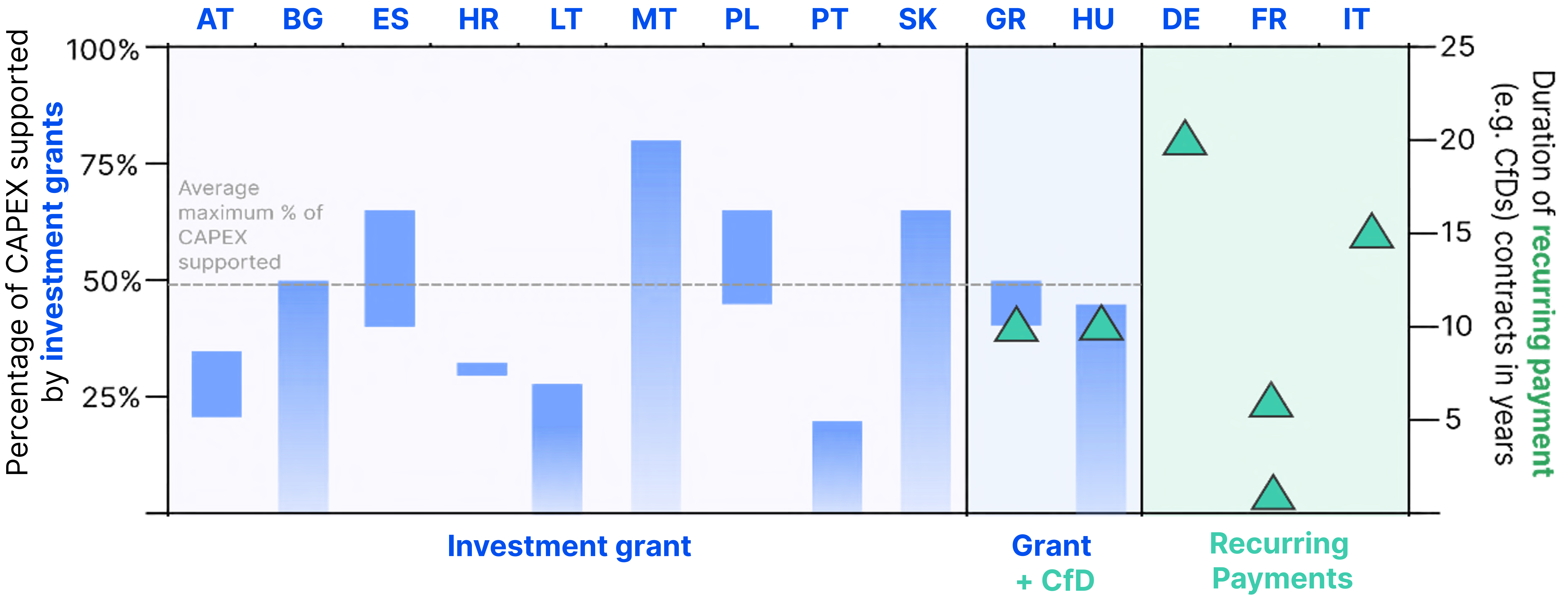


Notes (2), (3), (4), (5), and (6) and (7) – see Annex III

Heterogenous designs implemented across Europe

Range of State Aid intensity suggests different market conditions for storage

Type of remuneration per Member State with a flexibility measure in 2024. Please note that data reflected in this graph represents the possible range for aid intensity as per State Aid documents. However, auction results may not reach the maximum. For example, in the case of Spain, the call for grid-scale and thermal storage resulted in around 19% of investment costs covered by the aid, and around 5% in the call for pumped hydro storage[1].



Note (8) – see Annex III

Recurring payment contract (e.g. CfD)

Investment grant contract. From zero up to a % of the CAPEX

Investment grant contract. Range of possible %. Indicates different maximums, usually associated with the size of asset or beneficiary

Most Member States support flexible resources through **direct investment grants**. They typically cover some **share of the investment cost**.

The share of eligible costs is defined at the national level, based on the identified funding gap (the lower the revenues or the higher the costs that storage may expect from the market, the higher the gap[2]). This calculation considers the estimated revenues that the storage can expect from the market. Variations in aid intensity suggest **different market conditions for storage across the EU**.

Other approaches

Greece and Hungary **combine contracts for difference (CfDs) with investment grants**.

Three EU countries support batteries through **recurring payments only**, namely France, Germany and Italy.

[1] A cap may also apply to the total aid received, limiting the effective percentage covered.
[2] Not all the shares eligible for direct grants plotted on the figure are computed based on the State Aid Framework concept of funding gap. For example, Malta's flexibility measure is under the *de minimis* exemption.

Different ways to support renewables integration

Among the objectives for flexibility measures, Member States identified RES integration security of supply, grid operation and stability, and congestion management.

The ways flexibility measures are expected to contribute to the different goals vary, especially for RES integration:

- Co-located storage, with up to a 75% requirement of stored energy from connected RES (AT, PT);
- Ability of awarded resources to participate in all markets, including balancing (ES, HU, GR, LT, BG);
- Provision of specific system services (HR: automatic frequency restoration reserve[1]), grid service (PL: services for the DSO) or dedicated flexibility product (IT: time-shifting product).

Member States, however, do not always assess quantitatively the expected contribution to RES integration or the cost-effectiveness of the flexibility measures.

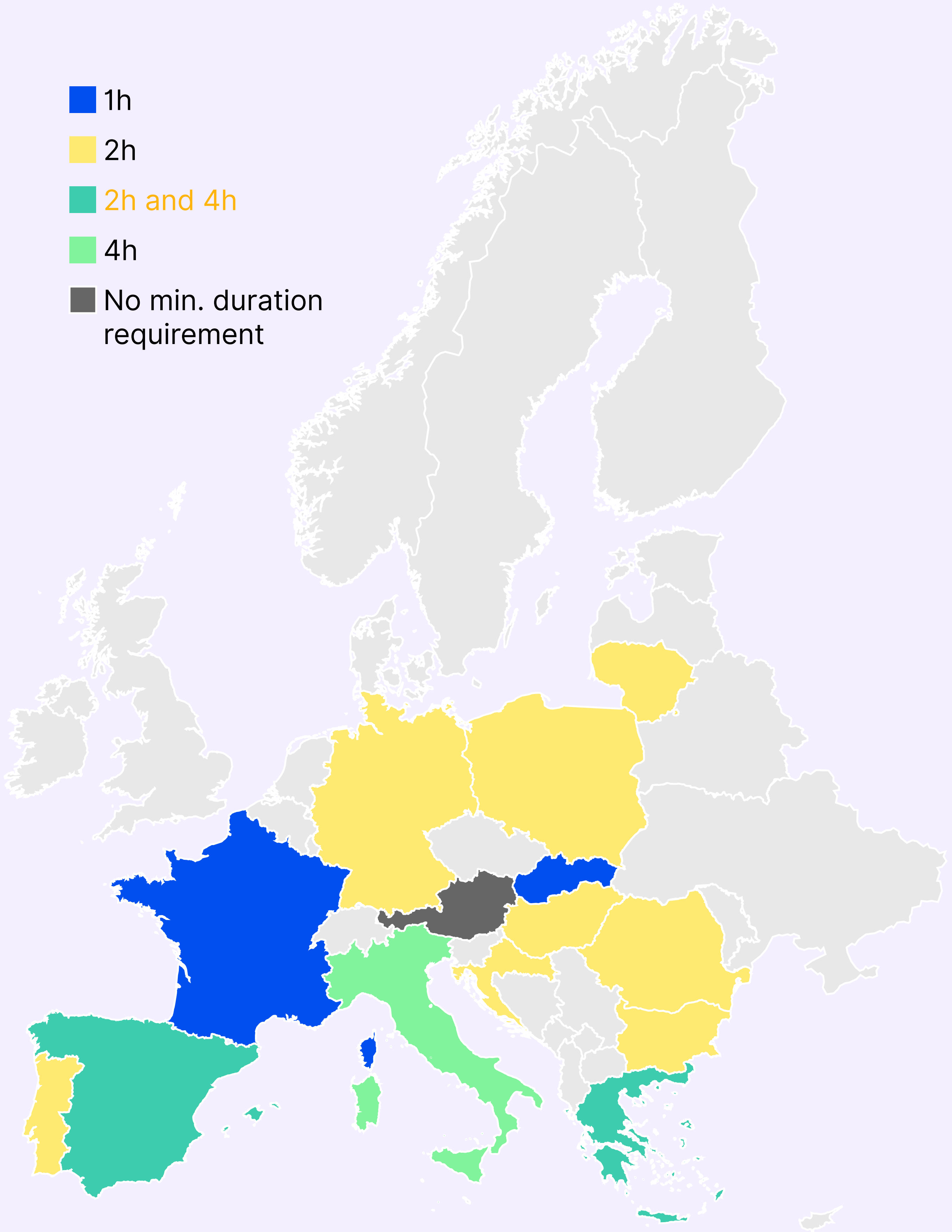
A balance between storage duration and costs

In 13 out of the 15 Member States with flexibility measures in 2024, a minimum duration requirement was set for storage. The minimum duration requirement of **two hours** was the most common.

While longer battery durations are more effective for contributing to RES integration, they are also more costly. Storage systems with a duration of less than 2h are effective for the provision of fast ancillary services.

As an exception to setting a minimum duration requirement, the Italian flexibility measure (MACSE) sets a duration target of 4h. A weighting factor is applied to adjust the bid in the selection process, benefiting assets closer to the target.

Minimum duration requirement per Member State with a flexibility measure in 2024



Source: information provided by NRAs

[1] Automatic frequency restoration reserve (aFRR): it is a type of secondary frequency control reserve that automatically responds to deviations in the power system frequency. Its purpose is to restore grid frequency to its nominal value (e.g., 50 Hz) after a disturbance. The resources remunerated through the Croatian flexibility measure are only allowed to participate in the ancillary services market.

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Annexes

Annex I – Adequacy metrics per Member State

Member State	Single VOLL EUR/MWh	CONE fixed technology[1]	CONE fixed EUR/MW	Reliability Standard h/year
Belgium	12,832	Demand Response	30,000	3.00
Cyprus	-	-	-	3.00
Czech Republic	16,003	Open Cycle Gas Turbine	105,800	6.70
Denmark	23,570		35,143	
Estonia	9,206	Open Cycle Gas Turbine	72,859	8.00
Finland	8,000	Renewal & Prolongation	17,000	2.10
France	33,000	Demand Response	60,000	2.00
Germany	12,240	Demand Response/ Open Cycle Gas Turbine	2,072 & 57,067/ 23,377	2.77
Greece	6,838	Demand Response	18,735	3.00

Member State	Single VOLL EUR/MWh	CONE fixed technology[1]	CONE fixed EUR/MW	Reliability Standard h/year
Ireland	17,909	Open Cycle Gas Turbine	115,990	3.00
Italy	20,000	Open Cycle Gas Turbine	53,000	3.00
Luxembourg	12,240	Demand response/ Open Cycle Gas Turbine	33,905	2.77
Netherlands	68,887	-	-	4.00
Poland	17,173	Demand Response/ Open Cycle Gas Turbine	30,183/119,256	3.00
Portugal	-	-	-	5.00
Slovenia	17,233	Demand Response	21,753	-
Spain	22,879	Renewal & Prolongation	34,400	1.50
Sweden	7,065	Demand Response	10,068	1.00

Source: ACER based on information from NRAs. Status as of August 2025
[1] Marginal technology to meet the Reliability Standard. If minimum capacity to meet Reliability Standard is not known, technology with the lowest CONE (fixed) is listed.
Notes per Member State: see Annex II

Annex II – General Notes

- ***Note (1):*** Total natural gas consumption in 2030 is based on Fit-for-55 scenario from the Analysis of the European LNG market developments – ACER 2025 Monitoring Report. The values for 2026, 2028 and 2035 are interpolated between 2024 data (EUROSTAT) and the 2030 projection. Gas consumption in electricity sector is estimated from ERAA 2024 electricity production by gas-fired and combined heat and power plants, taking into account their efficiencies. The reduction in natural gas consumption from electrolysers and heat pumps is estimated based on their electricity use in ERAA 2024 and assumed efficiencies: electrolysers produce hydrogen at 75% efficiency, while heat pumps replace gas heating at 350% efficiency.
- ***Note (2):*** Costs for 2025 reflect the expected costs. The overall costs for France are an approximation considering that all capacity certificates are valued at the market reference price. A significant share (which varies year-on-year) of the capacity certificates is implicitly valued through the Accès Régulé à l'Electricité Nucléaire Historique (ARENH) mechanism, a scheme that enables suppliers to purchase electricity from nuclear generators at a regulated price. Therefore, the actual costs for France are dependent on the reference used to value the capacity certificates related to the ARENH mechanism.
- ***Note (3):*** In Ireland existing capacity can bid into the auction above the Existing Capacity Price Cap (ECPC) if they are approved by the Regulatory Authorities for a Unit Specific Price Cap (USPC). Existing capacity gets paid the same auction clearing price as new capacity in the unconstrained auction run (pay-as-clear) and can get paid up to their USPC in the constrained auction (pay-as-bid). New capacity can bid up to the Auction Price Cap.
- ***Note (4):*** The analysis is based on a set of standardized technical and economic assumptions that reflect average market conditions in 2024 and publicly available benchmarks. The following input parameters have been applied: Natural gas price: 34 EUR/MWhg; CO_2 price: 64 EUR/t; Gas-fired power plant (PPT) efficiency: 55%; Emission factor: 0.20 t CO_2/MWhg; Variable Operation and Maintenance (VOM) costs: 2.5 EUR/MWh; Strike price in the Italian Capacity Market (CM): 231 EUR/MWh, corresponding to the estimated annual average in 2024. Several sensitivity analyses on key assumptions, including varying power plant efficiency, alter net income magnitudes, but the impact on the bidding zone rankings is limited.
- ***Note (5):*** In ERAA 2023, some regions show values of LOLE one to two orders of magnitude higher than others, corresponding to 11.0 h for Great Britain, 82.0 h for Northern Ireland, 71.1 h for Malta and 107.2 h for Ireland. To preserve a representative colour saturation of the map, their value has been aligned with the following higher value of 4.95 h of Spain (>3 h);

Notes on Adequacy Metrics per Member State (from Annex I):

- Note on **Cyprus**, three adequacy metrics are set: LOLE of 3 hours per year, reserve margin of 189 MW and expected energy not served at 0.001% of annual demand;
- Note on **Finland**, an additional reliability standard expressed as expected energy not served equal to 1,100 MWh/year is in place;
- Note on **Germany**, the reliability standard is calculated as the average of annual reliability standards for a five-year period; and the reference technology alternates between demand response (with CONE fixed 23,377 EUR/MW for commercial and 2,072 EUR/MW for industrial) and OCGT (with CONE fixed = 57,067 EUR/MW);
- Note on **Luxembourg**: use the same adequacy metrics as Germany;
- Note on **Poland**, the reliability standard is based on two CONE technologies;
- Note on **Spain**, the reliability standard is determined by the mean CONE fixed of the Combine Cycle Gas Turbine life extension (mean of min CONE of 27,216 EUR/MW and max CONE of 41,585 EUR/MW).

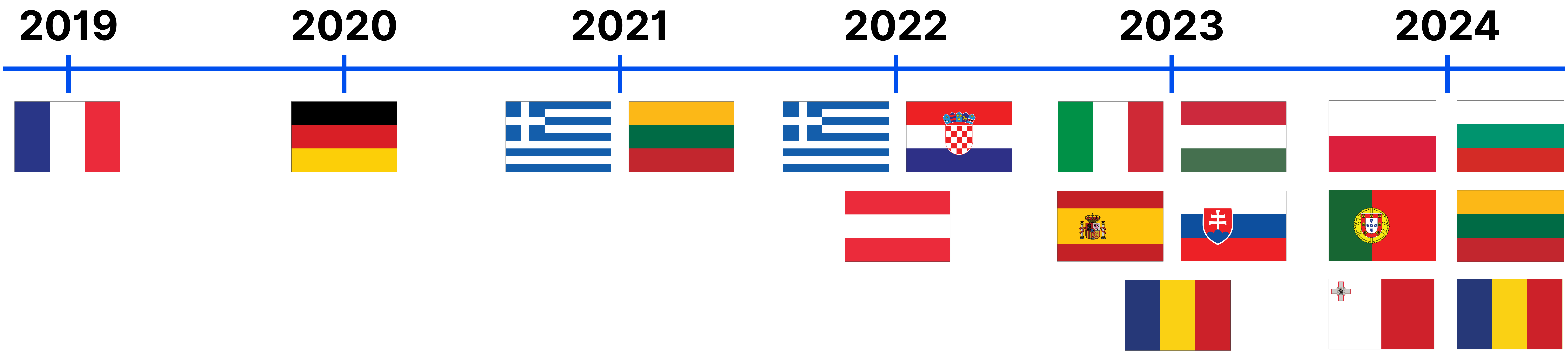
Annex III – Notes on flexibility measures

- ***Note (1):*** In this report, ACER defines a Member State as having a flexibility measure if it is established in national legislation or has approved State Aid from the European Commission. These Members States have not necessarily procured capacity or run auctions.
- ***Note (2):*** The remunerated flexibility volumes are plotted starting in the year they entered the system all the way out to 2030, cumulatively. Some assets entered the system in previous years and are plotted starting from 2024. The cumulative plotting reflects that these volumes of flexible assets stay for years in the system.
- ***Note (3):*** The dataset "DSR – projected" comes from estimations provided by the French NRA. The battery storage projections include volumes from the Croatian, Polish, and one of the two Romanian flexibility measures as reported by NRAs, as well as the Italian flexibility measure, as reported in the State Aid decision (State Aid decision nº 104106). The graph does not include projected volumes from other existing and future flexibility measures. As such, ACER expects that flexibility volumes will be higher than those plotted.
- ***Note (4):*** Due to unavailability of data, or because some data provided were estimations rather than data from contracts/auction results, some data points have not been reflected in the figures:
  - **Missing datasets**: cost and volume data on the Lithuanian flexibility measure, cost data for the German and Croatian flexibility measures, cost data for the Greek and French CfDs.
  - **Cost estimations provided by NRA**s (not actual costs): cost data for the Polish flexibility measure and one of the Romanian flexibility measures, cost data for the Hungarian CfD.
- ***Note (5):*** Most countries have provided data in terms of capacity (MW) and a few have provided data in terms of energy (MWh), reflecting the way the flexibility measures were procured. ACER converted all data received in terms of energy (MWh) to capacity (MW) assuming batteries with a duration of 2 hours, as this has been the most frequent duration requirement across all flexibility measures.
- ***Note (6):*** German auction results provide the volume of RES + battery systems combined, where battery storage must be at least 25% of the total capacity. Flexibility volumes were plotted for Germany by summing all auction results in the 2020–2024 period and multiplying by 25%.
- ***Note (7):*** Croatia has a flexibility measure for provision of ancillary services to the TSO, not yet connected to the grid. There is no data availability about the actual costs of this measure. Estimated volumes shared by the NRA have been included within the dataset "Battery storage – projected".
- ***Note (8):*** data for the graph "Range of State Aid intensity suggests different market conditions for storage" is not available for RO. In FR the auction for DSR is carried out yearly, and repeated every year. Penalties for non-delivery are associated with the schedule and delays in commissioning in the case of investment grants. In case of recurring payments, requirements and penalties for non-performance include the obligation to participate in specific markets (GR, HU), and a number of activation per year (FR).

Annex IV - Timeline of introduction of flexibility measures

Timeline of introduction of flexibility measures

Specific years in which flexibility measures were introduced in the respective Member States as per publication of the measure

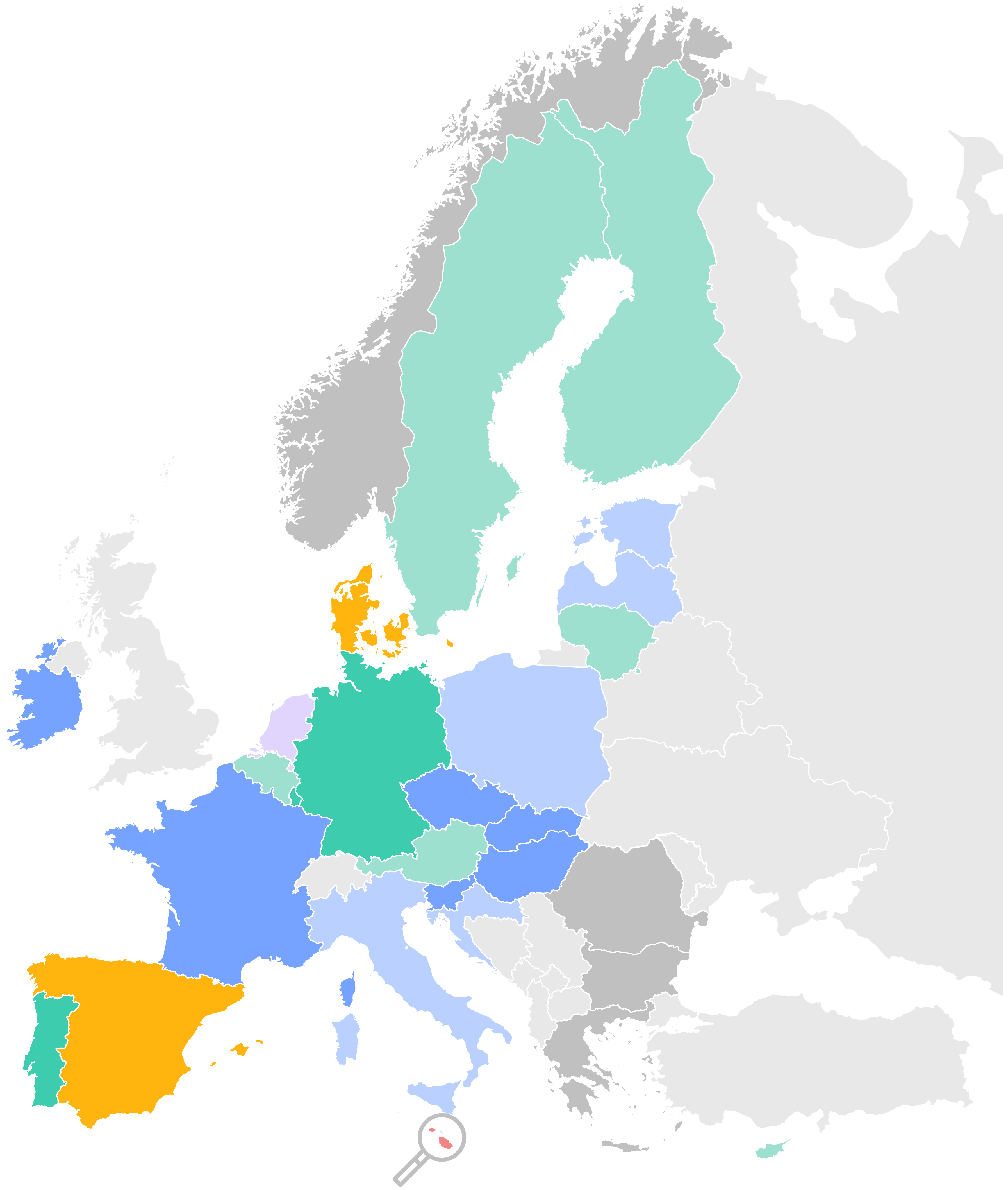


Source: Based on information collected by NRAs.
Note: Member States that are included twice in the timeline have different types of flexibility measures entering in different years.

Annex V - Flexibility Needs Assessment Report

Who adopts the Flexibility Needs Assessment Report

- The first Flexibility Needs Assessment has to be adopted by all Member States by July 2026 according to Article 19e of the Electricity Regulation. The report can be adopted by the NRA, a Designated Entity (e.g. the TSO) or a Designated Authority (e.g. the Ministry of Energy);
- At the time of the survey, not all countries had defined the entity responsible to adopt the FNA as per Article 19e of the Electricity Regulation;
- NRAs from Member States without definition were asked about their expectation. These Member States are marked with the tag “expected” on the map.



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