Guidehouse

frontier economics

January 2026

Study on capacity remuneration mechanisms for the Netherlands

Ministry of Climate Policy and Green Growth

Final report

outwit complexity™

Prepared for:

Ministerie van Klimaat en Groene Groei

Abbreviations

Abbreviation	Description
ACER	EU Agency for the Cooperation of Energy Regulators
ACM	Authority for Consumers and Markets (NL)
BRP	Balance Responsible Party
CCGT	Combined-Cycle Gas Turbine
CEP	Clean Energy Package (EU)
CISAF	Clean Industrial Deal State aid Framework
CM	Central Capacity Mechanism
CONE / net-CONE	(Net) Cost of New Entry
CRM	Capacity Remuneration Mechanism
DCA	Descending Clock Auction
DEI+	Demonstration Energy and Climate Innovation (NL)
DSM	Demand Side Management
DSR	Demand Side Response
EENS	Expected Energy Not Served
ENTSO-E	European Network of Transmission System Operators for Electricity
EOM	Energy-Only Market

Abbreviation	Description
HO	Hedging Obligation
IPC	Intermediate Price Cap
LDES	Long-Duration Energy Storage
LOLE	Loss of Load Expectation
MLZ	Monitor Leveringszekerheid (NL Security-of-Supply monitor)
OCGT	Open-Cycle Gas Turbine
OTC	Over-the-Counter
PPA	Power Purchase Agreement
RES	Renewable Energy Sources
RO	Reliability Option
SDE++	Stimulation of Sustainable Energy Production and Climate Transition (NL)
SoS	Security of Supply
SR	Strategic Reserve
TRL	Technology Readiness Level
TSO	Transmission System Operator

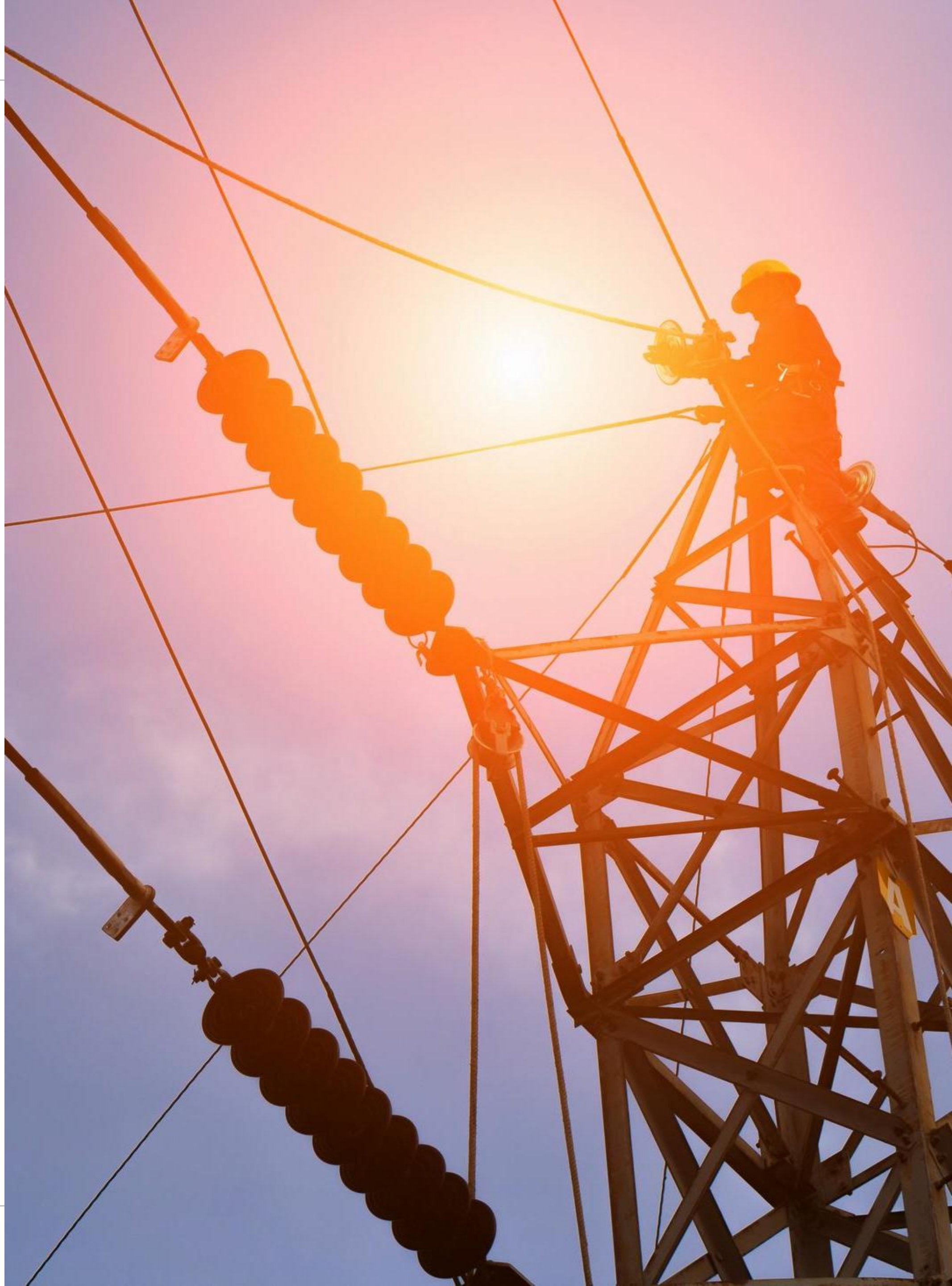
Glossary of main terminology (1/2)

Term	Abbr.	Description
Advance payment for new builds	-	CRM-related instrument which tenders offer upfront payments to new, flexible assets in regions where extra capacity is needed. This approach improves investment security by covering part of depreciation costs, with participation limited to climate-compatible assets.
Capacity Auction	-	CRM in which firm capacity is procured through centrally organized auctions, with participation typically limited to new assets and specific technologies. Providers must meet availability obligations and receive payments.
Capacity remuneration mechanism	CRM	Electricity market instrument that provides (additional) payments for available capacity (generation, storage and demand-side resources) to ensure resource adequacy.
Central capacity mechanism	CM	CRM in which a central buyer determines the required capacity volume and procures it through central auctions or tenders. Providers receive capacity contracts and must be available in scarcity situations.
Clean Industrial Deal State Aid Framework	CISAF	EU state-aid framework that sets the conditions under which Member States can support clean energy, industrial decarbonisation and related measures, including specific rules and requirements for flexibility measures and CRMs.
Decentral capacity mechanism	-	CRM where suppliers or balancing responsible parties hold individual capacity obligations linked to their customers' demand. They must contract sufficient capacity certificates to meet these obligations.
Energy-only market	EOM	Market design where assets are remunerated through energy and balancing prices, without dedicated capacity payments; adequacy relies on scarcity prices and investment signals from the energy market.
Expected Energy Not Served	EENS	Expected volume of electricity demand that cannot be supplied due to insufficient capacity [GWh/year].
Hedging Obligation	HO	CRM-related instrument in which balancing responsible parties are obliged to hedge a defined share of their expected demand via long-term or forward contracts.
Hybrid CRM	-	CRM which combines central procurement of new capacity via long-term contracts with decentralized supplier obligations for short-term capacity certificates. Both segments have separate compliance and cost recovery mechanisms.
Long-duration energy storage	LDES	Storage technologies that can deliver electricity over many hours or days and thereby support adequacy during prolonged periods of low renewable generation or high demand.
Loss of Load Expectation	LOLE	Expected number of hours per year in which available resources do not fully cover demand [hours/year].

Glossary of main terminology (2/2)

Term	Abbr.	Description
Monitor Leveringszekerheid	MLZ	Resource adequacy monitor assessment by TenneT that assesses future adequacy by indicators such as LOLE and EENS for different scenarios.
Non-fossil flexibility support schemes	NFFSS	Targeted support schemes that tender support for non-fossil flexible resources (e.g. storage, demand response) to stimulate investment and innovation in flexibility.
Reliability Option	RO	CRM based option-like contracts: capacity providers receive a fixed premium but must pay back the difference between the market price and a pre-defined strike price when prices exceed this strike price, effectively hedging consumers against very high prices.
Resource adequacy	-	Ability of the power system to meet demand with sufficient generation capacity at any given time, i.e. under normal and exceptional conditions. Issues can be temporal or long-term.
Security of Supply	SoS	Security of supply means ensuring continuous reliable and affordable supply of energy in sufficient quantity to meet demand and covers four aspects; resource adequacy, transmission adequacy, demand flexibility and energy security.
Strategic Reserve	SR	CRM in which a limited set of power plants and/or demand-side resources is kept outside the regular energy market and only dispatched in scarcity situations, while receiving payments for being available.

Content



This study formulates recommendations on the suitability of a CRM in the Netherlands through an in-depth assessment of shortlisted CRMs

Background

- Ensuring a reliable electricity supply is essential for the functioning of Dutch society and the economy.
- While no adequacy risks are expected between 2028–2030, the 2025 Dutch Security of Supply Monitor (MLZ)[1] signals a potential shortfall after 2030 due to increasing demand coupled with a reduction in dispatchable power generation, with the Loss of Load Expectation (LOLE) exceeding the threshold of 4 hours/year. More capacity and demand flexibility should be available to ensure adequacy of the Dutch power system.
- In response, the Dutch government[2] is proactively exploring the feasibility of introducing a Capacity Remuneration Mechanism (CRM) as a fallback solution to safeguard future supply adequacy. In the first half of 2026, measures are expected to be announced to ensure adequacy beyond 2030.
- CRMs could be a mechanism to support adequacy. Although CRMs can mitigate adequacy risks, they are complex, potentially costly, and may distort energy markets. Therefore, careful design and evaluation are crucial.
- This study on CRMs in the Netherlands will be important input for the decision-making process in the Netherlands.

Goal of this study

The **goal of this study** is to assess CRM options on their pros and cons and their suitability in the Netherlands to provide a solution to the adequacy challenge. This study delivers a comprehensive advisory report on different possible CRMs, their design variants and their effectiveness, advantages and disadvantages in the Dutch context.

As part of this study, we had four sessions with a **Steering Committee** consisting of representatives of KGG, TenneT and the Netherlands Authority for Consumers and Markets (ACM) to advice on the course of study. In addition, we had a **broader stakeholder session** with input from Energie Nederland, VEMW and academic experts. We value the input received during these sessions throughout the process in supporting and strengthening the work done in this report.

At this stage in the CRM discussion in the Netherlands, it is important to understand the pros and cons, design options and suitability of selected CRM types for the Netherlands. Detailed modelling and quantification is out of scope of this study and could provide more insights at a later stage in the CRM design and implementation process. High-level quantification is included where relevant.

Approach

We followed four steps to come to recommendations on possible implementation pathways for CRMs in the Netherlands.

1. Define **longlist of possible CRMs** based on literature review, prior experiences, and the current European context of CRMs.
2. **Shortlisting** of most suitable CRMs based on initial assessment.
3. **Detailed assessment** of design options and performance of the shortlisted CRMs related to the **Dutch context** based on a defined set of assessment criteria.
4. Formulating **recommendations** and suggestions for next steps.

Figure I: Overview of approach

[1] TenneT, Monitor Leveringszekerheid, 2025. Leveringszekerheid elektriciteit onder druk na 2030 ; [2] Kamerbrief stand van zaken leveringszekerheid elektriciteit | Kamerstuk | Rijksoverheid.nl

The Netherlands is facing an adequacy challenge after 2030, driven by a projected rise in demand, increase in RES generation and closure of thermal generation

The adequacy challenge in the Netherlands

- TenneT's Monitor Leveringszekerheid 2025 (MLZ)[1] indicates challenges are expected without further measures after 2030, when the Loss of Load Expectation (LOLE) is expected to exceed the threshold of 4 hrs.
- The LOLE value is used as reliability indicator, for which the threshold in NL is set at 4 hour/year. This level is considered an acceptable balance between reliability and costs, but is not a formalised standard.

Table A: *LOLE and EENS projections in TenneT MLZ[1]*

Indicator	Unit	2030	2033	2035
LOLE	[h/year]	1.1	12.6	9.2
EENS	[GWh/year]	0.8	14.1	15.7

- Stated main reasons for the expected resource adequacy concerns are:
  - Closure of 4 GW coal capacity by 2030 (ban on coal power generation).
  - Expected closure of 3.8 GW gas capacity before 2030 and 1.9 GW more closures towards 2035, partly driven by economic unviability.
  - Increase of electricity demand from 115 TWh in 2023, to 153 TWh in 2030, and 190 TWh in 2035.
- Maintaining resource adequacy is the main driver to investigate the suitability of a capacity mechanism for the Netherlands.
- The main reason for considering a CRM is the missing money problem. For existing thermal generation in the current market this results in economic unviability, for new assets this (in addition to maturity mismatch) results in the absence of longer-term investment signals.

The capacity gap in the Netherlands is estimated at ~1,5 GW by 2035

In TenneT's MLZ base case scenario, the LOLE and Expected Energy not Served (EENS) are modest. Based on own analysis, we derived the associated in 2033 and 2035 by the EENS duration curves at 4 hours.* For context, the capacity of gas plants that is expected to close due to economic unviability over this period is much greater (~5.7 GW) than the derived capacity gaps.

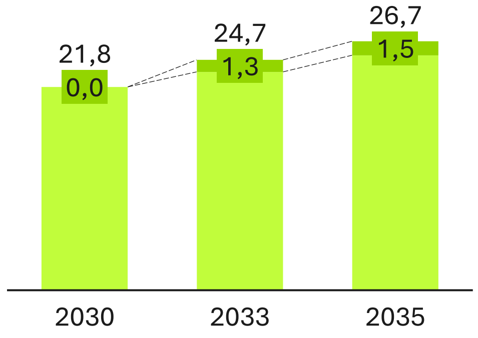


Figure II: *[GW] in relation to average winter day peak demand for the base scenario, derived from TenneT's MLZ[1] based on own analysis.*

Uncertain market and regulatory developments have implications on the CRM assessment

In the base scenario, the MLZ projects a high uptake of batteries, flexibility and Long-Duratio Energy Storage (LDES) to support system adequacy. Developments in the Dutch energy market are subject to various **uncertainties**. Uncertainties regarding demand growth and reduced dispatchable generation have been explored in the MLZ. The sensitivity analyses show:

- Even with reduced demand growth, a resource adequacy challenge appears in 2033.
- Reduced dispatchable generation capacity in 2033 increases expected energy not served (EENS), while if it occurs in 2030 it may result in an earlier adequacy challenge.

* Also see figure 5 in the main report for more information. [1] TenneT, Monitor Leveringszekerheid, 2025. Leveringszekerheid elektriciteit onder druk na 2030

Neighbouring countries in Europe have adopted capacity mechanisms to ensure resource adequacy, mainly driven by the missing money problem

CRMs across neighbouring countries

- Security of supply covers four aspects; **resource adequacy,** transmission adequacy, demand flexibility and energy security. Resource challenges are the primary reason for introducing a CRM. CRMs might also partly address further aspects of security of supply.
- The decision to implement a certain CRM across Europe depends on the timing of the expected adequacy challenge, the size of the challenge (LOLE and EENS) and how structural the adequacy problem is expected to be.
- Across Europe, challenges have been arising mainly due to the closure/phase-out or economic unviability of significant capacity of dispatchable thermal generation while capacity from new assets and technologies is insufficiently added, leaving a capacity gap in meeting the demand.
- Across Europe, missing money for assets is the main reason for introducing a central CRM when there is a structural adequacy problem, supplemented by other reasons based on national aspects. Uncertainty and external effect on security of supply are the main reason for introducing a Strategic Reserve, when the adequacy challenge is expected to be more temporary.
- Most neighbouring countries of the Netherlands have implemented or are considering implementing a CRM, with a trend towards central CRMs (CM). Academic) Research and discussions are ongoing on the topic of ‘regional’ (multinational) capacity markets, which are considered to prevent costly cross-border coordination inefficiencies which could occur with national CRMs.[2]

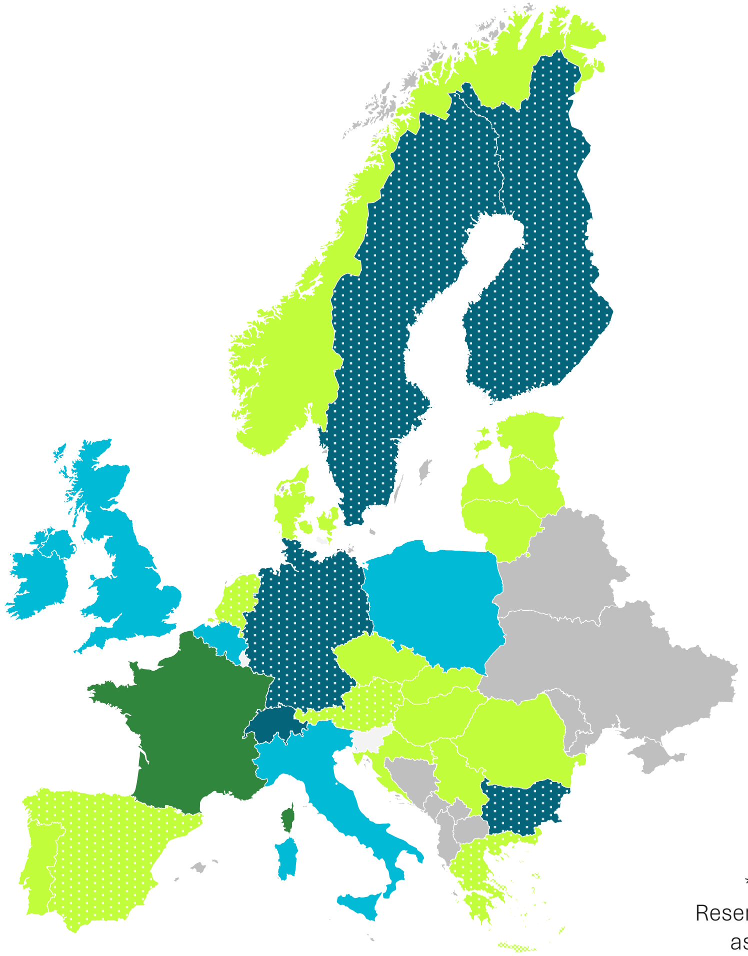


Figure III: CRMs across Europe[1]

“Energy-Only Market” (EOM)

EOM plus capacity reserve*

Capacity market with central buyer

Capacity market with decentral capacity obligations, *but already decision to move to central CRM (CM)*

Dots refer to capacity market discussions

* Bulgaria’s “cold reserve” is in practice a Strategic Reserve, but it has not been notified to the Commission as an official capacity mechanism and therefore not listed by ACER (2024).

[1] Guidehouse/Frontier Economics based on ACER (2024) and additional information. [2] Menegatti & Meeus, Three steps to a regional capacity market in the EU (2025)

A CRM could address the missing money problem in the Netherlands if its design fits the specific needs of the system

Considerations for CRM options for the Netherlands

- **Timing of the adequacy gap:** The Netherlands expects challenges after 2030. Under the base scenario in the MLZ 2025, the LOLE threshold is exceeded from 2033.[1] A **timely decision and implementation** of a CRM is required to solve the adequacy challenge in this period.
- **Persistence and size of the adequacy gap:** The expectations of the adequacy challenge in NL will be important to determine whether a **temporary or more structural solution** is required. Uncertainty around the development of the adequacy gap in the medium and longer term (size and persistence) due to uncertain technology uptake and demand developments requires certain **flexibility in its design.** But regardless of the persistence, an adequacy challenge is expected to arise in the **shorter term (after 2030) which requires a solution**.
- **Trends in existing generation / demand portfolio and projections:** Significant thermal generation capacity is expected to be mothballed in the coming years but has not yet reached end of technical life. This **thermal capacity could be leveraged within a capacity mechanism** by improving the economic viability of this capacity.
- **New technology expectations:** Uncertainty around the **and uptake of flexible technologies** creates uncertainty about the implications and uptake of flexibility and storage technologies by 2035 to support system adequacy.
- **New capacity build out** is likely required in the longer term as existing thermal generation phases out or peak electricity demand increase. As there is currently not enough incentive in the EOM to support new investments, a capacity mechanism could solve the missing money problem and maturity mismatch for new capacity build out. Capacity operated under a CRM should **not hinder the 2040 Dutch energy system decarbonisation goal**, e.g. by including decarbonisation requirements.
- **Level playing field neighbouring countries:** All neighbouring countries of the Netherlands have **already or are discussing the implementation of a CRM**. This increases the relevance of establishing a level playing field for investments across these countries. Differences in grid tariffs, taxation, emission requirements and capacity markets could create uneven investments signals.

A CRM suitable for the Netherlands

Introduction of a CRM in the Dutch electricity market is a possible solution to solve the future adequacy gap, projected to emerge by 2033:[1]

- The Dutch electricity market is currently in a comfortable situation, with ample dispatchable generation capacity. However, this is projected to change in near future: **dispatchable thermal capacity will reduce** due to the phase out of coal and retirements of gas fired capacity facing the missing money problem, and due to new (thermal and other technologies) capacity build outs hindered by maturity mismatches.
- At the same time, **demand is projected** to grow by electrification in mobility and industry.

There are a number of uncertainties around these projections, which all affect the timing, persistence and size of the projected adequacy gap:

- Electricity demand growth depends on the **pace of electrification and industrial activity in the Netherlands.** Industrial activity is currently under pressure in the Netherlands due to high energy costs, decarbonisation requirements and grid congestion.
- The **future available dispatchable capacity** is uncertain. Technology developments and economics of batteries and LDES can affect their build-out, while the pace and scale of gas-fired capacity retirements, retrofits and new builds is also uncertain.

[1] TenneT, Monitor Leveringszekerheid 2025

We identified a longlist of possible CRMs including established CRMs as well as more specific and creative mechanisms to support adequacy

Initial longlist of possible CRMs and related mechanisms

- We identified a longlist of possible mechanisms that could help to address the adequacy challenge in the Netherlands. We developed this longlist based on a literature review, established mechanisms and ongoing CRM developments and discussions across Europe (e.g. in Germany, Belgium, the UK), in discussion with KGG and the Steering Committee, as well as in-house expertise.
- The following **CRM mechanisms** are included: Strategic Reserve (SR), Capacity Auction (CA), central CRM (CM), hybrid CRM and decentral CRM.
- Additionally, we considered **more specific and creative mechanisms** targeted at supporting the development of capacity or certain technologies, which although not capacity mechanisms in terms of the EU electricity regulation 2019/943 can be deployed to serve the same goal of supporting capacity availability. These are: Hedging Obligations (HO), Non-Fossil Flexibility Subsidisation Schemes (NFFSS) and Advanced payments for new builds.
- The mechanisms in this **longlist** have different scopes and organisational characters and have in part been applied in different geographies.

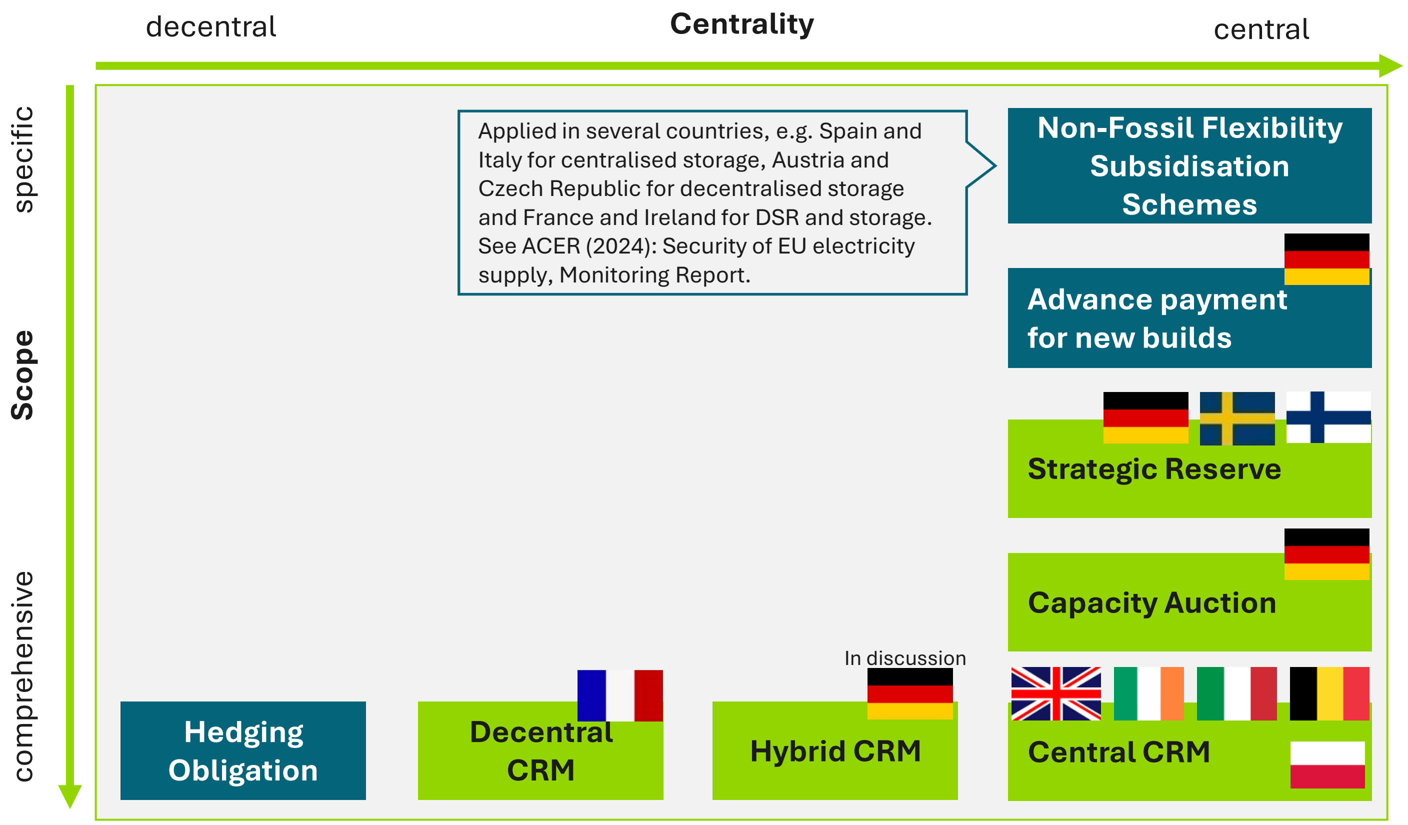


Figure IV: Long list of possible CRMs and related mechanisms considered for this study, based on mechanisms in European countries and ongoing discussions, literature and in-house expertise. The mechanisms are categorised along their level of centrality and scope.

A central mechanism, a Strategic Reserve and a Hedging Obligation are short-listed for further in-depth analysis

Shortlisting based on initial high-level assessment

To shortlist CRM options, we defined criteria that are key for assessing whether the aim (resource adequacy) can be reached at minimal cost. The criteria focus on aspects that matter for the Dutch adequacy challenge context;

- their ability to **reliably and accurately achieve** a selected security of supply standard.
- their **effectiveness** in creating a sufficient degree of planning security for investment and solving the maturity mismatches to support investment.
- their **efficiency** in ensuring security of supply at the lowest possible costs in the short term (static efficiency) and longer term (dynamic efficiency) and their interactions with the energy-only market.
- their **complexity** in terms of implementation and monitoring.

We performed an initial high-level assessment based on these criteria to check the fundamental suitability of the CRMs. In addition, we included a reasonable spectrum of approaches in the shortlist to address the resource adequacy challenge.

✓ Shortlisted mechanisms

Central CRM	▪ A CM can ensure that the reliability standard is met and provides investment signals for new capacity. ▪ It can address flexibility needs in the Netherlands through measures such as aggregation, simplified criteria, separate auctions, and adjusted de-rating factors. ▪ It is a proven and effective model that can be adapted to the Dutch context, and legal preparations are already ongoing.

Strategic Reserve	▪ A SR can safeguard resource adequacy in the Netherlands, likely at least in the early 2030s.
	  ▪ The amount of contracted capacity can be adjusted over time, making it suitable for the gradual shortfall expected in the coming years.
	  ▪ Given the capacity of the existing gas plants which are expected to retire, contracting 1–2 GW would cover the anticipated derived gap and ensure supply through the early 2030s.
	▪ It is effective as a temporary safeguard with relatively low refinancing needs, but it does not provide a permanent investment signal.

Hedging Obligation	▪ A HO can be seen as a reinforcement of the EOM and provides a more market-oriented solution than other CRM types. ▪ Its accuracy may be only moderate, as the mechanism and its calibration are untested. ▪ A HO does not effectively incentivise new long-term investments, but it helps retain existing assets in the market, which is particularly relevant until the early 2030s. ▪ It combines high efficiency and innovation-friendliness. ▪ However, it is not tested yet in Europe, that means its practicality is unclear.

✗ Mechanisms not included in the shortlist

Decentral CRM	▪ Its high complexity makes it unsuitable as a potential short-term solution compared to e.g. a SR. ▪ Experience from France shows that the expected flexibility benefits did not fully materialise. ▪ A decentral CRM focuses on short-term contracts, which are unlikely to provide a strong, long-term investment incentive for new capacity build-out.
Hybrid CRM	▪ A hybrid CRM with central and decentral elements reduces accuracy due to interdependencies and forecasting uncertainty. ▪ While it secures long-term investments, a central CRM achieves the same result without additional complexity. ▪ The benefit of long-term innovation-friendliness is questionable. ▪ The concept is not tested yet.
Capacity Auction	▪ Separate auctions are not shortlisted, as their effectiveness is low in the long run (crowding-out effects occur) and they do not provide a level playing field.
Adv. Pay	▪ Advanced Payments are not shortlisted, as their effectiveness regarding system adequacy is low and they do not provide a level playing field.
NFFSS	▪ NFFSS are not shortlisted, as their effectiveness regarding system adequacy is low in the long run (crowding-out effects occur) and they do not provide a level playing field.

The short-listed mechanisms have a different approach for determining and managing demand, supply and defined products

Description of short-listed CRMs

The descriptions below and Table B provide an overview of the short-listed CRM options. More information and high-level detailed design options is provided in section 3.2.

Central CRM

A central authority determines the total capacity needed for the system, and both new and existing resources can participate after prequalification. Providers receive capacity payments for maintaining availability, while compliance is centrally enforced with penalties for non-performance. In practice, the mechanism is usually funded through a regulated levy on suppliers, passed to consumers.

Strategic Reserve

A centrally determined reserve is held outside the energy market and activated only during emergencies. Providers need to fulfil prequalification criteria and are selected through tenders, paid for guaranteed availability, and monitored for compliance, with costs funded via a levy on consumers or via network charges.

Hedging Obligation

Suppliers are required to hedge against peak electricity prices using market-traded products like futures and options. All technologies can participate, while compliance is monitored by authorities and includes penalties for non-fulfilment. The costs of Hedging Obligations are included in the energy price paid by end customers.

***Table B:** Short-listed CRM characteristics*

	Design variable	Central CRM (CM)	Strategic Reserve (SR)	Hedging Obligation (HO)
Capacity Demand	Amount decided by whom?	**Central** authority	**Central** authority	Electricity **suppliers**
	Demand covered	**Market wide** – based on expected peak load plus a safety margin, covering the full system need during scarcity events	**Targeted** – relatively small amount of electricity generation capacity; demand determined based on security of supply assessments	**Market wide** – based on aggregation of individual obligations
Supply	New vs. existing assets	**New & existing** assets	**New & existing** assets	**New & existing** assets
	Technologies	**Generally open**, but prequalification criteria apply	Usually **technology specific**	**Generally open**, slightly dependent on design of "spike products"
Product	Obligation	**Availability** obligation, with **option** to integrate a **reliability** obligation	**Availability** obligation	**Reliability** obligation
	Payment	**Capacity payment** (in €/MW/year)	**Capacity payment** (in €/MW/year) & sometimes payments for (additional) activation	**Energy based** (EUR/MWh)
	EOM participation	**Allowed**	**Excluded**	**Allowed**
	Examples	**E.g. in Belgium, UK**	**E.g. in Germany, Finland**	**Previously topic of discussion in Germany**

Selection of sources: Frontier Economics / Consentec (2014):Folgenabschätzung Kapazitätsmechanismen (Impact Assessment); Connect Energy Economics (2025): Die Ausgestaltung der Absicherungspflicht (Hedging); Frontier Economics (2024): Kombinierter Kapazitätsmarkt – Eine Analyse der Vor- und Nachteile, short study for EnBW AG and RWE AG; Consentec et al. (2024): Überblick zur Ausgestaltung eines kombinierten Kapazitätsmarkts, short study for BMWK; country specific expertise.

Based on further assessment, a Strategic Reserve and a central CRM could best fit the Dutch context, depending on the relative weight of assessment criteria

In-depth assessment of shortlisted CRMs

We assessed the short-listed CRM options (CM, SR and HO) in further detail on their performance to address the adequacy challenge in the Netherlands. For this, a list of assessment criteria (which includes the four criteria used in short-listing) and an assessment framework (Annex VI) is created and applied. The assessment criteria are in figure V below.

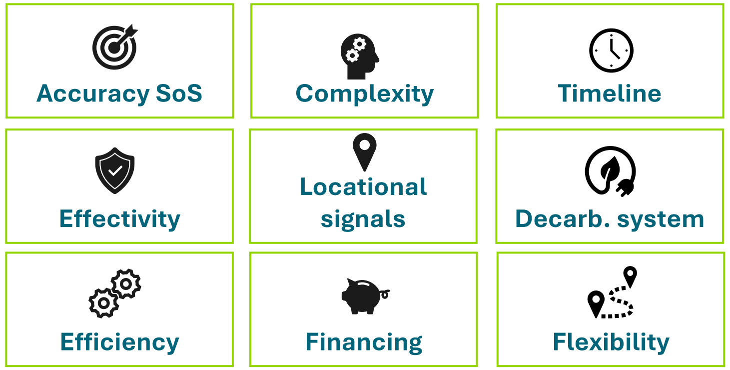


Figure V: Criteria for assessment of shortlisted CRMs.
A complete description is provided in Section 4.1.

Relevancy of the CRM assessment criteria in the Dutch context

The relative importance of these criteria in the Dutch context drives the decision on the suitability of a shortlisted CRM for the Netherlands. When looking at the situation in the Netherlands, certain criteria are decisive in the suitability of a CRM as they include differentiating factors. Other criteria involve design choices or a political decision on their relative importance. The latter are at this stage not decisive factors in the suitability of a CRM. The following slides detail the relevance and decisiveness of the different criteria for the Netherlands.

Summary of the relative assessment of the shortlisted CRMs

- Most suitable CRM options for the Netherlands, for implementation in the near future are a **Strategic Reserve or a Central CRM**. Both are proven options, fit within existing legal frameworks (CISAF fast-track and (in the short term) the Dutch energy law), and can be designed and implemented with limited lead times.
- Considered but **deemed unsuitable are Hedging Obligations** as this is an unproven mechanism for which limited practical experience exist, it does not directly consider physical assets, and its implementation would require a longer lead time (required for creating a well-designed option and to adjust legal frameworks).

Central CRM	• **Most effective and accurate** option of the three shortlisted CRMs for ensuring long-term resource adequacy and investment certainty in the NL, especially if the capacity gap would be expected to increase after 2030-2035. • However, its effectiveness and efficiency **depend on careful calibration** of auction design, contract durations, and eligibility criteria – balancing investment certainty with system flexibility. • **Dependencies** include the timely rollout of supporting legislation, the ability to coordinate with existing subsidies and decarbonisation policies, and the need for alignment with grid and market developments.
Strategic Reserve	• **Valuable as a short-term, low-complexity** bridge or safety net. • But **not a permanent solution** if the adequacy problem would persist or exacerbate beyond the 2035 timeframe.
Hedging Obliga-tion	• **Theoretically efficient, but practically untested** and uncertain in addressing long-term investment needs. • **Omitted as realistic CRM option,** given the lack of experience and resulting uncertainty on accuracy and effectiveness as well as long and uncertain implementation process.

Weighing of criteria in the Dutch context (1/2)

In the decision on the suitability of a shortlisted CRM in the Dutch context, effectivity and efficiency are decisive criteria. Complexity and locational signals depend on design choices.

Criteria	System needs in the Netherlands	Weighing of criteria in the decision on suitability of a CRM in NL
Accuracy SoS	The MLZ 2025 shows an adequacy challenge in NL from the early 2030s. To address this post-2030 gap reliably, a mechanism with central volume control and enforceable availability is needed. Depending on the gap's timing and size, a CM or SR would be best suited. Uncertainty around new technologies and demand growth means the gap could be larger or happen sooner. An effective CRM must accurately tackle this challenge.	Choosing a CM or SR ensures the necessary accuracy to meet adequacy levels, making this criterion inherent but not decisive. In contrast, a HO lacks reliability to meet the SoS standard and is therefore unsuitable for the Netherlands. This criterion is **not decisive** in suitability of a CRM in NL.
Effectivity	The Netherlands faces a likely adequacy challenge in the next 5 to 10 years as thermal generation capacity is phased out but still usable. This capacity could help to address short-term issues, while new or upgraded assets may be needed in the medium to long term to ensure system reliability.	Effectiveness is a **decisive** factor in the suitability of a CRM, as it shows how well the mechanism meets the system needs. In the Netherlands, only a CM can address long-term funding gaps after the mid-2030s, while an SR helps stabilise the short term. A HO cannot ensure sufficient capacity revenues.
Efficiency	Supporting the CRM decision in NL requires contracting resource adequacy at minimal cost by ensuring market liquidity, technology-openness, and efficient design to avoid over-procurement and balance effects of reliability options.	Efficiency varies among shortlisted CRMs, making it a **decisive** factor for their suitability in the Dutch context. A CM can operate as a broad, rather technology-neutral auction promoting innovation relative to a SR targeting specific participants temporarily and lacking long-term investment signals. A HO can likely support innovation with a technology-neutral design, but its long-term efficiency relies on uncertain market liquidity.
Com-plexity	CRM complexity is justified if lasting adequacy governance is needed. In the Dutch context, key factors include whether to follow fast-track Clean Industrial Deal State-Aid Framework (CISAF) guidelines or add custom design elements like locational signals or decarbonisation, which increase complexity.	All three mechanisms require some administrative effort and coordination, but compared to a CM or a HO, a SR is considered as the least complex mechanism. Since the importance of this criterion depends on **political decisions**, it is **not a decisive** factor for CRM suitability in the Dutch context, though design choices can affect the complexity and timeline.
Locational signals	Grid congestion is a key challenge in the Netherlands. Using locational signals in a CRM could direct capacity to specific areas, e.g. near industrial clusters, to ease congestion. However, this may reduce market liquidity and cost efficiency. Other mechanisms exist that mainly focus on congestion relief, while a CRM primarily ensures overall resource adequacy.	Locational signals in a CRM **rely on design choices**, with CMs better suited for Dutch grid constraints than SR or HO. Locational signals can be included through other mechanisms, too. Adding these signals to a CRM is **a political decision** that increases complexity and may delay implementation, so this factor is **not decisive** for CRM suitability in the Netherlands.

Weighing of criteria in the Dutch context (2/2)

In the decision on the suitability of a shortlisted CRM in the Dutch context, timeline and flexibility of the CRM are decisive factors. Financing/costs and decarbonisation depend on design choices.

Criteria	System needs in the Netherlands	Weighing of criteria in the decision on suitability of a CRM in NL
Financing	Key financing and explicit cost factors for a CRM in the NL include: • The Value of Lost Load (VoLL) influences the cost-benefit analysis of implementing a CRM, balancing societal risks against CRM costs. • Cost allocation decisions matter; following CISAF means charging consumers during the most expensive 1-5% hours, while not following it allows for alternative approaches.	Each mechanism involves different fiscal and political trade-offs. CRMs can have high explicit costs involved, and their cost must be balanced against the effects of supply shortages and impacts on price peaks and price formation. A cost benefit assessment requires a modelling approach, and the importance of this factor is ultimately a **political choice** and hence not decisive at this stage.
Timeline	A timely decision, design and implementation of a CRM is required if a CRM is intended as solution for the expected adequacy challenge after 2030. A ministerial decision on resource adequacy measures is expected in 2026, leaving maximum five years for preparation of a T-1 auction at end of 2031. Timing depends on auction lead times, design choices and the State aid approval process. The uncertainty in NL on whether the adequacy challenge could already manifest before 2033, could warrant an as soon as possible implementation of the selected CRM in NL to ensure the contracted adequacy is delivered at a possible earlier time.	Since CRM design and implementation timelines vary, this is a **decisive** factor in the Dutch context. A CM can likely be set up in time before an adequacy gap emerges (lead time ~ 2-4 years from ministerial decision to auction, depending on e.g. State aid approval), while a SR is the fastest option and could buy some time (lead time ~ 1-2 years from ministerial decision to auction). The timeline of a HO is uncertain due to missing precedents and the need to design this from scratch but might benefit of not requiring State aid approval.
Decarb. system	The Netherlands aims to fully decarbonise its energy system by 2040. Thermal capacity participating in a CRM should not obstruct the 2040 decarbonisation goal. The CISAF process also imposes decarbonisation requirements.	Since decarbonisation needs vary by design choices, this criterion is **not decisive** for selecting CRM in NL. Effective support requires balancing carbon goals, subsidies, and market signals, with its importance being a political choice. The relative weight of this criterion depends on a **political decision.**
Flexibility	Uncertainty around the development of the adequacy gap in the Netherlands in the short-, medium and longer term (timing, size and persistence) would require certain **flexibility to adapt the mechanism** or to phase it out when no longer required.	Flexibility varies among the shortlisted CRMs, making it a **decisive** factor for their fit in the Dutch context. SR and HO are more adaptable and easier to phase out, while a CM requires careful planning to prevent long-term inflexibility and political challenges.

Three possible pathways for the implementation of a SR or CM in the scope of action of KGG, based on the relative weighing of the assessment criteria

Three pathways for the implementation of a SR or CM in the scope of action

Given the Dutch context and the criteria assessment, Hedging Obligations are not considered as realistic option. This is due to the lack of experience and resulting accuracy and efficiency uncertainty, as well as long and uncertain implementation process. For SR and CMs, we identified three main pathways implementation that could be taken:

- **Pathway A: Temporary Strategic Reserve**. As-soon-as-possible implementation of a SR, with a clear timeline for phasing out the instrument again based on expectations that the adequacy gap will be temporary and timely solved by the market.
- **Pathway B: Central capacity mechanism**. As-soon-as-possible implementation of a CM, as a structural short- and longer-term solution in case the expectation is that the adequacy gap will persist.
- **Pathway C: Temporary Strategic Reserve, potentially followed by a central capacity mechanism**. The SR is used to 'buy time' to assess if a CM is necessary as structural solution and, if so, to provide more time for tailored CM design, approvals, implementation and auction.

When assessing the options for CRM implementation, **the current situation without a CRM in place** can be considered as a **baseline** to consider the CRM effects against.

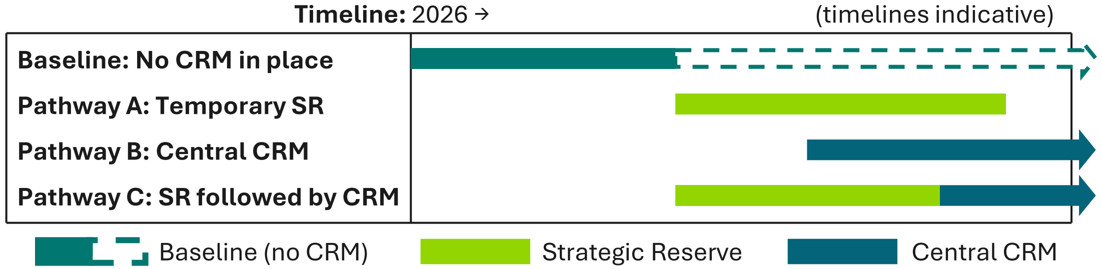


Figure VI: Illustrative baseline and pathway overview.

Priorities provide a direction for selecting between pathways

Which pathway to pursue depends on which assessment criteria are considered a priority in the Dutch context. Note that the relative importance of the criteria in the Dutch context is ultimately a political decision. Each pathway provides different opportunities, strengths and weaknesses. We see the following differentiating criteria between possible pathways:

- **Effectivity:** How does the CRM meet the system adequacy needs?
- **Efficiency**: Is the adequacy solved in the most cost-efficient way (static efficiency), are innovations and deployment of new technologies possible (dynamic efficiency)?
- **Timeline**: Is a quick implementation of a CRM required?
- **Flexibility**: How is optionality valued? Is there willingness for a longer-term commitment?

The following slide provides more detail on the situations where each pathway would be most appropriate, their strengths and weaknesses, and high-level design considerations.

Baseline to assess the societal impact of CRMs against

The current situation without CRM in place can be used as baseline to consider the effects of CRM implementation. First, current electricity market projections to assess the timing, size and persistence of the adequacy gap start from this baseline. Second, the societal impacts of a CRM can be assessed against the situation without CRM in place:

- The positive effects of a CRM are a reduction of the LOLE and EENS (and valuing these via the VoLL) and secondary effects on price peak and volatility impact. These can be quantified via modelling.
- The negative effects of a CRM can be quantified by the CRM costs (which are not present in a baseline without CRM in place).
- Indirect effects, such as long-term impact on business climate of the Netherlands (and associated socioeconomic impacts, e.g. jobs, economic growth), are harder to quantify but can be compared against the baseline.

Each pathway can provide a response to the adequacy challenge in the Netherlands, based on certain priority criteria but with different details and design considerations

Pathway	Appropriate when priority for	Strengths and weaknesses	Design considerations
Pathway **A: Temporary Strategic Reserve** (as soon as possible)	**Timeline** **Flexibility** ▪ A SR can be **designed and implemented relatively fast** (CISAF State aid fast-track). ▪ Provides **flexibility** to be phased-out in anticipation of a **temporary adequacy gap**.	▪ A temporary SR can make **benefit of the unique Dutch situation**, as the otherwise phased-out gas-fired capacity can be placed in Strategic Reserve (**effectivity**). ▪ The **limited pool of assets** that will practically participate in a SR reduces market **efficiency**. ▪ It does **not harmonize markets and provide a level playing field** for new investments (**dynamic efficiency**).	▪ A **CISAF fast-track design** reduces complexity and implementation time, but **has implications** in reduced flexibility for cost allocation, auction delivery times and durations, and decarbonisation requirements. ▪ In absence of a structural investment incentive for build out of new generation capacity, there is a **dependence on market developments or other instruments to solve any longer-term** .
Pathway **B: Central capacity mechanism** (as soon as possible)	**Effectivity** **Efficiency** ▪ A CM is a **proven mechanism** to serve as an 'insurance policy'. ▪ It provides a **structural solution** to the adequacy challenge, including new technologies and incentivizing new capacity build-outs.	▪ Shortened approval and implementation **timeline** if **designed in line with CISAF fast-track guidelines.**[1] ▪ A CM can have **high mechanism costs** compared to a SR. ▪ Creates a **clear pathway** and provides investment certainty to the market (**effectivity**). ▪ Once announced, it is **difficult to change course** due to market expectations and dependence (**flexibility**).	▪ A **CISAF fast-track design** reduces complexity and implementation time, but **has implications** in reduced flexibility for cost allocation. Requirements for auction duration mix and technology neutrality increases efficiency and decarbonisation. ▪ **Design harmonisation with CMs in place in surrounding markets** creates a regional level playing field for new capacity investments.
Pathway **C: Temporary Strategic Reserve, followed by a central capacity mechanism**	**Timeline** **Flexibility** ▪ The SR can be **implemented fast** and **'buy time'** to decide on the need and design of a structural CM ▪ The time bought enables more design **flexibility** for the CM outside the CISAF fast-track.	▪ In the short-term, a SR can have **reduced costs**, while a subsequent CM can reap the benefits of the progress in technology development (long term, dynamic **efficiency and effectivity**). ▪ Gaming effects could occur during the temporary SR. The market could enter a **standstill for new builds in anticipation** of the CM and the incentives it provides.	▪ Ensure a **smooth transition** between the mechanisms, aligning SR contract durations with the CRM change. A no-return rule for the SR needs to be examined, including whether capacities would still be banned under the CM. ▪ CM **design (partially) outside the CISAF fast-track** provides freedom on e.g. cost allocation (**financing**), auction mix (**accuracy SoS**), and **locational** criteria, for a more effective and efficient design in the Dutch context.

[1] In order to have the CM operational as soon as possible, a 'ramp up phase' for the mechanism could be considered. This could be implemented by holding the first T-1 and T-4 auctions at the same moment and subsequently starting the mechanism for the initial three years with deliveries from T-1 auctions only.

Scope for action summary and recommended next steps

The Netherlands is facing an adequacy challenge in the early 2030s

- The Netherlands expects challenges after 2030. In the base scenario of the MLZ 2025, the LOLE threshold is exceeded from 2033. A **timely decision and implementation** of a CRM is therefore required to solve the adequacy problem in this period.
- Projections on the precise timing, persistence and size of the adequacy challenge have inherent uncertainties. The main uncertainties are related to **trends in existing generation** (timeline of capacity retirements) **and demand** (pace of electrification) portfolios, and to **new technology expectations** (pace of LDES and batteries deployment).
- The most **suitable CRM options for the Netherlands are a central CRM** (most effective and accurate option) and **a Strategic Reserve** (valuable as short-term, low-complexity option). **Hedging Obligations are omitted**, given a lack of experience and uncertainty on accuracy and effectiveness.

Weighing of criteria in the Dutch context determines which pathway to take

Three pathways for CRM implementation are identified in scope of action for KGG.

- Pathway **A: Temporary Strategic Reserve –** As soon-as-possible implementation, with clear timeline for phase-out. Appropriate for timeline and flexibility priority.
- Pathway **B: Central capacity mechanism –** As soon-as-possible implementation as a structural solution for a persisting adequacy challenge. Appropriate for effectivity and efficiency priority.
- Pathway **C: Temporary Strategic Reserve, followed by a central capacity mechanism –** Use of a Strategic Reserve to 'buy time', which can be used for assessment on the need and design of a structural central CRM. Appropriate for flexibility and timeline priority.

Selection of the most suitable pathway depends which criteria is prioritized: **effectivity** (whether adequacy is met), **efficiency** (cost-efficiency of provided adequacy), **timeline** (speed of implementation) and **flexibility** (valuing of optionality).

Step to support a decision on CRM implementation

As next step to support a Ministerial decision on whether, and if so which, a CRM should be implemented as part of resource adequacy measures:

- Formalise a **view on the size, timing and persistence of the adequacy gap**. The view needs to be based on the best available data and insights, while acknowledging the inherent uncertainties in making projections.

No regret next steps to support CRM implementation

Practical no-regret next steps in the CRM design, State Aid and implementation process are:

- **Formalise the desired reliability standard**, as it is at the basis of the capacity need.
- Improve the robustness of CRM cost and benefit assessments. This includes **understanding differences in VoLL** with surrounding countries, quantitative modelling of **CRM design options** impacts on societal benefits such as EENS reduction, price peaks and price formation, by continuing ongoing research and developments.
- Start and **accelerate the State Aid approval** process where possible, e.g. by a parallel process. In case of a CM, receiving approval requires proving that a SR is not suitable.

Final considerations

- A **modelling approach** for comparing CRM options was **not in scope** of this research. For quantification of the impact on LOLE and EENS, and the impact of price peaks and price formation a modelling approach is required.
- **Uncertainties are inherent** and cannot be fully avoided with decision making based on projections of the future adequacy gap. At the same time, **improved understanding** of the up- and downside uncertainties of the adequacy gap assessment, the VoLL and indicative CRM costs and benefits **improves the robustness** of societal impact of CRM introduction.

Recommendations and next steps help manage uncertainties to enable a ministerial decision and provide an outlook for a CRM implementation phase

Recommendations and next steps to manage uncertainty enable an informed decision on resource adequacy measures

A ministerial decision is expected in the first half of 2026 on measures for resource adequacy improvement. This decision needs to be made based on the best available data, while acknowledging the uncertainties that are inherent with a decision on measures that will be effective only years in the future. To support this decision, a **no-regret action** is:

Formalise a view on the timeline, persistence and size of the adequacy gap

Next steps for the CRM implementation phase

After a ministerial decision on measures for resource adequacy improvement is made, there are practical next steps in case a CRM is decided on in the design, State Aid approval process and implementation plan. The exact process depends upon the decision of CRM type and timeline towards implementation; however **no-regret actions are pre-identified as the need to be considered in all cases**:

Decide on the use of a CRM to achieve other goals beyond adequacy alone

If a CM is preferred, prove a SR is not suitable to solve the adequacy gap

Work out detailed implementation pathway and timeline

Understand the VoLL differences with other countries by continuing ongoing research and developments

Formalise the desired reliability standard (RS)

Quantitatively assess the societal costs and benefits of CRM design options

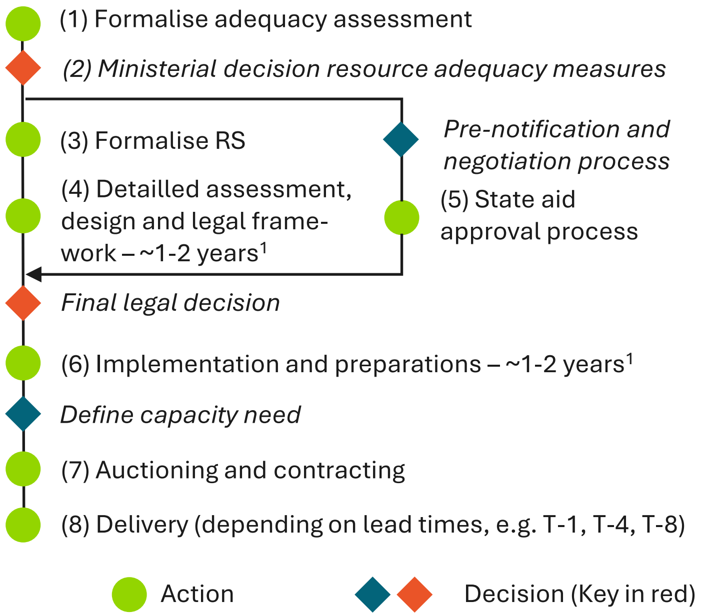


Figure VII: Overall process towards possible implementation of a CRM.

[1] Timeline estimations based on OTE, Leveringszekerheid Elektriciteitsvoorziening, 2020, Elia – Product sheet capacity remuneration mechanism (2025), the CRM implementation timeline in Belgium which included 2 years for state-aid approval (July 2019 – August 2021), which could be reduced in CISAF fast-track.

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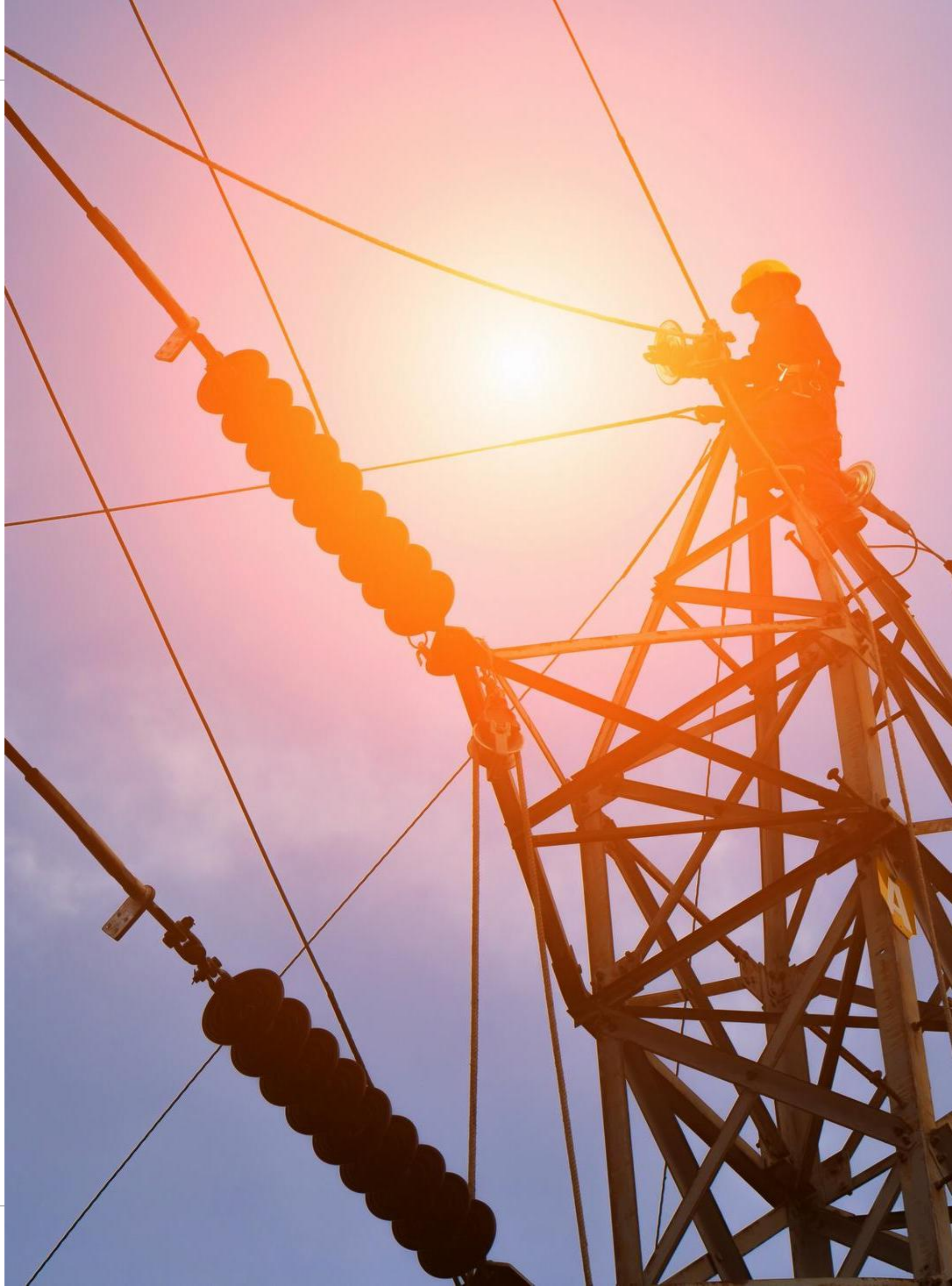

Capacity Remuneration Mechanisms for the Netherlands

This study formulates recommendations on the suitability of a capacity remuneration mechanism in the Netherlands through a shortlisting process and assessment of selected CRMs

Background

- Ensuring a reliable electricity supply is essential for the functioning of Dutch society and the economy.
- While no adequacy risks are expected between 2028–2030, the 2025 Dutch Security of Supply Monitor (MLZ) signals a potential shortfall after 2030 due to increasing demand coupled with a reduction in dispatchable power generation, with the loss of load expectation exceeding the national threshold of 4 hours/year. More capacity and demand flexibility should be available to ensure adequacy of the Dutch power system.
- In response, the Dutch government[2] is proactively exploring the feasibility of introducing a Capacity Remuneration Mechanism (CRM) as a fallback solution to safeguard future supply adequacy. In the first half of 2026, concrete measures will be announced to ensure adequacy beyond 2030.
- CRMs could be a mechanism to support adequacy. Although CRMs can mitigate adequacy risks, they are complex, potentially costly, and may distort energy markets. Therefore, careful design and evaluation are crucial.
- This study on CRMs in the Netherlands will be important input for the decision-making process in the Netherlands.

Goal of this study

Goal of this study is to assess CRM options and their suitability in the Netherlands to provide a solution to the adequacy challenge. This study delivers a comprehensive advisory report on different possible CRMs and their design variants, their effectiveness, advantages and disadvantages in the Dutch context.

As part of this study, we had four sessions with a **Steering Committee** consisting of representatives of KGG, TenneT and ACM to advice on the course of study. In addition, we had a **broader stakeholder session** with input from Energie Nederland, VEMW and academic experts. We value the input received during these sessions throughout the process in supporting and strengthening the work done in this report.

At this stage in the CRM discussion in the Netherlands, it is important to understand the pros and cons, design options and suitability of selected CRM types for the Netherlands. Detailed modelling and quantification is out of scope of this study and could provide more insights at a later stage in the CRM design and implementation process. High-level quantification is included where relevant.

Approach

We followed four steps to come to recommendations on possible implementation pathways for CRMs in the Netherlands.

1. Define **longlist of possible CRMs** based on literature review, prior experiences, and the current European context of CRMs.
2. **Shortlisting** of most suitable CRMs based on initial assessment.
3. **Detailed assessment** of design options and performance of the shortlisted CRMs related to the **Dutch context** based on a defined set of assessment criteria.
4. Formulating **recommendations** and suggestions for next steps.

Figure 1: Overview of report approach

Reading guide: Chapter 1 provides the set up and context of the project. Chapter 2 describes the CRM concept, experiences and context of CRMs across Europe, a description of the current energy system context in the Netherlands and concludes with a longlist of possible CRMs for initial assessment. Chapter 3 includes the shortlisting process and high-level design options of the shortlisted CRMs. A detailed assessment of the shortlisted CRMs is covered in Chapter 4. Chapter 5, finally, concludes this report with recommendations and suggestions for next steps.

[1] Leveringszekerheid elektriciteit onder druk na 2030 [2] Kamerbrief stand van zaken leveringszekerheid elektriciteit | Kamerstuk | Rijksoverheid.nl

Need for a plan on CRMs in NL to be well-prepared for the future

Dutch legislation currently only has a legal basis for Strategic Reserves; preparations are ongoing to broaden this to enable implementation of a central CRM

Due to the upcoming phase out of significant thermal capacity, increasing levels of renewables and projected demand growth, **capacity remuneration mechanisms (CRMs) are a front-of-mind topic in the Dutch energy debate** as a potential to address expected challenges from the mid-2030s as signalled in the 2025 Monitor Leveringszekerheid.

Currently, the **Dutch legislative context only provides a legal basis for introduction of a Strategic Reserve** (Energiewet Art. 5.12). A proposed change of this article is under development, where its formulation is broadened to also provide a legal basis for introduction of a central capacity mechanism.

Apart from the legislative context, several **political discussions** have stated the need and relevance to consider CRMs in the Netherlands:

Letter to parliament of 18 September 2023

- Gives a first response to motion Erkens (20 June 2023) that requests the government to consider the pros and cons of Strategic Reserves and CRMs.
- Describes the long timeline that introduction of a Strategic Reserve or CRM can have i.a. due to requirements of EU Electricity Regulation & State aid Approvals.
- Provides general pros and cons for various types of CRMs

Letter to parliament of 11 March 2024

- Summarises expert insights from conversations on the topic of security of supply for electricity.
- Fulfils motion Erkens (20 June 2023).
- States that at this point in time introducing a CRM is not necessary, while for the medium- to long-term it is relevant to consider instruments that can contribute to security of supply.

Letter to parliament of 10 December 2024

- Based on outcomes of TenneT's MLZ 2024 the letter states that as of 2033 for the first time the targeted level of security of supply is projected to be exceeded.
- Fulfils motion Erkens & Grinwis (adopted 5 March 2024) that requests a proposal to improve security of supply beyond 2030, and to inform the Parliament on this end of 2024.
- Focus of letter is on price effects during scarcity moments, enhancing additional use of flexibility, and preparing for a backup option of a CRM.
- Study on CRMs in the Dutch context will be organised (this study) & Dutch law will be prepared to broaden for the introduction of a central CRM.

Letter to parliament of 15 May 2025

- Based on outcomes of TenneT's MLZ 2025, the letter states it is deemed necessary to further dive into how instruments can be designed that can guarantee security of supply in the long term.
- Announcement to start stakeholder discussion on desired level of resource adequacy.
- Action: Preparation of legislative change (to facilitate introduction of central CRM)
- Action: Organise and perform appreciation of study on Demand Side Response
- Action: Organise and perform appreciation of study on CRMs (this study)

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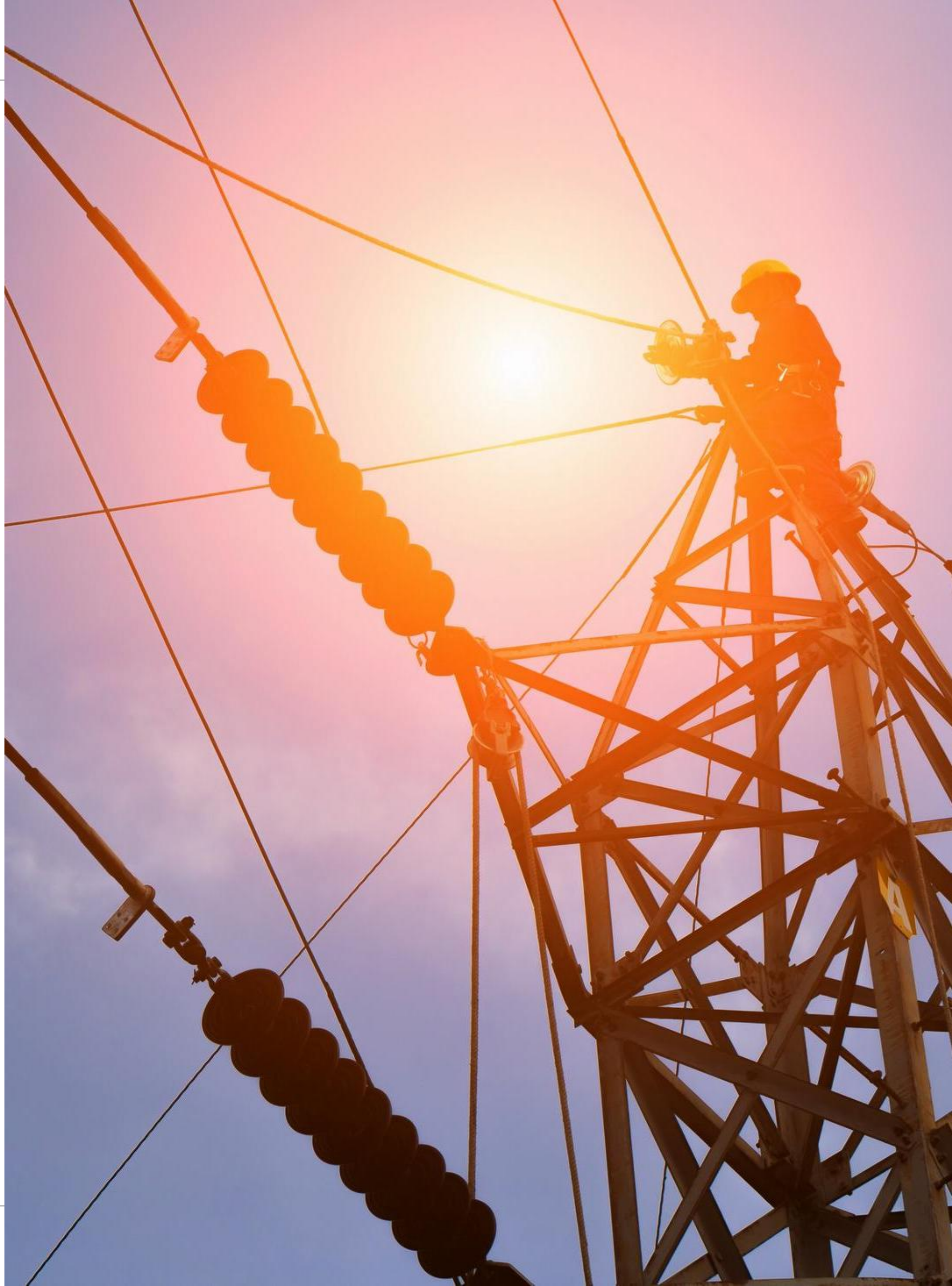


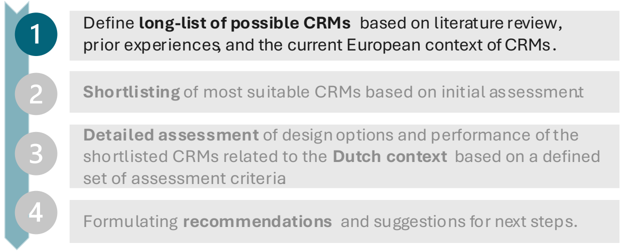
Context & background capacity mechanisms

CRMs are primarily aimed at solving resource adequacy problems. Across Europe multiple CRMs have been implemented or considered. NL is facing challenges from 2033.

Reading guide

This Chapter sets the stage for the selection of possible CRMs to be assessed on their suitability for the Netherlands.

- *Section 2.1* provides the definition of capacity mechanisms used in this study. We also identified theoretical and practical rationales for the introduction of CRMs across Europe.
- *Section 2.2* gives an overview of the longlist of considered CRMs and related mechanisms that are primarily targeted at addressing resource adequacy challenges, including a high-level description and design elements of the different mechanisms.
- *Section 2.3* summarises the European legislative context of CRMs and existing CRMs in countries surrounding the Netherlands. Further details on the criteria for accelerated CRM approval under the EC State aid can be found in *Annex II*.
- *Section 2.4* elaborates on the Monitor Leveringszekerheid and its projections oof generation capacity, demand and flexibility in the Netherlands as well as their implications for CRM options. This section concludes with considerations for suitable CRMs in NL based on EU experiences and the Dutch context.



Related step in the report approach

Summary

- Security of supply covers four aspects; **resource adequacy,** transmission adequacy, demand flexibility and energy security. Resource adequacy implies the ability of the power supply system to provide sufficient generation capacity to meet demand at any given time. Resource challenges are the primary reason for introducing a CRM. CRMs might also partly address further aspects of security of supply.
- Stakeholders use different definitions of a CRM. In this study we take over the **definition of the EU Electricity Regulation** and further define CRMs by means of their scope and degree of centrality.
- Market failures and barriers in the energy-only market, such as the missing money problem, are **economic rationales for the possible introduction of a CRM**.
- Across Europe, **missing money** for new investments is the main reason for introducing a central CRM, supplemented by other reasons based on national aspects. **Uncertainty and external effect** on security of supply are mentioned as the main reason for introducing a Strategic Reserve.
- Based on experiences across Europe, literature and in-house expertise we identified a **longlist of possible CRMs and related mechanisms** to address resource adequacy to be further assessed in this study; Hedging Obligation, Decentral CRM, Hybrid CRM, Central CRM, Capacity Auction, Advance payment for new builds, Strategic Reserve and Non-Fossil Flexibility Subsidisation Schemes (NFFSS).
- The **Netherlands is surrounded by (emerging) capacity mechanisms**, leading to a risk of growing reliance on neighbouring countries in case of adequacy challenges.
- Introducing a capacity market in the Netherlands would require **EC State aid approval**. For the EC to authorise a capacity market, there must be a problem with resource adequacy and additional criteria must be met for an accelerated approval.
- From 2033 onwards, **resource challenges are projected to occur in the Netherlands** (Loss of Load Expectation (LOLE) >4hrs), mainly driven by the phase out of existing thermal generation combined with a projected increase in demand.
- **Uncertain market and reg. developments in the Netherlands** have implications on the CRM assessment.

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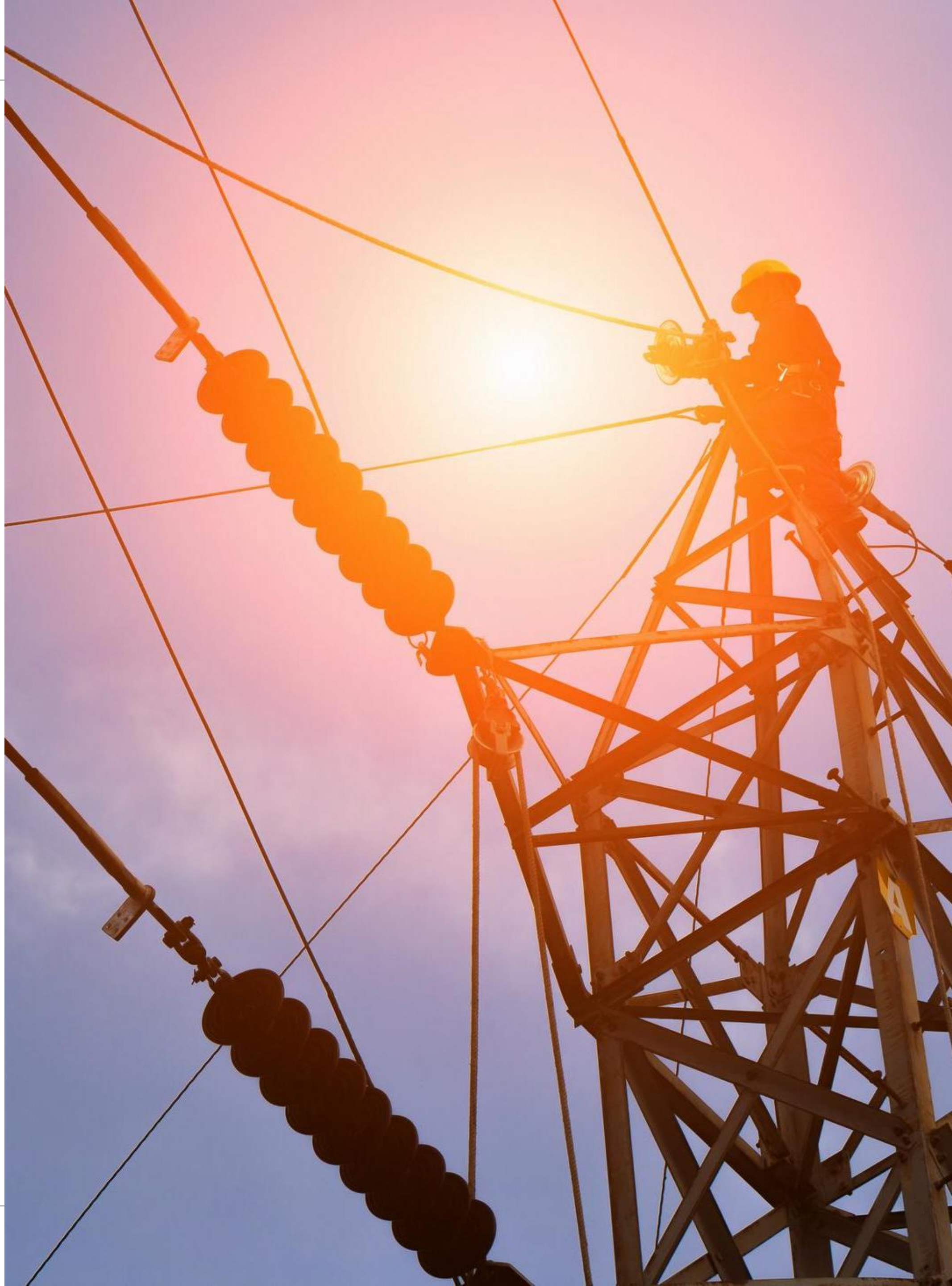

Security of supply covers four aspects

Resource challenges are the primary reason for introducing a CRM. CRMs might also partly address further aspects of security of supply.

Security of supply covers four aspects

01 Resource Adequacy

Ability of the power supply system to provide sufficient generation capacity to meet demand at any given time, i.e. under normal and exceptional conditions. Issues can be temporal or long-term.

02 Transmission Adequacy

Ability of the transmission and distribution network to transport electricity safely and reliably from generation to the centres of consumption.

03 Demand Flexibility

Ability of consumers to adjust their energy consumption in response to price changes or external conditions in order to contribute to the stability and efficiency of the energy system.

04 Energy Security

Ability to maintain an adequate supply of primary energy, including the associated infrastructure.

Primary reason for introducing a CRM

- **Relevant for introducing a CRM**
- **Different designs** reasonable depending on type of concern – temporary or longer-term.

CRM may address partly also further aspects of security of supply

- **Further aspects cannot be the primary objective for implementing a CRM as this is not in line with EU CRM definition.**
- We will consider these aspects as far as they are relevant to the CRMs considered, but we do not perform own analysis of these three parts.
  - could partly be addressed e.g. by locational aspects considered within a CRM. However, it needs to be proven that the CRM is focussing primarily on resource adequacy. Experience shows that such 'regional quotas (core shares)' are subject to high requirements in terms of methodology, traceability and justification in the context of state aid proceedings.[1]
  - Demand flex. can at least partly be supported by a technology-open CRM, but this does not include specific support for market ramp up.

[1] Consentec/Ecologic (2024)

Stakeholders use different definitions for CRMs

Various definitions of CRMs focus on assuring resource adequacy and paying for asset availability

The following definitions of CRMs are provided by stakeholders

EU Electricity Regulation **Art. 2 (22):** “Capacity mechanism means a measure to ensure the achievement of the **necessary level of resource adequacy** by **remunerating resources for their availability**, excluding measures relating to ancillary services or congestion management”

ENTSO-E: “Capacity mechanisms [...] **ensure resource adequacy** by **providing incentives to capacity providers –** namely generation, storage, and demand side response assets. These mechanisms help address the risk of supply shortages, especially during periods of peak demand or system stress.”

ACER: “Capacity mechanisms are support schemes that **remunerate capacity resources** (e.g. generators, demand-response or storage units) **to be available in return of providing security of supply services**.”

ACM **&** Min. KGG: “Capacity mechanism means that suppliers **get paid for the availability** of production capacity, storage or demand response, independent from and most of the time in addition to a compensation for the electricity that is supplied by them.”

This study takes over the definition of the EU Electricity Regulation, and further defines CRMs by means of their scope and degree of centrality

We focus in this study on capacity remuneration mechanisms primarily aimed at ensuring resource adequacy. Other mechanisms exist to support specific capacities or technologies, such as non-fossil flexibility support schemes, which do not fall in the category of CRMs. These mechanisms aim at a different purpose and scope than CRMs.

Theoretical rationales for introducing a capacity market

Market failures and barriers in the energy-only market are economic reasons for the possible introduction of a CRM

The electricity market design in Europe is primarily based on the principle of an „energy-only market“ (EOM).

In an EOM, electricity generation investments are remunerated primarily through energy-dependent charges (in €/MWh). In theory, an EOM results in a secure electricity supply in line with consumer preferences at the lowest possible cost. In practice, however, situations could arise in which the corresponding mechanisms of an EOM cannot take full effect. This could be due to various market imperfections or regulatory intervention in the electricity market.

Table 1: *Market failures/barriers that hinder the EOM from functioning as desired*

Market failure/barrier	Theoretical explanation
Missing money	▪ In a perfect EOM, generators receive sufficient revenue to cover fixed costs and finance capacity investments. Especially for end-of-merit order units, limited full load hours with **high price spikes** should be sufficient to finance new capacity investments. ▪ However: **regulatory interventions** (e.g. price caps) or market oversight (e.g. abuse control) **may prevent** (sufficient hours with such) **price signals**. ▪ Result: Producers are unable to recover fixed costs leading to under investments.
External effects on security of supply	▪ Security of supply is a public good: individual market participants (e.g. consumers or generators) cannot fully secure it on their own. For example, brownouts affect all users, even those willing to pay more. ▪ Consequence: Producers may lose scarcity revenues, lowering investment incentives, as the **benefit of reliability is not fully internalized**.
Political and regulatory uncertainty	▪ The electricity market is capital-intensive with **long investment cycles**, i.e. a **maturity mismatch** between the long amortisation time and revenues (short-term price volatility, no guaranteed future revenue streams) exist. ▪ High uncertainty regarding future political actions or market design changes can lead to high-risk premiums or even withheld investment. Solution would be clear, long-term, and consensus-based political frameworks avoiding ad hoc interventions.
Market power / abuse	▪ In scarcity situations, individual producers may hold significant market power leading to risk of market abuse. ▪ **Regulators may face challenges in distinguishing legitimate scarcity pricing (due to “peak load” or periods of low renewable generation) from abuse**. Hence, authorities may suppress necessary scarcity prices out of caution, leading to weak investment signals.
Attentism	▪ **Several neighbouring countries have introduced capacity mechanisms, which might lead to some form of attentism**. The additional capacity induced by a capacity mechanism abroad can contribute to security of supply via imports, leading to regulators not acting on capacity issues. ▪ Also, discussions about introducing a CRM in the respective country itself (i.e. NL) can lead to investors hesitating to invest in new generation.

Source: Frontier Economics / Consentec (2014): Folgenabschätzung Kapazitätsmechanismen (Impact Assessment).

Rationales for introducing a CRM across Europe (1/2)

In Europe, missing money is the main reason for introducing a central CRM in almost all reviewed countries, supplemented by other reasons based on national aspects

Selection of country examples

Our main focus of the review of countries are EU countries connected to the Dutch electricity market or neighboring to the Netherlands. The UK is added as non-EU country as it was part of the EU during the introduction of their CRM, it has longstanding experience with a central CRM, and it is connected to the Dutch electricity system via interconnectors. Bulgaria is omitted due to distance and characteristics of the country. Switzerland is omitted as a non-EU country.

Table 2: *Other countries which have implemented CRMs, with type, year and rationale for introduction*

Selected country	CRM type	Year	Explanation
UK[1]	Central CRM	2014	CM was implemented at a time of tight supply and significant change (closure of coal fired power plants and older gas plants), **missing money.**
Poland	Central CRM	2018	High dependency on outdated coal fleet, high electricity demand, **missing money.**
Belgium[1]	Central CRM	2024	Planned phase-out of nuclear power leads to a need for new secured capacity, **missing money & uncertainty.**
Ireland	Central CRM	2018	Small isolated electric island with volatile wind energy and high need of reserve capacity, **external effects on security of supply, market power.**
Italy	Central CRM	2022	**Regional disparities in grid infrastructure**, investments in new flexible capacity and avoidance of premature closures, **missing money.**

[1] Detailed country case studies for UK and Belgium are included in Annex V.

Sources: ACER (2024): Security of EU electricity supply, EU State aid decisions SA.48490 (Poland), SA.56101 (Belgium), SA.48780 (France), country expertise.

Rationales for introducing a CRM across Europe (2/2)

Uncertainty and external effects on security of supply are the main reason for introducing a Decentral CRM (in FR) and a Strategic Reserve (DE, FI, SE), supplemented by other reasons based on national aspects

Table 2 (continued): *Other countries which have implemented CRMs, with type, year and rationale for introduction*

Selected country	CRM type	Year	Explanation
France	Decentral CRM, but transitioning to CM	2017	High dependency on nuclear power and high seasonality (winter peak) while limited (demand) flexibility in the system, **external effects on security of supply.** However, France already decided to move to a central CRM as the decentral CRM proved to be too complex and did not provide price stability and foreseeability. This is because actors certified only last minute instead of a few years in advance.
Germany[1]	Strategic Reserve, CM in development	2021 (SR), 2024 (CM)	Strategic Reserve implemented. As reasons for implementation, the current transition of the electricity market in Germany was mentioned, which implies **uncertainty**. Plan to implement a CM due to a foreseen with increasing electrification and phase-out of nuclear & coal. **Missing money and uncertainty** as main aspects.
Finland	Strategic Reserve	2006	The reserve was established in 2006 and approved by the European Commission. In 2006, the government mentioned that the Strategic Reserve is needed for peak demand and chosen to ensure the availability of capacity at risk of exiting the market due to low utilisation **(missing money)**. In the State aid procedure in 2022, Finland mentioned that it has historically relied on (Russian) imports pointing to **external effects on security of supply**.
Sweden	Strategic Reserve	2003	Sweden established its Strategic Reserve in 2003. The European Commissions has recently approved an extension until 2035. The reserve was initially established after a nuclear phaseout and to handle extreme winter events. Hence, the Strategic Reserve mainly addresses the problem of **external effects on security of supply and uncertainty**.

[1] Detailed country case study for the SR in Germany is included in Annex V.

Sources: France - Haya Energy Solutions (2024): The other Electricity Cash Cow: the Capacity Mechanism; RTE Prepare for the new capacity mechanism - RTE Services Portal - Germany – EC (2018): Commission Decision 2018/860; Finland – Finlex (2006): Government proposal HE 228/2006); European Commission (2022): State aid SA.55604; Sweden – Svenska Kraftnät (2013): Effektreserven; Sweden – Regeringens proposition (2022)

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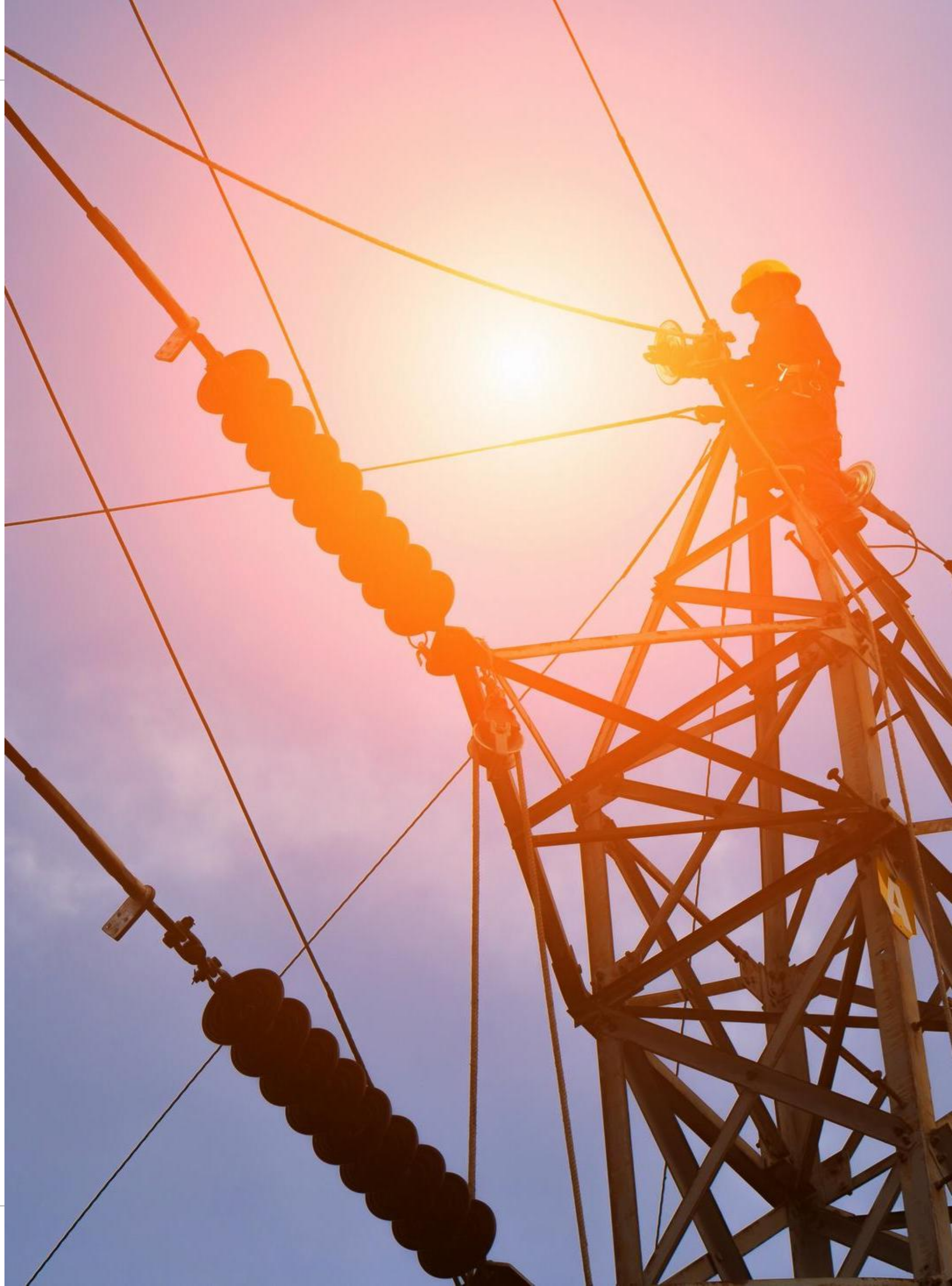

Longlist of possible CRMs

We developed a longlist of different CRMs and related mechanisms for potentially addressing resource adequacy based on experiences in Europe, internal expertise and literature

Initial longlist of possible CRMs and related mechanisms

- We identified a longlist of possible mechanisms that could help to address the challenge in the Netherlands. We developed this longlist based on a literature review, established mechanisms and ongoing developments and discussions across Europe (e.g. in Germany, Belgium), in discussions with KGG and the Steering Committee as well as in-house expertise.
- The following **CRM mechanisms** are included: Strategic Reserve (SR), Capacity Auction (CA), central CRM (CM), hybrid CRM and decentral CRM.
- Additionally, we considered **more specific and creative mechanisms** targeted at supporting the development of capacity or certain technologies, which although not capacity mechanisms in terms of the EU electricity regulation 2019/943 can be deployed to serve the same goal of supporting capacity availability. These are: Hedging Obligations (HO), Non-Fossil Flexibility Subsidisation Schemes (NFFSS) and Advanced Payments for new builds.
- The mechanisms in this **longlist** have different scopes and organisational characters and have been applied in different geographies.

We differentiate CRMs and further mechanisms based on two main variables

1. **Scope**: specific vs. comprehensive
   - The more specific, the more tailored to certain technologies and limited to e.g. new or existing assets in certain regions.
   - The more comprehensive, the more technology neutral and open to new and existing assets independent of their location in the country or interconnected countries.
2. **Centrality**: central vs. decentral
   - The more central, the more this is organised by one or a few central authorities or bodies.
   - The more decentral, the more it is organised by diverse parties or market players.

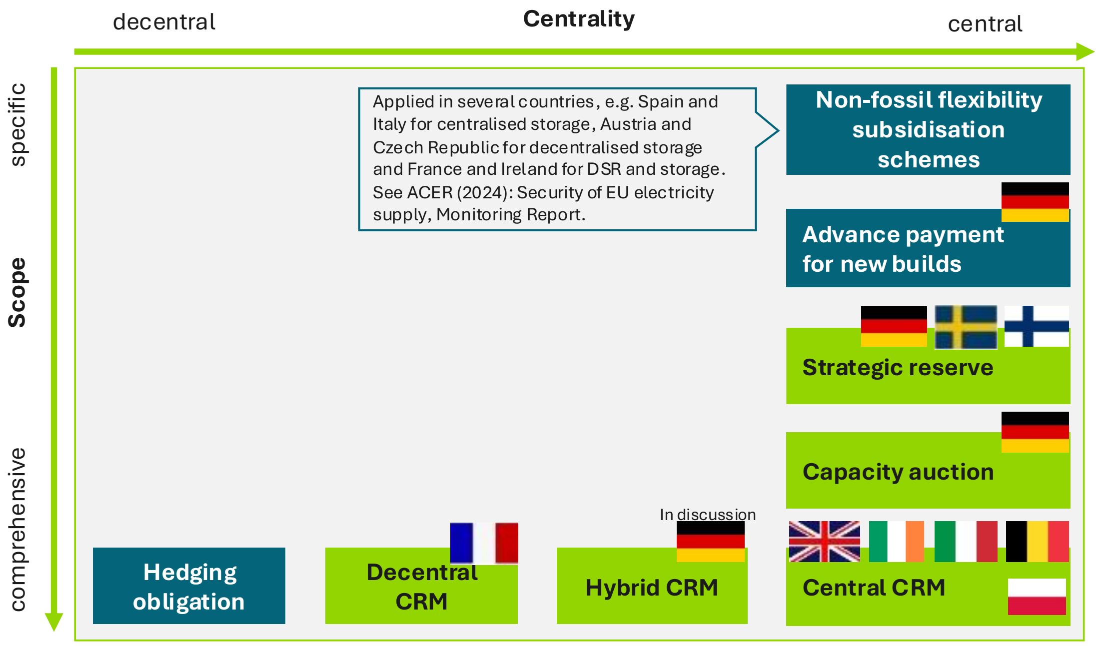

Figure 2: Long list of possible CRMs and related mechanisms considered for this study, based on mechanisms in European countries, ongoing discussions, literature and in-house expertise.

Selection of sources: Frontier Economics / Consentec (2014): Folgenabschätzung Kapazitätsmechanismen (Impact Assessment); Connect Energy Economics (2025): Die Ausgestaltung der Absicherungspflicht (Hedging); Frontier Economics (2024): Kombinierter Kapazitätsmarkt – Eine Analyse der Vor- und Nachteile, short study for EnBW AG and RWE AG; Consentec et al. (2024): Überblick zur Ausgestaltung eines kombinierten Kapazitätsmarkts, short study for BMWK; country specific expertise; ACER (2024): Security of EU electricity supply; Transnet BW (2022).

High-level descriptions of Capacity Remuneration Mechanisms

In a first step, we look at the core features of the possible CRMs

***Table 3:** Overview of possible CRM types and a high-level description*

Mechanism	High-level description
Strategic Reserve	A centrally determined reserve is held outside the energy market and activated only during emergencies. Providers need to fulfill prequalification criteria and are selected through tenders, paid for guaranteed availability, and monitored for compliance, with costs covered by levies.
Central CRM	A central authority determines the total capacity needed for the system, and both new and existing resources can participate after prequalification. Providers receive capacity payments for maintaining availability, and compliance is centrally enforced with penalties for non-performance. The mechanism is funded through levies or taxes.
Decentral CRM	Each supplier must secure their share of peak load through capacity certificates, with central authorities define obligation periods. Capacity can come from various sources, including generation, storage, and demand-side flexibility, all subject to prequalification. A self-fulfilment option allows demand reduction to count without certification. Compliance is centrally monitored, and costs are passed on to customers through electricity prices.
Hybrid CRM	A hybrid CRM combines central procurement of new capacity via long-term contracts with decentralized supplier obligations for short-term capacity certificates. Both segments have separate compliance and cost recovery mechanisms, with central management of penalties and obligations.
Capacity Auction	Centrally organized auctions procure new firm capacity to address projected gaps, with participation typically limited to new assets and specific technologies. Providers must meet availability obligations and receive payments, while compliance is monitored by the state and funded by levies or taxes.
Hedging Obligation	Suppliers are required to hedge against peak electricity prices using market-traded products like futures and options. All technologies can participate, and compliance is monitored by authorities, with penalties for non-fulfillment. The costs of Hedging Obligations are included in the energy price paid by end customers.
Advance payment for new builds	Central tenders offer upfront payments to new, flexible assets in regions where extra capacity is needed. This approach improves investment security by covering part of depreciation costs over e.g. ten years, with participation limited to climate-compatible assets.
Non-Fossil Flexibility Subsidisation Schemes (NFFSS)	Competitive tenders support new non-fossil flexibility resources, such as demand response and storage, to meet national targets. Beneficiaries must participate in the market and comply with requirements, with penalties for non-compliance and incentives designed to maintain market signals.

Selection of sources: Frontier Economics / Consentec (2014): Folgenabschätzung Kapazitätsmechanismen (Impact Assessment); Connect Energy Economics (2025): Die Ausgestaltung der Absicherungspflicht (Hedging); Frontier Economics (2024): Kombinierter Kapazitätsmarkt – Eine Analyse der Vor- und Nachteile, short study for EnBW AG and RWE AG; Consentec et al. (2024): Überblick zur Ausgestaltung eines kombinierten Kapazitätsmarkts, short study for BMWK; country specific expertise; ACER (2024): Security of EU electricity supply; Transnet BW (2022).

Overview of characteristics of longlist CRMs

The longlist mechanisms differ regarding demand, supply and defined products

Table 4: *CRM type characteristics*

Design variable		Strategic Reserve (SR)	Central CRM (CM)	Decentral CRM	Hybrid CRM (HM)	Capacity Auction (CA)	Hedging Obligation (HO)	Advanced Payments	NFFSS
Capacity Demand	Amount decided by whom?	**Central** authority	**Central** authority	Electricity **suppliers**	**CS: central** authority **DS: electricity suppliers**	**Central** authority	Electricity **suppliers**	**Central** authority	**Central** authority
	Demand covered	**Targeted** – relatively small amount of electricity generation capacity; demand determined based on security of supply assessments	**Market wide** – based on expected peak load plus a safety margin, covering the full system need during scarcity events	**Market wide** – determined by sum of electricity requirements of suppliers (demand driven by penalties)	**CS: targeted** on additional (new) capacity **DS: market wide** – determined by sum of requirements of suppliers (demand driven by penalties)	**Targeted** on additional (new) capacity required	**Market wide** – based on aggregation of individual obligations	**Targeted** on additional (new) capacity required	**Targeted** – national flexibility objective
Supply	New vs. existing assets	**New & existing** assets	**New & existing** assets	**New & existing** assets	**New & existing** assets	**New** assets	**New & existing** assets	**New** assets	**New** assets
	Technologies	Usually, **technology specific**	**Generally open**, but prequalification criteria apply	**Open** to all technologies due to self-fulfilment option	**CS: Generally open**, but prequalification **DS: Open** due to self-fulfilment option	**Technology specific**	**Generally open**, slightly dependent on design of "spike products"	**Technology specific**	**Technology specific** (non-fossil flexibility, e.g. batteries & DSR)
Product	Obligation	**Availability** obligation	**Availability** obligation, with **option** to integrate a **reliability** obligation	**Availability** obligation	**Availability** obligation, but **option** to integrate a **reliability** obligation in CS	**Availability** obligation	**Reliability** obligation	**Availability** obligation	**Availability and partly reliability** obligation (min. level of market participation)
	Payment	**Capacity payment** (in €/MW/year) & some-times payments for (additional) activation	**Capacity payment** (in €/MW/year)	**Capacity payment** (in €/MW/year)	**Capacity payment** (in €/MW/year) for CS & certificate holders	**Capacity payment** (in €/MW/year)	**Energy based** (EUR/MWh)	**Prepayment to cover depreciation costs upfront**	Different types of payments possible/ occur
	EOM participation	**Excluded**	**Allowed**	**Allowed**	**Allowed**	**Allowed**	**Allowed**	**Allowed**	**Allowed** & required
Examples		**E.g. in Germany, Finland**	**E.g. in Belgium, UK**	**France**	**Discussion in Germany**	**Power plant strategy in Germany**	**Previously topic of discussion in Germany**	**Proposal for Germany by TransnetBW**	**E.g. in France, Spain or Austria**

Selection of sources: Frontier Economics / Consentec (2014):Folgenabschätzung Kapazitätsmechanismen (Impact Assessment); Connect Energy Economics (2025): Die Ausgestaltung der Absicherungspflicht (Hedging); Frontier Economics (2024): Kombinierter Kapazitätsmarkt – Eine Analyse der Vor- und Nachteile, short study for EnBW AG and RWE AG; Consentec et al. (2024): Überblick zur Ausgestaltung eines kombinierten Kapazitätsmarkts, short study for BMWK; country specific expertise.

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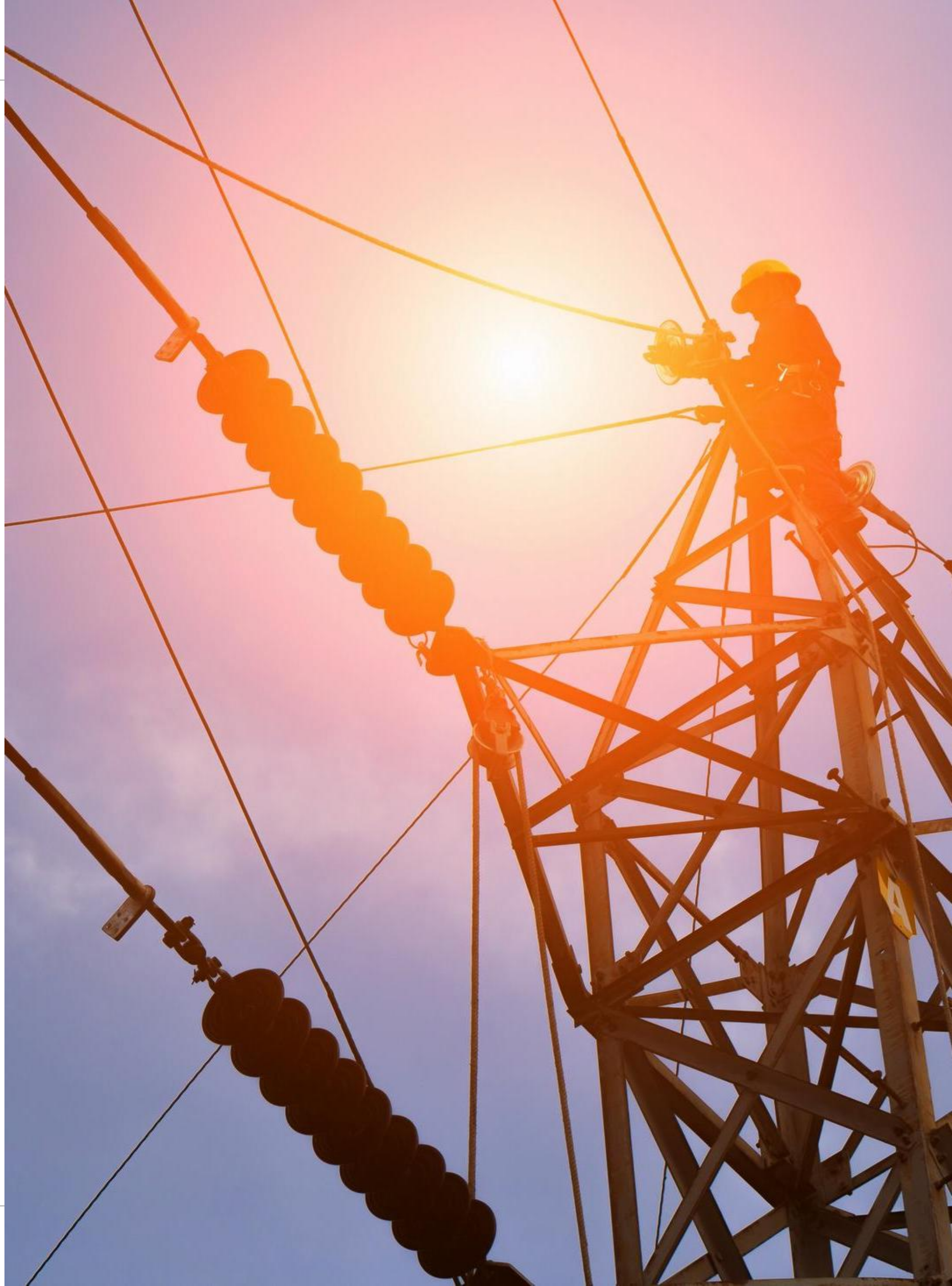

Legal requirements of CRMs at a European level

European legislation requires a quantitative proof of lacking resource adequacy for the authorisation of a CRM as State aid

Introducing capacity mechanisms is regulated at an EU level

- **EU legislation (Article 21(5), Regulation (EU) 2019/943)** prohibits the introduction of a capacity mechanisms unless adequacy concerns exist.[1]
- The introduction of a capacity market requires a **quantitative assessment** to justify the need for additional measures to ensure resource adequacy.
- Such concerns must be demonstrated through
  - a European Resource Adequacy Assessment (ERAA) under Article 23, or
  - a National Resource Adequacy Assessment (NRAA) under Article 24.
- The **ERAA, conducted by ENTSO-E**[2], assesses resource adequacy across Europe over a 10-year horizon, considering generation, demand, and cross-border flows.
- The **NRAA focuses on national conditions** (e.g. generation mix, policies, market design) and **applies a country-specific reliability standard**. The methodology for this standard is guided by ACER[3], but member states define their own acceptable level of security.

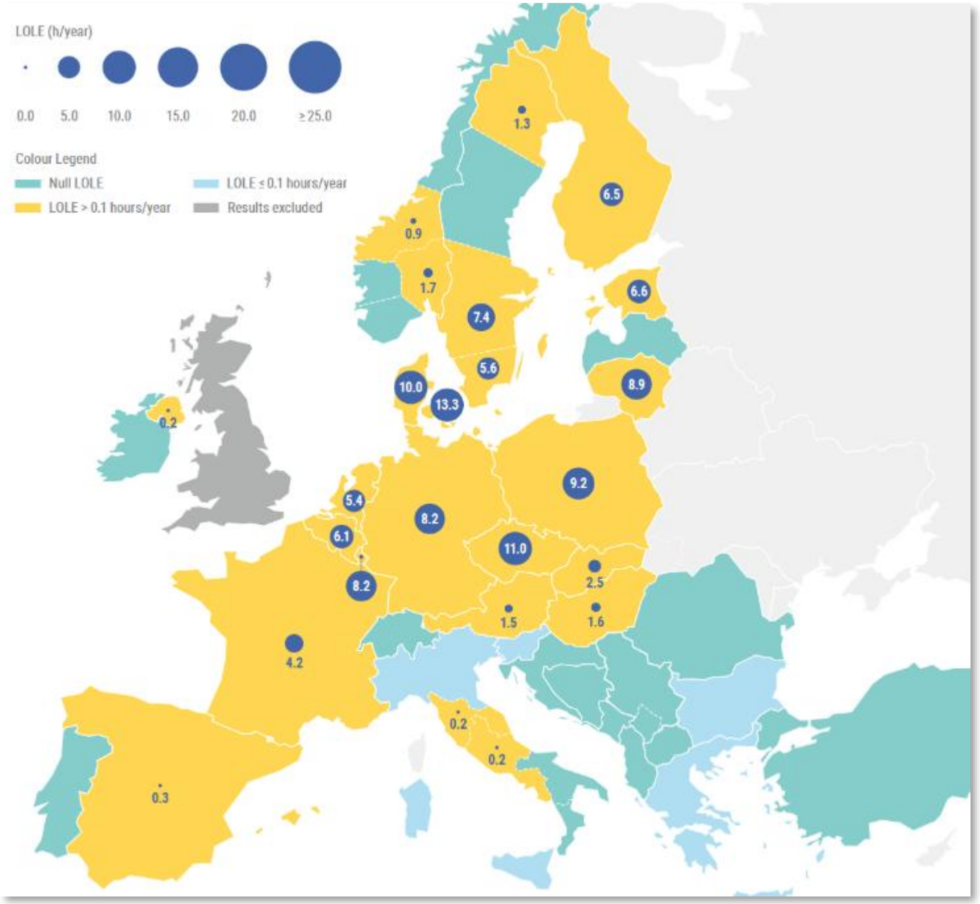

Figure 3: Expected LOLE across Europe in 2030. Source: ENTSO-E: ERAA 2024.[4]

[1] https://eur-lex.europa.eu/eli/reg/2019/943/oj/eng; [2] https://www.entsoe.eu/eraa/; [3] https://www.acer.europa.eu/electricity/security-of-supply/european-resource-adequacy-assessment ; [4] ERAA, 2024, available at https://www.entsoe.eu/eraa/2024/

Introducing a capacity market in a member state

Compliance with general electricity regulation and general State aid law is required, for an accelerated State aid approval additional criteria must be met.

General electricity regulation (EU) 2019/943

Art. **20** **Monitoring of resource adequacy** by member states and development of an implementation plan in case of concerns.

21 **Capacity mechanisms as a last resort allowed** to eliminate resource adequacy concerns but check of interdependencies with neighbouring MS and whether a **Strategic Reserve** would be sufficient. CRM must be only temporary (**max. 10y**) and **in line with State aid rules**.

22 **Design principles for capacity mechanisms**, e.g. CO_2 limits for generation, payments only for availability.

23 **European resource adequacy assessment by ENTSO-E.**

24 **National resource adequacy assessment** is based on the similar methodology but can consider national peculiarities.

25 When applying capacity mechanisms, Member States shall have a **reliability standard** in place.

26 Capacity mechanisms and – if technically feasible SR – shall be **open to direct* cross-border participation** (by bidding into the market).

* Indirect cross-border participation refers to subtracting foreign contributions to capacity from the total capacity requirement.

General state aid authorisation criteria

a) **Necessity of aid, incentive effect** and compatibility with Electricity Regulation Articles 20(1), 21(1), 21(4), 22(1.c), and 23

b) **Market failure and appropriateness of aid** and compatibility with Electricity Regulation Articles 20(3-8) and 21(3)

c) **Eligibility** and compatibility with Electricity Regulation Articles 22(1), 22(4) and 26

d) **Proportionality of aid** and compatibility with Electricity Regulation Articles 22(1) and 22(3)

e) **Avoidance of undue distortions to competition and trade** and compatibility with Electricity Regulation Article 22(1-2)

CISAF 4.4** accelerated approval

CRM will be considered as compatible with general State aid rules if certain design criteria are fulfilled, inter alia:

1) If a market-wide capacity mechanism is proposed, it must be demonstrated that a **Strategic Reserve is not sufficient** to solve the problems.

2) **In case of a CRM, fast track criteria are partially orientated towards a central CRM**:
- Competitive auction process for 75-90% of the volume every 4-6 years in advance.
- At least 90% of the costs of the CRM must be allocated to consumers based on their consumption during the 1-5% highest price periods per year. Charges may be levied on balance responsible parties (such as suppliers) – also for a SR.
- Technology openness – also for a SR.

3) The measure is authorised for a **maximum period of 10 years**.

***see Annex II of this study for further details.*

Sources: CEEAG C/2022/481 and European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final.

CRMs across Europe

The Netherlands is surrounded by (emerging) capacity mechanisms, leading to a risk of growing reliance on neighbouring countries in case of adequacy challenges

CRM are seen as one mean to ensure resource adequacy across Europe

- Several countries do not expect that necessary investments in controllable generations will be ensured via the energy-only market.
- Several countries set up capacity remuneration mechanisms (CRM) in the past or plan to do so. Several factors prevent investors to invest in larger scale assets (such as e.g. gas-fired power plants or Long-Duratio Energy Storage (LDES)):
  - In a market with more volatile RES-E (subsidised), revenue risks for refinancing larger scale investments increase.
  - Hedging long term investment risks is not possible since long term forward markets do not exist, and customers only agree to short term contracts extending to several years.
  - Political interventions into the power markets across Europe decreased trust of investors in the stability of the framework.
- Several countries have moved/are moving towards a Central CRM in recent years, for example:
  - Belgium moved from a Strategic Reserve to a central mechanism in 2021 due to challenge becoming structural (phase out of nuclear) and to stimulate new investments.
  - In France, a decision has been made to move from a decentral mechanism to a central mechanism as the decentral mechanism proved to be too complex and did not provide price stability and foreseeability. This is because actors certified only last minute instead of a few years in advance.
- (Academic) Research and discussions are ongoing on the topic of 'regional' (multinational) capacity markets, which are considered to prevent costly cross-border coordination inefficiencies which could occur with national CRMs.[1]

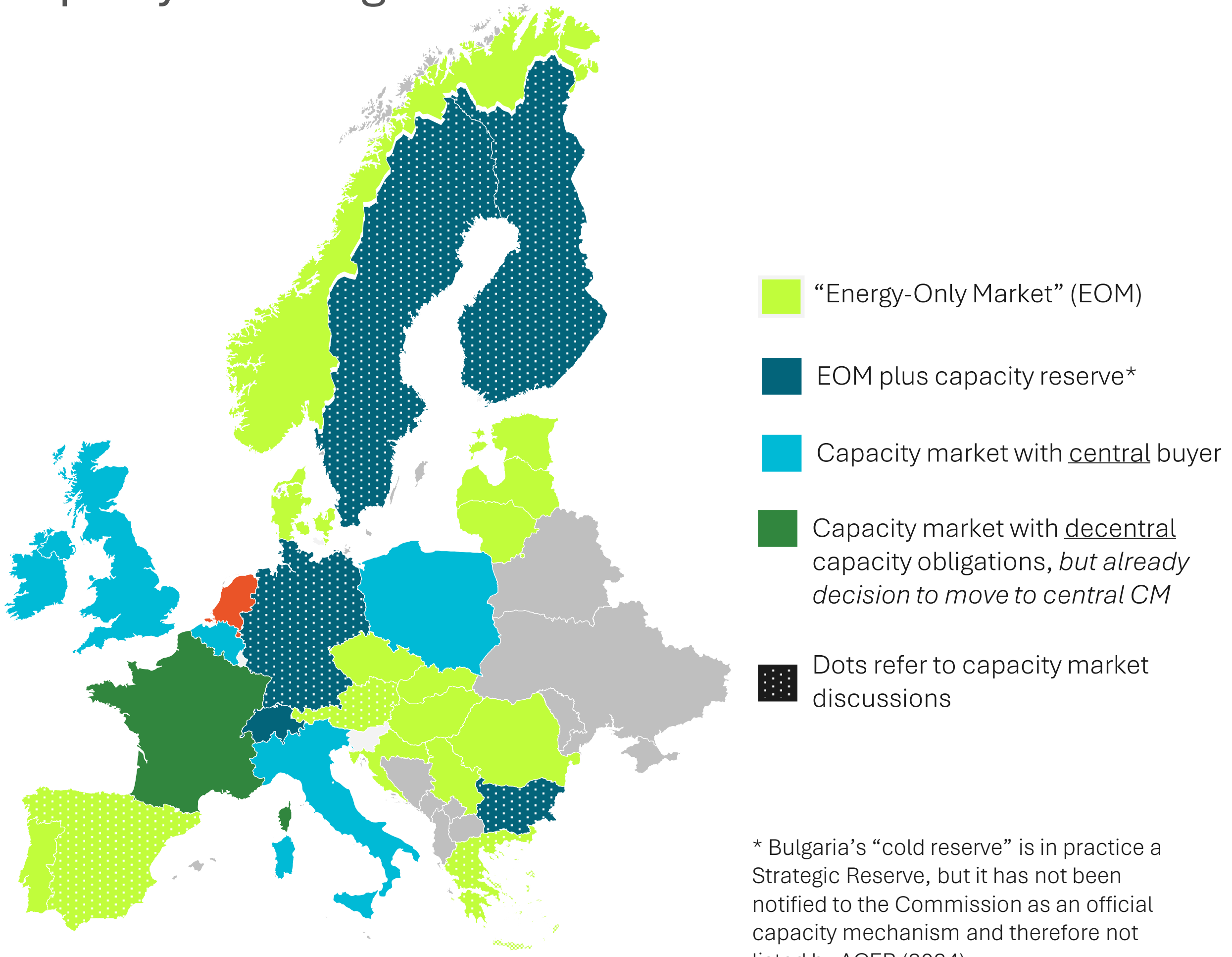

Figure 4: CRMs across Europe. Source Figure: Guidehouse/Frontier Economics based on ACER (2024) and additional information.

* Bulgaria's "cold reserve" is in practice a Strategic Reserve, but it has not been notified to the Commission as an official capacity mechanism and therefore not listed by ACER (2024).

[1] Menegatti & Meeus, Three steps to a regional capacity market in the EU (2025)

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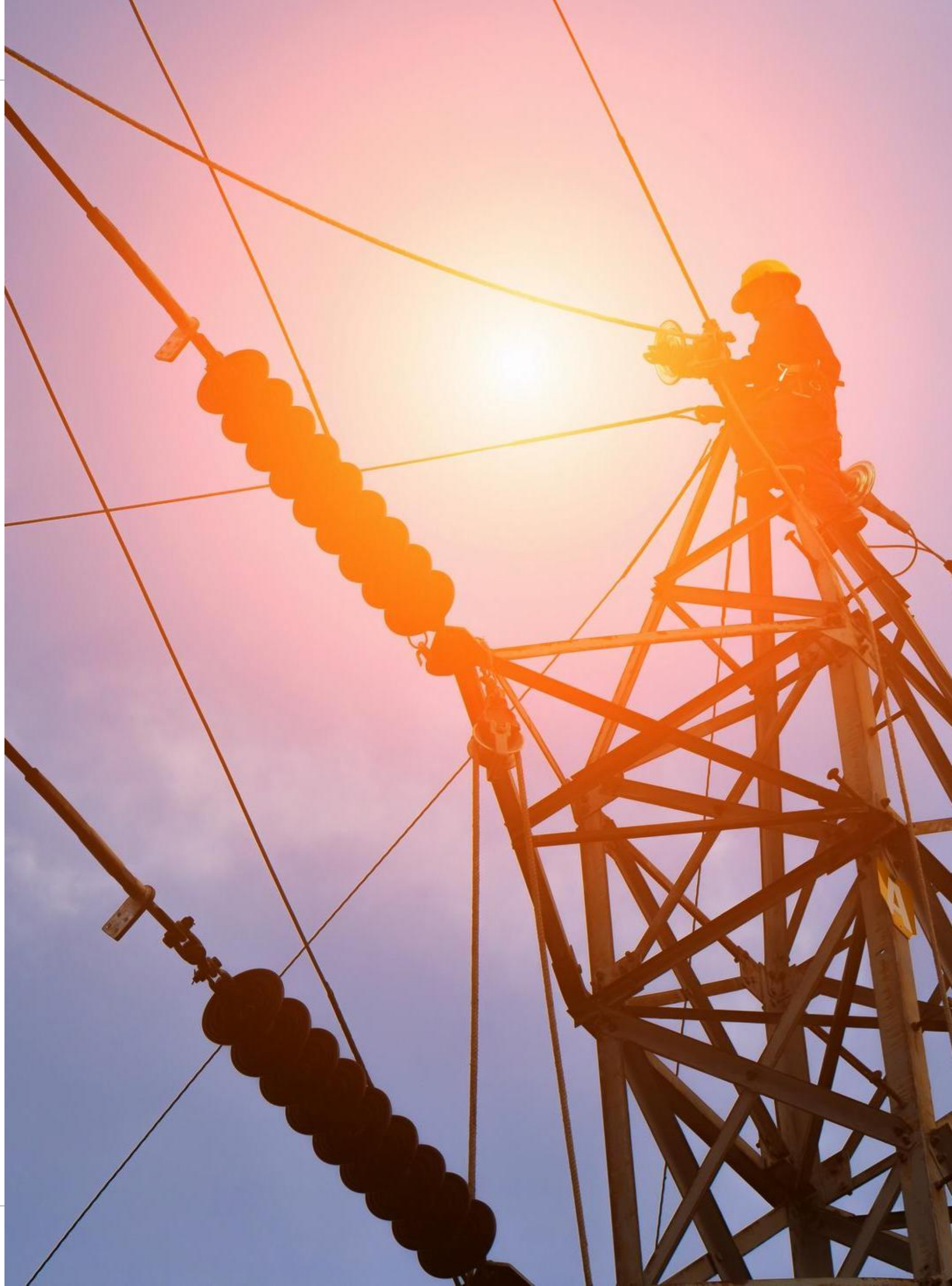


Recap of Monitor Leveringszekerheid 2025

From 2030 onwards, resource adequacy and missing money are the main drivers to investigate a capacity remuneration mechanism for the Netherlands

Resource adequacy concerns after 2030 are the main driver to investigate CRMs in NL

- Resource adequacy is the main driver to investigate the suitability of a capacity mechanism for the Netherlands.
- The LOLE value is used as reliability indicator, for which the threshold in NL is set at 4 hrs. This level is considered an acceptable balance between reliability and costs, but is not a formalised reliability standard.
- The primary adequacy problem currently lies with the ability of generation capacity to meet demand at all times. According to TenneT's Monitor Leveringszekerheid (MLZ) 2025[1],the LOLE is expected to exceed to threshold of 4 hrs per year after 2030, if no further measures are taken.

Table 5: *LOLE and EENS projections in TenneT MLZ[1]*

Indicator	Unit	2030	2033	2035
LOLE	[h/year]	1.1	12.6	9.2
EENS	[GWh/year]	0.8	14.1	15.7

- Main reasons for the expected resource adequacy concerns are stated as:
  - 4 GW coal capacity closure before 2030 (coal ban law).
  - Expected closure of 3.8 GW gas capacity before 2030, and 1.9 GW more closures towards 2035.
  - Increase of electricity demand from 115 TWh in 2023, to 153 TWh in 2030, and 190 TWh in 2035.
- While sufficient availability of transmission capacity and demand flexibility are important challenges for the Netherlands, they are separately addressed.

The missing capacity to bring back the LOLE to 4 h after 2030 is estimated at ~1.5 GW

- The duration of most moments with a deficit is expected to be relatively short (1 or 2 hours), and the deficit is relatively small (mostly < 2 GWh).[1] However, the average duration and energy deficit of outages is expected to increase;
  - From an average outage of 3.3 hrs per event in 2030 to 7.2 hrs in 2033.
  - From an average energy deficit from 2.4 GWh per event in 2030 to 8 GWh per event in 2033.
- Most times with a shortage occur during winter evening times, and longer durations of low renewable generation.
- To bring the resource adequacy level to the desired level (leading to a 4h LOLE), for 2033 ~1.3 GW of additional capacity would be required and for 2035 ~1.4 GW.*

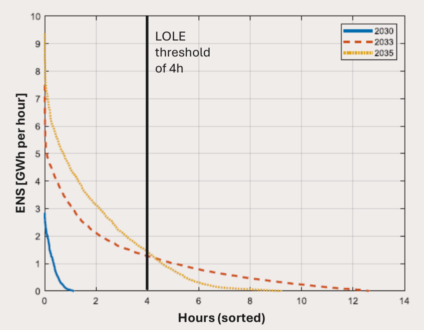


Figure 5: Energy Not Served (ENS) duration curves. Source: Adapted from TenneT, Monitor Leveringszekerheid 2025, Figure 4-4.[1]

Part of existing gas generation assets also have uncertain economic viability from 2030

- Apart from the expected s in 2033 and 2035, TenneT's economic viability check (part of the sensitivity analysis in MLZ) for the year 2030 states that of the assumed asset base, 1.7 GW (of a total of 14.4 GW) of gas capacity is 'in danger' of having no economic viability in 2030 already.
- These mostly consider older, less efficient, gas turbines. Their full load hours are estimated between 0-1000 hrs per year, which could be insufficient to recover their fixed maintenance costs.
- This capacity is part of the 1.9 GW gas capacity that is assumed to be further phased out towards 2035.

Bridging the gap

Main technology groups that are projected in MLZ 2025 to help overcome the expected adequacy challenge:

- (CO_2-) Dispatchable generation (focus on gas based – either newbuild or retrofitting conventional)
- Demand Response
- Long-Duratio Energy Storage (LDES)
- (Interconnections with UK & Norway)

[1] TenneT, Monitor Leveringszekerheid 2025 (Link)

*Derived based own assessment of data provided in TenneT's MLZ 2025.

Guidehouse frontier economics

Electricity generation in the Netherlands

Historically large dispatchable generation capacity is set to diminish, against rapid RES growth

Current generation mix

The generation capacity in 2023 was 59 GW, consisting of:[1]

- 24 GW dispatchable, of which 18 GW is gas fired power plants,
- 35 GW of renewable generation (24 GW of solar PV, 11.5 GW wind),
- The largest dispatchable generation is situated close to load centres (industrial clusters).
- 0.55 GW of gas plant capacity was mothballed.

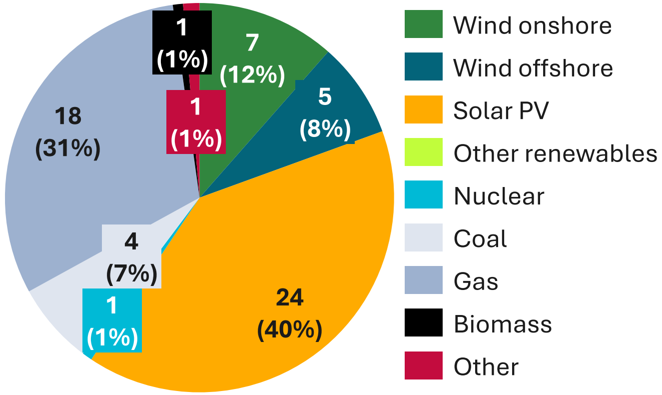


Figure 6: (left) Generation capacity in NL in 2023 [GW][1]; (right) Locations of large dispatchable generation.[3]

Regulatory developments

- The government is working on a proposal for Contracts for Difference (CfDs) for solar PV and wind, but there is no clarity yet on its implementation.[4]
- The proposed hydrogen blending obligation for gas power plants is abolished, in favour of offshore wind support.[5]
- Security of supply and affordability are prioritized over the aim of a decarbonised electricity sector by 2035, bringing electricity in line with the 2040 energy sector target.[5]
- The regulator ACM is preparing for the introduction of a grid tariff for electricity generators (which historically were not subject to grid tariffs).[6]

Future developments

- Renewable generation capacity is projected to triple by 2035.
- Dispatchable generation is forecasted to decrease from 24.2 GW to 14.2 GW between 2023 and 2035. This is related to the coal phase out (2030: -4 GW) and 5.7 GW of gas generation that may become economically unviable (MLZ 2025 projection).
- The governmental target is to fully decarbonise the energy system by 2040.
- Some investments in making gas plants ready to co-fire hydrogen are taking place, such as the Maxima plant.[2]

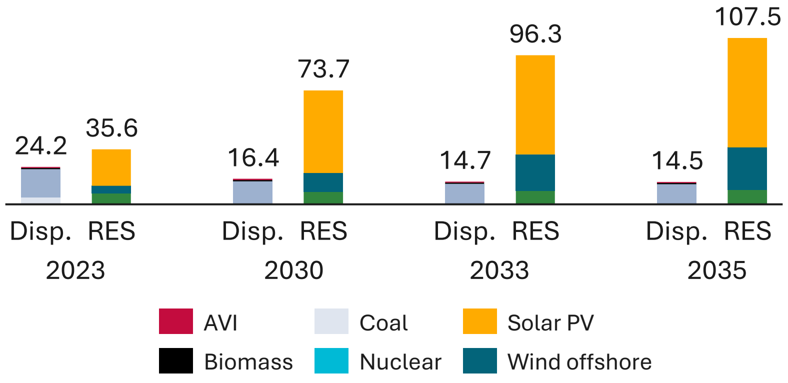


Figure 7: Projected developments in dispatchable (disp.) and renewabele (RES) generation [GW][1]

Uncertainties

- The role out of renewables may be constrained by low wholesale market prices, a lack of offtakers willing to enter into power purchase agreements (Long-Duratios), and grid congestion. While instruments have been announced, its implementation is uncertain. This may result in delays, which can be observed in the roll out of offshore wind.
- Uncertainties around renewables generation build-out, demand growth, and commodity prices (and their interplay) propagate to uncertainties around the economic unviability of gas plants as assumed in the MLZ 2025 scenarios.
- There are political ambitions to build nuclear generation of 4-6 GW, half of which to be operational by 2040, which requires navigating techno-economic and societal hurdles.

[1] TenneT Monitor Leveringszekerheid 2025; [2] ENGIE 29-04-2025; [3] Omvang en ombouw van regelbaar vermogen in 2035, Berenschot ; [4] Kamerbrief over voorbereidingen voor tweerichtingscontracten; [5] Klimaat en energienota 2025; [6] ACM - Voorbereiding invoedingstarief

Electricity demand in the Netherlands

After years of stability, electricity demand is projected to increase. Electrification of industry and mobility taking the lion's share.

Current electricity demand

The electricity demand in 2023 was 115 TWh; the majority was used in the built environment and industry. The peak electricity demand in 2023 was 18 GW.[1]

Electricity demand has been stable, fluctuating around 120 TWh since 2008.[3]

NL has been a net exporter of electricity in recent years (7.51 TWh in 2023).[3]

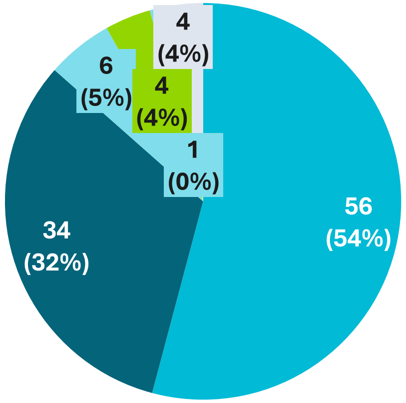


Figure 8: Electricity demand in the Netherlands in 2023 [GW].[1]

Future developments

In TenneT's projections of non/low flexible demand, +75 TWh of demand growth, is mostly driven by electrification of industry (+31 TWh) and mobility (+30 TWh).[1]

Power-to-gas/electrolysis capacity is projected at 3, 3.6 and 4 GW (2030, 2033, 2035 respectively).

Peak demand is projected to grow to 27 GW.[1]

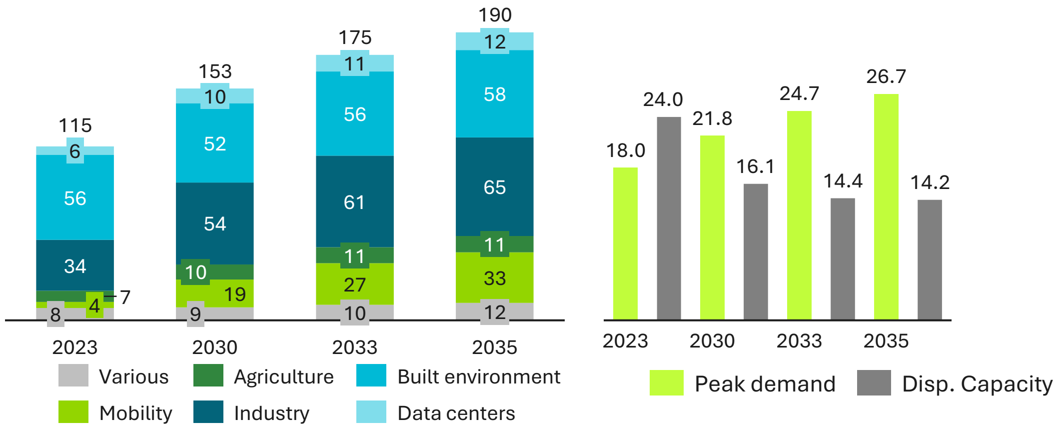


Figure 9: (left) Demand projections in NL [TWh][1]; (right) Projection of peak demand and total dispatchable capacity [GW].[1]

Regulatory developments

- Industrial electrification technologies are eligible for support under the SDE++ subsidy, and many applications have been successful in the past few rounds.[4]
- In the Actieagenda Elektrificatie Industrie, direct electrification is formally recognised as the preferred decarbonisation route for industry. Further stimulating measures will be explored , such as a demand-side Contracts for Difference, a Long-Duratio guarantee fund, and adjustments to subsidy instruments.[5]
- Mandating replacement of gas boilers with (hybrid) heat pumps is no longer envisaged, however subsidy and financing support remain available.[6]
- The Opschalingsregeling waterstof via elektrolyse (OWE) has seen two successful rounds and the framework is in place for future rounds.[7]

Uncertainties

- Demand growth of industry depends on the international competitiveness of Dutch industry (which is currently low). Increasing grid tariffs and differences in subsidy and taxation of industrial electricity may disincentivise investments.
- Grid congestion is a bottleneck and creates uncertainty when and where grid connections are available.
- Future grid tariffs are uncertain and cannot be hedged by consumers (as opposed to e.g. future electricity prices).

[1] TenneT Monitor Leveringszekerheid 2025
[2] TenneT Annual Market Update 2024
[3] CBS - supply and demand electricity
[4] RVO - SDE++ applications
[5] Actieagenda Elektrificatie Industrie
[6] Kamerbrief resultaten actieplan warmtepompen
[7] RVO - Outcome second OWE round

Flexibility options in the Netherlands

Significant capacities of flexible assets are projected in the MLZ, which are subject to economic, technical and grid connection uncertainties

Development of flexibility options

Flexibility options are beneficial for the electricity system as they can reduce the need for dispatchable generation capacity, and to help meet security of supply standards when peak demand exceeds dispatchable generation capacity.

The three categories of relevance for SoS are storage (batteries and LDES), demand side response, and interconnection.

- **Batteries** are able to provide short term flexibility (1 to 8 hrs*) to bridge short-term shortage of renewable energy generation (e.g. diurnal profile of solar PV). In 2024, installed capacity increased by 53%, to 350 MW, with another 1.5 GW in the pipeline.[5,6]
- **Long-Duration Energy Systems (LDES)** (e.g. Compressed Air Storage, flow batteries) are under development and may be able to bridge longer term shortages. In TenneT's MLZ, 84 hr and 12 hr duration LDES is assumed.
- **Demand side response (DSR):** projected to approximately triple by 2035, absolute growth is modest compared to battery storage.
- **Interconnection:** NL is part of the CORE network and has subsea interconnectors to the UK (BritNed, 1 GW), Norway (NorNed, 0.7 GW) and Denmark (COBRAcable, 0.7 GW).[7] In the MLZ, the effective interconnection capacity is projected to grow from 17.4 GW in 2030 to 20.1 GW (expected to grow with +2 GW through LionLink). Exchange with Norway and the UK contributes the most to resource adequacy, on account of lower correlation of RES in those regions.

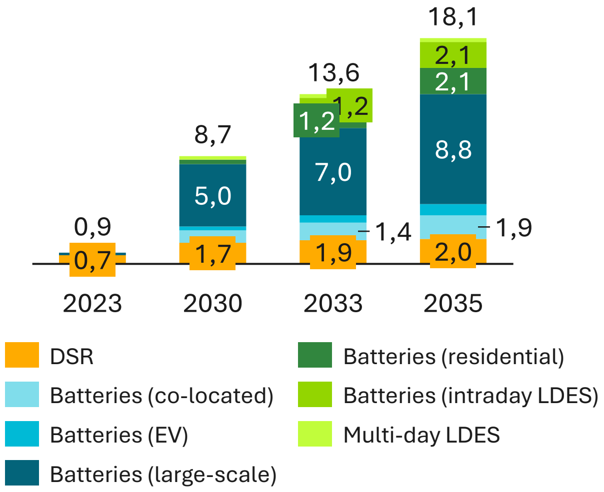


Figure 10: Projected growth of flexible capacity in the Netherlands [GW].[1]

Demand side flexibility is expected to grow strong up to 2030, but level out up to 2035. Supply side flexibility growth is expected to continue towards 2035, based on technology and economic improvements.

Regulatory developments

- Alternative Transport Rights (tijdsduur & tijdblokgebonden ATR) improve the business case of storage, by reducing grid connection fees up to -65%.[6]
- Investigation by ACM is ongoing if batteries can be compensated for role in more efficient grid usage.[4]
- KGG and Ofgem approval of LionLink, with a targeted operation date of 2032.[8]
- A scarcity component is announced in the imbalance price, in response to generation shortages manifesting primarily in system imbalances, instead of EOM price spikes.

Uncertainties

In general, the MLZ projects a rapid uptake of flexibility options (besides dispatchable generation).

- The balance between potential revenues and costs for batteries is uncertain. The revenue of batteries is currently driven by arbitrage, imbalance, and balancing services. The latter will quickly cannibalise, as the total required capacity for balancing services is limited. Battery costs could see a continued steep reduction curve from technology improvements, economies of scale and learning effects.
- Although LDES projections have large capacities and contribution to SoS towards 2035 , the development of LDES is highly uncertain due to its current . The business case is not clear a priori and it may require a separate instrument to unlock investments.

In the MLZ TenneT assumes 4 hr batteries

[1] TenneT Monitor Leveringszekerheid 2025; [2] TenneT Annual Market Update 2024; [3] CBS - supply and demand electricity; [4] ACM onderzoekt bijdrage batterijsystemen en elektrolysers aan elektriciteitsnet; [5] Explosieve groei batterijopslag in Nederland; [6] Rabo Research - Toename grootschalige batterijopslag in Nederland ondanks barrières; [7] TenneT - Projects website; [8] Ontwikkelkader Windenergie op Zee

Implications for CRM options for the Netherlands

Uncertain market and regulatory developments have implications on the CRM assessment

Implications related to the MLZ

TenneT's Monitorleveringszekerheid 2025 (MLZ)[1] explores the short- and medium-term security of supply. Its results imply different potential needs in the short term versus the mid term:

- **Short term:** While in 2023 the dispatchable generation capacity (24 GW) comfortably exceeded peak demand (18 GW), this is expected to reverse ahead of 2030 with the coal and gas capacity reductions (-7.8 GW) and projected electricity demand growth. This is under a scenario of rapid growth of flexibility options (0.9 GW to 8.7 GW), which partly alleviates the gap.
- **Mid term:** In TenneT's MLZ 2025 base case scenario, the LOLE and our associated derived s in 2033 and 2035 (~1.5 GW) are modest. The capacity of gas plants that is expected to close due to economic unviability over this period is much greater (~5.7 GW).

Developments in the Dutch energy market are subject to various **uncertainties**. Uncertainties regarding demand growth and reduced dispatchable generation have been explored in the MLZ. The sensitivity analyses show:

- Even with reduced demand growth, a resource challenge appears in 2033.
- Reduced dispatchable generation capacity in 2033 increases expected energy not served (EENS), while if it occurs in 2030 it may result in an earlier adequacy challenge.

The retirement of coal plants and potential retirement of dispatchable gas capacity are the main drivers of the security of supply challenge in the Netherlands.

Implications relating to market and regulatory developments

Interplay RES/dispatchable generation/flex options: The interplay between RES rollout, dispatchable generation and flexibility options in the energy market is multifaceted:

- A greater share of RES, reduces the business case of dispatchable generation (fewer full load hours and reduced energy prices), and improves the arbitrage opportunities for storage. Policy uncertainty in RES roll-out support schemes add to investor uncertainty.
- Supporting the rollout of other flexibility options outside of the energy market (e.g. by targeted renewable roll-out subsidies), can lead to crowding out of dispatchable generation (see slide 47).

Both RES and flexibility options are needed in the future energy system and their stimulation outside the energy market negatively impacts profitability of dispatchable generation.

Locational incentives: In the short- to medium-term, current generation retirements are expected to be the main driver of LOLE. This creates an opportunity to either avoid/delay retirements, or to use existing sites and grid connections for new dispatchable generation or flexibility options. These are expected to be favourable in e.g. CRM auctions, on account of economics and feasibility, without requiring specific locational incentives. In the longer term, the relevance of demand growth may increase, which is projected to be driven by electrification of industry and mobility. Proximity to industrial clusters could be stimulated through incentives, while mobility is expected to be more distributed.

International perspective: In 2020-2024, prices between BE-DE-NL have seen significant convergence. This increases relevance of establishing a level playing field for investments across these countries. Differences in grid tariffs, taxation, emission requirements and capacity markets could create uneven investments signals.

Decarbonisation: The governmental objective to decarbonise Dutch energy sector by 2040 implies that lock-in of fossil fuel generation under a CRM must be avoided. Design of a CRM should be such that it enables a path to decarbonisation while addressing short term security of supply issues.

Hedging: While a limited Hedging Obligation is in place (fixed price contracts with SME/retail customers only), the transition toward a CRM based on Hedging Obligations requires careful consideration of the interplay with the illiquid future and forwards market in the Netherlands.

[1] TenneT Monitor Leveringszekerheid 2025

Summary and conclusion

A CRM could address the missing money problem in the Netherlands if its design fits the specific needs of the market

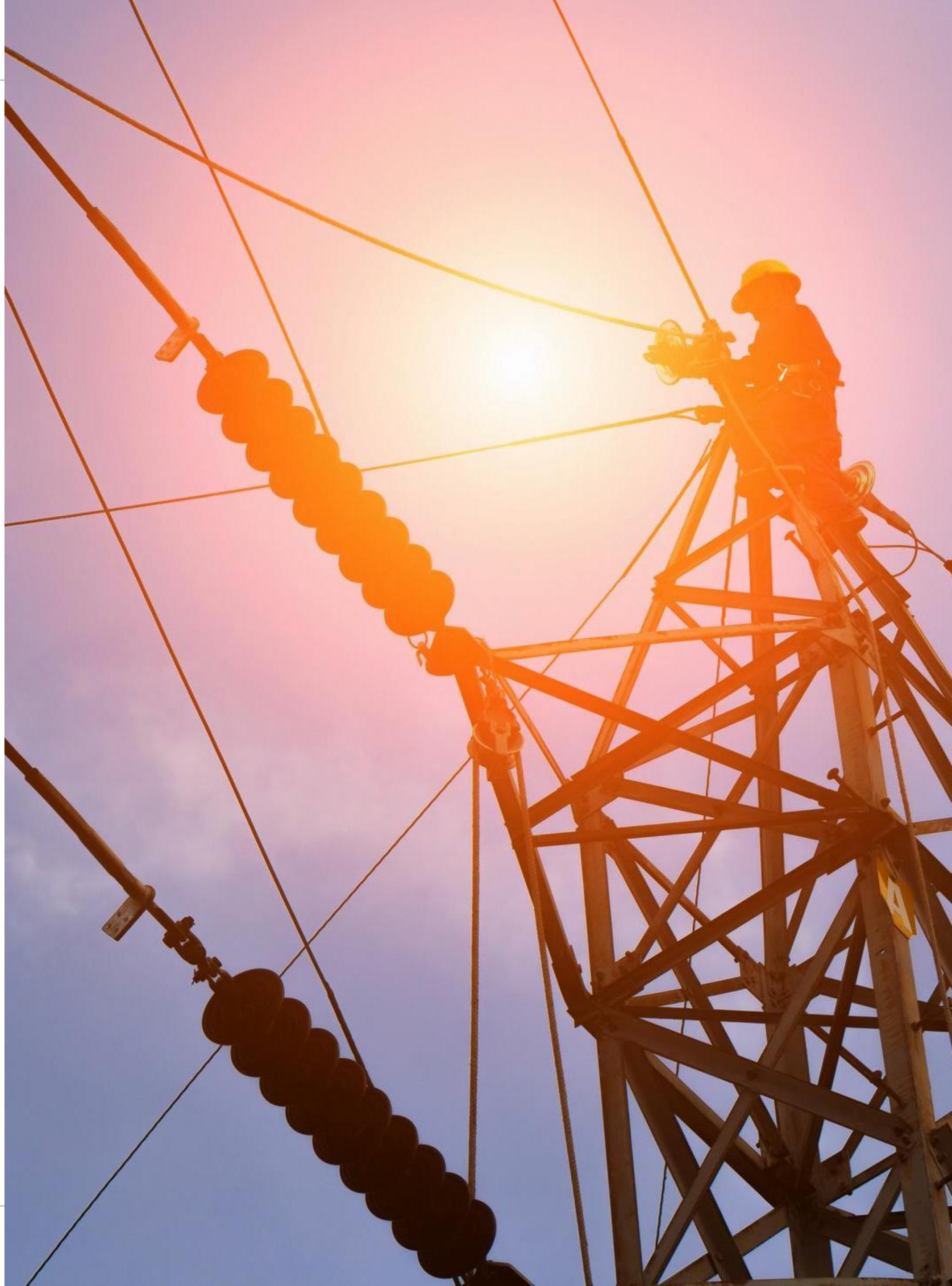
CRMs across neighbouring countries

- Security of supply covers four aspects; **resource adequacy,** transmission adequacy, demand flexibility and energy security. Resource challenges are the **primary reason for introducing a CRM**. CRMs might also partly address further aspects of security of supply.
- The **decision for a certain CRM across Europe** depends on the timing of the expected adequacy challenge, the size of the challenge (LOLE and Expected Energy Not Served (EENS)) and how structural the adequacy problem is expected to be.
- Across Europe, challenges have been arising mainly due to the **closure or economic unviability of significant capacity of dispatchable thermal generation**, leaving in meeting the demand.
- Across Europe, **missing money for assets is the main reason for introducing a central CRM** when there is a structural adequacy problem, supplemented by other reasons based on national aspects. **Uncertainty and external effect on security of supply are the main reason for introducing a Strategic Reserve**, when the challenge is expected to be more temporary.
- Most neighbouring countries of the Netherlands have implemented or are considering implementing a CRM with a **trend towards a central CRM**.

Considerations for CRM options for the Netherlands

- **Timing of adequacy challenge:** The Netherlands expects challenges after 2030. Under the base scenario in the MLZ 2025, the LOLE threshold is exceeded from 2033. A **timely decision and implementation** of a CRM is required to solve the challenge in this period.
- **Persistence and size adequacy challenge:** The expectations of the challenge in NL will be important to determine whether a **temporary or more structural solution** is required. Uncertainty around the development of the adequacy gap in the medium and longer term (size and persistence) due to uncertain technology uptake and demand developments requires certain **flexibility in its design.** But regardless of the persistence, an adequacy challenge is expected to arise in the **shorter term (by 2033) which requires a solution**.
- **Trends in existing generation / demand portfolio and projections:** Significant thermal generation capacity is expected to be mothballed in the coming years, but has not yet reached end of technical life. This **thermal capacity could be leveraged within a capacity mechanism** by improving the economic viability of this capacity.
- **New technology expectations:** Uncertainty around the and uptake of flexible technologies creates uncertainty about the implications and uptake of flexibility and storage technologies by 2035 to support system adequacy.
- **New capacity build out** is likely required as existing thermal generation phases out. As there is currently not enough incentive in the EOM to support new investments, a capacity mechanism could solve the **missing money problem and maturity mismatch** for new capacity build out. Capacity operated under a CRM should **not hinder the 2040 Dutch energy system decarbonisation goal**, e.g. by including decarbonisation requirements.
- **Level playing field neighbouring countries:** All neighbouring countries of the Netherlands have already or are discussing the implementation of a CRM. This increases the relevance of establishing a level playing field for investments across these countries. Differences in grid tariffs, taxation, emission requirements and capacity markets could create uneven investments signals.

Content



Suitable CRMs for the Netherlands

We shortlisted three CRMs from the initial longlist for further in-depth analysis based on an initial high-level assessment

Reading guide

This Chapter describes the initial high-level shortlisting process of the longlist of possible CRMs as identified in Chapter 2.

- *Section 3.1* details the shortlisting process and methodology and summarises the rationale for (de)selection of the different longlist criteria. Further detailed rationales for the (de)selection of the different longlist CRMs can be found in *Annex III*.
- *Section 3.2* gives a high-level overview of the design options of the three shortlisted CRMs. More detail on the design options for the shortlisted CRMs can be found in *Annex IV*. *Annex V* provides a detailed overview of CRM design and implementation experience with the shortlisted CRMs in selected EU countries (UK, Belgium and Germany).

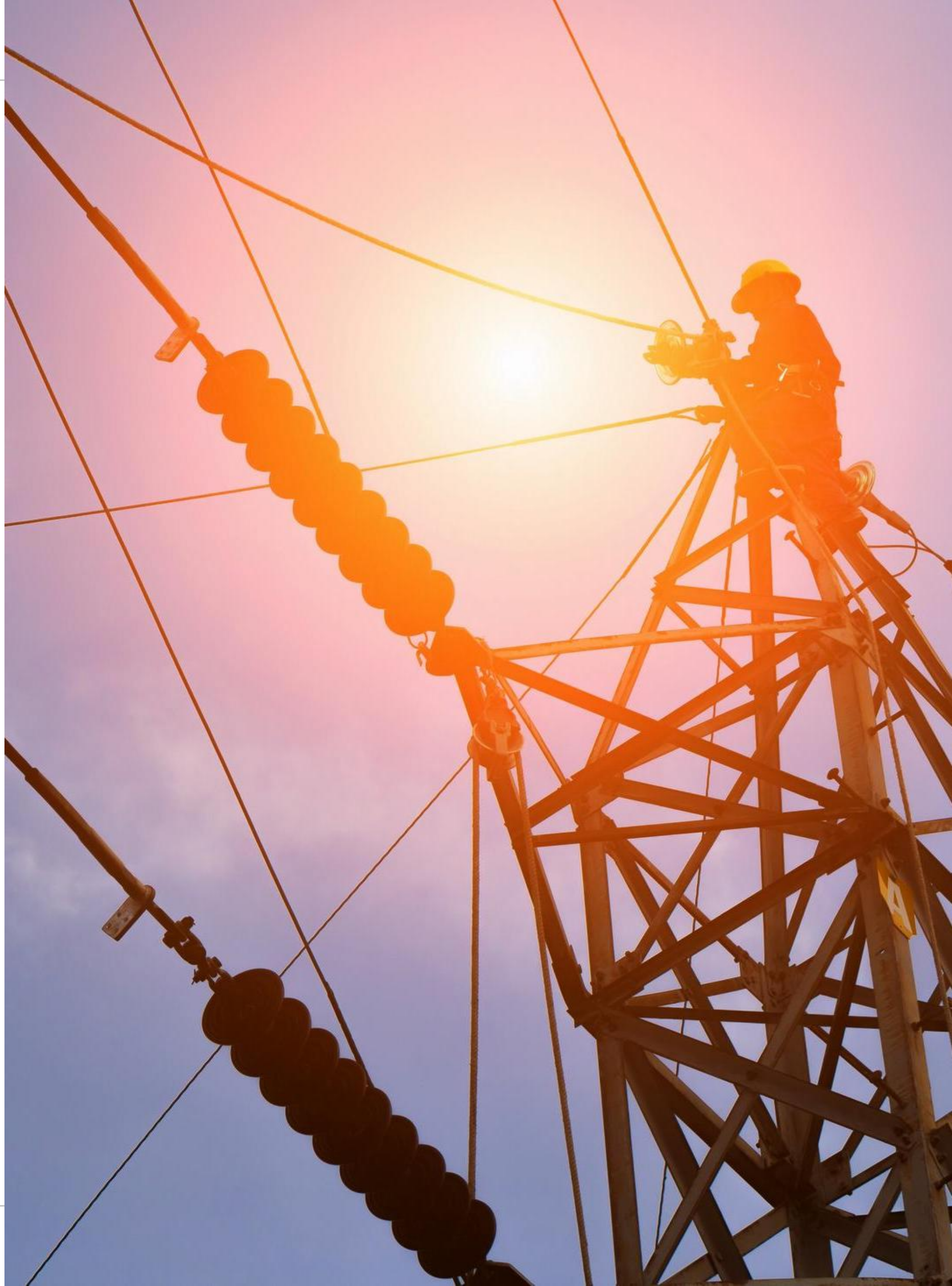
Summary

- In Chapter 2, we identified a **longlist of possible CRMs and related mechanisms** that could potentially address challenges in the Netherlands.
- We included the following **CRM mechanisms** in the longlist: Strategic Reserve, Capacity Auction, central CRM, hybrid CRM, decentral CRM and Hedging Obligation. Additionally, we included **more specific and creative mechanisms** targeted at supporting the development of certain technologies, although not capacity mechanisms in the strict definition; Non-Fossil Flexibility Subsidisation Schemes and Advanced Payments for new builds. The mechanisms in this **longlist** have different scopes and organisational characters and have been applied in different geographies.
- We identified a first set of assessment criteria to shortlist the CRMs that cover fundamental characteristics of the different mechanisms that cannot readily be steered by design variables. Further they cover important characteristics of CRMs relevant to the Dutch adequacy context; **accuracy, effectiveness, efficiency and complexity.**
- The shortlisted CRMs for further in-depth analysis in Chapter 4 include **a central CRM, a Strategic Reserve and a Hedging Obligation**. Each of these CRMs has different design options characterised by – where applicable - their capacity requirement, timing and number of auctions, auction design, reliability options, participation and prequalification requirements, products, obligations & penalties and financing.

Related step in the report approach

1. Define **long-list of possible CRMs** based on literature review, prior experiences, and the current European context of CRMs.
2. **Shortlisting** of most suitable CRMs based on initial assessment
3. **Detailed assessment** of design options and performance of the shortlisted CRMs related to the **Dutch context** based on a defined set of assessment criteria
4. Formulating **recommendations** and suggestions for next steps.

Content



Approach to shortlisting of suitable CRMs for the Netherlands

We shortlisted three CRMs for further in-depth analysis based on an initial assessment of their accuracy, effectiveness, efficiency and complexity

Initial longlist of possible CRMs and related mechanisms

In Chapter 2, we identified a longlist of possible mechanisms that could help to address the adequacy challenge in the Netherlands. We developed this longlist based on established mechanisms and ongoing discussions across Europe (e.g. in Germany) as well as a literature review.

The longlist includes the following **CRM mechanisms**: Strategic Reserve (SR), Capacity Auction (CA), central CRM (CM), hybrid CRM and decentral CRM. Additionally, we included **more specific and creative mechanisms** targeted at supporting the development of certain technologies, although not capacity mechanisms in the strict definition; Hedging Obligation (HO), Non-Fossil Flexibility Subsidisation Schemes (NFFSS) and Advanced Payments for new builds.

The mechanisms in this **longlist** have different scopes and organisational characters and have been applied in different geographies.

CRM longlist

- Strategic Reserve
- Central CRM
- Decentral CRM
- Hybrid CRM
- Capacity Auction
- Hedging Obligation
- Advance payment for new builds
- Non-Fossil Flexibility Subsidisation Schemes (NFFSS)

Approach and methodology for the shortlisting of a central mechanism, a Strategic Reserve and a Hedging Obligation

Based on this longlist, we conducted an initial high-level assessment. To create a shortlist from the eight options on the longlist, we first defined assessment criteria that are key for assessing whether the aim (resource adequacy) can be reached at minimal cost, i.e. all short-listed options should largely fulfil these criteria. The criteria are:

Accuracy SoS | Effectivity | Efficiency | Complexity

- their ability to **reliably achieve** a selected security of supply standard **(accuracy).** *The Netherlands is facing an adequacy challenge after 2030. A suitable CRM should be able to guarantee a certain level of security of supply from this period onwards to provide certainty to the market and to ensure adequacy is maintained.*
- their **effectiveness** in creating a sufficient degree of planning security for investment and solving the maturity mismatches to support investment. *In the shorter term, significant thermal capacity is foreseen to close in the Netherlands due to economic unviability. A suitable CRM should be able to cover the missing money problem of existing and new assets, and potentially solve any maturity mismatches for any required new investments.*
- their **efficiency** in ensuring security of supply at the lowest possible costs in the short term (static efficiency) and longer term (dynamic efficiency) and their interactions with the energy-only market. *A suitable CRM is able to contract what the Dutch energy system needs, both in the short- and long term. In the short-term, existing thermal generation could be incentivised to stay operational under a CRM. In addition, projections around the uptake of batteries, demand flexibility and other (innovative) new technologies requires a CRM that can accommodate also a broad range of assets and technologies.*
- their **complexity** in terms of implementation and monitoring. *As the first challenges in NL are expected to occur in the short-to medium term, a CRM should be designed and able to be implemented by that time.*

The following slide summarises the outcome of the initial assessment. A detailed overview of the rationale for the (de)selection of the longlist mechanisms is included in Annex III.

In chapter, 4 a decision on the suitability of a shortlisted CRM in the Dutch context will be made by assessing which criteria are determining factors for CRM applicability in the Dutch context (not the same criteria as used to make the shortlist).

Summary of shortlisting of CRMs

Positive criterion; **neutral criterion**; negative criterion. More details on the shortlisting rationales are included in *Annex III*.

Central CRM and Strategic Reserve shortlisted based on high-level assessment of criteria. Hedging Obligation selected as a more market-based mechanism to explore its potential for the Netherlands in the in-depth analysis.

Strategic Reserve	Central CRM	Decentral CRM	Hybrid CRM	Capacity Auction	Hedging Obligation	Advanced Payments	NFFSS
Improves SoS by contracting a limited amount of firm capacity outside the market, to be activated only in exceptional scarcity situations, resulting in reliable **SoS accuracy**. Additionally, has low implementation **complexity** in comparison to market-based mechanism. Ineffective as a long-term capacity investment driver, but may be a solution for a temporary missing money problem (**effectivity**). **Efficiency** is moderate as not technology-neutral.	**Effective** and established model which can be adapted to the Dutch model. **SoS accuracy** can be reliably achieved, and mechanism enables adjusting procured capacity rapidly in response to changing expectations of load and generation growth. **Efficiency** depends strongly on design, e.g. competitive auctions, inclusive pre-qualification rules, transparent de-rating factors, and appropriate contract durations. CM are moderately **complex** in implementation and administration.	Relatively flexible mechanism based on decentral decisions. Internalisation of costs to electricity prices could be an **efficient** way to distribute costs to the Dutch consumers and society. However, **effectiveness** regarding resource adequacy is uncertain, and the mechanism may not address the underlying challenges for the market. As capacity is decided by suppliers, this increa-ses uncertainty of the amount procured (**accuracy**). Extensive administration makes it **complex**.	Central system with decentral elements. Provides effective investment signals via long-term capacity contracts, similar to a CM (**efficiency**). However, level of **accuracy** is unclear, and benefit of long-term innovation-friendliness is questionable. In addition, a hybrid CRM comes with a high degree of **complexity** and is not yet tested. The central segment tends to dominate investment signals, crowding out the decentral segment and skewing price and participation (**efficiency**).	A Capacity Auction is designed to address shorter term capacity scarcity, potentially at specific locations – however, long-term **effectiveness and accuracy** is not ensured as crowding-out effects may occur (see slide 51). **Efficiency** of a CA is uncertain as it can achieve good static efficiency. However, if designed technology-specific (as currently planned in the German proposal), this can affect efficiency negatively. **Complexity** is moderate (less for participants, more for the State aid approval process).	Can be seen as a reinforcement of the EOM and may pose a more market-oriented solution compared to other CRM types (**efficiency**). However, the **effectiveness** regarding resource adequacy is not ensured as there is no direct relation to physical assets, and the mechanism may not address the underlying challenges for the market. It is an unproven mechanism in Europe, so its **SoS accuracy and complexity** are uncertain.	Market-wider resource adequacy is only addressed implicitly and partly (**SoS accuracy**). **Effectiveness** is questionable as it only addresses a maturity mismatch for specific assets required for redispatch but does not address further aspects like missing money. Might be **efficient** for well-identified grid bottlenecks, however, the instrument is only rated neutral as it is not open for all technologies. Its **complexity** is limited.	NFFSS are reasonable for supporting flexibilities in the system and thereby changing the technology mix (if not substituting investment into flexibilities considered outside the scheme). However it induces crowding out effects (see slide 51) on capacities not captured, hence it cannot **effectively** guarantee resource **adequacy**. **Efficiency** of an NFFSS is uncertain as it limits static efficiency. Its **complexity** is limited.
Shortlisted	**Shortlisted**	**Not shortlisted**	**Not shortlisted**	**Not shortlisted**	**Shortlisted** despite rather low rating to include a more market-oriented mechanism in the detailed assessment	**Not shortlisted**	**Not shortlisted**

Crowding-out effect in case of Capacity Auctions and NFFSS

Crowding-out effect negatively affects effectiveness of a mechanism as resource adequacy will not be increased significantly

Chain of effects of a targeted subsidy scheme on EOM

Primary effects

Subsidisation schemes lead to **increased capacity**

Price peaks on EOM are **less frequent** and **lower** (average price level decreases)

Secondary effects

Profitability of investments outside subsidy scheme **decreases**

Crowding out effect: Available capacity is similar to those at the start, only technology mix may change

Illustration of the crowding-out effect

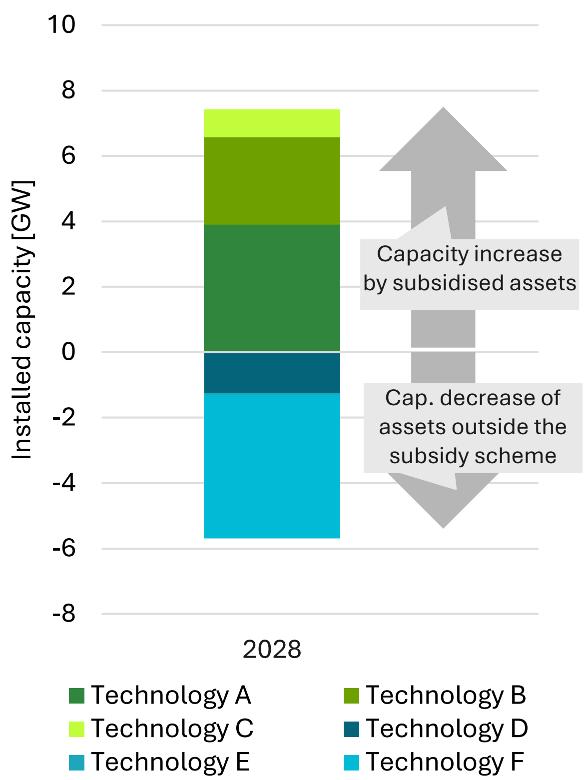
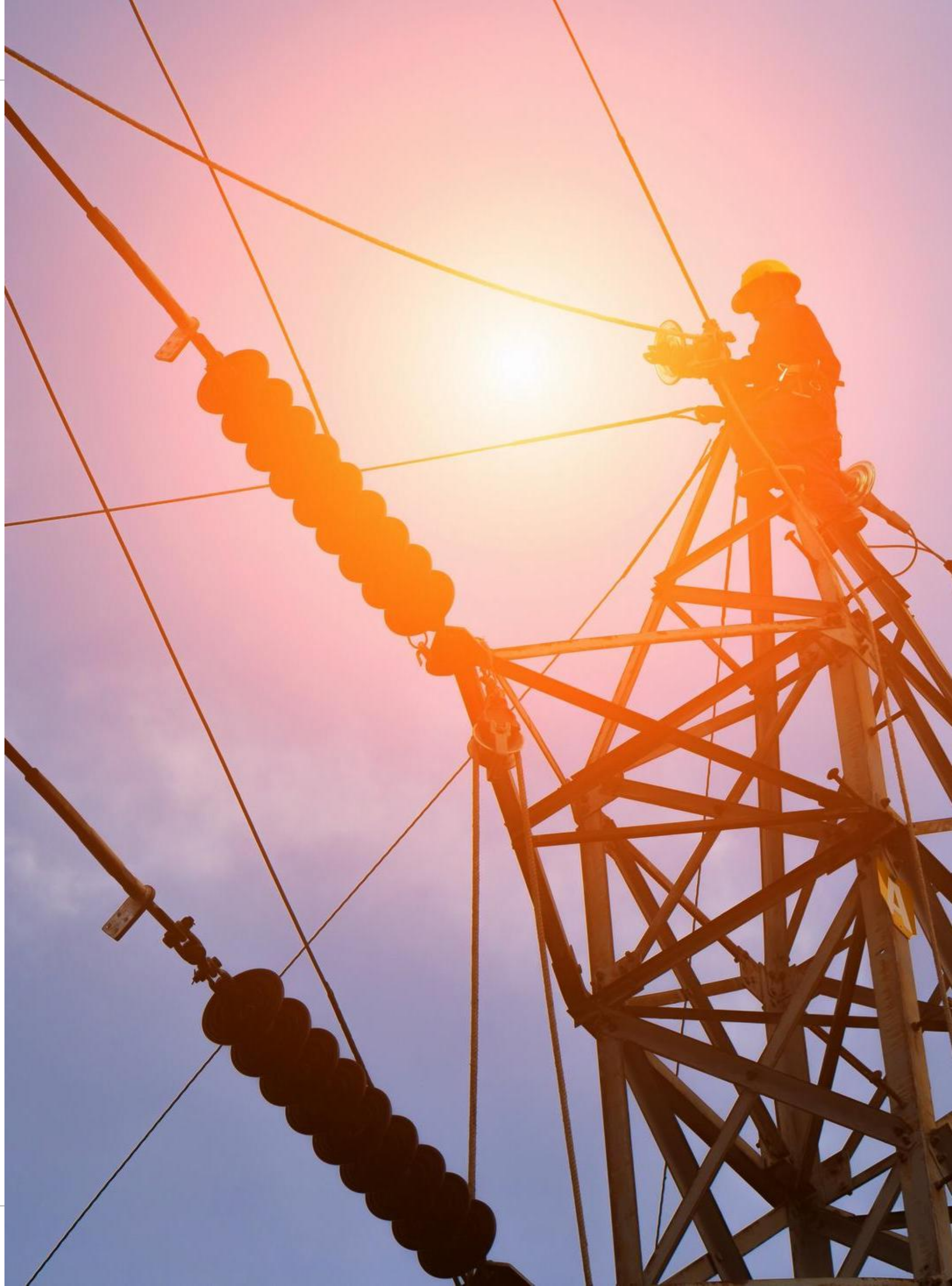


Figure 11: Modelling of the crowding-out effect for the German market by Frontier Economics

- We assume that certain subsidised conventional technologies (A-C) enter the German EOM from 2025 onwards & compare this to a situation without subsidy.
- We analysed the effects of the subsidy on installed capacity in 2028 with our energy system model COMET.
- Results show that in 2028
  - **Increase** of capacity of subsidised technologies A, B and C **by 7.4 GW**
  - **Lower investment** in other technologies D, E and F **by 5.7 GW**
  - **Total positive effect** is rather **low (1.7 GW**, i.e. 23 % of total subsidised capacity), only technology mix changed
- **Key take away:** If non-fossil flexibility, e.g. battery and DSR, is subsidised, this may negatively impact investments in other technologies (as shown here) but also investment in these technologies outside the support schemes.

Content



Guidehouse frontier economics

CRM design options: design variables

CRMs are designed based on a set of design variables. Design options for the shortlisted CRMs can be described along eighth design variables, where applicable

CRM design options

The design options for the shortlisted CRMs are described along eight design variables. Detailing of the design variables is done based on experience with CRM design in neighbouring countries (see also Annex V on specific country case studies) and team's experience in this field.

The design options are tailored towards implementing the CRM in the Dutch context, taking into account the Dutch market conditions and CRM requirements.

The design options will be used for the detailed assessment of the CRMs using the assessment framework in Chapter 4.

The following slides provide the high-level design for the central CRM, Strategic Reserve and Hedging Obligation. **More details on design options are included in Annex IV.**

Note that the design options are not intended as detailed modelling and quantification.

Design variables of a CRM

Definition of capacity requirement	▪ How is the capacity requirement determined? ▪ Is there differentiation between new and existing assets?
Timing and no. of auctions (if applicable)	▪ When will the capacity be tendered or certificates traded (e.g. in T-4, T-1)? ▪ How often will auctions take place?
Auction design (if applicable)	▪ Pay as cleared vs. pay as bid ▪ Price caps ▪ Locational incentives/restrictions
Reliability options (if applicable)	▪ Potentially: Definition of Reliability options and determination of the case of "excessive profits"
Participation and prequalification	▪ Obligatory or voluntary participation ▪ Prequalification criteria (e.g. min. capacity, network level, CO_2 limits, regional limitations, technologies) ▪ De-rating factors for technologies*
Products	▪ Differentiation of contract duration e.g. for new, refurbished or existing assets
Obligations and penalties	▪ Who is obliged and what are the conditions to be fulfilled? ▪ Do penalties exist and how are they set?
Financing	▪ Levy vs. state budget vs. rolling costs into electricity prices ▪ Dealing with existing funding mechanisms

*see for more details on de-rating, slide 143 in Annex IV: Detailed design options shortlisted CRMs.

Central CRM design options (1/2)

High-level description of basic design elements of the central capacity remuneration mechanism

Design variable	Central CRM design options
Definition of capacity requirement	▪ A **central authority determines the total capacity demand** (to be covered by new and existing assets) for a period of usually **5-7 years ahead.** ▪ The level reflects the **expected peak load during this period, including a safety margin**, and is based on resource adequacy analyses of future peak loads. For fast-track approval, it must at least comply with the ERAA conducted by ENTSO-E under Article 23 of Regulation (EU) 2019/943.[1]
Timing and no. of auctions	▪ Total capacity demand will be tendered centrally in **joint auctions for all technologies** (incl. DSR). ▪ Usually, **at least two auctions with different lead times**, e.g. one auction long before delivery (e.g. in t-4) and one closer to delivery (e.g. in T-1). ▪ **For fast track of State aid application**: 75%-90% of the estimated target demand for the delivery window should take place 4-6 years ahead of delivery.
Auction design	▪ **State aid fast track process:** bids in EUR/de-rated MW/year are the only criterion in the selection process (see CISAF in Annex II). ▪ **Pay-as-cleared and pay-as-bid both applicable**, but for State aid fast track process: pay-as-cleared (see CISAF in Annex II). ▪ If relevant, **price/bid caps possible** (e.g. one for all and one for existing assets) to prevent market power being exercised or to limit inframarginal rents. ▪ **Regionalisation possible**, e.g. via entry requirements (command or prohibition), regional shares or regional bonuses.
Reliability options	▪ A reliability option can be a solution to **prevent excess profits** by capacity providers, but needs to be regularly reviewed/adjusted.
Participation and prequalification	▪ **Participation only for prequalified participants**, but simplifications for certain technologies possible. ▪ **Prequalification criteria** can cover e.g. a minimum capacity, network level, CO_2 limits (see CISAF in Annex II for State aid fast track), regional limitations, technologies allowed to apply → depending on design (e.g. via avoiding high minimum capacity, allowing aggregation and simplifying prequalification criteria for flexibilities) effectiveness of implementation of mandatory **technology-neutrality** might differ. At least, **integration of new technologies may be challenging** due to prequalification criteria set years in advance before delivery. ▪ **Participation** can be **obligatory** or only **voluntary** (distinctions e.g. between different technologies possible). Foreign participation via interconnectors possible and EU requirement. ▪ **De-rating*** is applied, and de-rating factors are determined by the central authority (but self-de-rating – i.e. capacity providers determine their own de-rating factors – is also possible to take heterogeneous characteristics of assets into account). **For a fast-track State aid process**: de-rating factors must generally **correspond to the ERAA assumptions for the central reference scenario** (see CISAF in Annex II).

[1] European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final. In the following, we refer to this as CISAF. *see for more details on de-rating, slide 143 in Annex IV.

Central CRM design options (2/2)

High-level description of basic design elements of the central capacity remuneration mechanism

Design variable	Central CRM design options
Products	▪ **Central authority determines the contract terms** of the product, i.e. contract duration and lot sizes. ▪ The **contract duration** of the capacity products influences the participation of new builds or retrofits. A distinction is typically made between products for **existing** plants (contract term of **1 year**), **retrofits** (contract term of **3 to 8 years**) and **new** plants (contract term of **up to 15 years – also max. duration for fossil-fuelled generation assets in fast track of State aid approval**, see CISAF Annex II). ▪ **Certain reliefs**, e.g. on lot sizes, for smaller decentralised technologies required to ensure technology-neutrality.
Obligations and penalties	▪ Allocated capacity providers are obligated to keep/make capacity available (interdependencies with limitations from network access rights, e.g. non-firm ATR 85 connection agreements, needs to be considered). ▪ Obligation to keep the **allocated (de-rated) capacity technically available** for the entire duration of expected periods of shortage. ▪ **Penalty for non-availability** (generators): Amount determined considering the risk of undersupply and penalties incurred through no fault of the provider.
Financing	▪ Financing via **national budget (tax)** or **levy** on e.g. BRPs or end consumers possible. The levy can be static or dynamic (indexed to demand during scarcity hours). ▪ For **a fast-track State aid approval:** the levy must be dynamic, as at least 90% of the costs of the CM must be allocated to consumers on the basis of their consumption during the 1-5% highest price periods per year (see CISAF Annex II). Charges may be levied on BRPs.

Strategic Reserve design options

High-level description of basic design elements of Strategic Reserve mechanism

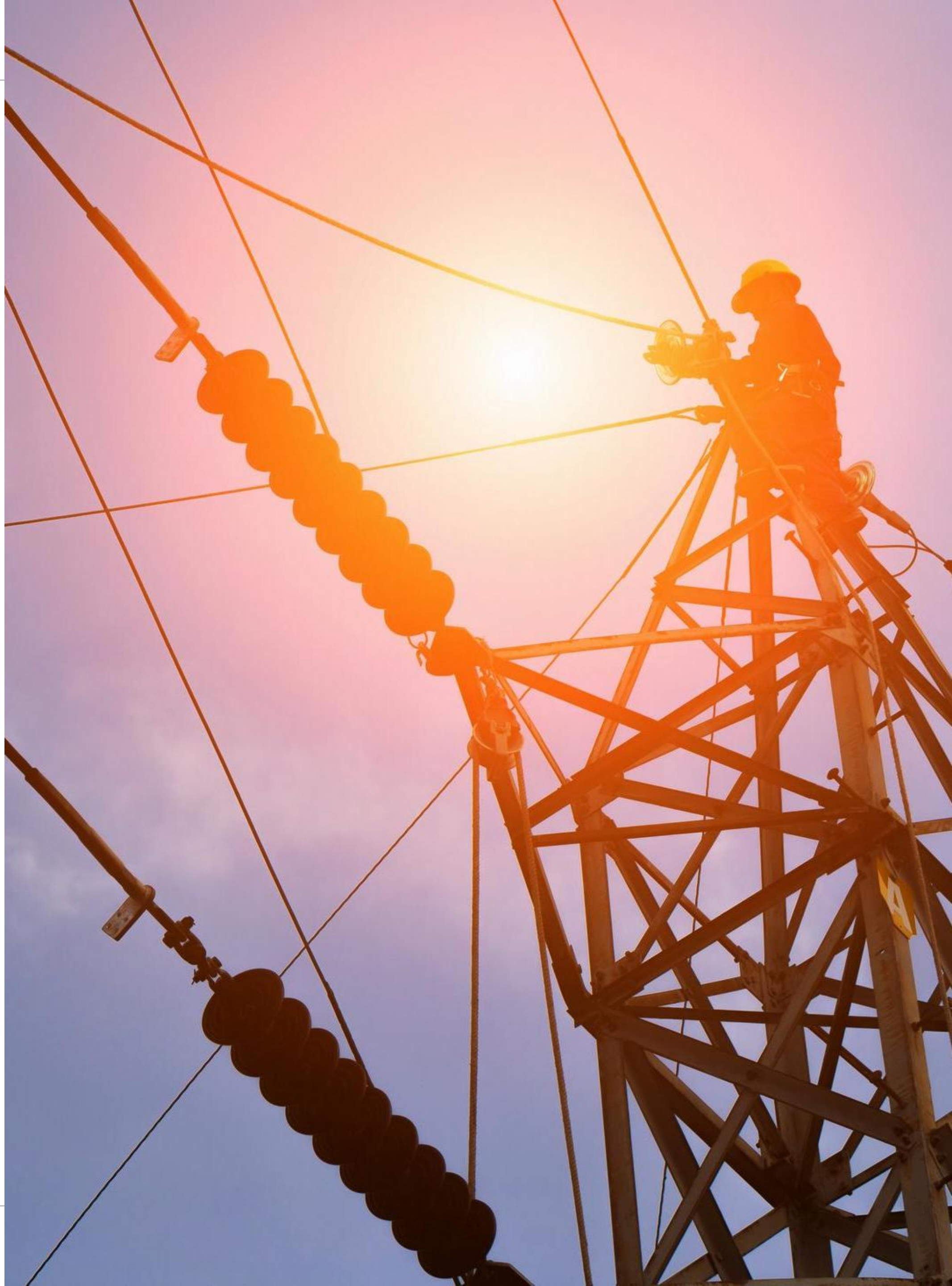
Design variable	Strategic Reserve design options
Definition of capacity requirement	▪ A **central authority** defines the amount of capacity (MW) to be contracted based on resource adequacy studies. ▪ **Typically, only a small fraction of peak load** is finally determined to address residual adequacy risks in extreme scarcity events. Accordingly, a SR will, by definition, rarely be activated.
Timing and no. of auctions	▪ **Central tendering** in joint auction. ▪ One tender per **delivery period** (covering between **1-2 years**) with a **lead time usually 1–2 years** before delivery.
Auction design	▪ **Centralised, one-sided auction** (by TSO/regulator). ▪ **Pay-as-cleared and pay-as-bid both applicable**, price/bid caps possible; regionalisation optional. ▪ **Reservation fee (€/MW/a)**, additional activation payment (€/MWh) possible.
Reliability options	▪ Reliability options in the strict sense are not used in Strategic Reserves as assets are **not participating in the EOM**. ▪ Instead, **availability obligations and penalties** provide the reliability signal (see obligations and penalties).
Participation and prequalification	▪ **Voluntary** participation, but usually not technology neutral. While a SR can be open to existing as well as new assets, competition is usually mainly expected to come from **existing generation** plants, **existing and new DSR, storages and gas turbines**, given the high costs associated with building a new generation plant and rather short contract durations. State aid guidelines require **cross-border participation if feasible** (i.e. no obligation). ▪ **Participation only for participants, which fulfil certain technical requirements (prequalification criteria).** These can cover e.g. min. capacity (>1 MW), CO_2 limits, start-up/ramp-up requirements. No formal de-rating, but technical requirements and availability criteria apply.
Products	▪ Reserve contracts **remunerate the availability of capacity** that is withheld from the wholesale market, activated only during scarcity (e.g. if day-ahead or intraday market fails to clear). ▪ Typical contract duration 1-3 years, but a fast-track State aid approval requires 1 year.
Obligations and penalties	▪ Providers receive a fixed reservation fee (€/MW/year) and have to guarantee **technical availability of the reserve during scarcity** (interdependencies with network access rights, e.g. non-firm ATR 85, needs to be considered)**.** Operational readiness of the contracted capacities is **verified via test calls.** ▪ Penalties must be paid for **non-availability**. For fast-track State aid approval, penalties have additional requirements (e.g. technological neutrality). ▪ Option to implement a **no-return rule** (as e.g. in Germany), i.e. after reserve contract ended, the capacity cannot return to the EOM.
Financing	▪ Costs are **borne via a surcharge on the transmission system operator's grid tariff or a levy** on e.g. BRPs or end consumers. ▪ **Tax-based financing of reserve provision** also possible in principle, but consumption-based financing is preferred for reasons of State aid law.

Hedging Obligation design options

High-level description of basic design elements of the Hedging Obligation

Design variable	Hedging Obligation design options
Definition of hedging requirement	▪ Hedging Obligation applies to **all BRPs** (i.e. all consumers and suppliers that manage demand in balancing groups). ▪ Obligation can be **based on sales or measured peak load**. Gradual increase up to 100% before delivery.
Timing and no. of auctions	▪ **No central auctions.** ▪ **Obligation coverage** builds up from 36 months before delivery.
Auction design	▪ **Compliance** can be met by buying/selling hedging products on existing markets (exchange), bilateral contracts (e.g. via OTC or Long-Duratio) or by self-fulfilment. Accordingly, the rules applicable in the respective markets apply. ▪ **Firmness framework** for reflecting substitution possibilities (see slide 155, Annex IV for more information on the firmness framework) .
Reliability options	▪ A reliability option is **usually not considered** as part of a Hedging Obligation.
Participation and prequalification	▪ On the **demand side, all BRPs** are obliged to hedge their electricity demand. ▪ On the **supply side, participation should be open to all technologies** and financial traders. Generation, storage, DSR or purely financial counterparties can sell the required products based on their “firmness”.
Products	▪ Three different ways of **hedging** for BRPs: standard futures, OTC contracts, or self-fulfilment. ▪ Compliance can be **portfolio-based.**
Obligations and penalties	▪ Obligation: BRPs of demand-side balancing groups have to **continuously comply**. ▪ Monitoring: the obligation is **monitored by the State or a State-commissioned agency**, this could be supported by an automatic reporting. ▪ **Penalties**: under-coverage in any interval is penalised (linked to market prices).
Financing	▪ The costs for hedging becomes **part of the regular energy price component for end customers**, which neither burdens the federal budget nor requires explicit (further) subsidies or levies.

Content



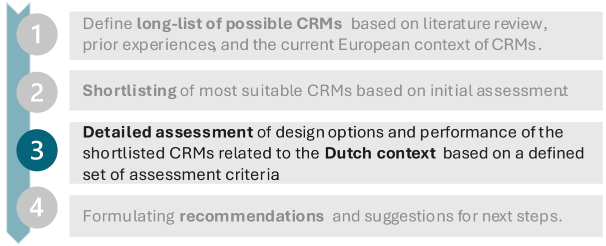
Assessment of shortlisted CRMs on their suitability for the Netherlands

We analysed the shortlisted CRMs along nine assessment criteria. A SR and CM are CRMs which could best fit the Dutch context, depending on the relative weight of assessment criteria

Reading guide

This Chapter describes the assessment criteria and presents the in-depth assessment of the three shortlisted CRMs (CM, SR and HO). It provides conclusions on the relative weight of the assessment criteria in the Dutch context to inform the recommendations in Chapter 5.

- *Section 4.1* summarises the criteria used for the assessment. Next to a further in-depth assessment of accuracy of SoS, effectivity, efficiency and complexity, we analysed five more criteria in detail. *Annex VI* includes further details on the assessment framework.
- *Section 4.2* details the in-depth assessment of the three shortlisted criteria along the nine assessment criteria. The conclusions of this section tie the outcomes of the assessment to Dutch context to inform the recommendations in Chapter 5.

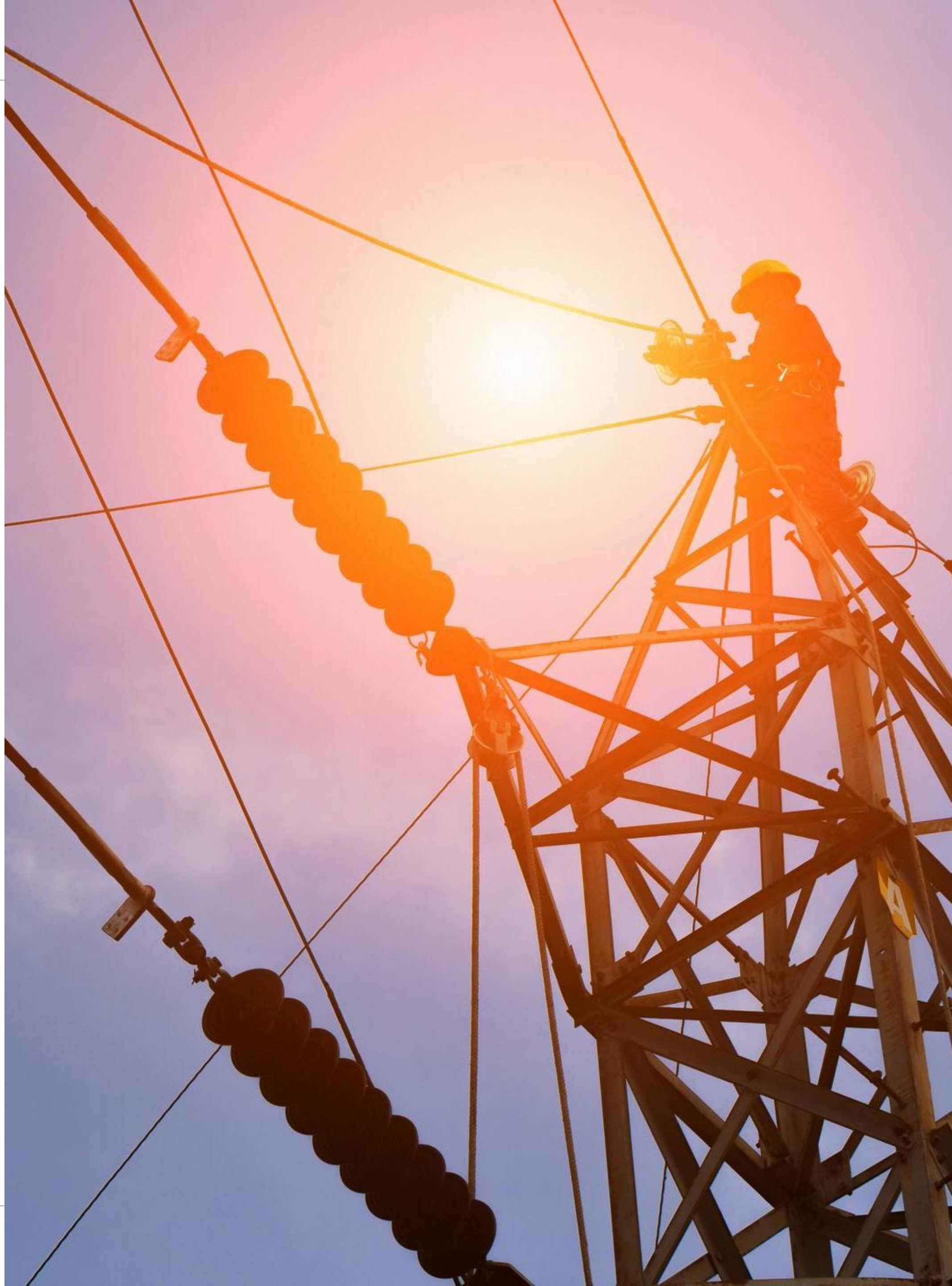


Related step in the report approach

Summary

- In Chapter 2, we shortlisted three CRMs for further in-depth analysis in this Chapter; a central CRM, a Strategic Reserve and a Hedging Obligation. This shortlist was based on an initial high-level assessment based on four criteria: **accuracy, effectiveness, efficiency and complexity.**
- In this Chapter, we conducted an in-depth assessment along nine assessment criteria. Next to a detailed assessment of **accuracy, effectiveness, efficiency and complexity**, we also analysed the shortlisted CRMs on their ability to include locational signals, financing and cost aspects, timeline, system decarbonisation and flexibility to adapt. We defined a detailed assessment framework for our assessment.
- Our assessment concludes that a central CRM and Strategic Reserve have advantages in the Dutch context, depending on the energy system developments, while a HO by itself is unlikely to reliably address the adequacy challenge.
- When weighing the societal **costs and benefits** impact of CRM design options, the explicit CRM costs need to be weighted against the impact on price peaks, price volatility and reduced EENS (supply shortages on the system and society when not implementing a CRM). Quantification could be done at a later point in the CRM decision, design and implementation process (see also section 5.2). **The weight of the different assessment criteria in the Dutch context is ultimately a political decision.**
- When looking at the situation in the Netherlands, the following criteria are most pressing and decisive in make a decision regarding the suitability of a CRM: **effectivity, efficiency, timeline and flexibility. The other criteria are more driven by design choices, and their relative importance (weighting) involves a political decisions.** We have used these four decisive criteria to recommend a scope of action for KGG in Chapter 5.
- At this stage in the CRM discussion in the Netherlands, it is important to understand the pros and cons, design options and suitability of selected CRM types for the Netherlands. **Detailed modelling and quantification is not part of this study** and can provide more insights at a later stage in the CRM decision, design and implementation process. In addition, societal benefits of CRMs are not always readily quantifiable therefore the weighting of certain criteria involves a political decision.

Content



Assessment approach

We defined a detailed assessment framework to analyse the shortlisted CRMs along nine criteria

Assessment framework

We developed a list of nine assessment criteria to evaluate the performance of the shortlisted CRMs in more detail. Including a more detailed assessment of the four criteria used for the shortlisting (accuracy, efficiency, effectivity and complexity), the following assessment criteria are used:

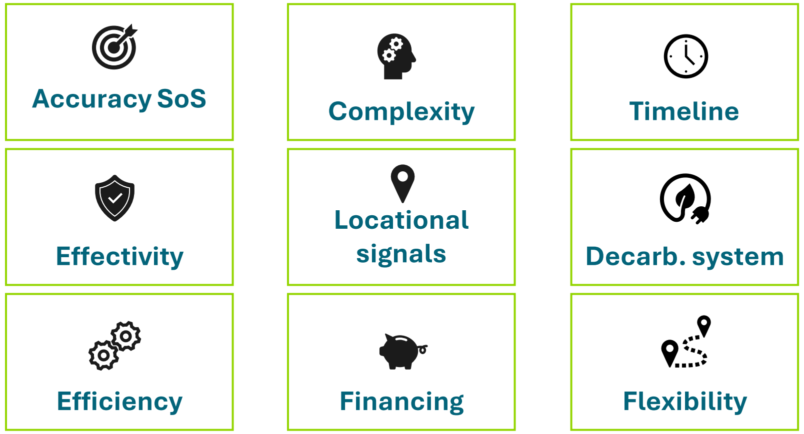


Figure 12: Criteria for the assessment of shortlisted CRMs.

The following slides further detail the criteria. Annex VI describes the assessment framework including when a criterion is considered positive or negative.

In-depth assessment

Section 4.2 details the in-depth assessment per criterion. Per criterion we provide an overview of the characteristics of each of the shortlisted CRMs, followed by further deep dive slides where relevant. This section ends with a summary of the scoring of the shortlisted CRMs for the different criteria and an overall conclusion on the suitability of a CM, SR and HO in the Dutch context.

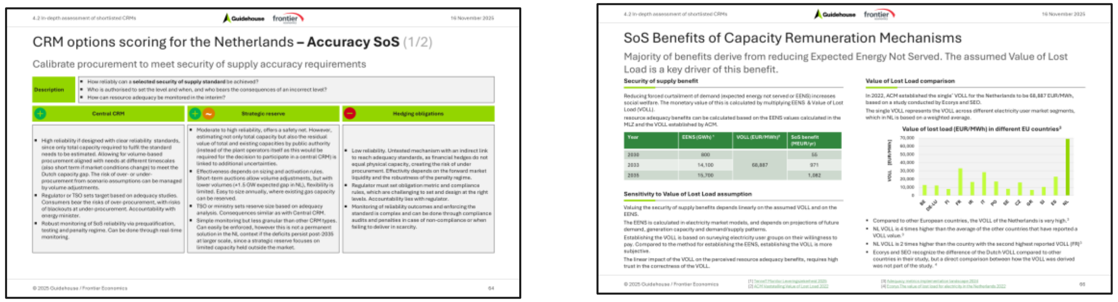


Figure 13: Illustrative example of the assessment slide and deep dive slides.

There are several dependencies between the aim of a CRM and its design, and the interplay with the market and regulation. The implementation of the CRM must be aligned with the expectations around the development of the in the Netherlands in the short to medium term time horizon as well as effectivity and efficiency of the mechanism. At the same time, there are many uncertain energy system developments to adapt to, such as demand growth, renewable rollout and the economic viability of existing dispatchable power generation assets. We translated the Dutch context to a set of decisive assessment criteria in making a decision on the suitability of a CRM in the Netherlands.

Assessment criteria (1/2)

Criteria*	Description
Accuracy SoS	■ How reliably can a **selected security of supply standard** be achieved? ■ Who is **authorised to set the level and when**, and who bears the consequences of an incorrect level? ■ How can resource adequacy be **monitored** in the interim?
Effectivity	■ Can a sufficient degree of planning **security for investments** be created? Can the measure provide investment signals to market participants for new builds and capital-intensive conversion/retrofit of existing plants? ■ Can the problem of **maturity mismatches** be solved? Are the contracts long-term enough to effectively support investment? Is the gap that needs to be filled long-term or short-term? Do timelines align in this regard?
Efficiency	■ Is resource adequacy ensured at the lowest possible cost in the short-term (**static efficiency)**, via ensuring productive and allocative efficiency (i.e. an efficient technology mix) at a certain moment in time? ■ Is cost efficiency ensured in the longer term (**dynamic efficiency**)? That means how **innovation-friendly** is the system and how easily can the system flexibly react to uncertainties in future developments? ■ How is the balance between market-based instruments/incentives and state interventions met? ■ Are **distortions** to be expected in the **energy market**?
Complexity	■ Is the **complexity as low as possible** in order to ensure comprehensibility for all market participants and minimise implementation and enforcement costs? ■ Are **processes/responsibilities/obligations and penalties** clear and understandable, in particular: who determines the required capacities, which market participants enter into which obligations, who bears which risks? ■ How '**feasible**' is the model (parameterisation & monitoring effort, compatibility with EU regulations, interactions with neighbouring countries)? How high are the **implementation and monitoring cost**?

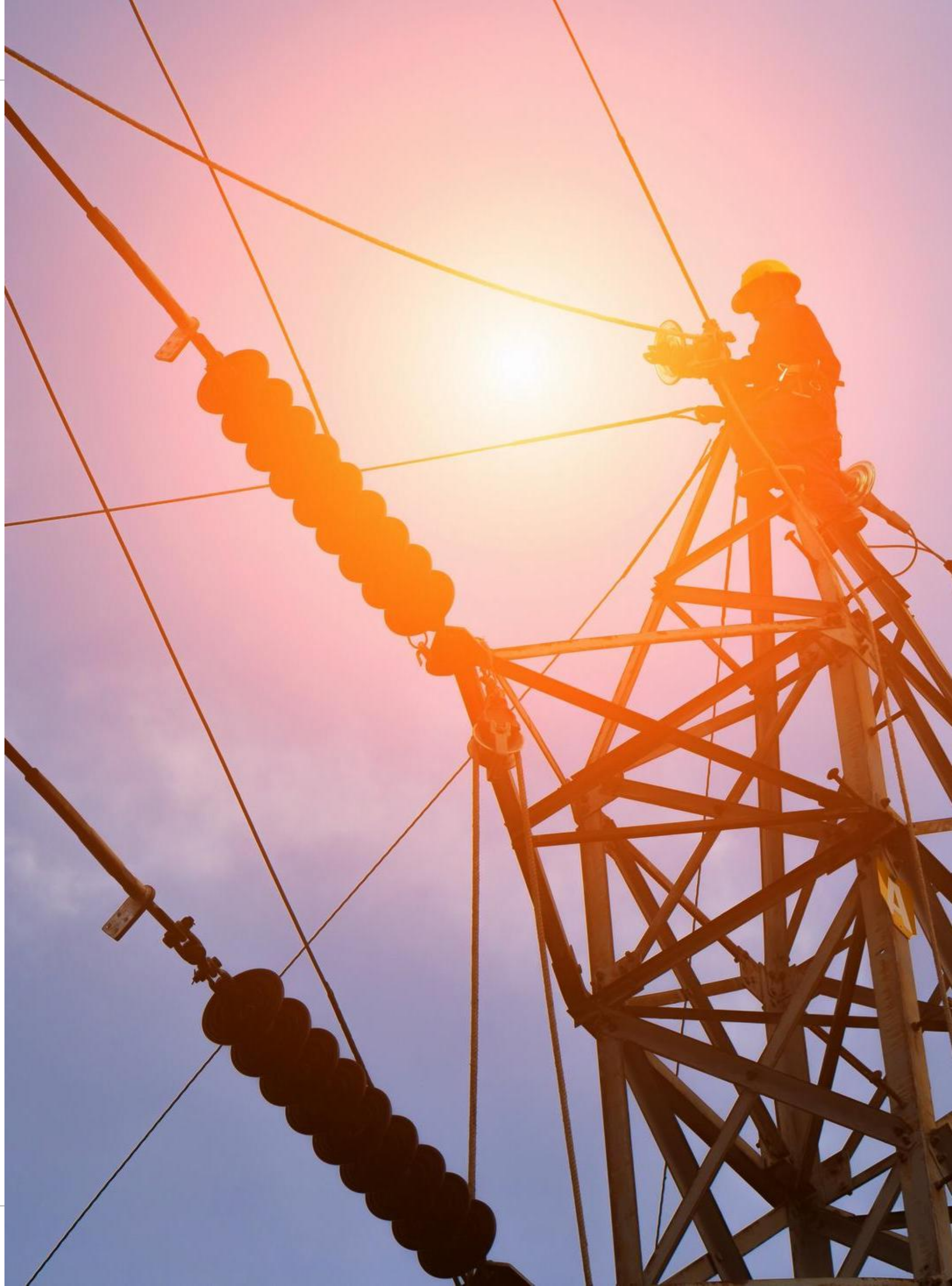
* Interdependencies have to be considered, e.g. between the effectivity and the timeline – does the mechanism kick in early enough; or between complexity/cost of implementation and timeline.

Assessment criteria (2/2)

Criteria*	Description
Locational signals	▪ Can the model provide **local signals** if needed , i.e. can capacity be geographically differentiated, or how complex would it be to add a local/regional component? ▪ Can the mechanism incentivise **additional capacity in congestion-prone areas**? ▪ What would be the effect of locational signal on **cross-border participation**?
Financing	▪ What are the CRM total explicit **costs** and how will these be **refinanced**? Is the financing considered secure and fair, to promote social and political support? ▪ Who will bear the costs? Is the **mechanism designed according to the 'polluter pays' principle –** meaning that those responsible for creating a peak load or stress event bear the cost? ▪ Can **interdependencies with existing subsidies** be taken into account?
Timeline	▪ What is the **required timeline for design and implementation** and **factors affecting**? How long is the time for State aid approval expected to be, if required? ▪ If the mechanism is in place, the timeline covers the process from publication of concept tender to closure of final tender, awarding tender and optional construction time.
Decarboni-sation system	▪ **To what extent does the CRM support the transition to a carbon- electricity system?** Are low-carbon technologies eligible and competitive? Can prequalification criteria include emission thresholds or clean fuel requirements? ▪ Does the mechanism **risk lock-on of fossil assets** or prolonging lifetime of high-emission plants? ▪ Are there synergies or conflicts with existing RES policies?
Flexibility	▪ Is there a risk of **structural dependence** on a CRM? How complex would it be to discontinue the CRM if it proves to be unsuitable? ▪ Is the mechanism **flexible to adjust to changing external circumstances**? Can procurement volumes or parameters be updated regularly?

* Interdependencies have to be considered, e.g. between the effectivity and the timeline – does the mechanism kick in early enough; or between complexity/cost of implementation and timeline.

Content



CRM options scoring for the Netherlands – **Accuracy SoS** (1/2)

Calibrate procurement to meet security of supply accuracy requirements

Description

- How reliably can a **selected security of supply standard** be achieved?
- Who is **authorised to set the level and when**, and who bears the consequences of an incorrect level?
- How can resource adequacy be **monitored** in the interim?

+ Central CRM	+ ~ Strategic Reserve	– Hedging Obligations
■ High reliability if designed with clear reliability standards, since only total capacity (plus safety margin) required to fulfil the standard needs to be estimated. Allowing for volume-based procurement aligned with needs at different timescales (also short term if market conditions change) to meet the Dutch . The risk of over- or under-procurement from scenario assumptions can be managed by volume adjustments. ■ Regulator or TSO sets target based on adequacy studies. Consumers bear the risks of over-procurement, with risks of blackouts at under-procurement. Accountability with energy minister. ■ Robust monitoring of SoS reliability via prequalification, testing and penalty regime. Can be done through real-time monitoring.	■ Moderate to high reliability, offers a safety net. However, estimating not only total capacity but also the residual value of total and existing capacities by public authority (instead of the plant operators itself as this would be required for the decision to participate in a central CRM) is linked to additional uncertainties. ■ Effectiveness depends on sizing and activation rules. Short-term auctions allow volume adjustments, but with lower volumes (±1.5 GW projected in NL), flexibility is limited. Easy to size annually, where existing gas capacity can be reserved. ■ TSO or ministry sets reserve size based on adequacy analysis. Consequences similar as with central CRM. ■ Simple monitoring but less granular than other CRM types. Can easily be enforced, however this is not a permanent solution in the NL context if the deficits persist post-2035 at larger scale, since a Strategic Reserve focuses on limited capacity held outside the market.	■ Low reliability. Untested mechanism with an indirect link to reach adequacy standards, as financial hedges do not equal physical capacity, creating the risk of under procurement. Effectivity depends on the forward market liquidity and the robustness of the penalty regime. ■ Regulator must set obligation metrics and compliance rules, which are challenging to set and design at the right levels. Accountability lies with regulator. ■ Monitoring of reliability outcomes and enforcing the standard is complex and can be done through compliance audits and penalties in case of non-compliance or when failing to deliver in scarcity.

CRM options scoring for the Netherlands – **Accuracy SoS** (2/2)

Calibrate procurement to meet security of supply accuracy requirements

Description

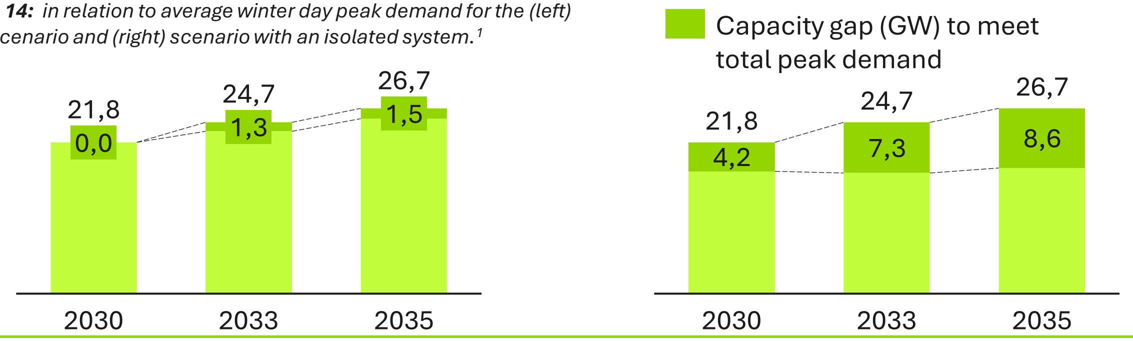
- How reliably can a **selected security of supply standard** be achieved?
- Who is **authorised to set the level and when**, and who bears the consequences of an incorrect level?
- How can resource adequacy be **monitored** in the interim?

Zoom-in: in relation to peak demand

Derived from the EENS in the MLZ 2025, the in NL is expected to grow after 2030 to around 6% of peak winter day (see Chapter 2). This gap is driven by a decline in conventional controllable capacity combined with an expected increase of peak demand of 13% between 2030 and 2035.

The derived in the Netherlands is also heavily affected by supply and demand developments in neighbouring countries. In an isolated system, the would already be 4.2 GW (19% of peak demand) in 2030, increasing to 8.6 GW in 2035. This demonstrates the uncertainty around how structural the in NL will be towards and after 2035. Although renewable generation and storage capacities are expected to significantly increase during this time, this growth is likely insufficient to fully offset the rising demand and loss of dispatchable capacity, highlighting the need for action to ensure supply security.

Figure 14: *in relation to average winter day peak demand for the (left) base scenario and (right) scenario with an isolated system.*[1]



Sub conclusions

- A central CRM is the most precise compared to SR and HO for hitting the 4h LOLE standard over various timescales; over-procurement risk is manageable via the auction mix and volume adjustments.
- A Strategic Reserve can help to address smaller, short-term accuracy challenges in the early 2030s, acting as a safety net, but lacking granularity and long-term suitability if deficits persist beyond 2035.
- A Hedging Obligation has low reliability due to its indirect link to physical adequacy. It depends heavily on market liquidity and penalty design, with complex monitoring and enforcement.
- To ensure NL meets its ~1.3–1.5 GW post-2030 [1] with high confidence, a mechanism with central volume control and enforceable availability is warranted.

[1] Derived from TenneT, Monitor Leveringszekerheid 2025 (Link), own assessment

Adequacy benefits of Capacity Remuneration Mechanisms

Majority of benefits derive from reducing Expected Energy Not Served. The assumed Value of Lost Load is a key driver of this benefit.

Security of supply benefit

Reducing forced of demand (Expected Energy Not Served, EENS) increases social welfare. The theoretical monetary value of EENS reduction from CRM introduction can be calculated by multiplying the EENS reduction with the Value of Lost Load (VoLL) (equation below). The MLZ provides EENS projections, while the VoLL is established by the ACM.

$$Theoretical\ SoS\ benefit = EENS\ * VoLL$$

Table 6: *Estimation of SoS benefits based on EENS and VoLL*

Year	EENS (GWh)[1]	VoLL (EUR/MWh)[2]	SoS benefit (MEUR/yr)
2033	14,100	68,887	971
2035	15,700		1,082

Theoretical estimation only: A reduction of the EENS to zero is assumed, any residual EENS or a reduction of the VoLL will reduce the shown SoS benefits.

Sensitivity to residual EENS and Value of Lost Load assumption

Valuing the security of supply benefits has a linear relation with the assumed VoLL and with the achieved EENS reduction (see equation).

The EENS reduction is calculated through an electricity market model, and depends on projections of future demand, generation capacity and demand/supply patterns. A CRM will not reduce the EENS to zero, some residual will likely remain.

Establishing the VoLL is based on surveying electricity user groups on their willingness to pay. Compared to the method for establishing the EENS, establishing the VoLL is more subjective. The linear impact of the VoLL on the perceived resource adequacy benefits, requires high trust in the correctness of the VoLL.

Value of Lost Load comparison

In 2022, ACM established[2] the Value of Lost Load (VoLL) for the Netherlands to be 68,887 EUR/MWh, based on a study conducted by Ecorys and SEO.[4]

The single VoLL represents the VoLL across different electricity user market segments, which in NL is based on a weighted average.

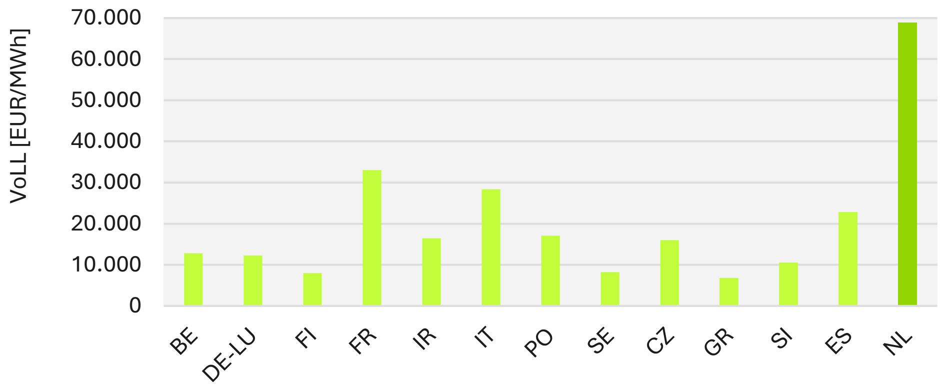


Figure 15: Comparison of Value Of Lost Load in the Netherlands and different EU countries[3]

- Compared to other European countries, the VoLL of the Netherlands is very high.[3]
- The VoLL in NL is four times higher than the average of the other countries that have reported a VoLL value.[3]
- The VoLL in NL is two times higher than the country with the second highest reported VoLL (FR)[3]
- Ecorys and SEO recognise the difference of the Dutch VoLL compared to other countries in their study, but a direct comparison between how the VoLL was derived was not part of the study. [4]

[1] TenneT Monitor Leveringszekerheid 2025
[2] ACM Vaststelling Value of Lost Load 2022
[3] Adequacy metrics implementation landscape 2024
[4] Ecorys The value of lost load for electricity in the Netherlands 2022

CRM options scoring for the Netherlands – **Effectivity** (1/2)

Provide bankable, multi-year capacity revenues to prevent retirements and unlock new firm capacity

Description	
	▪ Can a sufficient degree of planning **security for investments** be created? Can the measure present investment signals to market participants for new builds and capital-intensive conversion/retrofit of existing plants? ▪ Can the problem of **maturity mismatches** be solved? Are the contracts long-term enough to effectively support investment? Is the gap that needs to be filled long-term or short-term? Do timelines align in this regard?

+ **Central CRM**	~ **Strategic Reserve**	– **Hedging Obligations**
▪ High security of investments, as bankable, multi-year contracts (1 year for existing plants; 3–8 years for retrofit; up to 15 years for new-built) directly address maturity mismatch and the missing money issue for both new capacity and retrofits. Strong investment signal if auctions are predictable and transparent. ▪ Strong tool to solve also long-term gaps. Supports life-extension of existing gas with short lead time, retrofits/clean firm with mid lead time and long lead time allowing newbuilt assets. This could help address changing energy system needs (e.g. delayed RES roll-out or accelerated electrification in Dutch industry.) ▪ High robustness of effectivity and accuracy, as central CRM procure capacity with enforceable penalties and secondary trading to mitigate risks.	▪ Lower security of investments in new capacity or retrofit of current plants compared to a CM. Based on short-term auction, it maintains exiting units for short-term adequacy outside the market. However, the investment framework is less secure than a CM and may not solve the fundamental problems. ▪ No solution to maturity mismatch, as the contracts are short and the scheme is temporary, not solving problems for new investments. ▪ Moderate robustness, if a contracted unit fails, the volume reserved is small and options to replace this are limited. If multiple units fail, there is a risk of shortfalls.	▪ Hedging Obligations do not create stable, asset-backed cashflows for investors, providing little support for investments in retrofits and new-built plants. However, they can indirectly support investment by creating demand for long-term Long-Duratios, but this signal is less certain than explicit capacity contracts. ▪ Long-term Long-Duratios can help to partially solve maturity mismatches, but obligation design does not guarantee contract length or bankability. Effectiveness depends on supplier creditworthiness and market developments. ▪ No physical capacity guarantee and therefore low robustness. If hedged generators default, the suppliers must source replacement in the market, which may be scarce during stress events.

CRM options scoring for the Netherlands – **Effectivity** (2/2)

Provide bankable, multi-year capacity revenues to prevent retirements and unlock new firm capacity

Description	
	▪ Can a sufficient degree of planning **security for investments** be created? Can the measure present investment signals to market participants for new builds and capital-intensive conversion/retrofit of existing plants? ▪ Can the problem of **maturity mismatches** be solved? Are the contracts long-term enough to effectively support investment? Is the gap that needs to be filled long-term or short-term? Do timelines align in this regard?

Zoom-in: Addressing the and its uncertainties

The medium and long-term in NL comes with **large uncertainty** related to various market developments (see Chapter 2):

- Short to medium-term: From 2030-2035, ~1.9 GW of gas power plants are retiring.[1] Extending the lifetime of (part of) these plants via a Strategic Reserve can reduce the gap, at a cost and carbon intensity level. A central CRM could e.g. through dedicated auctions or simplified obligations as well as emission threshold push new technologies.
- Medium- to long-term: At longer timescales and in case of a structural or increasing , only a central CRM could address the needed investment security and solve the maturity mismatch by increasing T-4 (or even T-6) auction volumes.

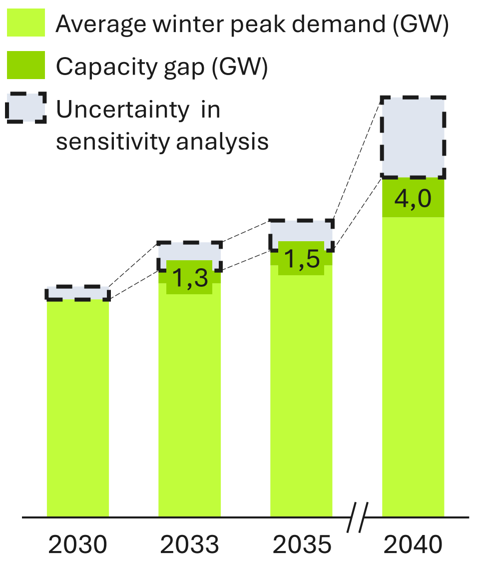


***Figure 16:** Uncertainty of the in the Netherlands in the short vs longer term.*[1]

Sub conclusions

- Central CRM is the most effective and flexible solution: multi-year revenues keep plants online and enable new builds, while multiple lead times secure both short- and long-term capacity.
- Strategic Reserves could function as a bridging instrument to avoid shut down of existing but otherwise not profitable capacity and keep them available for extreme scarcity events. However, it is not suited to incentivise potentially required new investment in case of an increasing .
- Hedging Obligations are least effective, providing no stable, asset-backed cashflows and limited support for new or retrofit investments. They rely on indirect mechanisms like long-term Long-Duratios without explicit capacity contracts.
- Only a central CRM could reliably address the maturity-mismatch/missing-money problem beyond the mid-2030s. A Strategic Reserve can stabilise the near term, while a Hedging Obligation cannot substitute for capacity revenues.

[1] Own analysis based on projections from TenneT, Monitor Leveringszekerheid 2025 (Link) and Netbeheer Nederland, II3050 2023 (link).

CRM options scoring for the Netherlands – **Efficiency** (1/2)

Contract what the Dutch energy system needs, both in the short- and long term

Description

- Is resource adequacy ensured at the lowest possible cost in the short-term (**static efficiency)**, via ensuring productive and allocative efficiency (i.e. an efficient technology mix) at a certain moment in time?
- Is cost efficiency ensured in the longer term (**dynamic efficiency**)? That means how **innovation-friendly** is the system and how easily can the system flexibly react to uncertainties in future developments?
- How is the balance between market-based instruments/incentives and state interventions met?
- Are **distortions** to be expected in the **energy market**?

+ ~ Central CRM

- High static efficiency when CRMs are designed as competitive, market-wide auctions. Mechanisms like Reliability Options (RO) help claw back scarcity rents and reduce consumer costs while preserving dispatch incentives.
- However, weak carbon criteria risk locking in fossil assets in case of long-term contracts, requiring CO_2 limits to align with decarbonisation goals and remain innovation-friendly.
- Market-based execution is feasible despite CRMs being state set up. Competitive auctions maintain alignment with energy market incentives.
- Design risks include over-procurement and cross-border frictions.
- Participating capacity remains active in the energy market. Can distort energy market due to impact on energy prices and price peaks, depending on where new technologies will be placed in the merit order.

~ Strategic Reserve

- Tendering is – if competition is ensured – efficient, but scope of technologies is often limited (static efficiency).
- No intervention in the EOM market price setting mechanisms, since the reserve capacity is kept outside of the energy market. As a reaction to capacity leaving the EOM, prices on the EOM may increase and in turn may incentivise new capacity or flexibility (dynamic efficiency).
- The focus of a SR on older or less-economic existing capacities, reduces the potential pool of assets to participate in the reserve auctions. This reduced auction liquidity can lead to reduced competition and strategic bidding effects. Auction designs that incorporate sufficient transparency on de-rating factors and uncertainty in the auction demand curve can counter strategic bidding.

+ ~ Hedging Obligations

- Potentially cost-effective, leveraging existing markets without new levies, but limited track record and risk of retail cost increases if over-prescriptive.
- Promising in theory to ensure technology-neutral design that can support innovation, but efficiency in the longer term depends on uncertain market liquidity.
- Market-integrated instruments that rely on private contracts and supplier risk management but still requiring significant regulatory oversight of regulator.
- Impact on energy market may be mixed, as it may distort liquidity and supplier risks, but this is uncertain as the mechanism is untested and will depend on mechanism design.

CRM options scoring for the Netherlands – **Efficiency** (2/2)

Impact of Capacity Remuneration Mechanisms on the Energ- Only Market

Zoom-in: Effect on the day-ahead Energy-Only Market*

The ***figures on the right*** show a curve with sorted day ahead prices [EUR/MWh] in the Netherlands (price duration curve).[1] The bottom chart illustrates a merit order curve, showing the sorting of generation by marginal costs.

Indicative* impact of central CRM: Provides additional payments to capacity providers regardless of energy produced. Participating capacity can be existing generation or new to build assets.

- *Impact on price formation in EOM:* can flatten peak prices and reduce the frequency of extreme price events if additional new assets are introduced in the market, especially when at the baseload/mid-merit order level. Risk of over-procurement could result in lower energy prices which reduce price signals for new investments.
- *Impact on price peaks in EOM:* Peak prices likely to be lower and less volatile if sufficient capacity is ensured through the CM. Investment incentives might shift from (peak) energy prices to capacity payments, risking reduced market efficiency.

Indicative* impact of Strategic Reserve: Participating capacity is excluded from the EOM, which will only be activated during scarcity events. Typically, participating capacity consists of older or less competitive generation that would otherwise be retired. Auction design that ensures liquidity is required to combat strategic bidding effects.

- *Impact on price formation in EOM:* no impact as capacity is not active in the market and SR will be activated after market closure.
- *Impact on price peaks in EOM:* no impact on price peaks during scarcity events if SR will be activated after market closure. As a reaction to leaving capacity, prices on the EOM may increase (modelling required for assessment).

Indicative* impact of Hedging Obligations:

- Hedging Obligations increase demand in the futures- and forward-market. This may strengthen investment signals in dispatchable capacity and flexibility solutions. At the same time, it risks exit of smaller suppliers due to increased financial instrument requirements.
- Hedging demand can reduce peaks in the day ahead market. As a result of reduced peaks, the investment signals for (unfirm) RES may diminish, while if attracted through a CfD regime, the design of both instruments should be done in tandem.

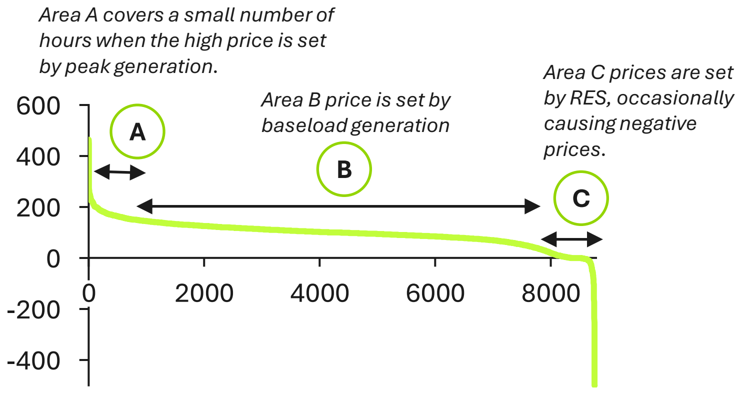


Figure 17: *Illustrative price duration curve [EUR/MWh] for NL[1].*

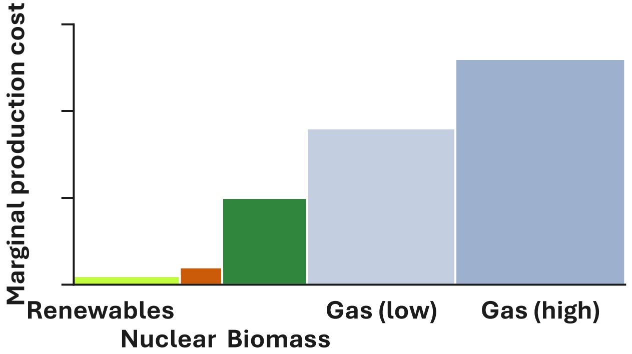


Figure 18: *Illustrative merit order of technology capacity vs. marginal production costs.*

[1] Day-ahead prices of 2023 have been used as last non-leap year, ENTSO-E transparency platform.
*Note that detailed modelling is required to quantify the exact impact of a CRM on price formation and price peaks. This is out of scope of this study.

Price formation and price peak impact

The impact depends on the merit order location of capacity additions or removals by a CRM

General conclusions of the impact of CRMs on the energy-only market

The introduction of a CRM impacts the Energy-Only Market. This affects both electricity price formation and the frequency, duration and height of price peaks. This in turn impacts investment signals for new technologies.

Price formation and price peaks are impacted through various mechanisms:

- **Capacity additions and the impact on the merit order curve and price peaks:** CRMs can lead to capacity being added to the market, when the CRM increases the investment appetite and new capacity is developed and placed in the market. The impact of new capacity on electricity price formation depends on their place in the merit order curve: the price formation is only affected if the clearing price is above the marginal production cost of the new capacity. With an increased available capacity, a higher demand can be met which likely reduces the frequency of scarcity events. This implies a reduced frequency of price peaks. Reduced price peaks, both in lower peak prices and in lower peak duration, are an indirect societal benefit of CRM introduction. It contributes to reduced energy price uncertainty and could contribute to reduced energy poverty.
- **Capacity removals and the impact on the merit order curve and price peaks:** The introduction of CRMs can lead to capacity being removed from the market, e.g. when capacity is being placed in a Strategic Reserve and cannot participate in the energy market anymore. The impact on electricity prices depends on their (former) place in the merit order curve.
- **Moments of capacity shortages (risk of forced load shedding):** In moments of capacity shortages, with risk of forced load shedding, a Strategic Reserve can be called upon. The added generation capacity can prevent energy not served, and the costs of the associated value of lost load. Energy price peaks will occur. However, these should be lower than the value of lost load.

Sub conclusions

- A central CRM ensures longer-term adequacy by supporting investment in flexible and low-carbon technologies, but comes with a risk of over-procurement and limits on windfall profits and investments signals by reduced peak price volatility. A CM can be efficient with competitive auctions, technology-openness and calibrated reliability options. But if not calibrated well, A CM can overcompensate and suppress energy-only market signals.
- A Strategic Reserve preserves the energy-only market and can act as emergency backstop. However, it only indirectly addresses the missing money problem for (new) assets, in case EOM price peaks are increased by reduced capacity. A SR offers limited system-wide efficiency and weak market signals, serving mainly as a temporary safety net with minimal market distortion (if the SR is well-designed).
- A Hedging Obligation seems efficient on paper, but is fragile in terms of calibration and oversight.
- Comparison of explicit costs of a CM and a SR is a comparison between large volume at lower unit cost (in case of CM, it contracts full peak demand and capacity stays in the energy market) and small volume at higher unit cost (in case of SR, it only the adequacy gap, however each MW must recover all costs from the mechanism). However, in case of a CM, prices on the EOM are expected to decrease, which needs to be considered.
- The most credible route to efficiency is a well-designed CM that limits over-procurement and balances effects of a reliability option; a SR should remain tight and temporary, while Hedging Obligations offers theoretical efficiency but high execution risk.

Day ahead market in the Netherlands 2020-2024

A similar degree of peak pricing occurred year to year, except during the energy crisis

Peak prices affect the potential revenue dispatchable generation can create

The revenue dispatchable generation such as gas plants can create are affected by the occurrence of price peaks. Analysis of the historic (2020-2024) day-ahead electricity prices in the Netherlands shows:

- Relative to the median price, price peaks in the Netherlands became higher in 2024 (after declining from the energy crisis).
- The energy crisis in 2021 and 2022 is reflected in significantly higher price peaks (expressed at a P99 prices, the 1% of hours with highest prices).
- Day ahead prices in Belgium and Germany in 2020 to 2024 are very similar to the Netherlands, which implies sufficient interconnection capacity to typically reach price convergence. UK has relative similar pricing as well, implying its convergence with the CORE market area[1]. Norwegians' different generation mix and limited interconnection capacity is reflected in the different median and peak price levels.

Introduction of a CRM can act as a complementary revenue source for dispatchable generation,[2] next to the revenues accrued during price peaks.

Potential full load hours gas plants in NL could achieve (simplified analysis)

The full load hours gas plants could achieve are driven by the clearance price and the marginal generation cost (mostly comprising of gas price and EU ETS price). A simplified analysis (using annual average gas and EU ETS prices)[3] does not show a clear downward historic trend in potential full load hours.

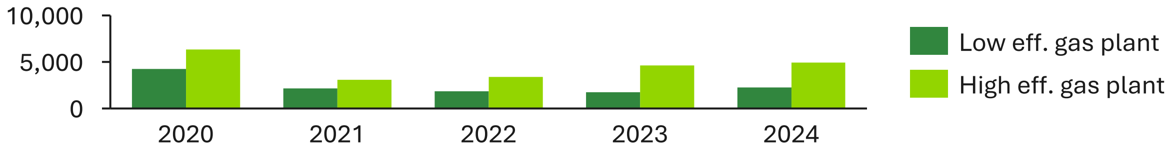


Figure 19: Potential annual full load hours of gas plants

Height of price peaks in the Netherlands, UK and Norway

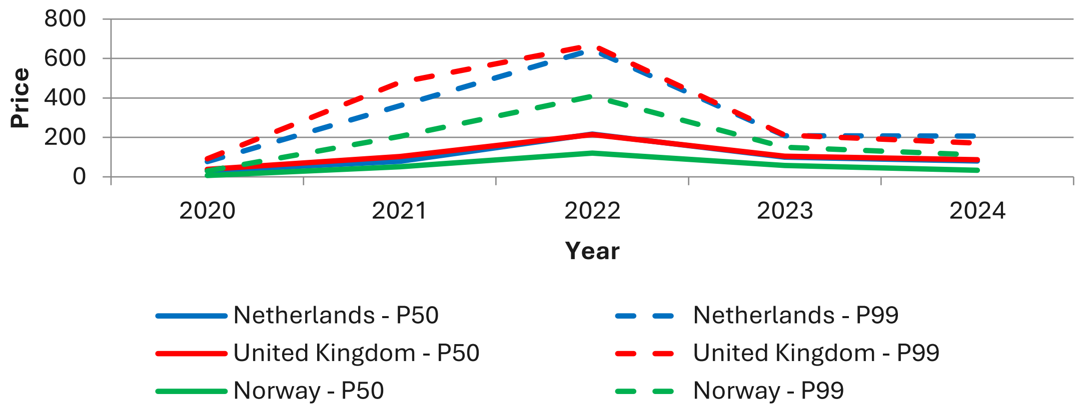


Figure: Electricity prices P50 (median) and P99 (threshold price of 1% highest prices)

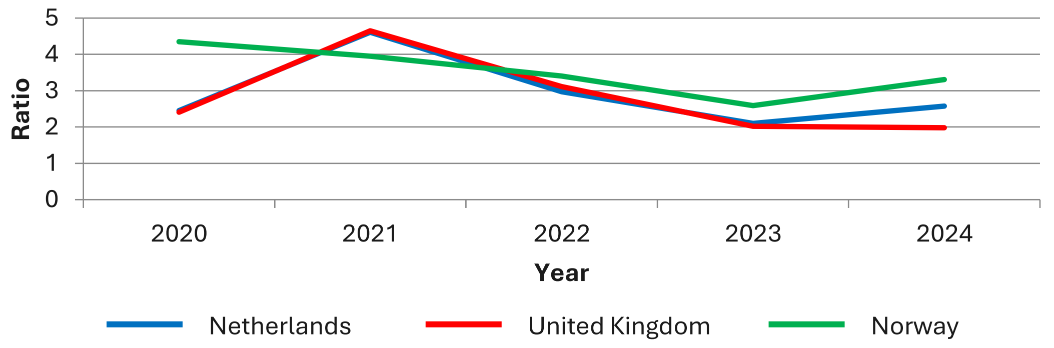


Figure 20: Ratios between the P99 and P50 price levels

[1] CORE market area description by ENTSO-E (Link) [2] Note that a CRM does not need to be limited to dispatchable generation, but also demand side response, batteries, LDES and other technologies could be included. [3] Analysis of historic electricity prices, data by Ember. Use of annual average gas and EU ETS prices. Low efficiency: 45%, high efficiency: 60%.

Impact on investment signals and business climate

A central CRM provides a stronger investment signal compared to a Strategic Reserve

Indicative high-level impact on investment signals for (new) assets

The business case of existing assets, such as battery storage and offshore wind, in the Dutch energy system can be impacted by the introduction of a capacity remuneration mechanism. Main impacts relate to the impact on peak prices and price volatility that remains in the market.

New to build assets that are considered in the Netherlands, such as LDES and nuclear power generation, require longer term investment certainty due to their capital intensiveness.

The table below describes the high-level impact on investment signals for selected asset types under selected CRMs. More detailed quantitative analysis is required to assess the impact for specific assets.

High-level impact on business climate

A reduced risk or occurrence of scarcity events improves the business climate in the Netherlands, as it helps avoiding unexpected costs or high-impact events such as forced shutdowns.

A quantitative assessment of the impact of CRMs on price formation and price peaks requires electricity market modelling, and can also quantify the impact of mechanisms on business climate.

Table 7: *Indicative examples of high-level impact on investment signals for selected asset types under a Strategic Reserve or central capacity mechanism.*

Selected asset type	Impact from SR	Impact from a CM
Battery storage (short duration)	Preserved scarcity pricing and price volatility would result in volatile/uncertain revenues from arbitrage and ancillary services.	Provides stable income through CM, improving bankability. Possible reduced arbitrage opportunities due to reduced peak pricing.
Long-Duration Energy Storage (LDES)	Does not provide additional long term investment signals. Possible benefits from preserved scarcity pricing on the business case.	Improved viability due to capacity payments if technology is incentivised under a CM. Lower price peaks in the EOM could reduce income opportunities.
Nuclear generation*	No direct support as SR does not provide long term investment signals. Investment decision based on merchant risk.	Stronger business case via longer term contracts, depending on appropriate lead times and contract duration, as CM supports new assets. If CM favours shorter term or flexible assets, nuclear investment at disadvantage.
Offshore wind	No direct effects. Business remains reliant on merchant risk, Long-Duratio structures or others.	Limited direct benefit due to derating factor. Risk of payback obligations (RO) and reduced windfall profits.

* Assuming nuclear generation received state aid from other instruments, it can only participate in a CRM if overcompensation is avoided (State Aid regulation).

CRM options scoring for the Netherlands – **Complexity** (1/2)

Keep lean governance to meet regulation with clear roles, monitoring and penalties

Description	
	▪ Is the complexity as low as possible in order to ensure comprehensibility for all market participants and minimise implementation and enforcement costs? ▪ Are **processes/responsibilities/obligations and penalties** clear and understandable, in particular: who determines the required capacities, which market participants enter into which obligations, who bears which risks? ▪ How '**feasible**' is the model (parameterisation & monitoring effort, compatibility with EU regulations, interactions with neighbouring countries)? ▪ How high are the **implementation and monitoring cost**?

~ – **Central CRM**	+ ~ **Strategic Reserve**	~ – **Hedging Obligations**
▪ Moderate to high complexity to implement in Netherlands, as market-wide auctions require careful design, prequalification, testing and detailed rulebooks. ▪ Mechanism has been applied in other European countries, with clear roles and responsibilities (TSO to set volume based on adequacy studies, central body to run auctions). ▪ Feasible based on international experiences but requires robust dimensioning, calibration and cross-border arrangements, all modelling- and IT-intensive. EU compatibility (e.g. with neighbouring countries) is well-used. ▪ Considerable administrative effort and cost to set up, including auction platforms, pre-qualification. Monitoring can be done in different time intervals to surface improvements. Preparations ongoing to enable within the Dutch legal basis (Energiewet art. 5.12).	▪ Low to moderate complexity with limited volumes being procured and kept out of energy-only market. Simple activation criteria under defined scarcity conditions. ▪ Easy governance with regulatory authority/TSO setting up volume and activation criteria. Responsibilities and settlement are transparent. ▪ Feasible for temporary gaps, with limited monitoring effort and focus on volume and activation criteria. Often nationally bounded (exists within legal basis in NL (Energiewet art. 5.12), simplifying operations but reducing regional efficiency. ▪ Moderate implementation administrative costs, lower than a market-wide CRM due to smaller scope and simpler processes. Exposure is bound by defined volume or period.	▪ Moderate complexity that depends on how mechanism and spike products would be designed and enforced, as this has not been used as CRM before. ▪ Clarity will vary with design. Suppliers (i.e. the demand side) are obliged, and enforcement would be done by the regulator. ▪ Feasibility is medium and depends on market developments like forward-market liquidity, robust metrics and reliable monitoring conditions, which will be affected by design choices. No current Dutch and European legal basis to use Hedging Obligations for adequacy. ▪ More complex compliance in monitoring, for instance to monitor all suppliers' positions in relation to load profiles/peak windows. Requires compliance systems, reporting and audits.

CRM options scoring for the Netherlands – **Complexity** (2/2)

Keep lean governance to meet regulation with clear roles, monitoring and penalties

Description	
Description	▪ Is the complexity as low as possible in order to ensure comprehensibility for all market participants and minimise implementation and enforcement costs? ▪ Are **processes/responsibilities/obligations and penalties** clear and understandable, in particular: who determines the required capacities, which market participants enter into which obligations, who bears which risks? ▪ How '**feasible**' is the model (parameterisation & monitoring effort, compatibility with EU regulations, interactions with neighbouring countries)? ▪ How high are the **implementation and monitoring cost**?

Zoom in: Complexity in governance, roles and responsibilities

The three mechanisms differ in complexity, governance structure, and cost-effort trade-offs. In all three mechanisms, there is a large role for the regulator.

- The **central CRM** is complex and spreads responsibilities across key actors in the process, with a large role for the government at the start of the process and a large role for the TSO across the process.
- The **Strategic Reserve** has a large role for government and regulator early in the process, which shifts towards the TSO during operations.
- The **Hedging Obligation** has a large role for the regulator due to complex supervision, and an active role for market actors in phase 3-4 for consultation.

Explanation of tables:

High-level phases:
1) Need assessment & policy decision,
2) Legal & compliance setup,
3) Design & parameterisation,
4) Auction & contracting,
5) Operation & monitoring,
6) Review & adaptation

***Tables 8, 9, 10**: Key actors and indicative degree of their involvement* - Low (red), medium (orange), high (green)

Central CRM

Stakeholder	1	2	3	4	5	6
Government	green	green	orange	red	red	green
ACM	green	green	green	green	green	green
TenneT	green	orange	green	green	green	orange
Market actors	orange	red	green	green	orange	orange

Strategic Reserve

Stakeholder	1	2	3	4	5	6
Government	green	green	orange	red	red	orange
ACM	green	green	orange	orange	orange	green
TenneT	green	orange	green	green	green	orange
Market actors	red	red	orange	orange	orange	red

Hedging Obligation

Stakeholder	1	2	3	4	5	6
Government	orange	orange	orange	red	red	orange
ACM	green	green	green	green	green	green
TenneT	green	red	orange	orange	orange	orange
Market actors	orange	red	green	green	orange	orange

Sub conclusions

- A central CRM demands high regulatory and operational complexity due to market-wide auctions, forecasting, and rulebook design, for instance considering cross-border contexts. The legal basis in the Energiewet is being prepared.
- Strategic Reserve is simpler, with limited volumes and straightforward governance, but still requires careful activation criteria and is typically nationally bounded. Has an existing legal basis in the Energiewet.
- The Hedging Obligation is complex to supervise (supplier compliance, spike products), hinges on design and execution and lacks a clear legal basis in the Netherlands.
- If rapid, low-friction implementation is the priority, a Strategic Reserve is most valuable. If enduring adequacy governance is required, CRM complexity is acceptable and standardised. The Hedging Obligation imposes a medium complexity with limited adequacy pay-off. All mechanisms involve significant administrative effort and coordination.

[1] Guidehouse and Frontier Economics analysis based on various documents such as Regulation 2019/943 (Link), EC 2016 (Link), country case studies in Annex V and market design examples across Europe.

CRM options scoring for the Netherlands – **Locational signals** (1/2)

Tying capacity award to real energy system boundaries where needed

Description	▪ Does the model provide **local signals**, i.e. can capacity be geographically differentiated, or how complex would it be to add a local/regional component? ▪ Can the mechanism **incentivise additional capacity in congestion-prone areas**? ▪ What would be the effect of locational signal on **cross-border participation**?

+ ~ **Central CRM**	~ **Strategic Reserve**	~ – **Hedging Obligations**
▪ The central CRM can integrate entry restrictions, regional shares, or bonuses to reflect grid bottlenecks while respecting internal-market rules and requirements. It should be noted that locational constraints adds rules and IT complexity and may impact efficiency due to market segmentation (reduced liquidity). ▪ Locational procurement in different auctions and auction rounds can signal where new capacity is needed to reflect network constraints, strengthening local adequacy and creating flexibility. ▪ Potential constraint if signals are sub-zonal, as foreign capacity is admitted at the bidding zone border level, not into sub-areas. EU law mandates openness to cross-border participation, but technical specifications (from ACER) limit entry via interconnectors, complicating sub-zonal deliverability.	▪ Some targeting possible (e.g., qualifying units held out of market in constrained zones), but not a system-wide locational optimizer related to grid constraints. ▪ Limited incentive for newbuild capacity, but strong for targeting existing units/flexibility in a congested area temporarily. ▪ Minimal cross-border effects, as many reserves are domestic and locational scoping mainly effects internal assets. Strategic Reserves do not affect scarcity prices as they are activated only after price formation.	▪ Hedging Obligations operate at financial level (with bidding zone price reference) and do not create sub-zonal price signals. To add this, you would need zonal or nodal pricing. ▪ Stronger locational price granularity is the primary way to send siting signals that would incentivize capacity, a pure Hedging Obligation does not do this by itself. ▪ Suppliers' portfolios are not a reliable tool to tailor the grid-constrained needs across the Netherlands, as they do not govern physical capacity or flows.

CRM options scoring for the Netherlands – **Locational signals** (2/2)

Tying capacity award to real energy system boundaries where needed

Description	▪ Does the model provide **local signals**, i.e. can capacity be geographically differentiated, or how complex would it be to add a local/regional component? ▪ Can the mechanism incentivise **additional capacity in congestion-prone areas**? ▪ What would be the effect of locational signal on **cross-border participation**?

Zoom-in: Examples of locational considerations across Europe

Across Europe, some countries have used locational signals in a central capacity mechanism to incentivise additional capacity in congestion-prone areas, for different reasons. In this zoom-in, we share two examples of locational considerations, namely for Ireland and Italy.

Ireland

Locational constraints in Ireland's CRM are driven by the need to ensure security of supply in areas like Greater Dublin, where transmission limitations and demand growth are critical. The mechanism uses Locational Capacity Constraint Areas (LCCAs) and auction parameters to guide capacity placement while accounting for planning and grid challenges. These constraints aim to balance geographic distribution and minimise market distortion, though they offer limited flexibility due to infrastructure and permitting hurdles.[1]

Italy

Italy's bidding zone split was designed to reflect physical grid constraints and improve market efficiency by aligning price signals with regional supply-demand conditions. This zonal structure directly informs the CRM, which sets differentiated capacity targets and auction parameters based on locational needs. The CRM also supports long-term storage mechanisms, ensuring flexibility and adequacy across Italy's diverse grid regions.[2] In the Dutch context of a single bidding zone, locational signals would be needed to create similar locational differentiation.

Figure 21: Italian bidding zones[3]

Sub conclusions

- A central CRM can reflect grid bottlenecks through locational elements, though this adds complexity and may impact efficiency negatively (reduced market liquidity). Sub-zonal signals may restrict cross-border participation, while locational procurement rounds help target new capacity needs and improve local adequacy.
- A Strategic Reserve offers limited locational targeting, mainly for existing units in congested zones, but lacks system-wide optimisation and has minimal cross-border impact.
- Hedging Obligations do not generate sub-zonal signals; stronger locational granularity would require zonal/nodal pricing or tailored instruments, as supplier portfolios do not reflect physical grid constraints.
- Where Dutch grid constraints matter, a central CRM is the only mechanism that scales into a locational adequacy tool; a reserve can only target locations temporarily and to a limited extent. Hedging Obligations are very unsuitable-suited for locational adequacy.

This assessment considers how locational signals could be included, the desirability of doing so is reflected on in the weighting of the criteria at the end of section 4.2.

[1] SEM Committee (Link); [2] Lightbox, Terna, Italy (Link), [3] Politecnico di Torino, The impact of the formation of Bidding Zones on Capacity allocation and Renewable penetration (Link).

CRM options scoring for the Netherlands – **Financing** (1/2)

Ensure that costs for capacity allocation are recovered in a predictable, fair and dynamic way

Description	▪ What are the CRM total explicit **costs** and how will these be **refinanced**? Is the financing considered secure and fair, to promote social and political support? ▪ Who will bear the costs? Is the **mechanism designed according to the 'polluter pays' principle** – meaning that those responsible for creating a peak load or stress event bear the cost? ▪ Can **interdependencies with existing subsidies** be taken into account?

~ − **Central CRM**	+ ~ **Strategic Reserve**	+ **Hedging Obligations**
▪ High mechanism explicit costs, financed usually via regulated, transparent levy on suppliers that is passed on to consumers. Payback revenues from Reliability Options can offset consumer costs. ▪ Political support hinges on levy design and net costs after payback. A dynamic levy, focusing on moments of scarcity for refinancing (see Annex II), is required for fast-tracking State aid, but increases complexity. ▪ Interdependencies with subsidies can be considered but increase complexity as EU rules require avoidance of overstimulation. Capacity payments must avoid oversubsidisation with RES CfDs, NFFSS or congestion and system service payments beyond allowed thresholds. Revenue caps and contract clauses can be added to manage and monitor this.	▪ Lower explicit mechanism costs compared to a CM, usually financed via network tariffs or system operation charges. Can be funded via special fee on consumption. Because volumes are small and temporary, the cost impact is modest. ▪ Usually the costs for the reserve are borne by end consumers according to their consumption. They are passed on via a surcharge on the transmission system operator's grid tariff or as a new levy. Similar requirements for the levy apply in case of a fast track approval as in the case of a central CRM. ▪ Simpler to manage with existing subsidies, as contracts are temporary and can exclude units with overlapping subsidies, or payments are adjusted accordingly.	▪ No central auctioning mechanism, cost are internalised in retail energy prices in bilateral contracts. Cost flow through retail tariffs, and financing security depends on forward-market liquidity and supplier creditworthiness. ▪ Potential volatility is borne within supplier competition rather than via a surcharge. No payment to generators, so no subsidy to polluters. Largely neutral, as obligation sits with suppliers, so no direct overlap with subsidies. Heding may reflect market distortions if subsidised RES depress forward-prices, which may require monitoring.

CRM options scoring for the Netherlands – **Financing** (2/2)

Ensure that costs for capacity allocation are recovered in a predictable, fair and dynamic way

Description	▪ What are the CRM total explicit **costs** and how will these be **refinanced**? Is the financing considered secure and fair, to promote social and political support? ▪ Who will bear the costs? Is the **mechanism designed according to the 'polluter pays' principle** – meaning that those responsible for creating a peak load or stress event bear the cost? ▪ Can **interdependencies with existing subsidies** be taken into account?

Zoom-in: Cost of European resource adequacy [1]

The **cost of CRMs is highly dependent on country-specific details** such as the energy mix, energy trade with neighbouring countries, national resource adequacy assessments and the respective s. ACER reported the absolute cost of market-wide mechanisms to range between around 400 (Ireland) and 4,000 (France[2]) million euro per year, while the cost for Strategic Reserve ranged between 8 (Finland) and 80 (Germany) million euro per year.[1]

When comparing the mechanisms in relative terms per unit demand as % of annual average day-ahead price, ACER concluded that the impact of the CRM on the electricity bill is significantly lower in countries with a Strategic Reserve.[1] Here, it should be noted that both mechanisms have different goals and trade-offs.

Note I: These costs can not be directly translated to the Dutch context due to large differences in energy systems and developments between countries.

Note II: The cost of a Hedging Obligation has not been assessed before and is therefore not included in this overview.

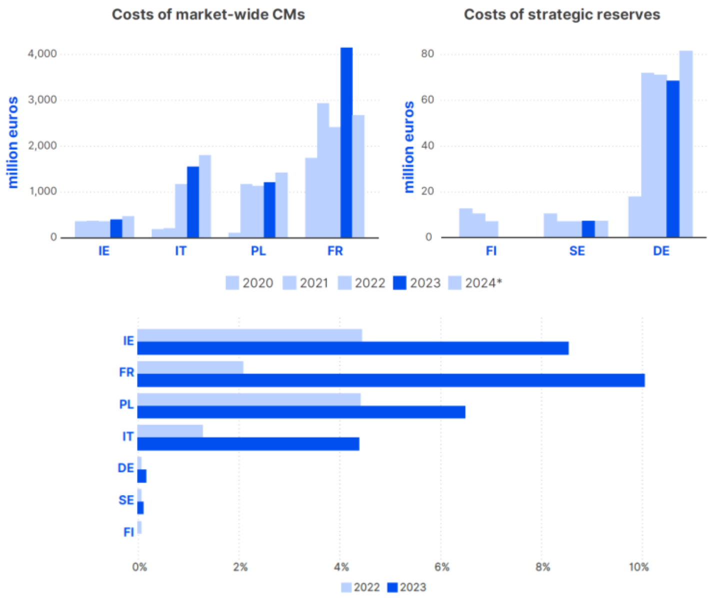


***Figure 22:** Per Member State, (above) incurred and projected costs to finance capacity mechanisms and (below) costs incurred in financing capacity mechanisms per unit demand expressed as a % of the annual average day-ahead price. (source: ACER[1])*

Sub conclusions

- A central CRM is in practice usually funded via a regulated levy on suppliers, passed to consumers. Payback from Reliability Options can offset explicit costs, but EU rules require careful subsidy coordination to avoid double remuneration.
- A Strategic Reserve keeps explicit financial exposure modest by contracting small volumes and funding them via a levy on consumers or via network charges, and simple alignment with subsidies.
- A Hedging Obligation has no central levy, as the costs are internalised in retail prices. The financing depends on market liquidity and supplier creditworthiness, with no direct payments to generators.
- Each mechanism offers distinct fiscal and political trade-offs. A central CRMs provides the most robust, transparent framework for predictable adequacy-linked cost recovery, but with greater complexity and subsidy coordination needs. Strategic Reserves are fiscally sounds for limited, targeted interventions and hedging suits contexts where levy visibility is sensitive.

[1] ACER (2024), Security of EU electricity supply report (Link); [2] France' high costs in 2023 was due to unavailability of nuclear capacity.

Zoom-in: Central CRM auction results comparison

Auction results of other countries to provide an order of magnitude estimate for a Dutch central CRM

Historic costs of CRM auctions in other countries

Several countries have implemented a central CRM and auction results are public. The figure on the right provides an overview of the price (clearing price, except for Belgium for which the average price is provided), and total procured capacity in different auction rounds.

- For UK and IR, most capacity is contracted under auction rounds with a longer delivery window (T-4).
- Shorter delivery window auctions often clear at a lower prices. Typically, only existing capacity can enter the auction.
- Cost levels vary significantly between countries and reflect the degree of scarcity. Scarcity can significantly push up prices, as evidenced in the 2024 auction in Ireland.

High-level estimate for the Netherlands

While historic prices in central CRM results of other EU countries do not reflect a potential future Dutch central CRM, they can be used to create a rough high-level explicit cost indication for 2035;

- An approximate average of the longer term (T-4 / T-5) auctions of the selected countries on the figure is 50 EUR/kW.
- A peak load in the Netherlands of 25 GW can be assumed (see Chapter 2).
- Assuming no safety margin factor on top of the peak load, and assuming all capacity is contracted as the average of the longer-term auctions, the cost of a central CRM in NL could be around 1,250 MEUR/year for 2035.

Dutch factors to which the auctions are tailored can significantly impact this high-level cost estimate, such as the auction mix (e.g. T-1 / T-4), the contract durations (e.g. one year/10 year), contracted peak load including safety margin and derating factors for various technologies.

Central CRM auction results in EU countries

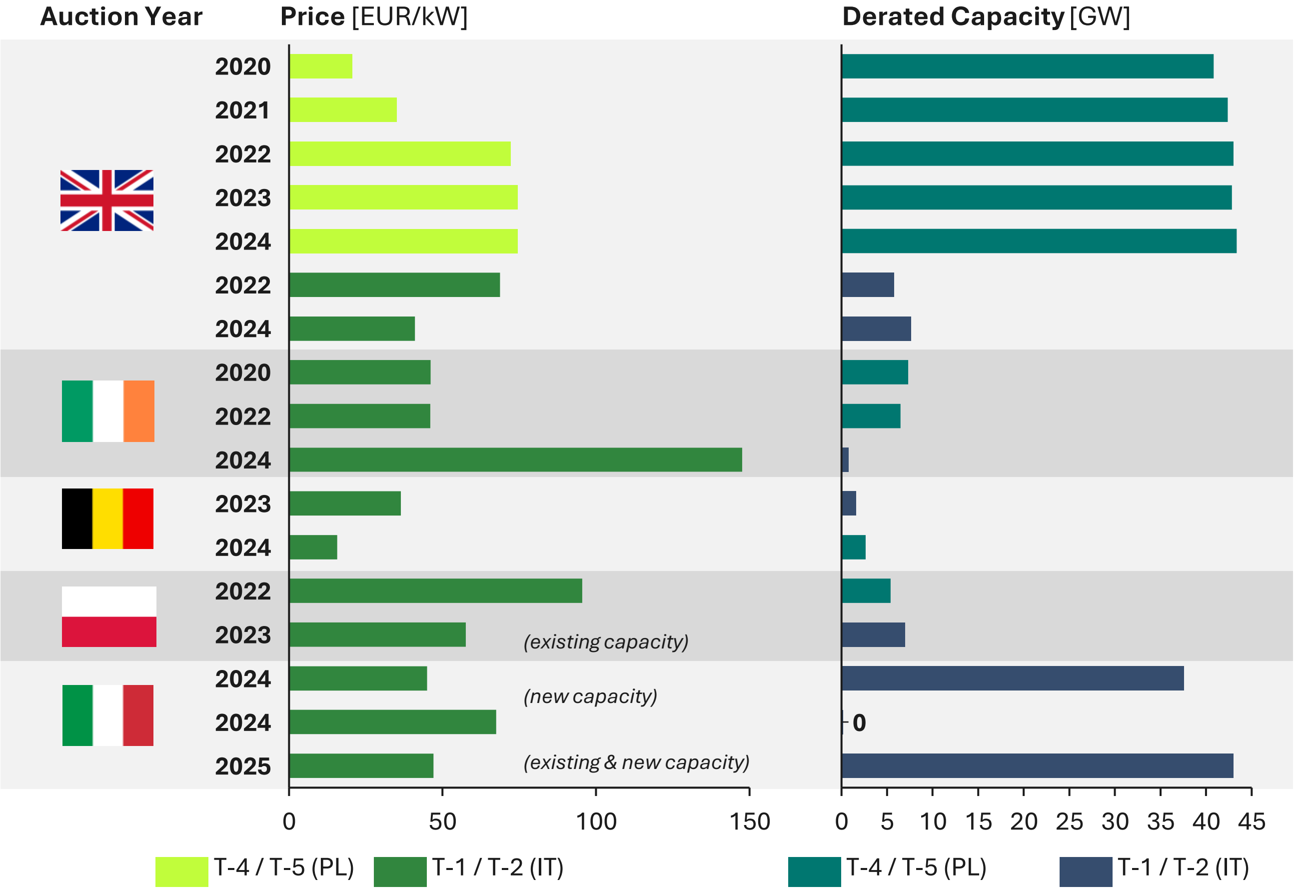


***Figure 23:** Central CRM auction results in EU countries*[1]

[1] Auction result sources: UK: National Grid ESO auction reports, IE: Eirgrid/SONI SEM capacity market auction results, BE: , PL: PSE capacity market auction results, IT: Terna auction reports.

Zoom-in: Strategic Reserve auction results comparison

Auction results of other countries to provide an order of magnitude estimate for a Dutch SR

Historic costs of SR auctions in other countries

Several countries have implemented a Strategic Reserve and auction results are public. The figure on the right provides an overview of the price and total procured capacity in different auction rounds.

- There is a high variation in clearing prices, reflecting the differences between the countries in auction design and generation capacity mix.
- Finland and Sweden, as well as Belgium in the past, have the Strategic Reserve specifically designed as winter supply reserve, while the German Strategic Reserve is year-round.

High-level estimate for the Netherlands

While historic prices in auction results of other EU countries do not reflect a potential future Dutch Strategic Reserve cost, they can be used to create a rough high-level cost estimate for 2035.

- The German auction results could be representative for the Netherlands, considering that the contracted capacity consists mainly of older, gas-fired capacity and the Strategic Reserve is for a full year (instead of winter supply reserve only). An approximate price of 80,000 EUR/MW/year could be assumed.
- A in NL between 1.5 GW could be assumed (see Chapter 3)
- This would amount to total Strategic Reserve costs in an order of magnitude range of 120 MEUR/year for 2035.

Dutch factors to which the auctions are tailored can significantly impact this high-level cost estimate, such as the participating technologies and the total contracted capacity.

Strategic Reserve auction results in EU countries

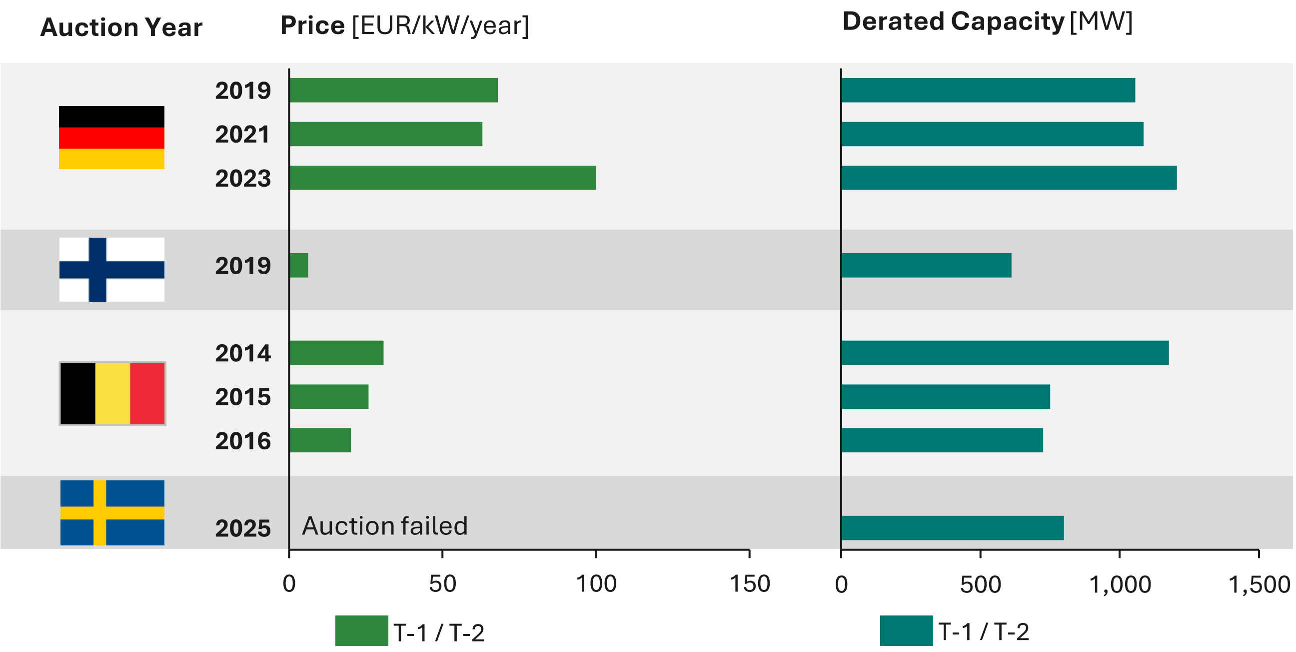


Figure 24: *Strategic Reserve auction results in EU countries*[1]

- Sweden introduced a Strategic Reserve in 2025, to contract winter supply reserves. The first auction in fall of 2025 failed as all bids exceeded the price ceiling of 120,000 SEK/MW/year (~ 11 EUR/kW/year).
- Winter reserve auctions in Finland, Sweden (current) and Belgium (past) are only contracted for winter months. Outside of the winter period, the generation is allowed to operate on the electricity markets, offering additional revenue sources. This is reflected by the lower Strategic Reserve auction prices.

[1] Auction result sources: DE: Netztransparenz auction results (1) (2) (3), FI: Energy Authority, Finnish experience with Strategic Reserve (2021), BE: Elia, Strategic Reserve: Volumes & Prices. Hourly auction result prices converted to minimum yearly costs, using 80% minimum availability rate for the winter period of 1 November – 31 March, SE: Reuters, Sweden fails to secure strategic power reserve for this winter (7-10-2025)

CRM options scoring for the Netherlands – **Timeline**

Sequence design to achieve CRM delivery aligned with the post 2030

Description

- What is the **required timeline for design and implementation** and **factors affecting**?
- How long is the time for State aid approval expected to be, if required?

~ Central CRM	+ Strategic Reserve	+ ~ Hedging Obligations
▪ Requires preparation time to develop (2-4 years).[1] Key steps are the regulatory framework, design, methodology, IT system setup, consultation and mock auctions. Other factors of complexity are cross-border participation, CO_2-eligibility and possibly State aid clearance. t-1/t-4 cadence could fit the "gap after 2030" window. ▪ CISAF fast-track provides a clear authorisation paths of 6-12 months (see Annex II), which is slightly longer than a SR as there is the additional requirement to show that a SR is not a suitable mechanism.	▪ Fastest to implement (1-2 years)[1] thanks to existing legal basis and simple design. Key steps include volume design, eligibility, activation criteria, draft contracts and readiness tests. Limited IT needs. Other important factors are adequacy study, procurement compliance and State aid notification. May potentially serve as short-term safety net, should this be required. ▪ Short State aid notification that can be done within 3-6 months if scope is narrow and proportionality is justified.	▪ As the mechanism is not yet tested, the timeline is difficult to estimate. The time for design might be longer given the need for new legislation and market product development for adequacy purposes. This builds on existing setups, but requires the definition of obligations, compliance, reporting, penalties and monitoring systems. ▪ However, as HO are not required to have State aid approval, as there is no direct payment to generators and the obligation is on suppliers, this saves State Aid process time. Only national regulatory oversight (under Directive EU 2024/1711).

Sub conclusions

- A central CRM requires the longest lead time (2-4 years) due to several steps. However, this could be implemented in time to meet the in the Netherlands in the 2030s, which has a 5 years implementation time window.
- A Strategic Reserve is the fastest to implement (1-2 years), leveraging existing legal frameworks and simpler design.
- Timeline for a Hedging Obligation is difficult to estimate, but could take about 2 years. It requires new legislation and market product development but does not require State aid approval, simplifying oversight.
- With Dutch challenges emerging after 2030, a CM could be made ready in time, while a Strategic Reserve remains the quickest contingency. Hedging does not offer a decisive timeline advantage.

[1] Timeline estimations based on OTE, Leveringszekerheid Elektriciteitsvoorziening, 2020, Elia – Product sheet capacity remuneration mechanism (2025), the CRM implementation timeline in Belgium which included 2 years for state-aid approval (July 2019 – August 2021), which could be reduced in CISAF fast-track.

CRM options scoring for the Netherlands – **Decarbonised system** (1/2)

Align CRM mechanism design with electricity system decarbonisation goals

Description

- **To what extent does the CRM support the transition to a carbon- electricity system?** Are low-carbon technologies eligible and competitive? Do prequalification criteria include emission thresholds or clean fuel requirements?
- Does the mechanism **risk lock-in of fossil assets** or prolonging lifetime of high-emission plants?
- Are there synergies or conflicts with **existing RES policies**?

+ ~ Central CRM	+ ~ Strategic Reserve	– Hedging Obligations
▪ The ability to accommodate decarbonisation signals depends on the design of the CRM (e.g. prequalification and contract differentiation can have high impact on the transition). Tighter CO_2 limits than EU floor are allowed (CISAF) on a technology-neutral basis, making for instance DSR and storage fully eligible. ▪ If CO_2 screens are weak or contract lengths of fossil assets are too long, there is a risk of fossil lock in. EU guidance stresses temporary nature and compatibility with climate targets, for instance by phasing stricter eligibility over time. ▪ If CO_2 screens are too strict they may limit the number of technologies or assets that are eligible, limiting the liquidity in Capacity Auctions. ▪ Can complement RES by ensuring firm capacity remains available during RES buildout.	▪ Low to moderate support, only when emission criteria would prioritise clean resources. Can specify eligibility but typically more an adequacy tool that is not technology-neutral. ▪ Limited lock-in of fossil assets due to low volume of capacity. Can act as a bridge during transition, providing insurance without distorting the energy market – it can create short-term insurance without long-term fossil commitments. ▪ Limited overlap with RES support, as the reserve is relatively small and temporary. ▪ CO_2 screens can be included, such as in the Belgium case study (Annex V). ▪ Strategic Reserves are, in practice, rarely activated. Therefore, the absolute emissions and impact on climate goals might be limited.	▪ Market-based and technology-neutral, can support to hedge low-carbon technology if carbon pricing and green Long-Duratio markets are strong, but this depends on forward-market liquidity. No explicit emission criteria, as the obligation is purely financial. ▪ No fossil lock-in or risk, but also no explicit incentive or obligation to decarbonise. Implementing such incentives or obligation is difficult to implement. ▪ Encourages and synergic with long-term contracting via Long-Duratios, aligning with RES financing needs. Does not guarantee firm clean capacity at peak, so adequacy decarbonisation impact is indirect.

CRM options scoring for the Netherlands – **Decarbonised system** (2/2)

Align CRM mechanism design with electricity system decarbonisation goals

Description

- **To what extent does the CRM support the transition to a carbon- electricity system?** Are low-carbon technologies eligible and competitive? Do prequalification criteria include emission thresholds or clean fuel requirements?
- Does the mechanism risk **lock-in of fossil assets** or prolonging lifetime of high-emission plants?
- Are there synergies or conflicts with **existing RES policies**?

Zoom-in: Carbon emission thresholds

European regulation on emission thresholds for CRMs is primarily governed by Electricity Regulation (2019/9431)[1], part of the Clean Energy Package. From July 2025, generators need to meet the CO_2 emission limits of <550 g CO_2/kWh to be eligible for CRM payments, excluding inefficient natural gas- and coal-fired assets to participate in CRMs (Annex II).
Moving towards the 2050 EU net-zero goal, the emission threshold can be expected to be tightened in the future. In the medium term, this could result in only ultra-efficient gas with CCS or hydrogen-fired assets to qualify. Towards 2050, this threshold would go to zero, only qualifying renewables, hydrogen and demand side response.

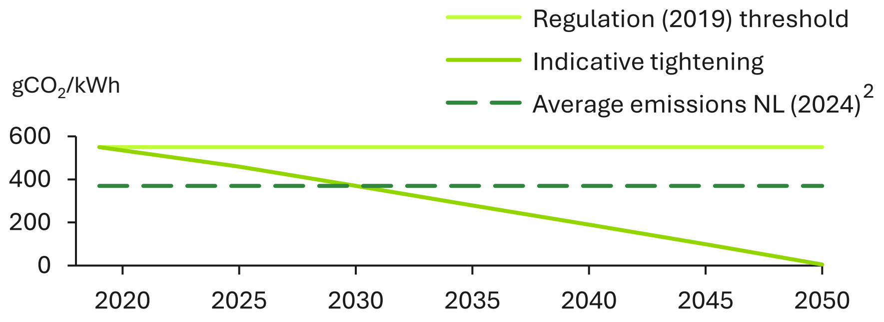


***Figure 25:** EU CRM emissions threshold timeline*

***Table 11**: Life cycle median emissions of different generation technologies.[3]*

Technology	Life cycle emissions (gCO_2e/kWh)
Coal	820-1,050
Natural gas	650-330
Biomass	200-330
Nuclear	5-25
Wind	8-35
Solar PV	40-60
Batteries[4]	10-35
Hydro	1-10

Sub conclusions

- A central CRM can strongly support decarbonisation if designed with strict CO_2 eligibility and contract differentiation. However, weak CO_2 screens risk fossil lock-in and require careful alignment with RES policies to avoid double remuneration.
- A Strategic Reserve offers moderate support, as it provides short-term adequacy without long-term fossil commitments and enables RES build-out with minimal overlap with RES support. CISAF requires application of EU regulation criteria.
- A Hedging Obligation indirectly supports decarbonisation by promoting market-based, technology-neutral financial instruments. It avoids fossil lock-in and aligns well with RES financing through Long-Duratios.
- To effectively support a decarbonised energy system, all mechanisms must balance carbon criteria, subsidy coordination, available technology and market signals. Their impact depends on design choices.

This assessment considers how decarbonisation signals could be included, the desirability of doing so is reflected on in the weighting of the criteria at the end of section 4.2.

[1] Regulation (EU) 2019/943 (Link); [2] Nowtricity (Link); [3] IPCC AR6, Chapter 6 (Link); [4] Only life cycle emissions, excluding grid carbon intensity - NREL (Link).

CRM options scoring for the Netherlands – **Flexibility**

Embed review and possibility to adjust mechanisms without creating market dependence

Description

- Is there a risk of **structural dependence** on a CRM? How complex would it be to discontinue the CRM if it proves to be unsuitable?
- Is the mechanism flexible to adjust to **changing external circumstances**? Can procurement volumes or parameters be updated regularly?

− Central CRM	+ ~ Strategic Reserve	+ Hedging Obligations
▪ Relatively high risk of structural dependency if implemented as market-wide mechanism. A central CRM creates vested interest and revenue expectations for providers. Discontinuation is difficult due to multi-year contracts. EU law requires periodic adequacy reviews and sunset clauses, but political pressure and security of supply needs often prolongs schemes. ▪ Moderate flexibility, as volumes can be recalibrated for the next delivery year and adjusted for the same delivery year, for instance if several auctions with different lead times (e.g. in T-4 and T-1) are implemented. Updates can be based on adequacy studies. However, long-term contracts reduce short-term adaptability. Design choices would require regulatory approval (and sometimes State aid amendments).	▪ Low to moderate risk of structural dependence. Strategic Reserves are explicitly temporary and easier to phase out as contracts are short and volumes relatively small. Discontinuation requires regulatory decision and contract expiry. ▪ High flexibility with volumes and activation criteria that can be revised each procurement cycle. Easy to scale up/down and terminate when outlook changes.	▪ Low risk of structural dependence, as there is no long-term subsidy structure and the obligation is regulatory. Can be adjusted by changing compliance rules, and no risk of stranded assets because no capacity contracts exist. ▪ High flexibility as obligation level and compliance rules can be adjusted annually, and no need for State aid amendments. Depends on forward market liquidity for effectiveness.

Sub conclusions

- A central CRM carries a high risk of structural dependence due to long-term contracts, complex discontinuation and limited short-term adaptability.
- A Strategic Reserve is explicitly temporary, with short contracts and small volumes, offering high flexibility and ease of phase-out through regulatory decisions.
- Hedging Obligations pose the lowest risk of lock-in, with no long-term subsidies or stranded assets, and offer high flexibility through adjustable compliance rules without requiring State-aid approval.
- In summary, a Strategic Reserve and Hedging Obligations are more agile and easier to discontinue or adapt, while central CRM demands careful design to avoid long-term rigidity and political entrenchment.

Summary of the assessment of shortlisted CRMs (1/2)

Criteria	Central CRM (CM)	Strategic Reserve (SR)	Hedging Obligation (HO)
Accuracy SoS	+ Most precise tool for hitting 4h LOLE standard over various timescales; over-procurement risk is manageable via auction mix.	+ ~ Can help address smaller, short-term accuracy challenges in early ‘30s, “safety net”; lacking granularity/long-term suitability if deficits persist.	– Low reliability due to indirect link to physical adequacy. Depends heavily on market liquidity and penalty design, with complex monitoring and enforcement.
Effectivity	+ Most effective and flexible solution: multi-year revenues keep plants online and enable new builds, while multiple lead times secure both ST and LT capacity.	~ Could function as bridging instrument, but not suitable with increasing . Excluding a high amount of generation capacity from EOM is undesirable.	– Least effective, providing no stable, asset-backed cashflows and limited support for new or retrofit investments. Rely on indirect mechanisms (e.g. LT Long-Duratios).
Efficiency	+ ~ Can be efficient with competitive auctions, technology-openness and calibrated reliability options.	~ Medium static efficiency due to usual focus of the reserve on selected technologies. Dynamic efficient if EOM price increases incentivise new technologies.	+ ~ Seems efficient on paper but is fragile in terms of calibration and oversight.
Complexity	~ – Demands high regulatory and operational complexity due to market-wide auctions, forecasting, and rulebook design, e.g. considering cross-border contexts.	+ ~ Simpler, with limited volumes and straightforward governance, but still requires careful activation criteria and is typically nationally bounded.	~ – Complex to supervise (supplier compliance, spike products), hinges on design and execution and lacks a clear legal basis in the Netherlands.
Locational signals	+ ~ Can reflect grid bottlenecks through locational elements, adding complexity and may impact efficiency and cross-border participation negatively.	~ Offers limited locational targeting, mainly for existing units in congested zones, but lacks system-wide optimisation and has minimal cross-border impact.	~ – Does not generate sub-zonal signals; stronger locational granularity would require zonal/nodal pricing or tailored instruments.

Summary of the assessment of shortlisted CRMs (2/2)

Criteria	Central CRM (CM)	Strategic Reserve (SR)	Hedging Obligation (HO)
Financing	~ − Funded via a regulated levy on suppliers, passed to consumers. Payback from ROs can offset costs, but EU rules require careful subsidy coordination. Likely more costly mechanism compared to SR.	+ ~ Keeps financial exposure modest by contracting small volumes and funding them via a straightforward levy on consumers. Likely less costly mechanism compared to CM.	+ Has no central levy, as the costs are internalised in retail prices. Financing depends on market liquidity and supplier creditworthiness.
Timeline	~ Requires the longest lead time (2-3 years) due to several steps. However, can still be implemented in time to meet the in the Netherlands in the early 2030s.	+ Fastest to implement, leveraging existing legal frameworks and simpler design.	+ ~ Takes about 2 years, needing new legislation and market product development, but does not require State aid approval, simplifying oversight.
Decarb. system	+ ~ Design can include strict CO_2 eligibility and contract differentiation strongly supports decarbonisation. Weak CO_2 screens risk fossil lock-in, require careful alignment with RES policies to avoid double remuneration.	+ ~ Offers moderate support, especially when clean resources are prioritised. Mainly provides short-term adequacy without long-term fossil commitments and minimal overlap with RES support.	− Indirectly supports decarbonisation by promoting market-based, technology-neutral financial instruments. Avoids fossil lock-in and aligns well with RES financing through Long-Duratios.
Flexibility	− Carries a high risk of structural dependency due to long-term contracts, complex discontinuation and limited short-term adaptability. Mix of lead times provides some flexibility to tailor to system needs at different time scales.	+ ~ Explicitly temporary, with short contracts and small volumes, offering high flexibility and ease of phase-out through regulatory decisions.	+ Poses lowest risk of lock-in, with no long-term subsidies or stranded assets, and offer high flexibility through adjustable compliance rules without requiring State Aid.

Weighing of criteria in the Dutch context (1/3)

In the decision on the suitability of a shortlisted CRM in the Dutch context, effectivity and efficiency are decisive criteria. Accuracy is not a differentiating factor between a SR and CM.

Assessment criteria	System needs in the Netherlands	Weighing of criteria in the decision on suitability of a CRM in NL
Accuracy SoS	The MLZ (2025) indicates an adequacy challenge in NL starting from the early 2030s. To ensure the post-2030 adequacy gap is closed with high confidence, a mechanism with central volume control and enforceable availability is warranted. Uncertainty exists around the development and uptake of new assets and technologies as well as demand growth over the coming 5 to 10 years. The actual could namely be larger or occur earlier than currently anticipated, for example due to developments in electrification and uptake of batteries unfolding differently than projected. A suitable CRM needs to be a precise tool in mitigating this challenge.	Both a CM and SR can provide the required accuracy, making this criterion inherent but not decisive. In contrast, a HO does not provide the same level of reliability in achieving the desired SoS standard *and hence can be excluded from being a suitable CRM option*. This **criterion is not a decisive** differentiator in suitability of a SR or CM for the Netherlands.
Effectivity	Adequacy projections provide that in the short-to-medium term a baseline adequacy challenge is expected over the next 5 to 10 years, even when taking into account the modelling uncertainties. Significant thermal generation capacity is expected to be mothballed in the coming years, capacity which has not yet reached end of technical life. This thermal capacity could be leveraged within a capacity mechanism to solve the short-term challenge. In the medium-to longer term, the system needs are more uncertain (the size and persistence of the). Additional assets (new builds or retrofits) might be required to structurally support system adequacy in the Netherlands.	Effectivity is a **decisive criterion** in the selection of a suitable CRM. It determines how effective the CRM is in addressing the system needs. The expectation on the need for new assets vs. relying on existing assets only, impacts the suitability of the CRM (CM or SR) in NL. Only a CM could reliably address the maturity-mismatch /missing-money problem beyond the mid-2030s for new assets. A SR can stabilise the near term, while a HO cannot ensure sufficient capacity revenues.
Efficiency	To support the decision on a CRM, ensuring that resource adequacy is contracted at the lowest possible cost in the short and longer term is an important factor. This is affected by the liquidity of the capacity market (different technologies, existing assets, new builds, innovations) in participating in auctions, technology-openness, and efficient design to avoid over-procurement and balance effects of reliability options.	As efficiency differs between the shortlisted CRMs, this is a **decisive criterion** in their suitability in the Dutch context. A CM is set up as a market-wide (rather technology-neutral) auction supporting innovation relative to a SR targeting specific participants and lacking long-term investment signals. A HO can likely support innovation with a technology-neutral design, but efficiency in the longer term depends on uncertain market liquidity.

Weighing of criteria in the Dutch context (2/3)

In the decision on the suitability of a shortlisted CRM in the Dutch context, complexity, locational signals and financing/cost are not decisive criteria as they depend on design choices.

Assessment criteria	System needs in the Netherlands	Weighing of criteria in the decision on suitability of a CRM in NL
Complexity	CRM complexity is acceptable if enduring adequacy governance is required. The main considerations in the Dutch context for complexity relate to: ▪ Whether following the fast-track CISAF design guidelines is acceptable, or ▪ Whether there is a need or willingness to include additional, more custom design elements to a CRM, for example locational signals or additional support for specific technologies, increasing complexity in the design and implementation.	All three mechanisms involve to certain extent administrative effort and coordination, but compared to a CM or a HO, a SR is considered as the least complex mechanism. The importance of this criterion is **ultimately a political decision**. Therefore, this criterion is **not decisive** for the suitability of a CRM in the Dutch context, but design choices can increase or reduce the complexity of a certain mechanism, impacting the *timeline*.
Locational signals	Locational signals within a CRM could help to target capacity towards certain areas to help alleviate grid congestion, which is a major issue in the Netherlands. Stimulating capacities in proximity to locations with grid capacity can alleviate grid congestion and grid reinforcement investments. However, introducing a locational signal reduces liquidity in the market which reduces the cost efficiency of the CRM (the mechanism limits to assets that can participate in that location). In addition, existing markets and mechanisms (e.g. flexibility markets) have as primary aim to support alleviating grid congestion. A CRM, in contrast, has primary aim to ensure adequacy on a system level.	Locational signals in a CRM depend on design choices for a CM or SR. Where Dutch grid constraints matter, a CM can scale into a locational adequacy tool; SR can only target locations temporarily and to a limited extent. A HO is rather unsuitable for locational signals. Adding locational signals to a CRM is **ultimately a political decision.** It also brings more complexity and in turn possibly a longer implementation time. This criterion is therefore **not decisive** in the suitability of a CRM in the Dutch context
Financing	The main considerations on financing and costs of a CRM in NL include: ▪ The VoLL in NL is very high (see slide 67). The VoLL drives the cost-benefit assessment between implementing a certain CRM or not. The cost of potential societal implications from challenges when not implementing a CRM needs to be trade-off with the cost of a CRM when not experiencing challenges (acceptability of 'insurance' cost). ▪ Cost allocation of a CRM involves a decision. Following the CISAF process implies allocating costs to consumers during the most expensive 1-5% hours (see also Annex II). Not following CISAF gives the freedom to make different allocation choices.	Each mechanism offers distinct fiscal and political trade-offs. CRMs can have high associated costs. The societal impact of a CRM with different design options needs to be weighted, by assessing the CRM **cost** against the impact of supply shortages on the system and society when not implementing a CRM. Quantification would require a modelling approach. **The weight of this criterion is ultimately a political decision and hence not decisive at this stage.**

Weighing of criteria in the Dutch context (3/3)

In the decision on the suitability of a shortlisted CRM in the Dutch context, the timeline and flexibility of the mechanism are decisive criteria. The weight of decarbonisation is a political decision.

Assessment criteria	System needs in the Netherlands	Weighing of criteria in the decision on suitability of a CRM in NL
Timeline	A timely decision, design and implementation of a CRM is required if a CRM is intended as solution for the expected adequacy challenge after 2030. A ministerial decision on resource adequacy measures is expected in 2026, leaving maximum five years for preparation of a T-1 auction at end of 2031 (for SR and CM). Auction lead times provide flexibility in the timeline of delivery (T-1, T-4). The timeline of the State aid approval process depends on the design of the mechanism (CISAF fast-track requirements or not). The uncertainty in NL on whether the gap could already manifest before 2033, could warrant an as soon as possible implementation of the selected CRM to have contracted capacity delivered possibly earlier.	As the design and implementation timeline differs for the different CRMs, this is a **decisive criterion** in the Dutch context that also relates to the *complexity* criterion. Both a SR and CM can be fast-tracked in the CISAF process (see Annex II), however a SR is expected to remain the quickest contingency. The timeline of a HO is uncertain due to missing precedents and the need to design this from scratch, but might benefit of not requiring State aid approval.
Decarb. system	The governmental target in the Netherlands is to fully decarbonise the energy (and electricity) system by 2040. New capacity build out is likely required after the phase out of non-abated thermal generation capacity. As there is currently not enough incentive in the EOM to support new investments, a capacity mechanism could solve the missing money and maturity mismatch problems. Capacity operated under a CRM or keeping in operation existing thermal capacity with a SR should not hinder the 2040 decarbonisation goal for the Dutch electricity system, for instance by adding decarbonisation requirements. Note that the CISAF process also has base requirements to decarbonisation and allows for more stringent requirements (see Annex II).	As the extent of decarbonisation requirements depends on design choices, this criterion is **not decisive** in the choice for suitable CRM in NL. To effectively support a decarbonised energy system, all mechanisms must balance carbon criteria, subsidy coordination, and market signals. Furthermore, other mechanisms or instruments outside a CRM can be deployed for decarbonisation. **The importance of this criterion is ultimately a political decision.**
Flexibility	Uncertainty around the development of the adequacy gap in the Netherlands in the short-, medium and longer term (timing, size and persistence) would require certain **flexibility to adapt the mechanism** with different products, auction lead times and contract durations or to phase out the entire mechanism in case it is no longer required.	As flexibility differs between the shortlisted CRMs, this is a **decisive criterion** for the suitability of a CRM in the Dutch context. SR and HO are more agile and easier to discontinue or adapt, while a CM demands a more careful design to avoid long-term rigidity and political entrenchment.

Priority criteria and CRM assessment in the Dutch context

A SR and CM are CRMs which could best fit the Dutch context, depending on the weight of decisive assessment criteria (effectivity, efficiency, timeline and flexibility)

Conclusions of CRM assessment in the Dutch context

Introduction of a CRM in the Dutch electricity market is a possible solution to solve the future adequacy gap, projected to emerge by 2033 with a LOLE of 12.6 hr/yr:[1]

- The Dutch electricity market is currently in a comfortable situation, with ample dispatchable generation capacity. However, this is projected to change in near future: **dispatchable thermal capacity will reduce** due to the phase out of coal and retirements of gas fired capacity facing the missing money problem.
- At the same time, **demand is projected** to grow by electrification in mobility and industry.

There are a number of uncertainties around these projections, which all affect the persistence and size of the projected adequacy gap:

- Electricity demand growth depends on the **pace of electrification and industrial activity in the Netherlands.** Industrial activity is currently under pressure in the Netherlands due to high energy costs, decarbonisation requirements and grid congestion.
- The **future available dispatchable capacity** is uncertain. Technology developments and economics of batteries and LDES can affect their build-out, while the pace and scale of gas-fired capacity retirements is also uncertain.

We assessed a shortlist of potential CRM options to address the adequacy challenge in NL:

- Most suitable CRM options for the Netherlands, for implementation in the near future are a **Strategic Reserve or a Central CRM**. Both are proven options, fit within existing legal frameworks (CISAF fast-track and (in the short term in the Dutch energy law), and can be designed and implemented with limited lead times.
- Considered but **deemed unsuitable are Hedging Obligations** as this is an unproven mechanism for which limited practical experience exist, it does not directly consider physical assets, and its implementation could require a longer lead time (required for creating a well-designed option and to adjust legal frameworks).

Conclusions of the relative assessment of shortlisted CRMs

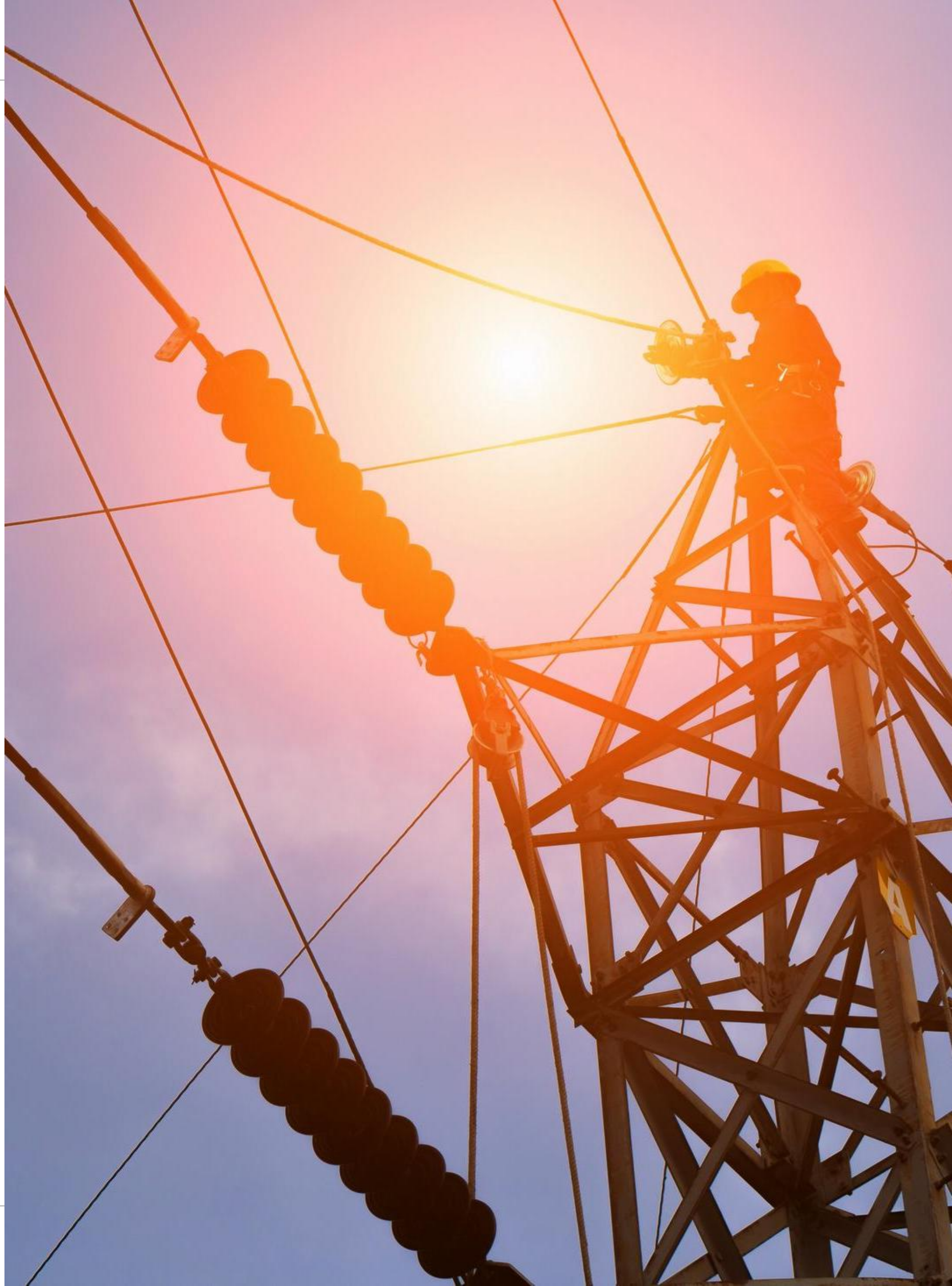
Central CRM	• **Most effective and accurate** option for ensuring long-term resource adequacy and investment certainty in the Netherlands, especially if the would be expected to increase after 2030-2035. • However, its effectiveness and efficiency **depend on careful calibration** of auction design, contract durations, and eligibility criteria—balancing investment certainty with system flexibility. • **Dependencies** include the timely rollout of supporting legislation, the ability to coordinate with existing subsidies and decarbonisation policies, and the need for alignment with grid and market developments.
Strategic Reserve	• **Valuable as a short-term, low-complexity** bridge or safety net • But are **not a permanent solution** if the adequacy problem would persist or exacerbate beyond the 2035 timeframe
Hedging Obliga-tion	• **Theoretically efficient,** but **practically untested** and uncertain in addressing long-term investment needs. • **Omitted as realistic CRM option in the scope for action for KGG,** given the lack of experience and resulting uncertainty on accuracy and effectiveness as well as uncertain implementation process.

Relevancy of the CRM assessment criteria in the Dutch context

When looking at the situation in NL, the following criteria are most pressing and decisive in make a decision regarding the suitability of a CRM: **effectivity, efficiency, timeline and flexibility.** We have used the above criteria to recommend a scope of action for KGG along possible pathways in Chapter 5. Note that the relative importance of the criteria in the Dutch context is ultimately a political decision.

[1] TenneT Monitor Leveringszekerheid 2025

Content



Scope of action for KGG towards CRM implementation

Three possible pathways for the implementation of a SR or CM in the scope of action of KGG, based on the relative weighing of the assessment criteria

Pathways in scope of action

Given the Dutch context and the criteria assessment, Hedging Obligations are not considered as realistic option given the lack of experience and resulting accuracy and efficiency uncertainty as well as long and uncertain implementation process. For SR and CMs, we identified three main pathways implementation that could be taken:

- Pathway **A: Temporary Strategic Reserve**. As-soon-as-possible implementation of a SR, with a clear timeline for phasing out the instrument again based on expectations that the adequacy gap will be temporary and timely solved by the market.
- Pathway **B: Central capacity mechanism**. As-soon-as-possible implementation of a CM, as a structural short- and longer-term solution in case the expectation is that the adequacy gap will persist.
- Pathway **C: Temporary Strategic Reserve, potentially followed by a central capacity mechanism**. The SR is used to 'buy time' to assess if a CM is necessary as structural solution and, if so, to provide more time for tailored CM design, approvals, implementation and auction.

When assessing the options for CRM implementation, **the current situation without a CRM in place** can be considered as a **baseline** to consider the CRM effects against.

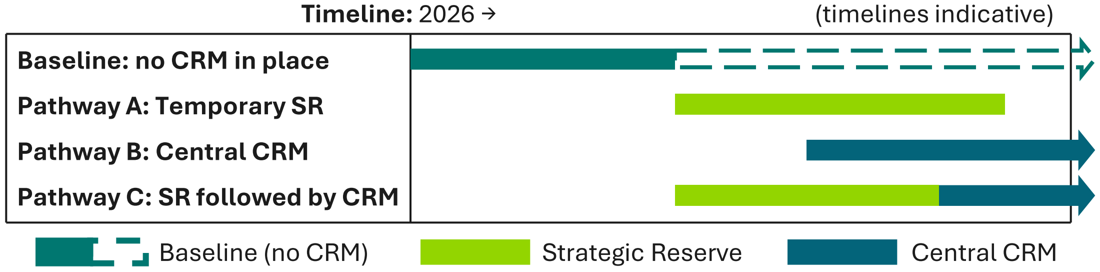


Figure 26: Illustrative baseline and pathway overview.

Priorities provide a direction for selecting between pathways

Which pathway to pursue depends on which assessment criteria are considered a priority in the Dutch context. Each pathway provides different opportunities, strengths and weaknesses. Key differentiating criteria between the pathways are and are evaluated relative to each other:

- **Effectivity:** How does the CRM meet the system adequacy needs?
- **Efficiency**: Is the adequacy solved in the most cost-efficient way (static efficiency), are innovations and deployment of new technologies possible (dynamic efficiency)?
- **Timeline**: Is a quick implementation of a CRM required?
- **Flexibility**: How is optionality valued? Is there willingness for a longer-term commitment?

The following slides provide more detail on the situations where each pathway would be most appropriate, their strengths and weaknesses, and high-level design considerations.

Baseline to assess the societal impact of CRMs against

The current situation of the EOM without CRM in place can be used as baseline to consider the effects of CRM implementation. First, current electricity market projections to assess the timing, size and persistence of the adequacy gap start from this baseline. Second, the societal impacts of a CRM can be assessed against the situation without CRM in place:

- The positive effects of a CRM in reduction of the LOLE and EENS (and valuing these via the VoLL) and secondary effects on price peak and volatility impact can be quantified via modelling.
- The negative effects of a CRM are quantified by the explicit costs of a CRM (which are not present in a baseline without CRM in place).
- Additional indirect effects such as long-term impact on business climate of the Netherlands (and associated socioeconomic impacts, e.g. jobs, economic growth) are harder to quantify but can be compared against the baseline.

Baseline: Electricity market without a CRM in place

Use the current situation without CRM as baseline to assess the societal impact of introducing a CRM

Rationale for using the current electricity market without a CRM as baseline

A solution is required post 2030 for the expected challenges in the Netherlands. Uncertainties in the outlook of the perceived adequacy gap exist. The exact timing, duration and size of the adequacy gap depends amongst others on:

- Supply side uncertainties, affecting the available generation capacity: pace of RES roll-out and thermal retirements, technology improvements and deployment (e.g. batteries, LDES).
- Demand side uncertainties, affecting the demand for generation capacity: pace of electrification in mobility and industry.

Weighing the costs and benefits of a CRM depends on the outcome of these uncertainties. Different assumptions in terms of duration (will an adequacy gap be temporary or structural) and size (how large will an adequacy gap will be), drive the cost and benefit outcomes.

Projections of continuing the current situation without a CRM, and the associated costs and benefits, can serve as reference scenario for weighing CRM introduction options.

Excursus: Other mechanisms than a CRM that affect supply adequacy

A CRM is not the only policy instrument that affects supply adequacy. Multiple other instruments, some of which are already deployed in the Netherlands, also affect the energy-only market and supply adequacy:

- Support for build-out of RES through renewable subsidies and roadmaps, such as the SDE++ or the offshore wind strategy, increase RES supply and affect price formation.
- Support of energy technology development towards commercially viable TRL can accelerate market implementation. Uptake of flexible supply technologies such as batteries and LDES can be supported by inclusion in instruments such as the DEI+.
- Direct subsidies or policies to support new generation capacity, such as governmental support for new build nuclear capacity or a potential conversion of coal assets to low-carbon (e.g. biomass or ammonia firing).

Crowding out effects need to be considered in case of targeted subsidy schemes (sec. 3.1).

Weighing the societal impacts of a CRM

Weighing the societal impacts of introducing a CRM requires creating insights to multiple effects of the CRM and the performance on the CRM criteria. The costs of a CRM need to be weighted against the (financial and societal) risks if no CRM is implemented but scarcity moments arise. A CRM can here act as an insurance for future adequacy problems. **Costs** of a CRM are quantified by the auction results (at least for a CM and SR), but positive effects on electricity wholesale prices needs to be weight up. **Societal benefits** are not directly quantified within the mechanism, and can only be indirectly quantified by e.g. modelling:

- CRMs can reduce price peaks and EENS. Quantification of these effects requires modelling. There is a linear relation between the VoLL and quantifying the benefits of LOLE reduction. The VoLL thus drives the assessment of societal CRM benefit. There must be a high level of trust in the VoLL value for the assessment of CRM efficiency to be reliable.
- The societal benefits of avoided price peaks, such as reduced energy poverty and consumer energy costs uncertainty, can only be quantified indirectly.
- Longer terms benefits of a CRM, e.g. maintaining a high standard of living and an attractive business climate by avoiding scarcity events are difficult to quantify in monetary terms.

Main take-aways

- Assumptions on the uncertainties in electricity market development drive views on when and for what duration a CRM needs to be introduced.
- For reliable assessment of the CRM cost/benefit trade-off, the VoLL needs to understood, including differences with other countries, as it forms the basis of decision for a CRM introduction.[1]
- There is a political element in the decision to (not) introduce a CRM, as it has social effects such as on energy poverty and consumer energy cost uncertainty, longer term effects on the Dutch business climate. Not all effects can be captured in a costs-benefit assessment.

[1] The Dutch VoLL is high in comparison to neighbouring countries. Understanding of the CRM benefit assessment can be increased by understanding where the differences in VoLL with neighbouring countries originate from.

Pathway A: Strategic Reserve (temporary)

Use a Strategic Reserve as a temporary safety net by keeping existing thermal generation in operation while the adequacy situation in the Netherlands is further monitored and assessed

Selection of this pathway in case of priorities for

Appropriate in case of priority for: **Timeline** **Flexibility**

- A SR can be **designed and implement relatively fast** (**timeline**) to meet the adequacy challenge by 2033. For this, the CISAF fast-track State aid framework design requirements could be followed (see Annex II). Not opting for the CISAF fast track, would still allow for a timely auction and delivery of the required capacity, also if the first challenges were to occur already between 2030 and 2033.
- Flexibility is valuable when the **is expected to be temporary**. In this case, a SR can provide a temporary solution with minimal market distortion and without creating a dependency in the market on CRM revenues (for assets which are not contracted in the SR). With this the pathway provides **flexibility** to phase-out the SR when it is not needed anymore as well as allowing for further monitoring and assessment of the resource adequacy situation in the Netherlands towards the medium and longer term.

Pathway strengths and weaknesses

- A temporary SR can make **benefit of the unique Dutch situation**, as the otherwise phased-out gas-fired capacity can be placed in Strategic Reserve (**effectivity**). This can limit the **costs** compared to a central CRM.
- The pool of assets that will practically participate in a SR will be limited to existing thermal (gas-fired) plants and possibly batteries. This potentially reduces the CRMs **efficiency**, but the EOM market will continue to function as before (implying equal **efficiency**).
- A SR does **not provide a structural stimulation for new generation capacity** apart from possibly rising EOM price peaks, which negatively affects **effectivity** if the gap increases and persists.
- Surrounding countries have or are moving toward structural central CRMs, so the pathway **does not harmonize markets and provide a level playing field** for new capacity investments (**dynamic efficiency**).

Design considerations

A **design in line with CISAF State aid fast-track** rules (Annex II) could minimise the approval and implementation time. While this reduces the **complexity** of the design process, it also reduces the design freedom. Any side effects arising from the design requirements need to be either accepted or compensated for using other instruments:

- CISAF requires 90% **cost allocation to consumers** based on their consumption **during the 1-5% highest price periods per year** (**financing**). This can aggravate the energy costs for consumers who are unable to shift their demand (e.g. certain industrial or residential consumers). Additional instruments may be required to compensate these users.
- The CISAF requirement to implement **short term, short duration auctions** (T-1, one-year contracts) fits with the priority for **flexibility** and creates options to accurately match the auction volumes with the capacity needs to reach the desired LOLE levels (**accuracy SoS**).
- **CO_2 emission limits from electricity regulation must** be complied with under the CISAF, potentially limiting the inclusion of older, less-efficient generation capacity in the reserve and thereby reducing the opportunity to benefit from the Dutch pool of existing capacity (**decarb. system**). On the other hand, placing fossil thermal capacity in a reserve could otherwise hinder decarbonisation goals, in case the reserve is being called upon for a significant time per year and not decarbonised by other instruments.

Not opting for the CISAF fast track provides more freedom for custom design of the mechanism.

In absence of a structural investment incentive for buildout of new generation capacity, there is a **dependence on market developments or other instruments to solve any longer-term** . These can be instruments for building out capacity (e.g. RES roll-out stimulation), for deployment of new technologies (e.g. batteries and LDES development and roll-out schemes) or flexible demand stimulation schemes.

During the temporary SR, there will be an **uneven playing field** between the Netherlands and surrounding countries which are in the process of or have implemented CMs.

Pathway B: Central CRM (as soon as possible)

Accelerate the implementation time to use a central CRM as structural short-, medium- and longer-term solution

Selection of this pathway in case of priorities for

Appropriate in case of priority for: Effectivity Efficiency

- A CM is a **proven mechanism** to serve as an 'insurance policy' for adequacy gaps. It can provide a **high level of reliability** that the LOLE targets will be met in both the short and longer term by solving the missing money and maturity mismatch problems (**effectivity**).
- This pathway **provides a structural solution** to the adequacy challenge also after 2035. Flexible capacity and low carbon technologies can be included through a technology neutral support to the development of new generation capacity. This creates a large potential market pool for capacity supply, increasing the CRM **efficiency**.

Pathway strength and weaknesses

- A CM can have a shortened approval and implementation **timeline** if **designed in line with CISAF State aid fast-track** rules and benefitting from ongoing preparations in the Dutch energy law, however still longer than a SR when taking into account the longer auction lead times (CISAF T-4 to T-6 auction requirement). The CISAF would allow for a timely implementation ahead of the expected by 2033.
- If covering the peak demand and pay-as-cleared (required in State aid fast track process), a CM can have **high mechanism costs** compared to a SR or situation without CRM (**cost**).
- The risk of over- or under-procurement is manageable via adjustments of the auction volume or reliability options (**accuracy SoS**).
- Directly moving towards a CM as structural solution (without temporary, intermediate solutions) creates a **clear pathway** for the market and provides investment certainty to market participants and investors (**effectivity**).
- However, once the implementation of a CM decided and publicly communicated, it is **difficult to change course** (e.g. delaying implementation, opting for another instrument, or exiting the scheme) due to market expectations in the lead time before implementation and the structural market dependence once implemented (**flexibility**).

Design considerations

A **design in line with CISAF State aid fast-track** rules (Appendix II) could minimize the approval and implementation **time**, While this reduces the design **complexity**, it has some design implications:

- A mix of auctions in a CM can both **cater to short-term flexibility and capacity needs** (e.g. T-1, one-year contracts) and **provide long-term investment security** (e.g. T-4, up to 15-year contracts). To have the CM operational as soon as possible, a 'ramp up phase' could be considered by holding the first T-1/T-4 auctions simultaneously and subsequently starting the mechanism for the initial three years with deliveries from T-1 auctions only. This can balance short-term static **efficiency** with long-term dynamic efficiency. CISAF limits the short-term flexibility by prescribing 75%-90% of target demand being auctioned 4-6 y ahead of the delivery window**.**
- CISAF requires 90% **cost allocation to consumers** based on their consumption **during the 1-5% highest price periods per year** (**financing**). This can aggravate the energy costs for consumers who are unable to shift their demand (e.g. certain industrial or residential consumers). Additional instruments may be required to compensate these users.
- CISAF requires a CM to be **technology neutral**. Openness to new technologies (decarbonised generation capacity, flexible demand, storage) supports **decarbonisation** policy goals.

Not opting for the CISAF fast track provides more design freedom of the mechanism, such as providing **locational signals**. For a CM, the implementation time could in this case still allow for a timely auction and delivery of the required capacity if the first adequacy challenge is not expected before 2033 and shorter-term auction lead times are included.

Create **alignment with surrounding markets**: the UK and Belgium have a CM. Introduction in the Netherlands of a CM with a design that is harmonized with the mechanisms in surrounding countries is a large contribution to a level playing field for the electricity markets. This can avoid market distortions and ensure a level playing field for investments in new capacity build out.

Pathway C: Temporary Strategic Reserve, subsequently central CRM

Use a temporary Strategic Reserve as short term solution, 'buying time' to develop and implement a custom central CRM as long-term, structural mechanism

Selection of this pathway in case of priorities for

Appropriate in case of priority for: **Flexibility** **Timeline**

- This pathway is a suitable solution when the **adequacy gap is expected to emerge on a short term and is expected to be structural**. The SR can be implemented fast (**timeline**) to provide a short-term solution to the expected by 2033, while 'buying time' for the design and implementation of a CM as a structural solution.
- If the short-term urgency of the adequacy gap is addressed by the temporary SR, there is more time for **flexibility to decide if a CM is required as structural solution, and if so, on the design** of the CM. There is more time to monitor how the uncertainties in the electricity market will unfold and affect the persistence and size of the adequacy gap. The time can also be used to think through the design of a CM and potentially (partly) deviate from the CISAF fast-track design guidelines. This can allow creating a CM that is more tailored to the Dutch context and create more efficient results.

Pathway strengths and weaknesses

- A temporary SR can on the short term **utilise capacity that would otherwise be phased** out. In the short-term a SR can have **reduced explicit costs**, compared to a central CRM costs. During the temporary SR, **progress in technical development and economics** of options for new capacity build-outs can be reached. Novel technologies like low-carbon dispatchable generation, batteries and LDES can reach higher TRL and improved economic attractiveness. A subsequent CM which provides incentives for new build capacity can reap the benefits of the progress in development (long term, dynamic **efficiency and effectivity**).
- Gaming effects could occur during the temporary SR. The market could enter a **standstill for new builds in anticipation** of the CM and the incentives it provides.

Design considerations

A **smooth transition** between the mechanisms must be ensured:

- **Avoid overlap** between the mechanisms, by aligning the SR auction lead time and contract durations with the change to a CM and ensure all SR contracts are ending when the CM becomes active.
- It needs to be examined further if the SR can and needs to include a **no-return rule**, excluding capacities from a future return to the energy market, and if capacities would still be banned from returning to the energy market after the switch to a CM.

When CISAF fast-track application is not required, there is **more freedom in CM design** as it allow for (partly) deviating from CISAF design requirements:

- Allow for deviating from CISAF auction lead time requirements of auctioning 75-90% of the estimated capacity requirement 4-6 years ahead, if reasonable. For example, more short lead time, short duration contracts could be included to accurately match the adequacy needs (**accuracy SoS**).
- As long as state-aid rules are obliged, CM cost allocation does not have to be to consumers during the 1%-5% highest price periods **(financing).** Other cost allocations could reduce the price peak impact of a CM, e.g. to avoid unduly high burdening of unflexible consumers (e.g. certain industrial or residential consumers), and potentially avoid the need for other policy instruments to compensate for such undesired side-effects of a CM.
- There is more freedom to include or exclude **locational** criteria, providing the option to support these with the CM or rely on other mechanisms instead.

During the temporary SR, there will be an **uneven playing field** between the Netherlands and surrounding countries which are in the process of or have implemented CMs.

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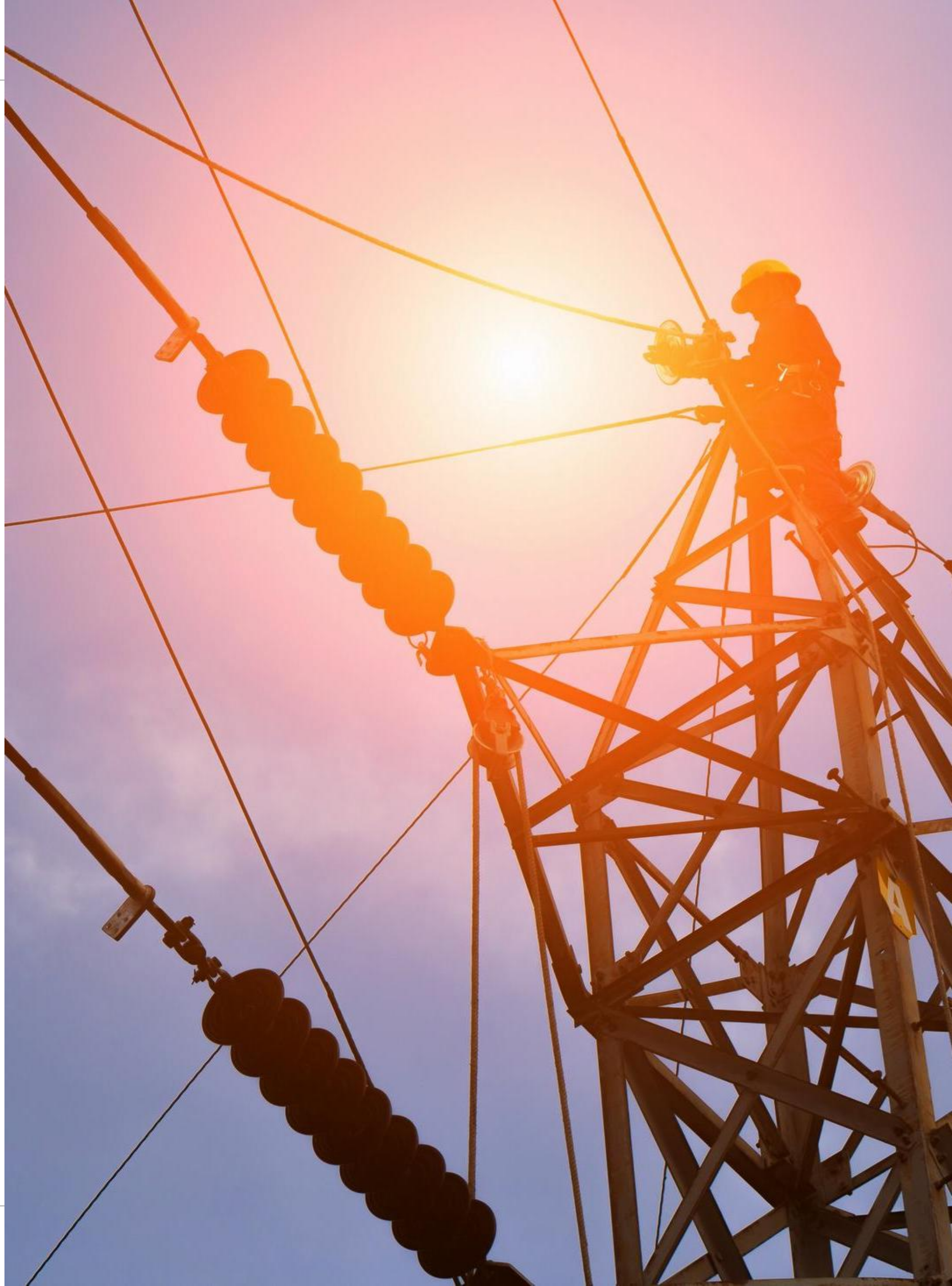

Conclusions on scope for action and recommended next steps

The Netherlands is facing an adequacy challenge in the early 2030s

- The Netherlands expects challenges after 2030. In the base scenario of the MLZ 2025, the LOLE threshold is exceeded from 2033. A **timely decision and implementation** of a CRM is therefore required to solve the adequacy problem in this period.
- Projections on the precise timing, persistence and size of the adequacy challenge have inherent uncertainties. The main uncertainties are related to **trends in existing generation** (timeline of capacity retirements) **and demand** (pace of electrification) portfolios, and to **new technology expectations** (pace of LDES and batteries deployment).
- The most **suitable CRM options for the Netherlands are a central CRM** (most effective and accurate option) and **a Strategic Reserve** (valuable as short-term, low-complexity option). **Hedging Obligations are omitted**, given a lack of experience and uncertainty on accuracy and effectiveness.

Weighing of criteria in the Dutch context determines which pathway to take

Three pathways for CRM implementation are identified in scope of action for KGG.

- Pathway **A: Temporary Strategic Reserve –** As soon-as-possible implementation, with clear timeline for phase-out. Appropriate for timeline and flexibility priority.
- Pathway **B: Central capacity mechanism –** As soon-as-possible implementation as a structural solution for a persisting adequacy challenge. Appropriate for effectivity and efficiency priority.
- Pathway **C: Temporary Strategic Reserve, followed by a central capacity mechanism –** Use of a Strategic Reserve to 'buy time', which can be used for assessment on the need and design of a structural central CRM. Appropriate for flexibility and timeline priority.

Selection of the most suitable pathway depends which criteria is prioritized: **effectivity** (whether adequacy is met), **efficiency** (cost-efficiency of provided adequacy), **timeline** (speed of implementation) and **flexibility** (valuing of optionality).

Step to support a decision on CRM implementation

As next step to support a Ministerial decision on whether, and if so which, a CRM should be implemented as part of resource adequacy measures:

- Formalise a **view on the size, timing and persistence of the adequacy gap**. The view needs to be based on the best available data and insights, while acknowledging the inherent uncertainties in making projections.

No regret next steps to support CRM implementation

Practical no-regret next steps in the CRM design, State Aid and implementation process are:

- **Formalise the desired reliability standard**, as it is at the basis of the capacity need.
- Improve the robustness of CRM cost and benefit assessments. This includes **understanding differences in VoLL** with surrounding countries, quantitative modelling of **CRM design options** impacts on societal benefits such as EENS reduction, price peaks and price formation.
- Start and **accelerate the State Aid approval** process where possible, e.g. by a parallel process. In case of a CM, receiving approval requires proving that a SR is not suitable.

Final considerations

- A **modelling approach** for comparing CRM design options was **not in scope** of this research. For quantification of the design options impact on LOLE and EENS reduction and the impact on price peaks and price formation, a modelling approach is required.
- **Uncertainties are inherent** and cannot be fully avoided with decision making based on projections of the future adequacy gap. At the same time, **improved understanding** of the up- and downside uncertainties of the adequacy gap assessment, the VoLL and indicative CRM costs and benefits **improves the robustness** of societal impact of CRM introduction.

Process towards possible CRM implementation

Summary of the next steps in the process towards possible implementation of a CRM

Next steps in resource adequacy measure decision

1. **Formalise the adequacy assessment.** A formalised view on the time, size and persistence of the adequacy gap is required. This can be based on existing research, including the upcoming TenneT MLZ 2026.
2. **Ministerial decision** on implementation of resource adequacy measures, potentially including a CRM introduction.

Next steps if implementation of a CRM is decided on as resource adequacy measure

3. Formalise a **reliability standard**, which will be at the basis of the required capacity volumes and auction timeline.
4. Perform a detailed **assessment of CRM design options**, continue ongoing VoLL research and developments, define the **detailed CRM design** and create the national **regulatory and legal framework.**
5. Start **State aid process** in parallel with detailed design phase. The State aid process includes a fast-track option. Taking the Commission on board early through a pre-notification and ongoing discussions can speed up the process.
6. Following a final legal decision and State Aid approval, CRM implementation and preparation phase.
7. Hold capacity or reserve **auction** and contracting.
8. The moment of **delivery** depends on the lead-times (e.g. T-1) and the time to retrofit or build new capacity.

Overall time required for design, approval and implementation

- **Timeline SR** from a ministerial decision: ~1-2 years until contracting after auction.* Moment of delivery can be within ~1 year (T-1) after auction if based on existing generation units.
- **Timeline CM** from a ministerial decision: ~2-4 years depending on the duration of the State aid process, auction and contracting time.* Moment of delivery depends on the lead times of the auction and can vary between 1 year for existing units to 4 years or more for new build capacity, depending on the technology, required permits and other factors.

Ways to **accelerate the approval and implementation** process:

- Use of the CISAF fast track to shorten the State aid approval process.
- Develop the detailed mechanism design in parallel with pre-notification to the EC for the State aid process and negotiation.
- Use lessons learnt and experience in neighbouring countries with design options and implementation

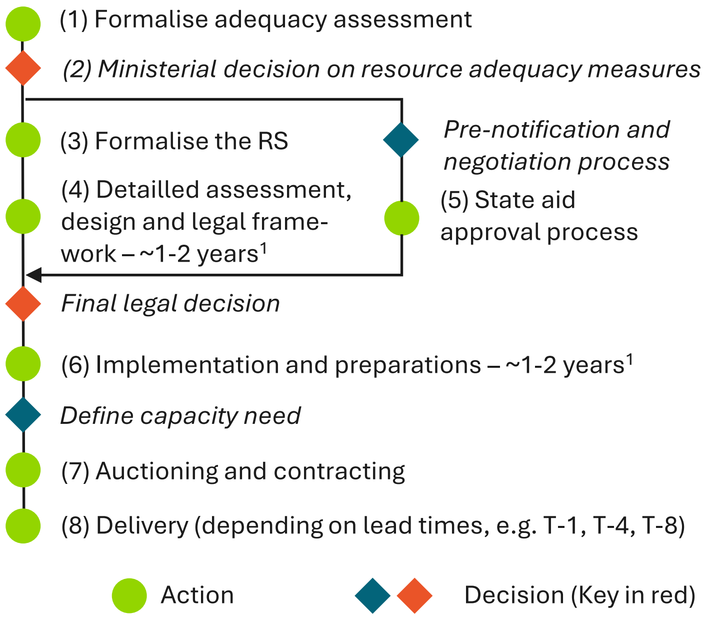

Figure 27: Overall process towards possible implementation of a CRM.

Table 12: Actors and their possible roles in CRM design and implementation

Actor	Possible roles (see section 4.2 complexity)[2]
	Decision on the implementation of a CRM in the Netherlands; Decision on capacity to be contracted.
	Advice on conditions for Strategic Reserve or central mechanism; Decision on cost.
	Advice on and adequacy situation. Contracting body and organising auctions.

1 Timeline estimations based on OTE, Leveringszekerheid Elektriciteitsvoorziening, 2020, Elia – Product sheet capacity remuneration mechanism (2025), the CRM implementation timeline in Belgium which included 2 years for state-aid approval (July 2019 – August 2021), which could be reduced in CISAF fast-track. 2 Indication of possible roles by Guidehouse.

Suggested next steps towards a resource adequacy measure decision

Recommendations to enable a Ministerial decision on resource adequacy measures

Recommendations to enable a decision on resource adequacy measures

A ministerial decision is expected in mid 2026 on measures for resource adequacy improvement. This decision needs to be made based on the best available data, while acknowledging the uncertainties that are inherent with a decision on measures that will be effective only years in the future.

- For prioritisation of criteria and the implications this has on which CRM pathway is the most suitable, a formalised view is needed on the timeline, persistence and size of the adequacy gap. Considering the short timeframe up to the ministerial decision and the currently available data, there is a role for TenneT and the (expected 2026 update of the) MLZ as knowledge basis.

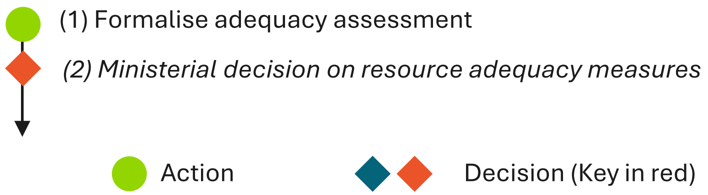

Figure 28: Related process steps toward a Ministerial decision on resource adequacy measures.

Challenge	Description	Potential impacts on CRM	No-regret actions
Formalise a view on the timeline, persistence and size of the adequacy gap	Current adequacy gap research looks 10 years ahead up to 2035.[1], [2] The Dutch energy system is facing a crucial 10-year period with the phase out of existing thermal generation combined with uncertainty around capacity additions (storage, demand response, offshore wind). This creates uncertainty about the exact timing, size and persistence of the .	The SR and CM differ in suitability as temporary or more structural solution for the adequacy problem, respectively. Selection if, and if so which CRM to implement, depends on whether the adequacy gap is deemed structural or temporary, expectations around when the gap will occur and expectations on how the gap will evolve over the coming decade.	• Formulate and monitor signposts to recognise a temporary or structural nature in , e.g. setting up of regular monitoring of demand developments such as industry and data centre demand, and new technology developments, e.g. TRL improvements and growth of DRS and LDES. • Create a best-available knowledge basis with quantitative adequacy assessments. This includes a role for TenneT with the (expected 2026 update of) the MLZ with refined insights and analysis of the results.

1 Ecorys - Value of Lost Load (2022) [2] ENTSOE EERA (2024)

Suggested next steps for the CRM implementation phase (1/3)

Recommendations to implement a CRM in the Netherlands.

Recommendations for the CRM implementation phase

After a ministerial decision on measures for resource adequacy improvement is made, in case a CRM is decided on there are practical next steps in the design, State Aid approval process and implementation plan. The exact process depends upon the decision of CRM type and timeline towards implementation; however no-regret actions are pre-identified as the need to be considered in all cases.

- The desired reliability standard needs to be formalised as it is at the basis of assessments for the capacity need.
- Continuing and aligning ongoing research and developments into the VoLL differences between countries increases understanding and robustness of the VoLL. As the VoLL is also an important factor for a societal benefit assessment of CRM design options, it increases robustness in the benefit assessment insights as well.
- CRM design options impact on societal benefits through reduced EENS, price volatility and price peak height can be assessed via energy modelling.
- Timely State Aid approval requires a swift start of the State Aid approval process and accelerating this where possible, for example by starting this in a parallel process. In case of a CM, receiving approval requires proving that a SR is not suitable.

A description of the challenges related to steps 3, 4, 5 and 6 (figure 29), their impact on CRMs and the identified no-regret actions is provided on the next slides.

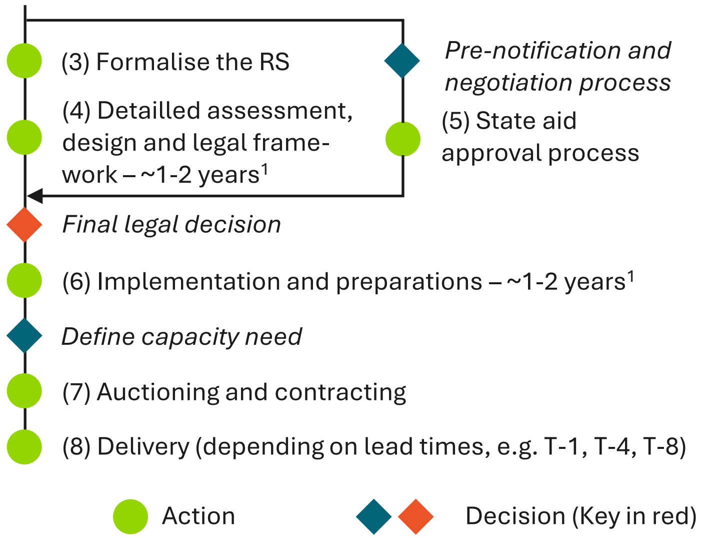

Figure 29: Related process steps in the implementation phase of a CRM.

Challenge	Description	Potential impacts on CRM	No-regret actions
Formalise the desired reliability standard (RS)	Current adequacy studies employ a grid reliability standard of LOLE <4 hours/year. However, this reliability standard is not yet formalized in legislation.[1] The reliability standard affects how much capacity needs to be contracted in a CRM and the cost/benefit assessment of the mechanism.[2]	With higher grid reliability standard (i.e. lower desired LoLE), more capacity needs to be contracted in the CRM.	• Consider the required reliability standard and the associated societal impacts, such as the long-term impact on investment climate and impact on end-consumers for LoLE values. • Formalise the reliability standard in law as basis for CRM design and state-aid approval. (roles for KGG)

(continued on the next slide)

[1] Timeline estimations based on OTE, Leveringszekerheid Elektriciteitsvoorziening, 2020, Elia – Product sheet capacity remuneration mechanism (2025), the CRM implementation timeline in Belgium which included 2 years for state-aid approval (July 2019 – August 2021), which could be reduced in CISAF fast-track.

Suggested next steps for the CRM implementation phase (2/3)

Recommendations to implement a CRM in the Netherlands.

Challenge	Description	Potential impacts on CRM	No-regret actions
Understand the VoLL differences with other countries by continuing ongoing research and developments	The Value of Lost Load has a linear impact on the perceived benefits of a CRM, and therefore a direct impact on the societal cost benefit assessment of CRMs.	The current assessment of the VoLL for the Netherlands is at 69k EUR/MW[3] substantially higher than surrounding countries. Changes to the VoLL would affect the benefits of a CRM, impacting the cost benefit analysis of CRM implementation and design.	Understand the differences in VoLL compared to other countries. Continue and align ongoing research and developments, such as the calculation of harmonised VoLL reference values,[4] the comparative assessment of VoLL calculation methodologies and deviations from the ACER standard,[5] and the regular update cycle of the Dutch VoLL[6]. (roles for ACM and KGG)
Quantitatively assess the societal costs and benefits of CRM design options	Introduction of a CRM has explicit costs but also associated benefits for society. CRM benefits include reduced EENS and indirect effects on price volatility, price peak height and - duration through price formation impacts.	Different CRM design options (see section 4.2 and Annex IV), as e.g. the auction mix, year of introduction, decarbonisation requirements or CRM financing, will affect the costs and benefits of the mechanism. To assess the impact, there needs to be a quantitative view on the impact on the merit order and price curves (where in the curve capacity would be introduced and how much capacity is added or removed).	Assess the costs and benefits of CRM design options under consideration through power market modelling. MLZ scenario market assumptions can serve as baseline, with the potential to add alternative scenarios for sensitivity analysis. Benefits assessment should include effects on EENS, price volatility and price peak height and duration for end-consumers, including CRM costs. (Role for KGG and TenneT)

(continued on the next slide)

[1] ACM – Voorzieningszekerheid Elektriciteit en de mogelijke rol en vormgeving van capaciteitsmechanismen (2025) , [2] ACER decision 23/2020 sets out a methodology for calculating the reliability standard, [3] Ecorys - Value of Lost Load (2022), [4] The EC requested ACER to calculate reference VoLL for all Member States (EC COM/2026/26), [5] ACER mandated research by Kapeller et al. (2025), [6] EU regulation 2019/943 stipulates that member states 'shall update their estimate of the value of lost load at least every five years'.

Suggested next steps for the CRM implementation phase (3/3)

Recommendations to implement a CRM in the Netherlands.

Challenge	Description	Potential impacts on CRM	No-regret actions
Decide on the use of the CRM to achieve other goals beyond adequacy alone	A CRM could be designed to support multiple targets next to capacity. supply adequacy, supporting e.g. decarbonisation by setting strict emission requirements for participating capacity or congestion management by adding a locational aspect to contracted	A CRM is primarily implemented to address an adequacy challenge at a system level; to ensure supply and demand are balanced. Additional goals can make the design of a CRM complex while there might be existing mechanisms with a primary aim to address them, such as EU ETS or GOPACS. From an economic perspective, the Tinbergen rule[1] states that to achieve multiple independent policy goals, an equal number of independent policy instruments is needed. Addressing multiple targets needs to be assessed very carefully.	• Perform an assessment of the design requirements to achieve other goals beyond adequacy, and the impact on the CRM costs and effectiveness of the additional requirements. Compare it to alternative solutions to address these issues. • Determine lessons learnt from other countries that have used a CRM to achieve secondary targets next to supply adequacy.
If a CM is preferred, prove a SR is not suitable to solve the adequacy gap	In the Art. 21 of Regulation (EU) 2019/943 & fast-track State aid procedure, a SR is the reference CRM option. For a CM, it must be proven that a SR is not sufficient to solve the adequacy gap.	If a CM is the preferred option based on the adequacy gap analysis, it must be shown that a SR is not sufficient to address the adequacy gap. In addition, qualifying for the fast-track State aid procedures helps to shorten the lead time.	• Quantitative analysis of whether implementing a SR would be sufficient to achieve security of supply criteria or not due to a persisting resource gap. (see Belgian example[2])
Work out detailed implementation pathway and timeline	To ensure timely decisions on the implementation of a CRM in the NL and to provide certainty to the market, a clear implementation pathway including timeline is required.	A clear implementation pathway and timeline helps keeping the implementation on track, for the mechanism to be effective when an adequacy gap would otherwise emerge, and informs stakeholders.	• Develop a detailed pathway and timeline for implementation. • Develop a stakeholder engagement plan.

[1] Tinbergen rule includes basic principle of effective policy, see for example, RePub, Erasmus University Repository: Jan Tinbergen - Selected Papers [2] EC, State aid decision capacity Mechanism Belgium, 2021.

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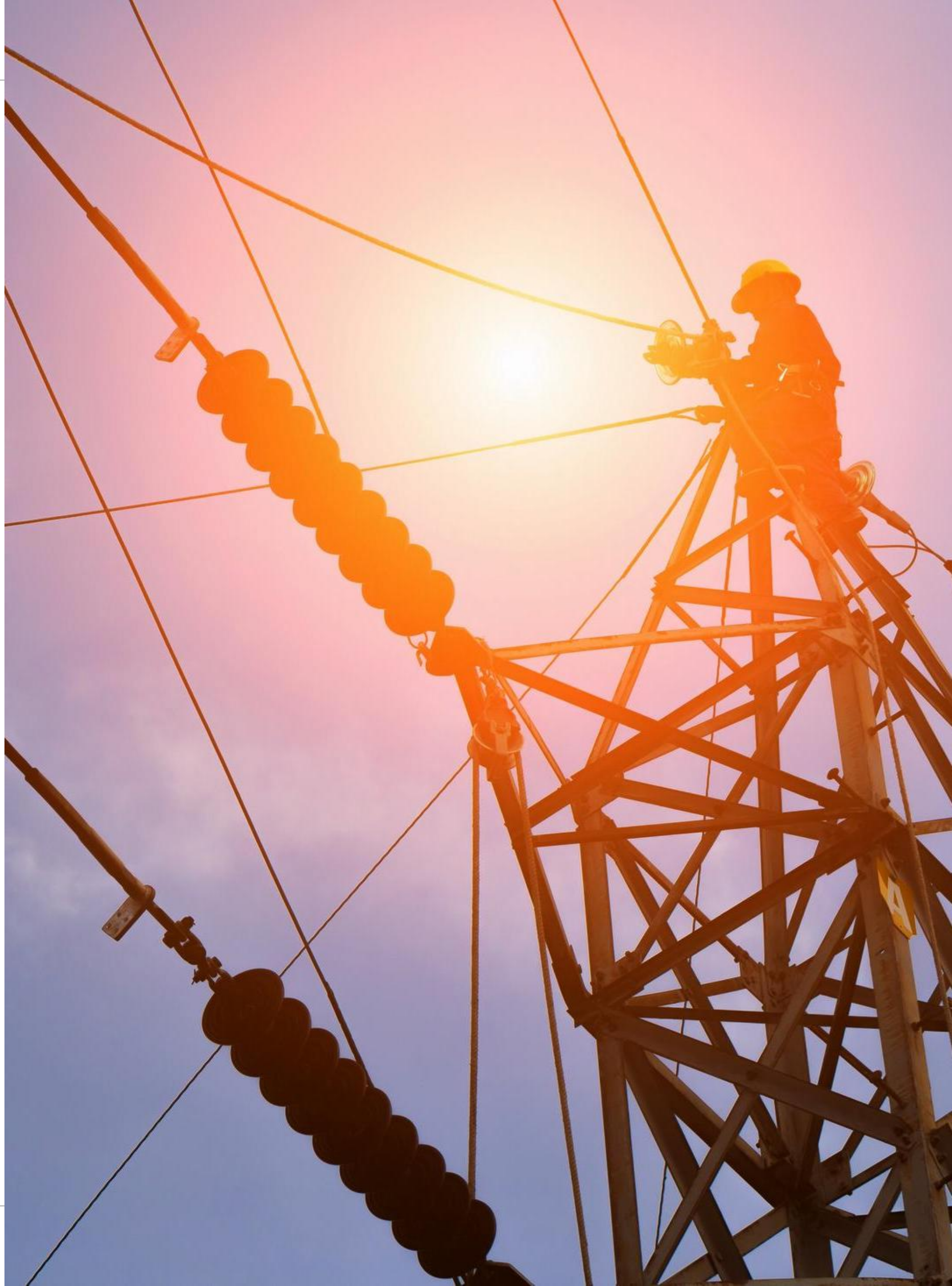

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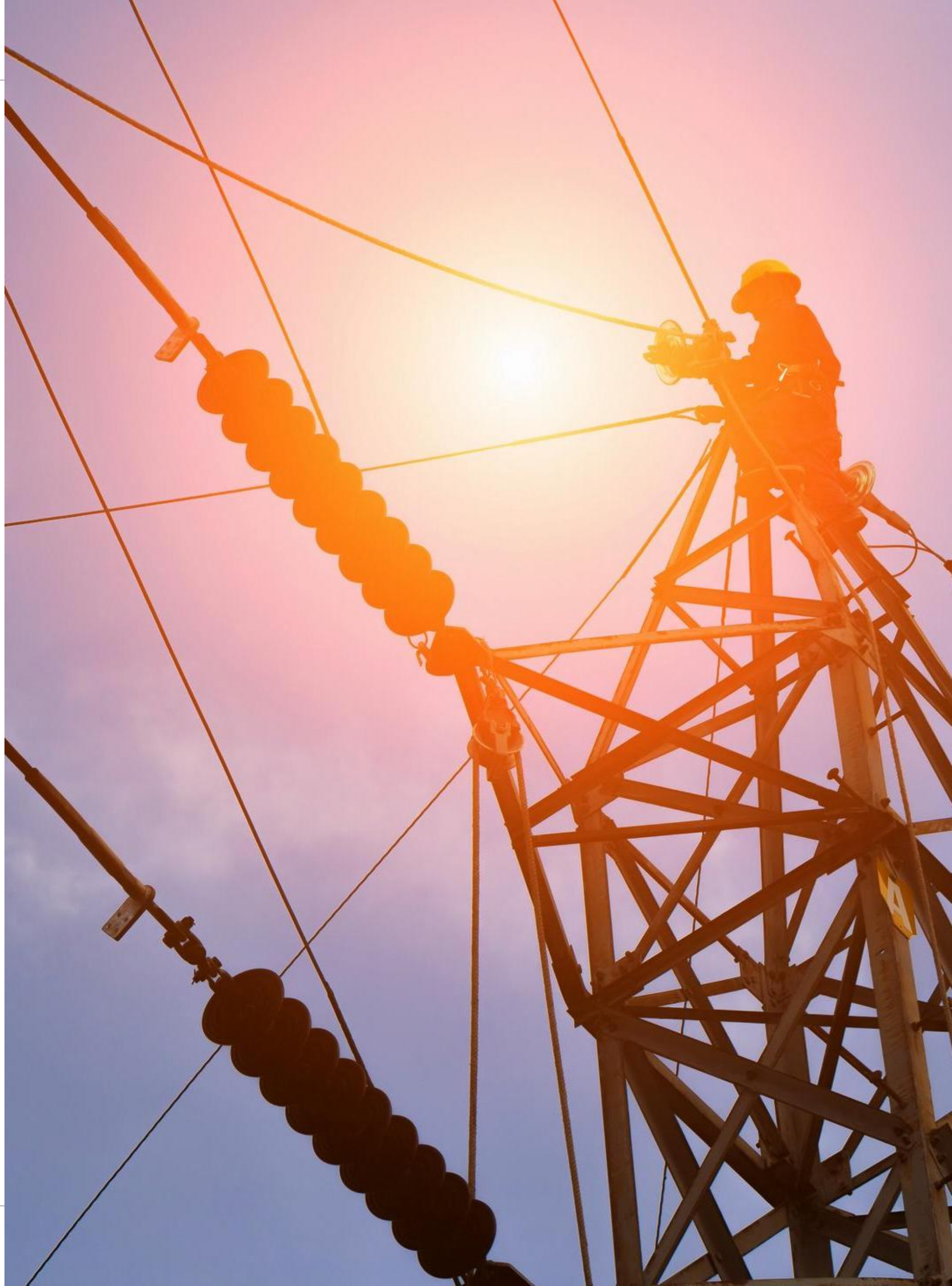

Overview of the criteria to be fulfilled for an accelerated approval by the European Commission (1/5)

Category	Criteria for Strategic Reserve	Criteria for a market-wide capacity mechanism
a) Necessity of aid, incentive effect	▪ **Reliability standard, calculated as the ratio of the cost of new entry / value of lost load, must not be met in the Member State concerned from at least the first delivery window within the authorisation period** ▪ All parameters calculated to assess availability, such as **de-rating factors, must be consistent with the assumptions and results of the ERAA.** (applies to both)	
b) Market failure and Appropriate-ness	▪ A Member State must have received an opinion from the European Commission after submitting its market reform plan. (applies to both)	
		▪ A Member State must confirm that it has examined whether a **Strategic Reserve** is capable of solving the problem of resource adequacy.
c) Eligibility	▪ The capacity mechanism must not be open to companies in difficulty. ▪ Participation must not be tied to a relocation. (applies to both)	
	▪ **Technology openness of the mechanism** ▪ Min. size for participation must not be > 1 MW de-rated or > 1 h of min. delivery duration (aggregation allowed) (applies to both)	

Sources: European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final.

Overview of the criteria to be fulfilled for an accelerated approval by the European Commission (2/5)

Category	Criteria for Strategic Reserve	Criteria for a market-wide capacity mechanism
c) Eligibility	▪ **CO_2 emission limits from electricity regulation must** be **complied with**, stricter CO_2 limits permitted. ▪ Calculation must be consistent with ACER method. (applies to both)	
	▪ **De-rating factors must generally correspond to the ERAA assumptions for the Central Reference Scenario** ▫ Individual capacity providers may deviate from the standard de-rating factor by up to 15%. (applies to both)	
		▪ CRM must be **open for cross-border participation**. ▪ Maximum entry capacity must be defined on the basis of the ACER specifications.
d) Proportionality of aid	▪ **Maximum auctioned volume** calculated on **the basis of the central ERAA ref. scenario** ▪ **Bid caps permitted subject to conditions.** (applies to both)	
		▪ **Competitive bidding process for 75 %-90 %** of the estimated target demand for the delivery window should take place **4-6 y ahead of the delivery window.** ▪ Additional processes can be initiated ad-hoc.
	▪ Competitive bidding processes should take place no more than one year ahead of the delivery window.	

Sources: European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final.

Overview of the criteria to be fulfilled for an accelerated approval by the European Commission (3/5)

Category	Criteria for Strategic Reserve	Criteria for a market-wide capacity mechanism
d) Proportionality of aid	▪ Rules for auction to be published at least 6 weeks before deadline	(applies to both)
	▪ **Bids in EUR/de-rated MW/a only criterion in the selection process** ▪ **Support paid according to either the initial bid (SR) or the clearing price (SR and MW)**	(applies to both)
		▪ Recipients may resell their allocated capacity up to (at least) 2 months before the delivery period.
	▪ Capacity agreements must have a duration of one year.	▪ Capacity agreements must in general cover one delivery window, longer terms are possible for capital-intensive projects – **one additional year per €25,000/de-rated MW** ▪ **Max. for fossil-fuelled generation assets 15 y** ▪ **Market concentration rule**: In highly concentrated markets (≥75 % controlled by top 3 generators), 10-year agreements must be available for projects with CAPEX ≥ €375,000/de-rated MW.
	▪ Delivery period must be a fixed period of max. 1 year.	(applies to both)

Sources: European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final.

Overview of the criteria to be fulfilled for an accelerated approval by the European Commission (4/5)

Category	Criteria for Strategic Reserve	Criteria for a market-wide capacity mechanism
d) **Proportionality of aid**	▪ Recipients must be "activated" at least once per delivery period (applies to both)	▪ Recipients must be "activated" at least once per delivery period (applies to both)
	▪ **Penalties for non-availability** (during the delivery period) must be **independent of technology** ▪ In case of **availability <= 50% in a delivery period, penalties must at least** cover **capacity yields** in the same period. (applies to both)	▪ **Penalties for non-availability** (during the delivery period) must be **independent of technology** ▪ In case of **availability <= 50% in a delivery period, penalties must at least** cover **capacity yields** in the same period. (applies to both)
		▪ Beneficiaries' participation in ancillary services during the delivery period must align with the adequacy assessment methodology: if such services contribute to adequacy, simultaneous participation is allowed; if not, Member States may either exclude such participants from the capacity mechanism or allow dual participation with potential penalties for non-availability.
		If Member State applies both a capacity mechanism and a flexibility measure, ▪ capacity should be jointly procured, ▪ capacity mechanisms may include min. non-fossil flexibility requirements based on assessed needs, ▪ resources can join only one scheme; targets must reflect any overlap

Sources: European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final.

Overview of the criteria to be fulfilled for an accelerated approval by the European Commission (5/5)

Category	Criteria for Strategic Reserve	Criteria for a market-wide capacity mechanism
d) Proportionality of aid	▪ Profits of participants in the SR must be independent of their "activation"/dispatch.	
	▪ **Cumulation of aid through several instruments is possible as long as overcompensation is excluded.**	▪ **Cumulation of aid through several instruments is possible as long as overcompensation is excluded.**
	▪ **At least 90% of the SR costs not covered by imbalance charges must be allocated to consumers based on their consumption during the 1-5% highest price periods per year.** Charges may be levied on balance responsible parties (such as suppliers).	▪ **At least 90% of the costs of the CM must be allocated to consumers on the basis of their consumption during the 1-5% highest price periods per year.** Charges may be levied on balance responsible parties (such as suppliers).
e) Avoidance of undue distortions to competition and trade	▪ The Member State must confirm that the SR meets the requirements in Electricity Regulation Article 22(2).	
	▪ Availability calculated as being equal to the power delivered	▪ Availability is calculated as the sum of i) the power delivered; and ii) the availability proposed on day ahead, intraday and/or balancing markets and which did not result in an activation.

Sources: European Commission (2025): Framework for State aid measures to support the Clean Industrial Deal (Clean Industrial Deal State aid Framework), Brussels, 25.6.2025, C(2025) 7600 final.

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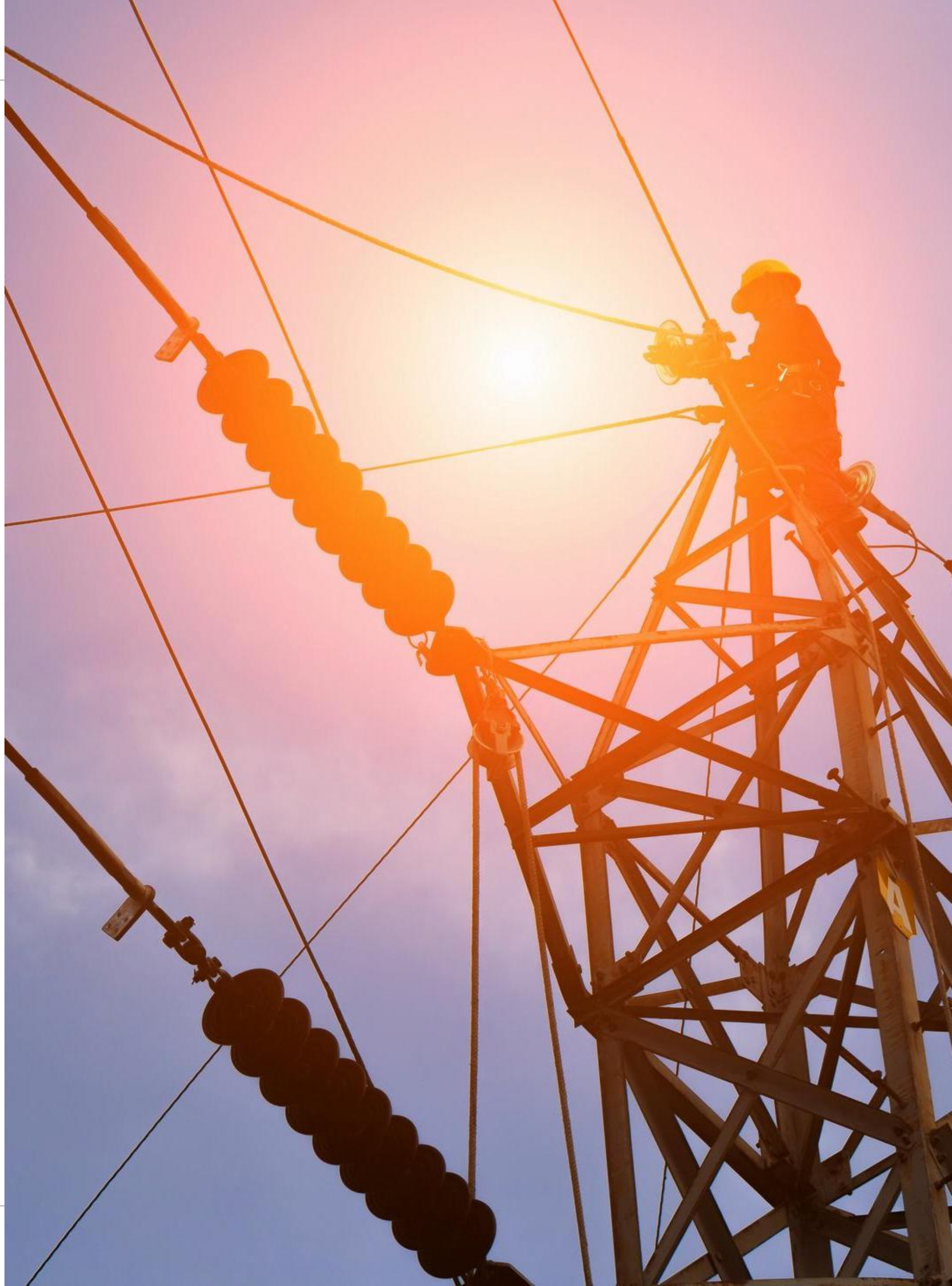


Assessment criteria (1/2)

Criteria considered for evaluation of longlist CRMs

Criteria*	Description
Accuracy SoS	▪ How reliably can a **selected security of supply standard** be achieved? ▪ **Is the desired level the right level?** Who is authorised to set the level and when, and who bears the consequences of an incorrect level? ▪ How can resource adequacy be monitored in the interim?
Effectivity	▪ Can a sufficient degree of planning **security for investments** be created? Can the measure present investment signals to market participants for new builds and capital-intensive conversion/retrofit of existing plants? ▪ Can the problem of **maturity mismatches** be solved? Are the contracts long-term enough to effectively support investment? Is the gap that needs to be filled long-term or short-term? Do timelines align in this regard?
Efficiency	▪ Is resource adequacy ensured at the lowest possible cost in the short-term (**static efficiency)**, via ensuring productive and allocative efficiency (i.e. an efficient technology mix) at a certain moment in time? ▪ Is cost efficiency ensured in the longer term (**dynamic efficiency**)? That means how **innovation-friendly** is the system and how easily can the system flexibly react to uncertainties in future developments? ▪ How is the balance between market-based instruments/incentives and state interventions met? ▪ Are **distortions** to be expected in the **energy market**?
Complexity	▪ Is the complexity as low as possible in order to ensure comprehensibility for all market participants and minimise implementation and enforcement costs? ▪ Are **processes/responsibilities/obligations and penalties** clear and understandable, in particular: who determines the required capacities, which market participants enter into which obligations, who bears which risks? ▪ How '**feasible**' is the model (parameterisation & monitoring effort, compatibility with EU regulations, interactions with neighbouring countries)? How high are the **implementation and monitoring cost**?

* Interdependencies have to be considered, e.g. between the effectivity and the timeline – does the mechanism kick in early enough; or between complexity/cost of implementation and timeline.

Assessment criteria (2/2)

Only considered in detailed assessment of shortlisted CRMs

Criteria*	Description
Locational signals	▪ Does the model provide **local signals**, i.e. can capacity be geographically differentiated, or how complex would it be to add a local/regional component? ▪ Can the mechanism incentivise **additional capacity in congestion-prone areas**? ▪ What would be the effect of locational signal on **cross-border participation**?
Financing	▪ What are the CRM total explicit **costs** and how will these be **refinanced**? Is the financing considered secure and fair, to promote social and political support? ▪ Who will bear the costs? Is the **mechanism designed according to the 'polluter pays' principle** – meaning that those responsible for creating a peak load or stress event bear the cost? ▪ Can **interdependencies with existing subsidies** be taken into account?
Timeline	▪ What is the **required timeline for design and implementation** and **factors affecting**? How long is the time for State aid approval expected to be, if required? ▪ If the mechanism is in place, the timeline covers the process from publication of concept tender to closure of final tender, awarding tender and optional construction time.
Decarbonisation system	▪ **To what extent does the CRM support the transition to a carbon- electricity system?** Are low-carbon technologies eligible and competitive? Can prequalification criteria include emission thresholds or clean fuel requirements? ▪ Does the mechanism **risk lock-on of fossil assets** or prolonging lifetime of high-emission plants? ▪ Are there synergies or conflicts with existing RES policies?
Flexibility	▪ Is there a risk of **structural dependence** on a CRM? How complex would it be to discontinue the CRM if it proves to be unsuitable? ▪ Is the mechanism **flexible to adjust to changing external circumstances**? Can procurement volumes or parameters be updated regularly?

* Interdependencies have to be considered, e.g. between the effectivity and the timeline – does the mechanism kick in early enough; or between complexity/cost of implementation and timeline.

Hedging Obligation

A Hedging Obligation provides a more market-oriented solution, which may efficiently help to retain existing assets in the market, but unlikely incentivises new long-term investment

High-level description

The updated Internal Electricity Market Directive foresees an **obligation for electricity suppliers** to implement appropriate hedging strategies to limit the risk of changes in the level of wholesale electricity prices (via standard baseload/ peak forward products). The considered Hedging Obligation supplements this regulation with an obligation **to hedge against peak electricity prices (via new spike products)**. This obligation is **market-wide** and can be based either on sales volumes and assumed load profiles or on measured peak load within a defined time window. The total demand to be hedged results from aggregating individual obligations.

On the **supply** side, **all technologies, both new and existing**, can provide hedging through futures or options. These "spike products" – designed by the market based on the centrally determined type of obligation – are traded on the market and priced through supply and demand. Participation is open and not limited to asset-backed resources. **Optionally, a state-guaranteed minimum price for the asset-backed resources** may reduce investment risk, though residual volume risks remain.

Compliance is monitored by authorities, with **penalties** for non-fulfilment. The costs for hedging on the futures markets become part of the regular energy price component for end customers.

High-level screening of pro and cons of the CRM

Advantages

- High degree of efficiency due to **technological openness** and promotion of **innovation-friendliness** (if spike product definition is broad enough)
- Probably **no State aid process** required (legal check required – not in scope of this project)
- Costs are internalised in the energy prices, eliminating the need for financing through public budgets

Disadvantages

- **Effectiveness might be low if**
  - Investment **with long-term refinancing periods required** and maturity mismatch is not solved
  - **no asset-backed resources required** to fulfil obligation
- Continuous monitoring of hedging compliance likely requires **significant administrative oversight** similar to a decentral CRM.
- Very **close to existing balancing system**

Short-listing

A Hedging Obligation can be seen as a reinforcement of the EOM and may pose a more market-oriented solution compared to other CRM types. However, the effectiveness regarding security of supply is uncertain, and the mechanism may not address the underlying challenges for the market

Hedging Obligation – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ With a Hedging Obligation in place, the level of resource adequacy is controlled centrally, but this is done indirectly via the specific structure of the Hedging Obligation. For example, the Hedging Obligation can define peak load time windows that need to be hedged. ▪ Because compliance can be achieved with purely financial products (not necessarily asset-backed), there is no guarantee that physically reliable capacity is available during stress events; adequacy coverage is therefore indirect and uncertain. This creates a disconnect between financial coverage and actual system adequacy. However, application of a firmness rating of different products (see Connect 2025) could increase accuracy. ▪ Overall, security of supply with Hedging Obligations is assessed neutral.	▪ Capacity under Hedging Obligation not decided by a central authority but by electricity suppliers. This reduces the accuracy of the procured amount, as suppliers have a less comprehensive total system. A small under-procurement risk remains due to diffuse responsibility. ▪ Required capacity (per supplier) can be adjusted relatively flexibly every year, based on capacity developments. ▪ Untested mechanism, which may lead to more difficult calibration of exact amount & distribution of the Hedging Obligation, having a higher risk of under-/over-procurement. Risk that financial hedges don't perfectly translate to physical capacity. The reliability of outcome would be questionable until proven in practice.	
Effectivity	▪ The Hedging Obligation cannot solve the maturity mismatch for long-term investment in new plants or retrofits and the supplier obligations are usually short term (1-3 years), meaning that only short-term hedges are concluded. ▪ One potential enhancement is the introduction of a state-backed minimum price over short periods (1-3 years), which could reduce downside risk. However, this would still not solve the maturity mismatch for long-term investment decisions. ▪ Theoretically, it could also be possible to match maturities for shorter supply obligations over a longer period if the provider of the hedging product sells it on a rolling basis over 1-3 years, allowing for a longer-term cash flow with short term contracts. However, there is no guarantee that the provider will be able to sell the hedging product and the price for the rolling selling is not known ex ante at the time of the investment decision, thereby limiting the ability to plan. ▪ In addition, investment decisions are associated with lead times (approx. 4-6 years) that suppliers would need to request a hedging product with. This is usually out of the hedging period. Therefore, effectivity is assessed negatively.	▪ Doubtful whether a Hedging Obligation would spur the needed new capacity (investments) in NL. It lacks the promise of stable long-term revenues; thus, a new plant would still face high risk. ▪ Lighter-market based mechanism that might provide existing dispatchable generation extra income from option premiums. ▪ Assets (e.g. existing gas turbines) would still need some form of longer-term certainty to secure investments and remain operational.	

Hedging Obligation – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ The Hedging Obligation is highly efficient in principle, as it is market-based, technology-neutral, and leaves freedom to suppliers to optimise their own portfolio. It fosters innovation and allows demand-side flexibility, storage, or distributed generation to participate via options. This contribute to an efficient technology mix, especially since there is no pre-qualification required. Hence, static as well as dynamic efficiency is ensured. ▪ The absence of centralised auctions also avoids bureaucratic distortions, and the use of standardised hedging instruments ensures competitive pricing. The increased transparency, coupled with effective penalisation, can help to deter dubious providers from entering the market. ▪ The efficiency of the Hedging Obligation is therefore rated positively.	▪ If successful, Dutch consumers would pay for reliability through hedging premiums rather than a separate charge, which might be efficient if competition is robust. ▪ Specific investment incentives for innovation in technologies that deliver flexibility is likely low due to relatively weak investment incentive that results from the Hedging Obligation.	
Complexity	▪ The clear advantage of the Hedging Obligation is that no direct public funding is needed as costs are internalised in electricity prices and borne by suppliers. This, assumably, makes the model unsuitable for State aid (a legal check would be required). If a minimum price guarantee is also provided, the model might be subject to State aid. Furthermore, existing market products are used (forward, futures etc.) ▪ However, the Hedging Obligation is also associated with bureaucratic effort. The definition of "firmness" is difficult and still open. Furthermore, the hours which must be hedged must be defined and the check of compliance with the obligation is resource intensive. This is especially the case on the demand (i.e., supplier) side due to its fragmented nature. ▪ Furthermore, trading in options is not always permitted for smaller companies for compliance reasons and must first be made possible through sometimes complex internal company approval processes internally on the supplier side, However, with a reasonable lead time, this should be possible. ▪ In practice, complexity is assessed as neutral.	▪ No legal basis in NL for implementation of Hedging Obligation, changes would be required. Some level of precedent available in NL with type of Hedging Obligation during energy crisis. ▪ Sufficient lead time in the Dutch context to implement a CRM in general, as adequacy gap is expected only after 2030.	

Decentral CRM

A decentral CRM is unlikely to be effective as it does not solve the maturity mismatch for long-term investment

High-level description

In a Decentralised Capacity Market (DCM), as seen in France, **capacity demand** is set **bottom-up**: each supplier must secure their share of peak load through capacity certificates, with central coordination only for defining obligation-relevant days and periods. Suppliers
will balance the costs of procuring certificates against the penalties of non-delivery in scarcity periods.

Capacity **supply** comes from **existing and new** generation units, storage, and demand-side flexibility, all subject to central prequalification and de-rating. A **self-fulfilment option** allows demand reduction to count without certification.

The **product obligation for certificates** is based on **availability** during scarcity periods, with market-driven, **short-term contracts**. Certificate providers receive a **capacity payment** (in €/MW/year). The units can only **operate in wholesale markets**.

Despite decentralisation, **central monitoring** remains intensive: authorities define obligation periods, validate compliance, and impose penalties for non-performance. Costs are borne by suppliers and passed on through electricity prices.

High-level screening of pro and cons of the CRM

Advantages

- High degree of technological openness and promotes innovation-friendliness
- Costs are internalised in the energy prices, eliminating the need for financing through public budgets

Disadvantages

- Maturity mismatch not solved for investment with long-term refinancing periods leading to low effectiveness
- High level of complexity
- Fast track for State aid process rather unlikely
- Close to existing balancing system

Short-listing

A decentral CRM is a relative flexible mechanism based on decentral decisions. However, the effectiveness regarding resource adequacy is uncertain, and the mechanism is highly complex.

Decentral CRM – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ A decentral CRM ensures security of supply by obligating suppliers (or balance responsible parties) to contract sufficient capacity to meet their share of peak demand. In contrast to a Hedging Obligation, asset-backed products, i.e. a physical fulfilment is required. ▪ A key risk is the inaccuracy of load forecasts. The high parametrisation effort (e.g. regarding level of penalties, scarcity periods and gate closure for certificates) increases the chance of errors when creating forecasts with the risk of a tendency towards oversizing. Oversizing is the case when – as e.g. in France[1] – the sum of the individual maximum loads on the days relevant to the obligation (on which suppliers must prove their load contribution with certificates) are greater than the system maximum load. ▪ To reduce the risk of oversizing, it is important to e.g. choose a gate closure time that is close enough to delivery time to reduce uncertainty but also early enough to allow for additional capacity to emerge. ▪ Overall, maintaining adequate resource adequacy in a decentral CRM is assessed neutral.	▪ General assessment applies to the Netherlands: capacity amount in a decentral CRM is not decided by a central authority but by the electricity suppliers based on centrally determined parameters. This increases uncertainty of the amount procured also for the Netherlands. ▪ Required capacity (per supplier) can be adjusted relatively flexibly every year, based on capacity developments.	
Effectivity	▪ The Decentral CRM does not structurally solve the maturity mismatch for capital-intensive new investments. Most contracts in the certificate market are short-term (typically 1–3 years). Furthermore, short lead times (1 year) provide limited revenue certainty. ▪ In addition, the long-term counterparty-risk makes the bankability of projects more difficult as the counterparty is no longer a single buyer as in the Central CRM, but suppliers of different sizes with different financial capabilities. ▪ Hence, the effectivity of a Decentral CRM is viewed negatively	▪ A Dutch decentral CRM obligation could monetise existing gas capacity (preventing some closures) but might struggle to encourage newbuild capacity since annual capacity certificates provide a weaker investment signal for new plants (short revenue horizon). This would mean that the missing money problem in NL would not be completely resolved.	

Decentral CRM – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ The possibility of self-fulfilment and a high degree of freedom in the choice of fulfilment options result in a high degree of technological openness of a Decentral CRM and thus promote static as well as dynamic efficiency. ▪ In theory, demand flexibility is incentivised in the Decentral CRM by the fact that no capacity certificates or pre-qualifications are required for demand side response. This can be achieved by granting the possibility of self-fulfilment with a high degree of freedom in the choice of the fulfilment option. However, French experience shows that e.g. for DSR self-fulfilment was only ca. 1/3 of total DSR (2/3 was certified)[1] and additional central tenders were required to incentivise further DSR.[2] ▪ A low level of inefficiencies can occur due to an over-incentive for flexibilities through possible multiple marketing if they can credit their performance implicitly (self-fulfilment) and explicitly (sale of certificates) multiple times. However, this risk can be controlled through appropriate monitoring. ▪ In general, the efficiency is of the Decentral CRM is rated positively.	▪ Internalisation of costs to electricity prices could be an efficient way to distribute costs to the Dutch consumers and society. ▪ Specific investment incentives for innovation in technologies that deliver flexibility is likely low due to relatively weak investment incentive that results from annual capacity certificates.	
Complexity	▪ In comparison to the Central CRM, the monitoring of the demand side in addition to the supply side makes the Decentral CRM complex. ▪ Despite being labelled "decentralised," Decentral CRMs require extensive central administration: authorities must define the dimensioning, certification and pre-qualification. Moreover, they need to calculate obligations and oversee enforcement on the supply and demand side (for instance by setting up a trade register and ensuring penalisation). ▪ In addition, cost-optimised compliance with the obligation requires institutional capacity and competency on the supplier side. On the other hand, the possibility to self-fulfil could have a complexity-reducing effect on the supplier side, as no pre-qualification is needed. ▪ Finally, a fast-track for state-aid processes seems rather unlikely, as it is difficult to ensure a competitive auction process for 75-90% of the volume 4-6 years in advance. French experience shows that most of the certificates were traded one year before delivery.[1] ▪ Overall, the complexity is rated as high and therefore negative.	▪ No legal basis in NL for implementation of Decentral CRM, changes would be required. ▪ Sufficient lead time in the Dutch context to implement a CRM in general, as adequacy gap is expected only after 2030.	

[1] RTE: Retour d'expérience sur le mécanisme de capacité français
[2] RTE (2024): L'appel d'offres effacement

Central CRM

Central authority determines capacity requirements and puts these requirements out to tender in full through auctions

High-level description

In the central capacity mechanism (CCM), **capacity demand** is **market-wide** and determined centrally – either by a government agency or the system operator – based on expected peak load plus a safety margin, covering the full system need during scarcity events.

Capacity supply includes both **new and existing** resources, such as generation, storage, and demand-side flexibility (e.g. aggregators). Participation requires **prequalification**
and capacity is adjusted via technology-specific **de-rating factors** to reflect actual expected availability.

Successful bidders receive a **capacity payment** (in €/MW/year) in exchange for the obligation to maintain technical **availability** of their capacity. The units can ly **operate in wholesale markets**. **Optionally, a reliability option** can be added, requiring participants to return revenues when market prices exceed a strike price.

Compliance is centrally monitored, and penalties apply for non-performance. The mechanism is financed via levies or taxes, with dynamic levies offering stronger demand-side incentives.

High-level screening of pro and cons of the CRM

Advantages

- **High level of resource adequacy** ensured, i.e. via (long-term) investment signals
- **State aid procedure established** and suitable for fast-track if adequately designed
- **Moderate complexity** as monitoring limited to supply side
- Preparations ongoing to **broaden the applicability of the Dutch Energy Law** to enable implementation of a central CRM

Disadvantages

- Technology openness depends on prequalification criteria, but **innovation-friendliness challenging**
- **Political support can be challenging** due to financing requirements usually implying a levy

Short-listing

Effective and established model which can be adapted to the Dutch model. Currently, preparations ongoing to broaden the applicability of the Dutch Energy Law to enable the implementation of a central capacity mechanism.

Central CRM – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ A central CRM ensures security of supply by centrally procuring a predefined quantity of capacity based on system adequacy assessments (e.g. peak load forecasts plus reserve margin). This enables direct control over capacity levels. ▪ A key risk is over procurement, as central planners may set risk-averse and conservative targets due to uncertainty and early demand estimations. This leads to excess capacity and higher costs but does not threaten resource adequacy. However, it can distort electricity market prices and have negative market effects. ▪ Undersized auctions could threaten security of supply if budget constraints (e.g. in the case of tax financing) limit the available procurement volume, but this is seen as unlikely due to usually risk-averse behaviour. ▪ Overall, the mechanism guarantees a minimum capacity level in advance of delivery, providing high reliability and accuracy for resource adequacy, provided the capacity requirement is reasonably forecast and procurement processes are robust. Therefore, accuracy of security of supply is rated positive.	▪ Central CRM enables adjusting procured capacity rapidly in response to changing expectations of load and generation growth. Tailoring the ratio of T-4/T-1 auctions in the CRM design creates short term flexibility. This is relevant in the Dutch context as it is subject to large uncertainties in terms of generation (renewables rollout, specifically offshore wind), in terms of demand (degree of industry electrification), and in terms of growth in storage and demand response. ▪ Existing gas capacity in the Netherlands that may have a missing money problem, can be prepared for operation quickly. Short lead time procurement under a central CRM of such capacity supports the accuracy of SoS.	👍
Effectivity	▪ Central CRMs provide clear and strong long-term investment signals. They offer multi-year contracts, ranging from 1-3 years for existing plants and small retrofits, and up to 15 years for new plants and large retrofits. ▪ This differentiation ensures planning security, (also) promotes investments with longer amortisation periods and can promote new technologies with increased decarbonisation potential. The problem of maturity mismatch can therefore be effectively solved. ▪ In addition, the central CRM offers low counterparty risk due to state-backed contracts, which improves project bankability. ▪ Overall, effectiveness is rated very positively.	▪ Differentiated contracts can create investment incentives tailored to the current and future generation fleet in the Netherlands. Short lead time (T-1)/duration contracts help existing gas assets overcome profitability gaps (e.g. due to maintenance campaigns), mid lead time (e.g. T-4)/duration supports retrofitting existing gas assets (e.g. with CCS or hydrogen adaptations), and long lead time (e.g. T-7+)/duration supports newbuilt assets (e.g. CO2- dispatchable generation). ▪ Existing gas capacity is sufficiently available in the short term (low maturity mismatch risk), as preventing a quarter of expected closures before 2033 (1.3 GW of 5.5. GW closures) would bring LOLE to below 4 hrs/yr.	👍

Central CRM – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ Efficiency depends strongly on design. Central CRMs can achieve good allocative efficiency if auctions are competitive, prequalification rules are inclusive, de-rating factors reflect real reliability contributions, and contract durations are adapted for the different asset types. ▪ There is a trade-off between investment certainty (effectivity) and system flexibility (efficiency): the more capacity is contracted early (e.g., T-4 or with multi-year terms fixing capacities for future delivery dates), the less scope remains for short-term adjustments to meet actual demand. Multi-year contracts should therefore be awarded with caution to preserve the system's flexibility to respond to changing conditions. ▪ Technology-neutral tenders in the centralised CRM allow participation of various technologies, including Demand Side Response (DSR). The above-mentioned central product definitions impact the resulting technology mix also over time. ▪ Compared to more flexible models (e.g. Hedging Obligation or decentral CRM), the CRM is less innovation-friendly ex ante. Nonetheless, design options exist to better integrate decentralised flexibility (e.g. DSR, batteries). Ongoing tender adjustments and continuous auctions can enhance technology openness and allow low-carbon technologies to participate (e.g. long-duration energy storage) and thus enhance dynamic efficiency. ▪ In conclusion, central CRMs can be efficient and technology-neutral, but require careful auction design and robust governance to avoid inefficiencies. Hence, the efficiency assessment is neutral.	▪ In the energy future system in the Netherlands driven by renewables, there is a need for innovation in technologies that deliver flexibility. A central CRM can allow for technology openness and variation over time if designed appropriately. ▪ With increasing renewables in the system, the temporal mismatch between supply and demand increases, hence storage technologies and DSR need sufficient investment incentives. The MLZ projects 11.7 GW storage and 1.9 GW DSR by 2033 available to the grid. However, this is still insufficient to bridge the . A central CRM can help to bridge this gap by giving investment incentives to generation, storage or demand-side technologies.	
Complexity	▪ Central CRMs are moderately complex but well-established across Europe (also regarding State aid procedures required under European law). They also serve as the blueprint for the target model under the CISAF (Annex II), which is expected to enable a streamlined State aid approval process. ▪ The "single buyer" approach with the central body as the buyer of the capacity helps to reduce complexity by creating clear responsibilities and simplified processes. It ensures harmonised rules for qualification, obligations, penalties, and monitoring. ▪ Overall moderate complexity as monitoring is limited to parties supplying capacity, compared to instruments that require monitoring of e.g. certificate buyers (such as decentral CRMs).	▪ Preparations ongoing to broaden the applicability of the Dutch Energy Law to enable implementation of a central CRM. ▪ Sufficient lead time in the Dutch context to implement a CRM in general, as adequacy gap is expected only after 2030.	

Hybrid CRM

A hybrid CRM as a combination of a central and a decentral CRM, is complex and additional benefits are uncertain

High-level description

A hybrid CRM combines the central and decentral CRM:

- In the **central segment**, a public authority procures **new** capacity via **long-term contracts** and capacity payment (in €/MW/year), often including a **reliability option** to recover scarcity rents.
- In the **decentralised segment**, suppliers must cover their share of peak load by buying (short-term) capacity **certificates**, which can stem from **existing (and in theory new)** plants, storage, or demand-side flexibility. A **self-fulfilment option** allows demand reduction to count without certification.

The product obligation is based on **availability**, with central capacity potentially also facing a reliability obligation. All capacities remain **active in the electricity market**.

Compliance and penalties are centrally managed. Costs are recovered through levies for the central segment and through electricity prices in the decentral segment.

High-level screening of pro and cons of the CRM

Advantages

- **Long-term investment secured**
- High degree of **technological openness** and **promotes innovation-friendliness in decentral segment, but only short-term** (long-term central element predetermines technology mix)

Disadvantages

- **High level of complexity** (managing of interdependencies between segments)
- **No practical experiences** so far, especially numerous unanswered questions regarding interdependencies between the segments
- Unclear if central or decentral part determines final capacity availability
- **Fast track for State aid process unlikely**

Short-listing

A central system with decentral elements. The level of accuracy is reduced compared to a central CRM as dual-track planning creates interdependencies and forecasting uncertainty. Even though long-term investment is secured, too, this benefit is not only for the hybrid CRM, as a central CRM does it without decentral complexity. Finally, the declared benefit of long-term innovation-friendliness is questionable.

Hybrid CRM – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	■ The Hybrid CRM combines a centralised procurement for new capacity (e.g. via long-term contracts) with a decentralised capacity obligation for suppliers to secure peak load (e.g. via certificates or self-fulfilment). In theory, this dual mechanism aims to combine robust adequacy planning with market-based flexibility. ■ However, the central challenge lies in demand forecasting: the central buyer must anticipate how much residual capacity will be available in the decentralised segment. This is particularly difficult and uncertain due to interdependencies between the centralised and decentralised elements as investment decisions within the decentralised segment must be anticipated) and subject to crowding-out effects. Over- or under-procurement in either segment can result. In contrast, in the Central CRM, the total supply of secured capacity is known and only the demand is estimated. ■ A risk-averse regulator could react to greater uncertainties in the hybrid CRM with a larger volume of new construction. ■ Hence, the contribution of the hybrid CRM to resource adequacy is assessed negatively.	■ Dual-track planning (central + decentral) creates interdependencies and forecasting uncertainty about the residual capacity the decentral segment will deliver. ■ Risk of over- or under-procurement increases in comparison with central CRM. A risk-averse authority may oversize new-builds to compensate.	
Effectivity	■ The central segment of the hybrid CRM provides effective investment signals via long-term capacity contracts, similar to a traditional Central CRM. This supports new builds and major retrofits by ensuring revenue certainty. ■ A concern is that the decentralised segment offers only short-term contracts, typically without investment-grade bankability, and may be perceived as less attractive for investors. This asymmetry could disincentivise participation in decentral markets. ■ A key advantage, however, is that the centralised tenders eliminate the maturity mismatch problem for new plants. ■ Overall, the effectivity of the hybrid CRM is assessed positively due to the central elements that incentivise long-term investments.	■ The central segment's multi-year, state-backed contracts solve maturity mismatch and can keep existing capacity online and unlock new/retrofit capacity, which is what Netherlands needs after 2030. ■ This benefit is not only for the hybrid CRM, as a Central CRM does it without decentral complexity.	

Hybrid CRM – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ Hybrid CRMs aim to combine the static efficiency and innovation potential of decentralised approaches with the bankability and scale efficiency of central procurement. If well-calibrated, this could support a broad technology mix. ▪ However, it is to be expected that the proportion of contracts contracted via the centralised segment will increase due to the regular award of multi-year contracts in the centralised segment. The prospect of longer-term contracts with the centralised entity may also reduce possible investment in the decentralised segment. This is especially problematic, if a replacement is timed to participate in the central tender. ▪ If the decentral element dries up by participants focussing on central tenders, the technology mix might also be determined by the central auctions, similar to the Central CRM. In an extreme case, the central body would act as a monopolist when selling the certificates generated in the central segment in the decentralised segment, with negative consequences for pricing. The central body would then also bear the associated trading risk. ▪ Due to the risk of price suppression, strategic withholding, and diminished investment incentives in the decentral part, the efficiency is assessed as negative.	▪ The central segment tends to dominate investment signals, crowding out the decentral segment and skewing price and participation. ▪ Potential price suppression or withholding dynamics in the decentral part reduce allocative/dynamic efficiency.	
Complexity	▪ The hybrid CRM is a complex model, due to the need to coordinate two fundamentally different systems: centralised capacity tenders and a decentralised obligation system. ▪ One critical risk is interaction failure as design or implementation problems in one segment can undermine the functioning of the other. This interdependence is difficult to anticipate and highly error-prone. In extreme cases, the central authority becomes the main provider for certificates in the decentralised segment. ▪ There is no precedent under European law for State aid procedure, as such a model has not yet been implemented. This can lead to a considerable extension of the duration for the procedure. ▪ Overall, the lack of precedent, institutional complexity, and regulatory burden make it a high-risk model in terms of complexity.	▪ Regulatory body must coordinate two mechanisms with different rulebooks, penalties, and deliverability logics. ▪ There is no European precedent and fast-track state-aid looks unlikely, implying longer design and approval cycles and heavier governance burden than for instance the central CRM.	

Capacity Auction

A Capacity Auction secures new firm capacity through competitive tenders, but may lead to crowding out effects

High-level description

Capacity Auctions aim to ensure resource adequacy by procuring additional (new) firm capacity through competitive tenders. The **capacity demand** is centrally determined and targeted at closing projected s, based on system adequacy assessments and predictions of availability of existing assets (similar to the central part of the hybrid CRM).

On the supply side, auctions are open only to **new assets** and typically focused on **specific technologies** – e.g. in the German "power plant strategy" (hydrogen ready) gas power plants. The product involves an **availability obligation**, with payments in **€/MW/year**, while participants remain active in the energy market. As for other central CRMs, compliance is monitored by the state, with penalties for misuse or false reporting.

The mechanism is financed via levies or taxes.

High-level screening of pro and cons of the CRM

Advantages

- **Maturity mismatch can be solved** for investment with long-term refinancing periods via sufficiently long contract durations
- **Complexity rather low**
- Probably rather **low refinancing requirements – also compared to Strategic Reserve due to additional revenues from EOM market**
- Can address **shorter term challenges**

Disadvantages

- ...but **resource adequacy might be difficult to ensure** in the long term as estimating the gap between total capacity and existing capacity in future includes several uncertainties
- **Crowding-out effects** are likely to occur in the medium term
- **Efficiency likely rather low** if focus on a specific technology
- **Needs State aid approval**

Short-listing

A Capacity Auction is designed to address shorter term capacity scarcity, potentially at specific locations – however, long term effectiveness is not ensured as crowding-out effects may occur.

Capacity Auction – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ Capacity Auctions procure new capacity to close an identified adequacy gap. Similar to a hybrid CRM, the central planner needs to estimate not only total future demand needs (relying on different planning assumptions), but also how much residual capacity will be available in the future, i.e. how much will be invested outside the Capacity Auction and whether existing assets will remain in the market. This as well as crowding-out effects increase the uncertainty of the estimation. ▪ A risk-averse regulator could react to greater uncertainties with a larger volume of new construction. ▪ Therefore, the overall assessment of Capacity Auction for solving security of supply concerns is negative.	▪ Since Capacity Auctions only focus on new assets, procurement will have higher uncertainties (e.g. not reaching FID even after award under Capacity Auction mechanism) and longer lead times. ▪ Existing gas capacity in NL cannot be included; hence Capacity Auction won't prevent existing gas plants from retiring if they become unprofitable ▪ In case capacity needs to be adjusted upwards, a new tender for a Capacity Auction can be setup, albeit with a lead time for building the plant. Downward adjustment is not possible, as contracts consider multiple years.	(thumbs down)
Effectivity	▪ Capacity Auctions can solve the maturity mismatch and create investment signals for new assets as the option to provide multi-year contracts (e.g. 10-15 years) can be granted. As auctions or products with shorter contracts are also possible, short-term challenges could also be addressed. If the tenders are technology-specific, this is however only limited to these technologies. ▪ However, crowding-out effects are likely to occur in the medium term as investment incentives on the EOM market will deteriorate. As illustrated on slide 47, resource adequacy will therefore not be increased significantly. ▪ Overall, effectivity is therefore rated negative.	▪ Capacity Auctions would incentivise new investments in capacity (hence solving the missing money and maturity mismatch problems in NL). However, they are being prone to the 'crowding out effect'.	(thumbs down)

Capacity Auction – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ The efficiency of Capacity Auctions depends on the design: a Capacity Auction can achieve good static efficiency if auctions are competitive, prequalification rules are inclusive, and contract durations are adapted for the different asset types. However, if designed technology-specific (as currently planned in the German proposal), this can affect efficiency negatively. ▪ If repeated, Capacity Auctions are less innovation-friendly than e.g. a Hedging Obligation or a decentral CRM. Nonetheless, design options exist to better integrate decentralised flexibility (e.g. DSR, batteries) and ongoing tender adjustments and continuous auctions can enhance technology openness and allow low-carbon technologies to participate (e.g. long-duration energy storage) and thus enhance dynamic efficiency. ▪ In addition, Capacity Auctions affect the efficiency of market outcomes of the EOM negatively, leading to lower attractivity of newly build capacity outside the mechanisms and retrofits. ▪ Overall, the assessment is neutral.	▪ Need in NL for innovation in technologies that deliver flexibility (also see Central CRM) can be provided by Capacity Auction, as it is can focus on such specific technologies. ▪ Capacity Auction can directly contribute to Investment incentives for storage as needed in NL (also see Central CRM).	
Complexity	▪ On the one hand, it is a complex task for the regulatory authority to calculate the gap in capacity in the future. On the other hand, the management is quite simple with designing a tender and then granting payments based on an availability regulation (as planned in Germany, for instance). ▪ The complexity is particularly low for the participants in the auction, as the bid needs to submitted once. ▪ State-aid approval is needed and might be challenging as in Germany. Especially a focus on certain technologies, especially CO2 emitting gas power plants, was seen critically by the EC. In Germany, two pillars were agreed in 2024: the first pillar contained 5 GW of gas power plants, the second 7.5 GW of H2 (ready) gas power plants approved as a decarbonisation measure. However, with the new government foreseeing an extension of the power plant strategy, discussions are reopened and still ongoing. ▪ Hence, the assessment of the complexity of the Capacity Auction is neutral.	▪ No legal basis in NL for implementation of a Capacity Auction, changes would be required. ▪ Sufficient lead time in the Dutch context to implement a CRM in general, as adequacy gap is expected only after 2030.	

Strategic Reserve

A Strategic Reserve comprises pre-contracted electricity generation resources, which are held outside the regular market and only activated in rare scarcity situations

High-level description

The Strategic Reserve model focuses on **centrally determined** capacity volumes based on security-of-supply assessments. Since contracted capacities are held **outside the market** and are only activated centrally in exceptional scarcity situations, the size covers a **relatively small amount** of electricity generation capacity.

The assets are procured through tenders by a government agency, in which only prequalified providers of specific technologies can participate. Providers receive a **reservation payment** for the contracted period (often ranging from 1 to 10 years) and must guarantee **availability** during defined periods. Compliance is monitored by the state, with penalties for misuse or false reporting.

Costs can be recovered via a surcharge on the TSO grid tariff or a new levy on, for example, BRPs or end consumers. Tax-based funding is in principle possible, but consumption-based financing is preferred for State aid reasons.

High-level screening of pro and cons of the CRM

Advantages

- **Increases resource adequacy** under certain circumstances, i.e. if reserve is only needed in rare scarcity events and if is limited in size and time; (long-term) investment signals depend on contract length
- **Complexity rather low**
- Relatively **low refinancing requirements**
- **Fast track State aid process** generally possible
- **Already legal basis for implementation** in Dutch Energy Law

Disadvantages

- **Strategic Reserve** does not address a permanent missing money challenge for capacity in the EOM
- **Efficiency rather low** since Strategic Reserve is usually <u>not</u> technology-neutral

Short-listing

Strategic Reserve can be suitable for the Netherlands for the time up to the early 2030s, when reserve is likely only needed in rare scarcity events and the is limited in size and time.

Article 5.12 of the Dutch Energy Law already provides the legal basis for the implementation of a Strategic Reserve.

Strategic Reserve – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ A Strategic Reserve improves security of supply by contracting a limited amount of firm capacity outside the energy market, to be activated only in exceptional scarcity situations. ▪ The reserve requirement is calculated by a central office. Due to the uncertain development of demand and the fact that the central planner needs to estimate not only total future demand needs (relying on different planning assumptions), but also how much residual capacity will be available via the EOM, calculating the requirements constitutes a challenge. However, an approximation could be controlled by adjusting the tendering volumes to the capacity development. ▪ If it is assumed that a further developed EOM in principle leads to a welfare-maximising level of capacity and resource adequacy, an additional reserve should therefore be small and only moderate overcapacity results. In addition, the reserve represents an opportunity to directly address external effects on security of supply, one of the potential weaknesses of the EOM. ▪ Overall, the accuracy of dimensioning to ensure resource adequacy is assessed as positive.	▪ Under a Strategic Reserve the total amount of procured capacity can be adjusted over the years (by contracting new capacity and adjusting contract periods / extensions). Given NL's gradual projected shortfall, a Strategic Reserve would be likely to keep pace with the expected increase in . ▪ Existing gas turbines in NL would need some form of certainty now on whether or not a Strategic Reserve will be implemented in the near future. This is needed for them to remain operational for 'additional' capacity procurement under a Strategic Reserve further into the future.	
Effectivity	▪ Strategic Reserves are not intended to incentivise long-term investment. As contract durations are typically short, the tool does not provide sufficient revenue certainty to finance new assets or major refurbishments. This creates a structural weakness: the mechanism does not address an investment gap or a longer-term/permanent "missing money" problem. ▪ In contrast, the Strategic Reserve might prevent old plants from being decommissioned, by compensating them to stay operational outside the market, i.e. a temporary "missing money" problem can be solved. However, it needs to be ensured that the Strategic Reserve does not only shift "work" from inframarginal plants from the electricity market to the reserve (instead of generating additional work, which would have otherwise left the market). This can lead to an unintentional increase in the price level in the electricity market. ▪ In conclusion, the Strategic Reserve is ineffective as a long-term capacity investment driver, but may be a solution for a temporary missing money problem, which can be solved by compensating plants otherwise leaving the market.	▪ For the next decade, a Strategic Reserve could be a suitable mechanism in the Netherlands to avoid shortages, given the issue is mainly about existing gas plants retiring. Contracting 1–2 GW into a Strategic Reserve would cover the anticipated gap through the early 2030s, guaranteeing supply during that period. ▪ Beyond that, if more capacity is required (e.g. post-2035), a reserve would have to keep expanding or be replaced by a longer-term CRM (that focuses on incentivising new investments). ▪ Hence, its effectiveness is excellent as a temporary safeguard, but it's not a permanent solution for new capacity investment.	

Strategic Reserve – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ By design, a Strategic Reserve is usually not technology-neutral, as only technologies that can safely reserve energy (e.g. pumped storage, batteries, gas-fired power plants) can participate in the tenders. ▪ At the same time, there is a risk is that the reserve may remove (green) flexible assets from the market that would otherwise contribute to the market directly. This leads to a distortion of dispatch (possibly also to the detriment of CO2 intensity if mainly renewable go into the reserve) and has a negative effect on the technology mix. ▪ On the other hand, if only a small volume of capacity is procured, the overall system cost is comparatively low. ▪ If the reserve price is set sufficiently high, a dampening effect on electricity prices that reduces overall costs is not to be expected in the context of a reserve. In addition, the deployment sequence of the total capacity is ensured and therefore also the investment decisions are not distorted. This means that power plants in the Strategic Reserve are only deployed when any other plant available on the market is deployed. This is particularly relevant for flexible consumers, which may be forced out of the market if the deployment price is low, resulting in a loss of efficiency. ▪ Overall, the reserve can be considered moderately efficient.	▪ Expected Dutch is relatively small (1.3 GW in 2033) in short term, with sufficiently available (to be phased out) gas capacity. Targeting a small share of these gas assets as part of the Strategic Reserve, could make capacity easily and cost-efficiently available in the short term. ▪ Need in NL for innovation in technologies that deliver flexibility (see Central CRM) might be challenging to provide by a Strategic Reserve. Even though a Strategic Reserve is open for batteries and DSR, in Finland and Germany participation was low/not existent. ▪ Investment incentives for storage as needed in NL (see Central CRM) can likely not be provided by Strategic Reserve - since - although new assets can be considered in a Strategic Reserve - the economic viability of a battery that is operated outside of the EOM and only used in very few moments will be very low.	
Complexity	▪ Strategic Reserves are among the simplest capacity mechanisms to implement. The concept is well-established in several European countries (e.g., Germany). This might also lead to an easier EU State aid authorisation. ▪ An advantage of the reserve is the clear and limited scope – the parametrisation of the following is carried out by the government authority: volume, duration, timing, call-up premium, compliance monitoring and penalisation. However, as mentioned, this is subject to complex security of supply analyses. ▪ In summary, the Strategic Reserve has comparatively low complexity and is well-suited for quick implementation.	▪ Low implementation complexity in comparison to market-based mechanism. ▪ Strategic Reserve eligible for fast-tracked implementation under the EU CISAF regulation. ▪ Article 5.12 of the Dutch Energy Law already provides the legal basis for the implementation of a Strategic Reserve. ▪ Sufficient lead time in the Dutch context to implement a Strategic Reserve in general, as adequacy gap is expected only after 2030.	

Advance payment for new builds

An advanced payment for new builds aims to incentivise the construction of new secured generation capacity in specific regions

High-level description

The **advance payment for new builds** aims to incentivize the construction of new secured generation capacity in specific regions where additional capacity is needed for grid stability by providing more predictable returns.

Capacity **demand** is **determined centrally based on system analyses** of the TSO. Based on this, TSOs launch **regional tenders**, where **participation is limited to flexible and climate-compatible assets**. Contracts are awarded to bidders requesting the lowest guaranteed compensation for the forecasted number of redispatch operating hours, based on asset depreciation. Selected assets receive a "**new-build prepayment" over ten years to partially cover their depreciation costs upfront**, increasing investment security. During actual redispatch activation, no further depreciation compensation is paid until the pre-paid hours are used up; any additional use is compensated as usual.

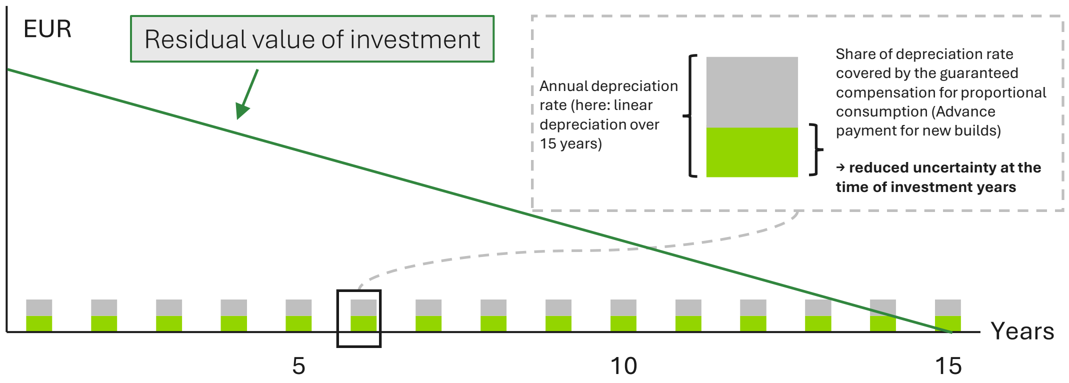


Figure: Residual value of investment and investment uncertainty over years.
Source: Transnet BW (2022)

High-level screening of pro and cons of the CRM

Advantages

- **Low complexity – little intervention** in the electricity market design required
- Probably rather **low refinancing requirements**

Disadvantages

- **Focus more on transmission adequacy than on resource adequacy** since advance payments only addresses a maturity mismatch for specific assets required for redispatch.
- In addition, inaccurate prediction of new-build needs and redispatch hours may challenge effectiveness further.

Short-listing

Effectiveness questionable as it only addresses a maturity mismatch for specific assets required for redispatch but does not address further aspects like missing money.

Advance payment for new builds – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ The advance payment for new builds concept provides predictable revenues for redispatch-relevant plants in the first years after commissioning. Thereby security of supply in the sense of and operational security is supported. Market-wider resource adequacy is only addressed implicitly and partly. ▪ As the mechanism depends on redispatch forecasts by TSOs and the persistence of grid bottlenecks, high level of under- or overcapacity very likely. ▪ Hence, the advance payment for new builds is rated negatively on security of supply, as it serves and may improve security of supply in some regions but does not help to provide system-wide resource adequacy.	▪ Since Advance payments only focus on new assets, procurement will have higher uncertainties (e.g. not reaching FID even after award under Advance payment mechanism) and longer lead times. ▪ Existing gas capacity in NL cannot be included; hence Advance Payment won't prevent existing gas plants from retiring if they become unprofitable. ▪ In case capacity needs to be adjusted upwards, a new tender for an Advance Payment can be setup, albeit with a lead time for building the plant. Downward adjustment is not possible, as contracts consider multiple years.	Thumbs down
Effectivity	▪ The instrument provides predictable revenue forecasts for new builds in the longer term (10 years). Furthermore, bankability for these assets can be improved. However, as the subsidy is linked to redispatch, hence, the maturity mismatch is only solved for specific assets. ▪ A risk is over- or under-compensation if the new-build needs and/or redispatch hours are inaccurately predicted. ▪ Overall, this leads to a negative rating of the effectivity of advance payments for new builds.	▪ Advance payments could strongly incentivise new investments in capacity by offering a prepayment to cover depreciation costs upfront (hence solving the missing money problem in NL).	Thumbs down

Advance payment for new builds – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Efficiency	▪ The advance payment for new builds is not technology-neutral. The proposal by TransnetBW relies on climate friendly, flexibly controllable, grid optimised secured capacity (i.e., it allows gas-fired power plants only to take part if these are H2-ready). Even though this could be solved, due to the focus on redispatch, naturally not all technologies are suitable. This reduces the efficiency. ▪ In addition, advance payment for new builds likely affect the efficiency of market outcomes of the EOM negatively, leading to lower attractivity of newly build capacity outside the mechanisms and retrofits. Hence, crowding out of non-subsidised investment elsewhere in the system can be expected. ▪ To summarise, advance payments for new builds might be efficient for well-identified grid bottlenecks, however, the instrument is only rated neutral as it is not open for all technologies.	▪ Need in NL for innovation in technologies that deliver flexibility (also see Central CRM) can be provided by Advance Payments, as it is can focus on such specific technologies ▪ Advance Payments can directly contribute to Investment incentives for storage as needed in NL (also see Central CRM). Specifically, the prepayments to cover depreciation costs might be an attractive way to stimulate investments.	
Complexity	▪ The set-up of the mechanism is simple: a TSO analysis for future redispatch needs is used for a tendering process for eligible new builds. A contract then guarantees the revenue component, with standard processes for the redispatch activation that is already established. ▪ Hence, complexity is rated positively.	▪ No legal basis in NL for implementation of Advance Payments, changes would be required. In addition to that, interdependencies and questions in relation with the Dutch market-based redispatch should be investigated and proven before advance payments are introduced, which increases complexity. ▪ Sufficient lead time in the Dutch context to implement a CRM in general, as adequacy gap is expected only after 2030.	

Non-Fossil Flexibility Subsidisation Schemes (NFFSS)

NFFSS are unlikely to be effective for achieving resource adequacy

High-level description

Regulation (EU) 2024/1747 (Articles 19g and 19h) allows Member States to introduce non-fossil flexibility support schemes (NFFSS) to reach **nationally defined targets for new flexible resources, identified by the regulator or a central authority**. These schemes aim to support the cost-effective achievement of security and reliability of supply, and decarbonisation, particularly in light of increasing shares of variable renewable energy. Hence, objectives partially overlaps with CRM.

NFFSS are strictly limited to new investments in non-fossil flexibility options such as demand side response and storage. Support is allocated through a **competitive tenders**, potentially based on **locational criteria**. Beneficiaries must **ensure a minimum level of market participation**, with incentives and exposure to market price signals preserved. **Penalties** apply for non-compliance.

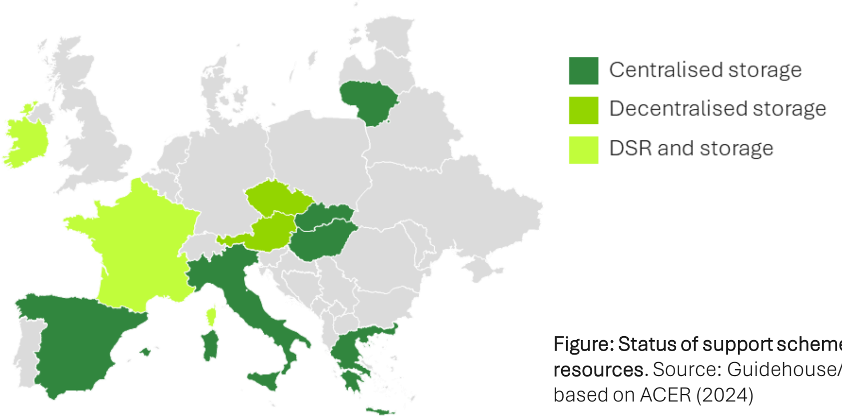


Figure: Status of support schemes for non-fossil flexible resources. Source: Guidehouse/Frontier Economics based on ACER (2024)

High-level screening of pro and cons of the CRM

Advantages

- Mechanism can address **flexibility concerns**
- Probably rather **low refinancing requirements – also compared to Strategic Reserve due to additional revenues from EOM market**

Disadvantages

- **Effectiveness for resource adequacy low; crowding-out effects** are likely to occur in the medium term;
- **Efficiency likely rather low** due to focus on a specific technology

Short-listing

NFFSS reasonable for supporting flexibilities in the system and thereby changing the technology mix (if not substituting investment into flexibilities considered outside the scheme), but induces crowding out effects on capacities not captured, hence cannot effectively guarantee resource adequacy.

NFFSS – Assessment for shortlisting

Criteria	General assessment	Assessment in Dutch context	Summary
Accuracy SoS	▪ Non-Fossil Flexibility Subsidisation Schemes are designed to promote the integration of variable renewable energy in the system. Hence, the main goal of the tool is not providing resource adequacy. ▪ Since the schemes are not designed around resource adequacy (i.e., the central planner does not plan to meet security of supply with the schemes), they cannot ensure the level of capacity needed for security of supply. ▪ The mechanism may help locally or temporarily as it mainly addresses short-to-medium-duration flexibility (such as batteries DSR) with variable renewable integration but cannot address longer-duration scarcity. ▪ In short, the mechanism cannot guarantee security of supply system-wide and is hence rated negatively.	▪ Since NFFSS schemes only focus on new assets, procurement will have higher uncertainties (e.g. not reaching FID even after award under NFFSS) longer lead times. ▪ Batteries and demand side response - if also operational in the EOM - improve flexibility but do not ensure sufficient firm capacity at peak (due to derating factors). Hence, only a relatively small share of the installed capacity can contribute during a prolonged peak. ▪ Existing gas capacity in NL cannot be included, hence NFFSS won't prevent existing gas plants from retiring if they become unprofitable. ▪ In case capacity needs to be adjusted upwards, a new tender round for NFFSS can be setup, albeit with a lead time for building the assets. Downward adjustment is not possible, as contracts consider multiple years.	Negative (thumbs down)
Effectivity	▪ NFFSS can incentivise investments in non-fossil technologies via competitive tenders. Thereby, they bridge revenue gaps in energy-only markets and provide support for assets that would otherwise face unpredictable income streams. ▪ However, due to limiting the support on non-fossil and newly build assets only, existing flexible assets or fossil power-plants are excluded. This limits the system-wide effectivity. ▪ Overall, NFFSS are thus rated negatively on effectivity.	▪ NFFSSs would incentivise new investments in capacity (hence solving the missing money problem in NL), however while being prone to the 'crowding out effect'.	Negative (thumbs down)

NFFSS – Assessment for shortlisting

Criteria | **General assessment** | **Assessment in Dutch context** | **Summary**

Efficiency

General assessment

- By nature, the non-fossil flexibility scheme is not technology-neutral and runs auctions, centred on non-fossil flexibility only. This limits static efficiency.
- NFFSS are focused on supporting innovative and non-market ready technologies, but dynamic efficiency depends on repetition and design of auctions.
- Finally, participation of subsidised new flexibilities on the EOM lead to a crowding-out effects as subsided new capacity often displaces non-subsidised investment in complementary technologies.
- Overall, efficiency is rated neutral.

Assessment in Dutch context

- Need in NL for innovation in technologies that deliver flexibility (also see Central CRM) can be provided by NFFSS, as it is can focus on such specific technologies
- NFFSS can directly contribute to Investment incentives for storage as needed in NL (also see Central CRM)

Complexity

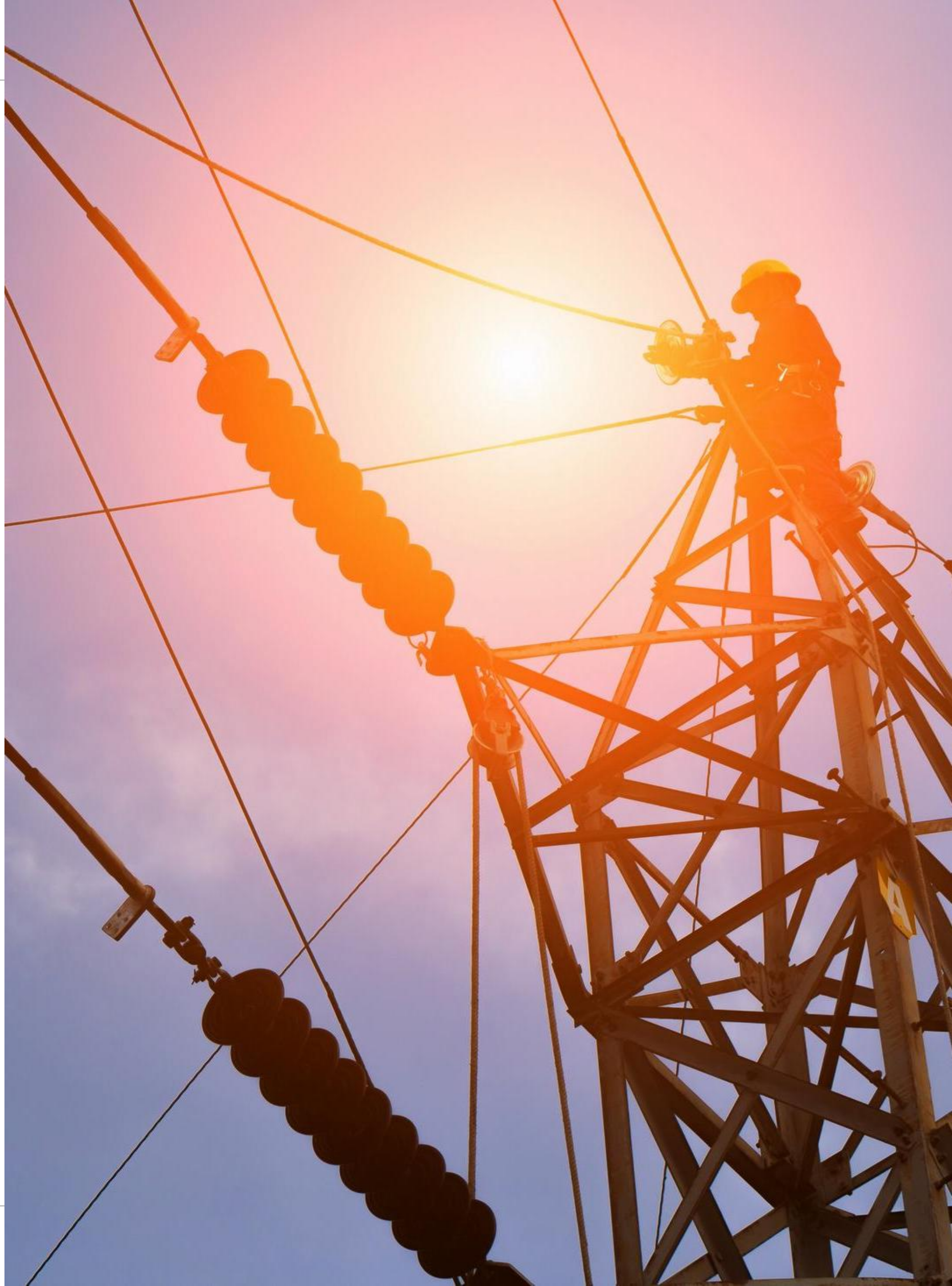
General assessment

- The complexity of the NFFSS is limited. Based on the assessment of the need for flexibility and flexibility targets that member states need to set for themselves either way, they have to define a target and run a competitive tender and award contracts with predefined obligations. Compliance then needs to be monitored, and potential penalties need to be executed (for instance in case the minimum participation levels are not met).
- For participants, the complexity is also limited once the rules to participate in the tender are clearly defined.
- A major benefit of the mechanism is that it seems to be compatible with EU state-aid rules and already established in Europe, signalling state-aid compatibility.
- Overall, complexity of the NFFSS is rated positively.

Assessment in Dutch context

- No legal basis in NL for implementation of NFFSS, changes would be required.
- Sufficient lead time in the Dutch context to implement a CRM in general, as adequacy gap is expected only after 2030.

Content



Central CRM: Detailed design options (1/6)

Dimensioning and procurement of capacity demand

Definition of capacity requirement

- In a central CRM **total capacity demand** to be covered by new and existing assets needs to be estimated, since capacity contracted can still operate at the EOM.
- Total capacity is **determined "top-down" by a central authority**. The central authority can be a government agency, or an agency commissioned by the government, e.g. the electricity TSO. In Belgium, a first proposal and simulation is done by the TSO and provides the basis for the proposal of the regulator. Final total capacity demand is determined by the ministry. (For more information, see country case study on Belgium, Annex V).
- Total capacity demand is estimated for a **period of usually 5-7 years ahead** (see timing and no. of auctions).
- The **level** corresponds to the **expected peak load during this period including a safety margin**.
- The level is determined based on a **resource adequacy analyses** of future peak loads, which **must meet** for a fast-track State aid approval at least **the requirements of the ERAA** (Article 23 of Regulation (EU) 2019/943). (Outside of a fast-track procedure, a NRAA may also be used.) An exemplary process can look as follows:
  - **Reliability standard** specification (calculated as the ratio of the cost of new entry / value of lost load) to be met: LOLE < e.g. 4 hours in a statistically normal year.
  - Development of a **scenario in which the reliability standard is met**.
  - **Simulation** based on market equilibrium model **determines scarcity hours**.
  - **Total demand to cover peak hours is determined**.

Timing and no. of auctions

- Total capacity demand will be tendered centrally in **joint auctions for all technologies** (incl. DSR).
- Usually, **at least two auctions with different lead times**, e.g. one auction long before the delivery date (e.g. in T-4) and one closer to the delivery date (e.g. in T-1).
  - Holding back some of the required capacity for a later auction (e.g. 10 % of total demand) offers the opportunity to adjust total capacity demand required based on **new findings gained / developments** in the period in between.
  - The lead times until delivery of the product have an **indirect effect on the choice of technologies** regarding new or existing assets. A long lead time (e.g. T-4, i.e. 4 years between contract award and delivery) is a prerequisite for newbuilds to be able to participate in Capacity Auctions. Lead time needs to be determined based on national legal requirements (e.g. planning procedures) and potential technologies. Lead time cannot be longer than 10y as electricity regulation (EU) 2019/943 limits a CRM approval to 10y. Shorter lead times (e.g. T-1) restrict the choice of technology to existing plants.
  - Exemplary timing with two auctions, one in T-4 and one in T-1
- **Requirements for fast track of State aid application**: 75 %-90 % of the estimated target demand for the delivery window should take place 4-6 years ahead of the delivery. Additional processes can be initiated ad-hoc (see CISAF Annex II).

In Belgium three auctions in T-4, T-2 and T-1.
In UK two auctions in T-4 and T-1.

2028	2029	2030	2031	2032	2033	2034	2035
T-4 2032			T-1 2032	Delivery 2032			
	T-4 2033			T-1 2033	Delivery 2033		
		T-4 2034			T-1 2034	Delivery 2034	
			T-4 2035			T-1 2035	Delivery 2035

Figure: Example of auction planning for multiple lead times and delivery years.

Central CRM: Detailed design options (2/6)

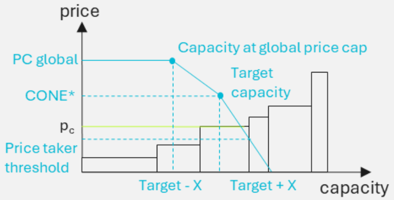
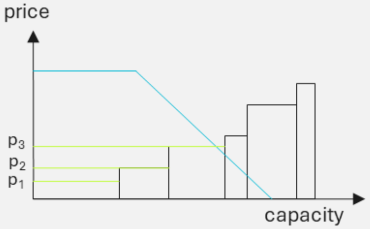
Auction design

Auction design

(pay-as-cleared vs. pay-as-bid)

- **State aid fast track process:** bids in EUR/de-rated MW/year only criterion in the selection process (see CISAF Annex II).

- **Pay-as-cleared and pay-as-bid both applicable,** but for **State aid fast track process: pay-as-cleared.** If relevant, implementing **price/bid caps possible** (subject to conditions) to prevent any market power being exercised or to limit inframarginal rents (CISAF Annex II).

	Pay-as-cleared (e.g. in UK, see case-study Annex V)	**Pay-as-bid (e.g. currently still in Belgium,** see case-study Annex V)
Principle	▪ Descending clock auction[1] ▪ Bids are paid at the 'clearing price', i.e. the marginal price. ▪ Global price cap for all assets. ▪ Existing capacity providers are by default 'price takers', i.e. they can only place exit bids when the auction price drops below a certain threshold. They are obliged to participate and can only opt out for certain reasons.  Figure: Example pay-as-cleared auction design	▪ Sealed bid auction. ▪ Bids are paid at the 'bid price', i.e. the offer price. ▪ Global price cap applies to all bids. ▪ Intermediate price cap (IPC) – applies only to 1 y products in order to limit infra-marginal rents especially for existing assets.  Figure: Example pay-as-bid auction design
Pros	▪ Participants are incentivised to bid at marginal capacity costs, so that the probability of selecting efficient providers is high ▪ Facilitates participation for new/smaller capacities, as less market knowledge is required	▪ Resulting payments differ depending on new construction, renewal and existing assets. This can reduce costs, but the advantage is small, as providers try to offer the clearing price (instead of their marginal cost, i.e. p_3 instead of p_2 and p_1).
Cons	▪ Resulting payments do <u>not</u> differ between new construction, renewal and existing plants: **risk of high inframarginal rents for existing plants**, which are politically undesirable. ▫ This can be partially **limited by an IPC for existing plants**, but IPC increases complexity. The IPC acts as a clearing price for existing plants if there is insufficient capacity. ▫ In addition, **reliability options** are generally used in a central CRM.	▪ If bidders expect that existing assets will not be sufficient to meet total demand, they will bid on the IPC (same issue in case of pay-as-cleared). ▪ Determining an IPC increases complexity. ▪ **Incumbents may have advantages in strategic bidding** due to their market knowledge, which makes it difficult for new/small plants to participate. ▪ **Cheaper suppliers may bid above their cost and therefore not be awarded contracts** in favour of more expensive suppliers.

[1] A **Descending Clock Auction (DCA)** is a multi-round auction that starts at a high price, which is gradually lowered until the amount of supply offered by bidders matches the demand. All successful bidders are then paid the final clearing price. See e.g. Ofgem (2024)

[2] A **Sealed-Bid Auction** is an auction where all bidders submit their offers confidentially and simultaneously, without knowing others' bids, and the winner is determined once bids are revealed. The winning bidder typically pays either their own bid (first-price) or the highest losing bid/second-highest bid (second-price).

Central CRM: Detailed design options (3/6)

Auction design and reliability options

Auction design (Locational incentives)

- **Locational incentives possible via**
  - **Entry requirements** (as part of prequalification requirements): strict guidelines on where new plants can be built (effective exclusion of plants in regions upstream of bottlenecks).
  - **Regional shares**: restriction that at least a certain level of capacity (in % of total capacity or in MW) is contracted in a certain region.
  - **Regional bonuses**: capacities in a certain region receive a bonus, i.e. the bid will be reduced by the amount of the bonus.
- **The introduction of a local component would significantly increase the legal justification required for the implementation of a CRM.** In terms of state aid law, it is likely to be decisive that it can be demonstrated that the aid primarily serves to remedy a threat to resource adequacy.[1] Locational incentives will not go with a CISAF fast-track procedure.

Reliability options

- **Mechanism**: Obligation of the supplier to pay positive differences between an ex-ante strike price (as a revenue cap) and a reference market price (e.g. the hourly day-ahead exchange price) to the (central) authority.
- **Objectives**:
  - Incentive to be available in the event of supply bottlenecks, as additional revenues must be reimbursed regardless of market participation. May support, but probably unlikely sufficient in size to replace a penalty.
  - Limitation of windfall profits and thus increased political stability of the capacity mechanism.
  - Limitation of abuse of market power, as upsides are limited by additional revenues in situations of scarcity.
  - Partial refinancing of the capacity market.
  - Potential negative effect: cap on scarcity prices can lead to the expected losses from the cap being priced into the bid prices in the centralised capacity tender, thereby increasing the bid prices for the capacity payments.
- **Determination of strike price – regular review/adjustment required**
  - Basic idea: strike prices should only apply in situations of scarcity, i.e. they should be high
  - Determination is based, for example, on the marginal cost of the technology that has a price-setting effect in a shortage situation or historical DA prices or a combination thereof.
  - If necessary, a minimum value equal to the activation costs of demand response may also be set to ensure technology openness (no skimming of 'normal' arbitrage profits)
- The **quantity is usually based on the de-rated capacity** offered/obliged in a scarcity situation within the framework of the CRM.

Example:
With a reference price of €320/MWh and a strike price of €300/MWh, a producer with a de-rated capacity of 100 MW would have to pay €20/MWh for each MWh. For 1 hour, this would mean a repayment of €20/MWh × 100 MW = €2,000.

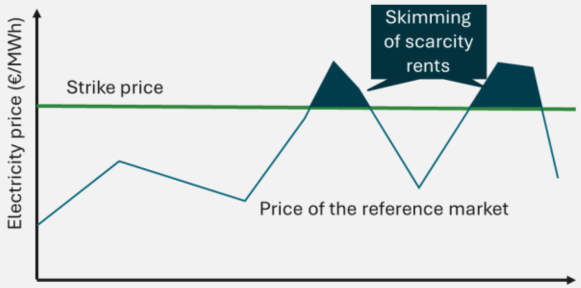


Figure: Working of reliability options

1: See Consentec/Ecologic (2024).

Central CRM: Detailed design options (4/6)

Prequalification, participation and de-rating

Prequalification	▪ **Participation only for prequalified participants, but simplifications for certain technologies (e.g. DSR) possible.** ▪ **Prequalification criteria** can cover e.g. a minimum capacity, network level, CO2 limits, regional limitations (see auction design), technologies allowed to apply. ▪ **Fast track for State aid approval: CO_2 emission limits from electricity regulation** must be met, stricter CO_2 limits are permitted (as e.g. in the case of Belgium). Calculation must be in line with ACER methodology for the ERAA.[1] (See CISAF Annex I) ▪ **Technology-neutrality required**, but effectiveness of implementation depends on design of prequalification criteria (e.g. via avoiding high minimum capacity, allowing aggregation and simplifying prequalification criteria for flexibilities). **Integration of new technologies may be challenging** due to prequalification criteria set years in advance before delivery (i.e. prior to e.g. T-4 auction).
Participation	▪ **Participation can be** ○ **obligatory** for certain assets, e.g. existing assets > 1 MW (as in Belgium, see case-study Annex II), or ○ only **voluntary**, e.g. for certain technologies (like DSR in Belgium) ▪ **Foreign participation required by State aid guidelines**. However, awarding multi-year contracts is difficult because sufficient input capacity cannot always be guaranteed in the long term (see case-study for Belgium, where only 1-year contracts are granted, see Annex II).
De-rating	▪ **De-rating** is applied, and de-rating factors are usually determined by the central authority (but self-de-rating – i.e. capacity providers determine their own de-rating factors – is also possible to take heterogeneous characteristics of assets into account). ▪ **Reason**: De-rating factors reduce the nominal capacity of a plant to obtain more realistic estimates of the available capacity at a given point in time. ▪ For characteristics and determination see excursus on next slide ▪ **For a fast-track State aid process**: de-rating factors must generally **correspond to the ERAA assumptions for the central reference scenario**.[2] Individual capacity providers may deviate from the standard de-rating factor by up to 15%.

1: ACER (2020): ACER Decision on the ERAA methodology – Methodology for the European resource adequacy assessment. For updates see the ACER website
2: De-rating factors should be those published by ACER/ENTSO-E as an output of the latest available ERAA for the relevant bidding zone.

Excursus: De-rating factors

Definition

- De-rating factors are **correction factors that take into account the actual availability and reliability of a capacity source**. They are **not purely plant-specific**, but also depend on the characteristics of the electricity system as a whole, such as the composition of other capacities and electricity demand.
- De-rating factors reduce the nominal capacity of a plant in order to obtain more realistic estimates of the available capacity at a given point in time.

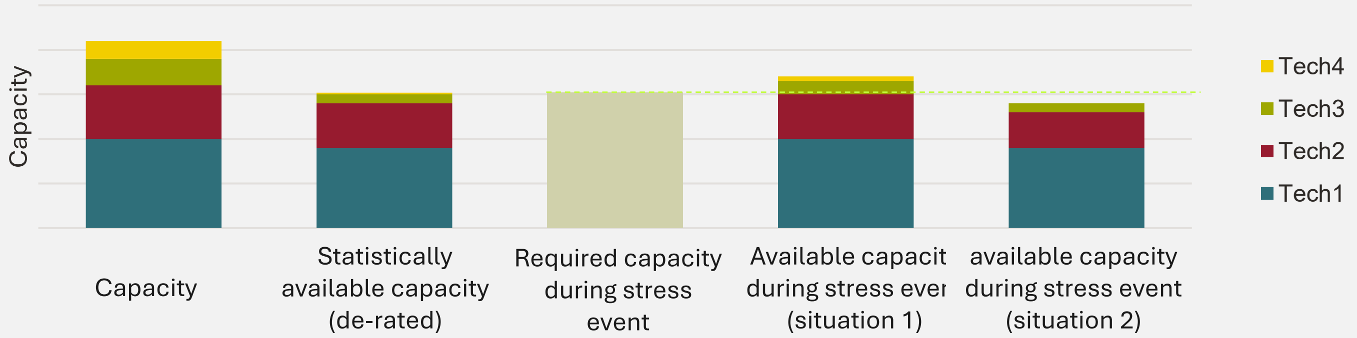
Characteristics

- **Purpose** in the capacity market: De-rating factors are used to define the actual amount of reliable capacity that a supplier can provide in a stress situation.
  For example: A power plant with a nominal capacity of 100 MW and a de-rating factor of 90% is valued in the capacity market as if it could only provide 90 MW.
- **Technology-specific:** De-rating factors take into account different availability and reliability levels depending on the technology. For example, a gas-fired power plant has a higher de-rating factor than a weather-dependent wind turbine.
- **Availability**: These reflect the probability that a certain capacity will actually be available when needed, especially during peak load times or stress situations.
- **Calculation**: Based on historical data and statistical analyses of plant availability.

Approaches to determining de-rating factors

- **Central technology-specific determination identical for all market participants:**
  - This ensures a high degree of security of supply, but has the disadvantage of being less innovation-friendly.
  - This approach is used in existing capacity markets (e.g. in Poland, Belgium, Italy and the UK).
- **So-called 'self de-rating' allows market participants to set their own de-rating factors.**
  - Higher penalties for unavailability are required to ensure the necessary level of security of supply.
  - Self-de-rating increases the possibility of better 'matching' actual availability by incorporating decentralised knowledge. However, it also increases the risk of 'overestimation', especially if penalties are set too low.
  - In practice, self-de-rating is used in particular for heterogeneous DSR.

Interplay between capacity, de-rated capacity and capacity in the specific shortage situation



- In a scarcity situation, there is no guarantee that the average availability of all plants will correspond to the statistical availability according to the de-rating factors.
- Even without misconduct on the part of the suppliers, it may happen that not all availability obligations are fulfilled, even via secondary trading.
- This needs to be considered when setting the penalty level.

Central CRM: Detailed design options (5/6)

Products

Products

- **Central authority determines the contract terms** of the product, i.e. contract duration and lot sizes.
- The **contract duration** of the capacity products influences the participation of new builds or retrofits.
  - Longer contract periods mean that capacity payments are made over several years, thereby increasing the planning security for investments in new builds or retrofits. Therefore, a distinction is typically made between products for **existing** plants (contract term of **1 year**), **retrofits** (contract term of **3 to 8 years**) and **new** plants (contract term of **up to 15 years – also max. duration for fossil-fuelled generation assets in fast track of State aid approval**).
  - The contract durations for installations are usually determined by threshold values for investment costs (€/MW). If the investment sums for prequalified plants exceed these thresholds, the corresponding contract durations are applied.
- In order to be able to **effectively integrate smaller decentralised technologies** such as storage and flexible loads, either the **lot sizes** must be selected accordingly small, **aggregations** must be permitted, or **auction volumes must be reserved**. The technology mix at a central CRM is therefore strongly influenced through the centrally determined product definition.

1: Legislation UK (2014): The Electricity Capacity Regulation 2014, §29, for more details consult https://www.gov.uk/government/collections/transitional-arrangements-auction

Excursus: Auction design for central CRM

Separate auctions for new assets or for flexible technologies

***Excursus:* Separate auctions for new vs. existing assets?**

- Different products for new builds, retrofits and existing assets do not imply that their quantity must also be specified and/or a separate auction is to be held. Rather, **bids for different products can also compete in a joint auction.**
  - Pro: decision of new, retrofit vs. existing assets will be solved by the market and capacity providers with more specific knowledge of individual assets.
  - Con: What is happening if in a T-4 auction only existing assets are successful (due to likely lower bids) and the remaining capacity offered in T-1 needs to be covered by new assets, but the lead-time is not sufficient anymore? → Might be a rather theoretical situation, as problem never appeared in UK and neither in Belgium (see Annex V).
- A **separate auction** for new assets may solve the "con" point above, but also comes with a disadvantage linked to the "pro" argument: The **central authority needs to estimate not only the total capacity demand, but also the level of required new assets**. This requires assumptions on the development/availability of the existing assets in the future. In turn, this increases the uncertainty of the estimates and – in case of a risk averse central authority – **increases the likelihood of over-dimensioning**.

***Excursus:* Separate auctions for flexible technologies?**
See next slides

- Again, **a joint auction could secure an efficient market decision** (comparing different bids of different technologies from different providers) **if certain flexible technologies are not disadvantaged**, e.g. through prequalification criteria, **or require additional support for market ramp-up**.
- In case of the latter, separate auctions aimed at supporting these technologies, which are seen as required but not yet competitive, may be reasonable.
  For example, in UK, two additional "limited eligibility" auctions[1] aimed at building capacity of smaller flexibility were held in 2016 and 2017 as transitional auctions. In the 2016 auction lower credit cover and reduced obligations in stress events were foreseen. However, also the main auction in UK has procured significant decentralised flexibility from the start.
- **Overall, flexibility requirements can be taken into account in centralised CRM tenders through various measures (see next page).**

1: Legislation UK (2014): The Electricity Capacity Regulation 2014, §29,
for more details consult https://www.gov.uk/government/collections/transitional-arrangements-auction

Excursus: Separate auctions for flexible technologies measures (1/2)

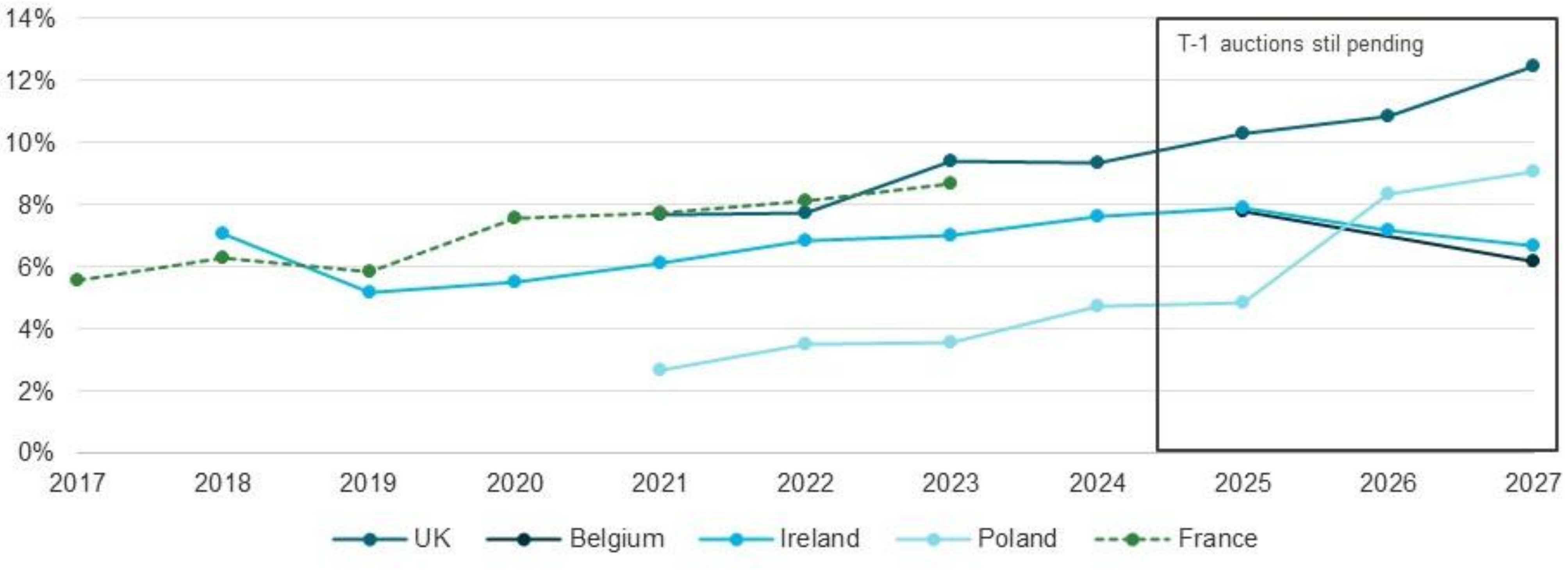
International examples show: Flexibility requirements can be taken into account in centralised CRM tenders through various measures

	Measures to integrate flexibility into central auctions	Implemented, e.g. in
Aggregation of capacities	▪ Capacity aggregation is possible in most central CRMs.	
Simplified prequalification and certification requirements for DSR	▪ DSRs can undergo simplified prequalification in most central CRM.	
Auction mechanism	▪ Dedicated auctions for smaller flexibilities (e.g. UK 2016 and 2017)	
	▪ Reservation of capacity for short-term (e.g. T-1) auctions, in which participation by DSRs is generally easier ▪ Sealed-bid auction format lowers the barrier to entry for smaller flexibility providers	
	▪ DSR can be offered at prices above the generally applicable bid caps.	
	▪ Reservation of capacity for T-1 auctions, in which participation by DSR is generally easier	
Adjusted de-rating for DSR and storage	▪ Option for self-de-rating in conjunction with higher penalties	
	▪ Penalty- correction of de-rating factors for DSR and storage	
Simplified availability obligations for DSRs	▪ DSR only needs to be available for a reduced number of consecutive hours	

Excursus: Separate auctions for flexible technologies measures (2/2)

International experience also proves the successful integration of decentralised flexibility in central capacity markets

Share of storage and DSR in total contracted capacities over time



- There is no evidence that centralised tenders would incorporate flexibility less effectively and efficiently than decentralised systems.
- In the French decentral CRM, the proportion of flexibilities has only increased with the introduction of centralised elements

Source: Frontier Economics (2025): Einbindung von dezentraler Flexibilität in einen integrierte Kapazitätsmarkt, report for BDEW.

Central CRM: Detailed design options (6/6)

Obligations, penalties and financing

Obligations and penalties

- **Successful bidders** receive a **capacity payment** (Euro/MW per year) and have in return the obligation to keep the agreed (de-rated) capacity technically available at times defined as relevant (i.e. at the entire duration of expected periods of shortage, **availability obligation**).
  - Times relevant for maintenance are usually announced ex ante with a certain lead time (e.g. in UK 4 hours ahead) and confirmed ex post [see Annex II for details}.
  - Triggers for times relevant to provisioning can be, for example, the day-ahead price (BE) or the forecast difference between available generation capacity and expected demand (UK) [see Annex II for details].
  - Agreed capacity may vary – e.g. for storage facilities, only one-time activation, or for DSR, only above certain prices. The fulfilment of the contract by the contracting parties (generation or DSM units) is monitored centrally, e.g. through availability tests. In addition, pre-delivery monitoring with penalties exist in BE.
- **Penalties** are provided for non-fulfilment of the contract.
  - The amount is determined considering the risk of undersupply and penalties incurred through no fault of the provider. Orientation generally based on the agreed annual performance price with annual capacity payment as the upper limit.
  - Requirements for **fast track of State aid application:**
    - Penalties for non-availability (during the delivery period) must be **independent of technology.**
    - In case of availability <= 50% in a delivery period, penalties must **at least cover capacity yields in the same period**.

Financing

- The costs incurred by the central CRM are **financed by administrative means**. This can take the form of a **tax** or a **(static or dynamic) levy** on e.g. BRPs or end consumers.
  - Static levy is based on the BRPs/end consumer's total consumption over the year.
  - Dynamic levy is based on the BRPs/end consumer's consumption during peak load times.
- **A comparison of the financing options in the central CRM shows advantages/disadvantages.** For example:
  - A dynamic levy has a high incentive to reduce load during stress events as the BRPs/consumer can reduce their financial burden, but implementation is complex.
  - In contrast, financing via tax revenue is easy to implement, but has negative characteristics in terms of the incentive to reduce the load, fairness and political feasibility (especially in times of tight public budgets).
  - Fast track of State aid requires that at least 90% of the costs of the CM must be allocated to consumers on the basis of their consumption during the 1-5% highest price periods per year (→ dynamic levy). Charges may be levied on balance responsible parties. (See CISAF, Annex I)

Strategic Reserve: Detailed design options (1/4)

Dimensioning and procurement of capacity demand

Definition of capacity requirement	■ A **central (government) authority defines the amount of capacity (MW) to be contracted**. The central authority can be e.g. the ministry (as in Germany)[1a] or the regulator (as in Finland)[2]. ■ **Dimensioning is based on system adequacy studies and security of supply assessments**. ○ First, the central authority needs to estimate total future demand needs by relying on different planning assumptions (similar to a central CRM). ○ Second, the desired SoS level needs to be defined; ○ Third, the existing capacity / capacity available at the EOM needs to be estimated. ○ For **a fast-track State aid approval**, maximum auctioned volume needs to be calculated on the basis of the central ERAA ref. scenario (similar to central CRM, see Article 23 of Regulation (EU) 2019/943). ○ Typically, only a small fraction of peak load (e.g. 2 GW Strategic Reserve vs 75 GW peak load in Germany) is finally determined to address residual adequacy risks. The mechanism is not designed to cover total system adequacy but only extreme scarcity events, designed as a "safety net" rather than a comprehensive mechanism. Accordingly, a Strategic Reserve will, by definition, rarely be activated.
Timing & no. of auctions	■ Total capacity required will be **tendered centrally in a joint auction for all technologies considered**. ■ Usually, there is **one tender per delivery period – covering between 1-2 years** (e.g. FI 1y[2], DE 2y[1b]). Hence, reserve tenders take place every 1-2 years. ■ Auctions in Germany, Finland and Sweden are typically run with a **lead time of approx. 1-2 years before delivery**.
Auction design	■ Procurement is organised through **centralised one-sided auctions** organised by a central body (e.g. the regulator or the TSO itself). Final contracts are usually concluded between the system operator and the successful bidders. ■ If the bid is successful, the suppliers receive a **reservation fee (EUR/MW/a)** for their reservation obligation. In addition, a **payment for activation (EUR/MWh)** can be foreseen as for instance in Finland. For a fast-track State aid process, the only criterion in the selection process allowed is bids in EUR/de-rated MW/a. ■ **Pay-as-cleared (e.g. Germany)[1c] and pay-as-bid (e.g. Finland)[2] are both applicable – also for a fast State aid process.** ■ If relevant, implementing **price/bid caps possible** to prevent any market power being exercised or inframarginal rents. Price caps can e.g. be benchmarked against the annuitized costs of a new-build gas power plant to ensure that costs do not exceed a proxy for efficient new capacity. ■ **Locational restrictions can be added** – similar to a central CRM, or one could establish grid-related restrictions for new plants, meaning that they must be located where they can meaningfully support adequacy. However, the introduction of a local component would significantly increase the legal justification required for the implementation of a Strategic Reserve.[4]

1a: §13e EnWG, 1b: §8 KapResV, 1c: §19 KapResV; 2: European Commission (2022): State aid SA.55604 (2022/N) – Finland, Brussles, 11.10.2022, C(2022) 7306 final 3: CISAF, Annex I. 4: See Consentec/Ecologic (2024)

Strategic Reserve: Detailed design options (2/4)

Participation and prequalification (technical requirements)

Reliability options	▪ Reliability options in the strict sense are not used in Strategic Reserves as they are **not participating at the EOM**. ▪ Instead, **availability obligations and penalties** provide the reliability signal (see obligations and penalties).
Participation	▪ Participation is **voluntary** and usually allowed for **generation, storage or DSR** held outside the electricity market based on State aid rules.[1] For fast track under State aid procedure, technology neutrality is required. ○ In practice, Strategic Reserves are predominantly supplied by generation. ○ In Germany, DSR participated for the first time in the auction with delivery in 2024-26 (0.75% of awarded capacity), with the remainder from generation. ○ In Finland, DSR last participated in 2017-2020 (3%), and no storage was procured there either. ▪ While a Strategic Reserve can be open to existing as well as new projects, competition is usually mainly expected to come from **existing generation** plants, **existing and new DSR storages and gas power plants,** given the high costs associated with a new generation plant. In Germany, new plants are highly unlikely due to a no-return rule (§ 3, 2 KapResV), i.e. after reserve contract ended, the capacity cannot return to the EOM. ▪ The state-aid guidelines suggest that, **where feasible (i.e. no obligation), Strategic Reserves shall be open to direct cross-border participation** of capacity providers located in another Member State.

1: CISAF, Annex I
2: ACER (2020): ACER Decision on the ERAA methodology – Methodology for the European resource adequacy assessment. For updates see the ACER website
3: German TSOs: Standardbedingungen für Kapazitätsreserveanlagen, German TSOs (2023): Teilnahmevoraussetzungen für die Beschaffung von Kapazitätsreserve

Strategic Reserve: Detailed design options (3/4)

Products, obligations and penalties

Prequalification	▪ **Participation only for participants, which fulfil certain technical requirements (prequalification criteria).** These can cover e.g. ○ **minimum capacity** (min. not > 1 MW for fast-track for State aid approval [1]). ○ **network level,** ○ **CO_2 limits – for fast track for State aid approval: CO_2 emission limits from electricity regulation must be met**, stricter CO_2 limits permitted. Calculation must be consistent with ACER method.[2] ○ **regional limitations,** ○ a **certain start-up / ramp-up capability** (e.g. availability within 12 hours to solve day-ahead shortages or ±30% reserve adjustment within 15 min after activation, see German country case study Annex II). ○ In general, DSR must meet continuous, interruptible demand characteristics. **To effectively integrate DSR**, certain technical requirements might need to be adjusted, e.g. **aggregation** must be permitted (as usually the case) and **duration of provision** of reserve only for a limited time window (for instance in Germany, single or multiple provision of reserve, sustained for ≥60 min within a 12-hour window).[3] ▪ There is a trade-off between reliability (having strict criteria) and efficiency (having different technologies competing). ▪ **No formal de-rating**, but certain technical requirements must be met (see above).
Products	▪ Reserve contracts **remunerate the availability of capacity** that is withheld from the wholesale market, activated only during scarcity. If not included, activation is remunerated separately. However, for a fast-track State aid approval, profits of participants in the SR must be independent of their "activation"/dispatch. ▪ The reserved capacity is excluded from the wholesale market and **only activated if e.g. the day-ahead market or intra-day market fails to clear** so units can ramp in time**. It is only dispatched** after network and market measures incl. balancing energy but TSOs in Germany may deviate from this rule relative to balancing energy if required for secure system operation (KapResV, §25 and 26). This is in line with the CEP that states that the resources are dispatched if the transmission system operators are likely to exhaust their balancing resources and that pre-activation of resources is allowed (see CEP §22, 2a). ▪ The typical **contract duration** ranges from **1-3 years**. A fast-track State aid approval requires capacity agreements with a duration and delivery period of one year.

Strategic Reserve: Detailed design options (4/4)

Financing

Obligations and penalties	▪ **Providers receive a fixed reservation fee (€/MW/year) and have to fulfil the following obligations:**
	○ Providers must guarantee **technical availability of the reserve during scarcity**. For instance, in Germany, Strategic Reserve is triggered if there is no market clearance at the last day ahead auction or in the opening auction of intraday trading, or in intraday continuous trading open purchase bids reach the technical price limit and are not fully fulfilled within one hour. The call is subordinate to other measures (including the use of balancing energy).
	○ The operational readiness of the contracted capacities is **verified via test calls**, e.g. an announced test call one month before the delivery period and/or a certain number of unannounced test calls can be foreseen.
	▪ **Penalties**:
	○ The central authority (government agency or TSO) continuously monitors the supply situation and compliance with the agreements concluded on the provision of capacity.
	○ In case the reserve providers does not meet the obligations set in the legislation and the contract, e.g. via non-availability of contracted capacities, marketing of capacity on electricity markets (e.g. abroad) or provide false information, a penalty must be paid.
	○ Requirements for **fast track of State aid application:**
	  ○ Penalties for non-availability (during the delivery period) must be **independent of technology.**
	  ○ In case of availability <= 50% in a delivery period, penalties must at least cover capacity yields in the same period.
	○ In addition, the central authority could **terminate the contract**.
	▪ **Securities can be considered as a design option of the Strategic Reserve,** e.g., in Germany 15% of maximum remuneration achievable for a contract year before start of contract and additional security after acceptance of bid that amounts to 20% of total remuneration, §10 KapResV)
	▪ Option to implement a **no-return rule** (as e.g. in Germany), i.e. after reserve contract ended, the capacity cannot return to the EOM

Financing	▪ The costs for the reserve can be passed on via a **surcharge on the transmission system operator's grid tariff** to end consumers or via a new **levy on e.g. BRPs or end consumers**. Tax-based financing of reserve provision is also possible in principle, but consumption-based financing is preferred for reasons of State aid law. ▪ **For a fast-track State aid approval**, at least 90% of the SR costs not covered by imbalance must be allocated to consumers based on their consumption during the 1-5% highest price periods per year. Charges may be levied on BRPs. (CISAF, Annex I).

Hedging Obligation: Detailed design options (1/3)

Dimensioning and procurement

Definition of hedging requirement

- The updated Internal Electricity Market Directive foresees an obligation for electricity suppliers to implement appropriate hedging strategies. The Hedging Obligation supplements this regulation by **defining specific requirements for this obligation**. In contrast to the current national obligation in the Netherlands encompassing only suppliers, who have concluded a fixed-price contract with small consumers, **all suppliers are obliged** (e.g. consumers, managing their own demand, are also obliged to hedge – as this is the case in Australia).[2]
- **There are two ways to forecast the quantity that needs to be hedged:**
  - **On the basis of sales**: The obligation results from the obligor's energy sales and an assumed sales profile. The assumed profiles determine the peak demand that needs to be hedged with the hedging product.
  - **Based on a measured peak load**: The obligation is derived from the actual peak load, e.g. in a system peak load window defined in advance by a governmental authority or market actors.[1]
  - **The total quantity to be secured results from the sum of the individual obligations.**
- Next to the question on which forecast to rely on, the question is also **how much of the electricity demand should be hedged?**
  - As was shown in a recent study, suppliers often already hedge 90% of their delivery obligations.[1, 3]
  - A Hedging Obligation foresees an increase up to **100%**. However, as shown in next box, the required level can increase over time and may be lower in the time period before delivery.

Timing and no. of auctions

- No capacity tenders are run, instead, there is a **hedging calendar with a gradually increasing minimum coverage from early years toward delivery** to manage price and volume risk efficiently. This allows the suppliers to manage the portion above the hedging requirement entirely ly (as shown in the figure on the right side). In contrast, the current Hedging Obligation in the Netherlands requires complete back-to-back hedging as soon as possible.
- Connect (2025)[1] recommends **starting hedging 36 months ahead of delivery**, as the forward market is already liquid and processes are familiar to all participants. The forward market in the Netherlands however, is not very liquid (e.g. compared to Germany)[4], which means that suppliers could struggle to hedge within the Netherlands (raising prices and potentially resulting in cross border hedging).

Figure: Scope of action in relation to the Hedging Obligation.
Source: Frontier Economics based on Connect (2025)[1]

1: Connect (2025): Die Ausgestaltung der Absicherungspflicht. Marktwirtschaftliche Organisation der Versorgungssicherheit im Strommarkt; 2: Australian Government: Retailer Reliability Obligation; 2: BDEW (2023): Fakten und Argumente. Energiebeschaffungsmodelle und deren Wirkung auf Endkundenbelieferung; 4: Rabobank (2024): The Dutch electricity sector - part 4: Changing electricity markets present opportunities and risks for businesses and households

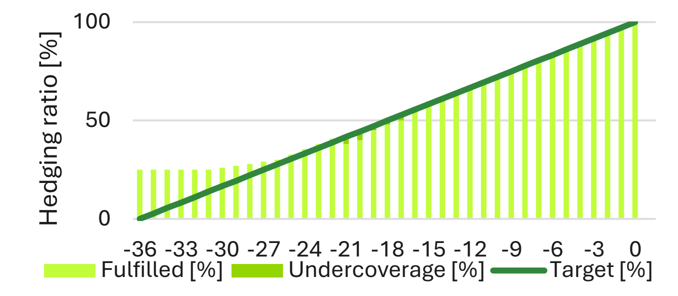
Hedging Obligation: Detailed design options (2/3)

Auction design and participation

Auction design	▪ **Compliance can be met by buying/selling hedging product on existing markets (exchange), bilateral contracts (e.g. via OTC or Long-Duratio) or by self-fulfilment**. Accordingly, the rules applicable in the respective markets apply. ▪ The various market segments (exchange trading, bilateral trading and own generation) differ in terms of the degree of standardisation and liquidity of the available solutions, counterparty risk and the handling of technological characteristics, among other things. To enable technology-neutral competition for hedging, a **firmness concept** is required that **reflects substitution possibilities**. ▪ A significant difference to the other short-listed mechanisms is that the Hedging Obligation can be **fulfilled with work-based products (futures/forwards) or performance-based products (options).** ▪ **For providing location signals in case of a Hedging Obligation, zonal or nodal price signals would be required**. However, this would **impact liquidity and –** like the other short-listed mechanisms – only bottlenecks on transmission level would be considered but not those on distributional level.
Reliability options	▪ A reliability option is usually not considered as part of a Hedging Obligation.
Prequalification & participation	▪ **Who is obliged:** on the demand side **all BRPs are obliged to hedge their electricity demand**. It makes sense to have a broad definition (including e.g. energy communities/citizens' associations), so all market participants face a level playing field. ▪ **Who can supply the hedge:** on the supply side, participation should be open to **all technologies and financial traders –** generation, storage, DSR or purely financial counterparties can sell the required products based on their "firmness". o While there might be no need to have specific prequalification criteria for generation, DSR should document triggers and have their firmness method audited. o In principle, both existing and new plants could be used for hedging. o The technology mix of the controllable capacities for hedging is determined by the individual decisions of the actors involved. ▪ **Cross-border participation is possible** on the demand and supply side if the firmness-factor would be supplemented by a term that reflects the firmness of the interconnector.

Hedging Obligation: Detailed design options (3/3)

Products, obligation and financing

Products	▪ **There is a broad product set that help to fulfil the Hedging Obligation.** In principle, there are three different ways of hedging for BRPs: ○ **Standard products** that are traded on exchanges and cover a broad product set with base/peak year/quarter/month futures. These allow easy processing and monitoring. In addition, "spike-products" with a more granular time frame targeted at fulfilling the Hedging Obligation at peak load/price times could be designed. ○ **Non-standard products** are traded OTC. They allow for individual solutions and the highest possible competition on technologies. For this kind of contracts, a **firmness framework** that quantifies their risk-coverage value, would be needed. The firmness factor is based on three elements: price risk, volume risk and contractual limits.[1] Instead of asset-by-asset accounting, compliance may be demonstrated on a portfolio basis. ○ Finally, **self-fulfilment** is an option that can be used. In particular, the BRPs could rely on own generation, storage, or DSR. ▪ Accordingly, consumers can **hedge their procurement in the long term** by purchasing early. Producers could theoretically benefit from long-term contracts that guarantee secure remuneration for their capacity and energy generation, depending on the product selected. Secondary trading is also allowed.
Obligations and penalties	▪ **Obligation:** BRPs have to continuously comply. ▪ **Monitoring:** the obligation is monitored by the State or a State-commissioned agency. The demand to be secured is continually compared with available products, using their firmness rating. An automated, mandatory reporting and calculation process would notify the agency of any shortfall. ▪ **Penalties:** ○ Under-coverage in any interval is penalised. Penalties could reference e.g. to the day-ahead or intraday-market prices. ○ The penalty should be technology-neutral (applies to the open net position, not to asset type). ○ The penalty framework should recognise forecast error and encourage higher early coverage when uncertainty is large.  Figure: Over- and under-performance during the hedging period. Source: Frontier Economics based on Connect (2025)[1]
Financing	▪ The costs for hedging become part of the regular energy price component for end customers, which neither burdens the federal budget nor requires explicit (further) subsidies or levies. Thus, State aid approval is likely not required (but needs to be confirmed by an additional legal check). ▪ However, there may be a margin risk for the BRPs themselves if passing on the newly incurred costs is made more difficult by restrictive legal provisions on the adjustment of end customer contracts.

(1) Connect (2025): Die Ausgestaltung der Absicherungspflicht. Marktwirtschaftliche Organisation der Versorgungssicherheit im Strommarkt

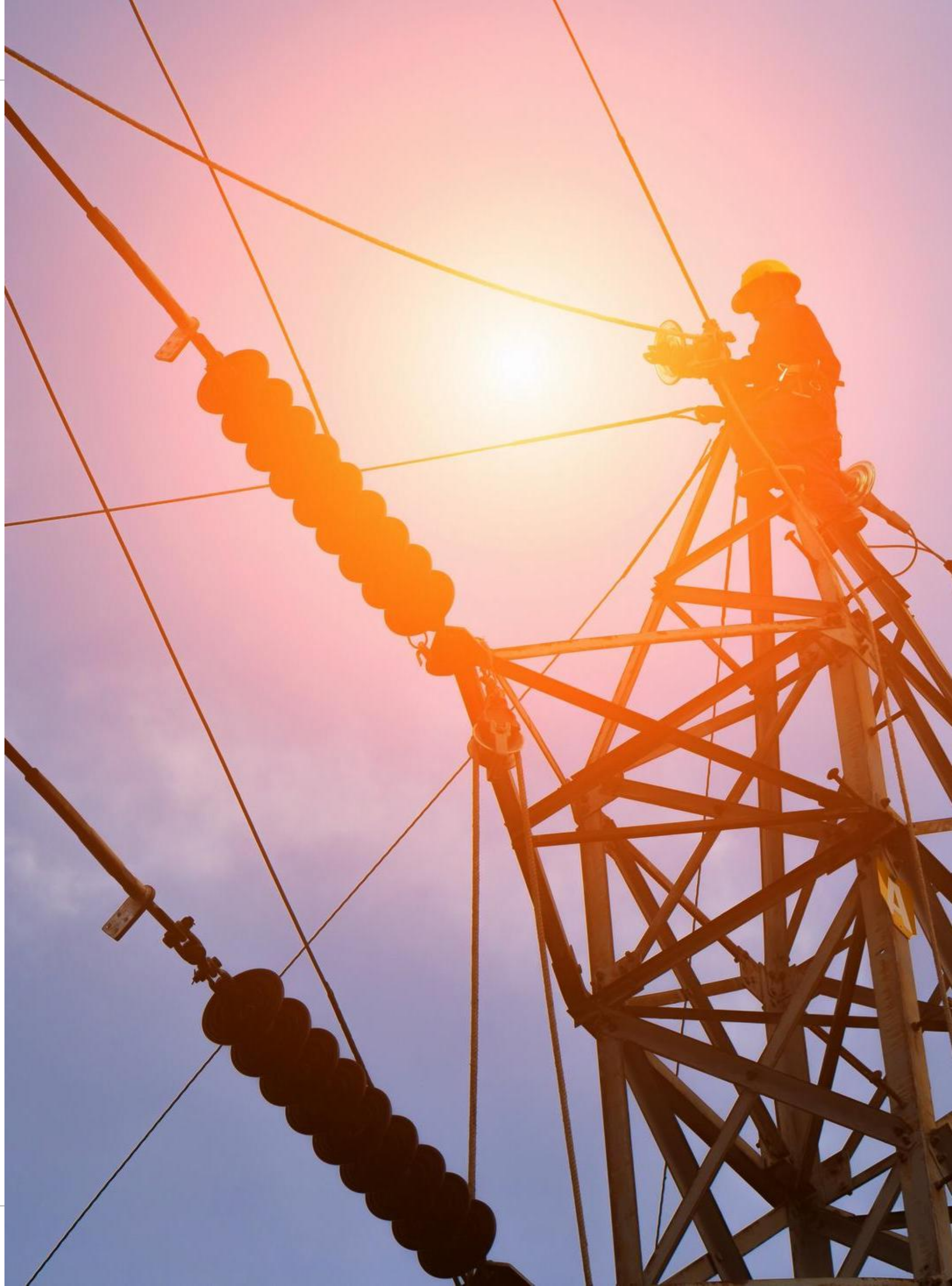
Excursus: According to Connect (2025)[1] the firmness concept should measure the reliability of a hedge (not only availability)

Because hedges differ in how reliably they protect in scarcity (by technology and contract design), a concept that measures the reliability is needed. Connect suggests a firmness framework for this, that is explained in the following.

What is "firmness"?	▪ Firmness is a 0 to 1 coefficient assigned to each hedging instrument that measures how reliably it covers price and volume risks as well as contract limits. The factor is the portion that is reliably effective in scarcity and determines the part of the hedge that counts toward compliance with the Hedging Obligation. The hedging "volume" is the sum-product of positions and their firmness factors.
What is the difference to de-rating factors?	▪ While both concepts evaluate the reliability of the obligations, there are differences as well. ▪ De-rating factors evaluate the availability of a technology while firmness evaluates the reliability of financial hedging products based on price risk, volume risk and contract limits.
Which components are taken into account?	▪ **Price risk**: How much does the instrument reduce the price risk? For instance, a future provides a lower price risk than an option with a strike-price of EUR 1000. ▪ **Volume risk**: How reliable is the hedge? For instance, a base-future has no volume risk compared to a wind-Long-Duratio. ▪ **Contract limits**: Are there contractual limits that can stop delivery during price spikes? For instance, a DSR could only allow usage of the product for 2h per day. This would reduce firmness compared to an asset that could be used all day.
How is firmness calculated?	▪ **For standard products (futures)**, the three factors are predetermined. Futures that can be traded on exchanges have a firmness of 1 as the three factors are fulfilled: the BRP needs to fulfil the obligations on the price and volume and has an incentive to invest in controllable capacity if risks increase. If the feed-in structure is guaranteed by the BRP in a renewable Long-Duratio, firmness is also 1 if there are no contractual limits as there is no price or volume risk. ▪ **For non-standard products (OTC)**, the three risks are valued individually with a factor of 0 to 1 and then multiplied. A renewable Long-Duratio that is not secured, has no price risk but a volume risk. The firmness factor should reflect this by showing the expected minimum generation for the relevant time window – every 15 min of the day (including corrections and s). However, it remains unclear how the firmness of individual supplier portfolios will be assessed.

(1) Connect (2025): Die Ausgestaltung der Absicherungspflicht. Marktwirtschaftliche Organisation der Versorgungssicherheit im Strommarkt

Content



Central CRM: Country Case Studies UK and Belgium (1/5)

Design	United Kingdom	Belgium
Motivation & legal basis	▪ **State aid approval:** SA.35980 ▪ **Legal basis:** UK Energy Act 2013. Secondary legislation governing implementation are e.g. Electricity Capacity Regulations 2014 & Capacity Market Rules. ▪ **Motivation:** The CM was implemented at a time of tight supply and significant changes (closure of coal fired power plants and older gas plants). Hence there was a real looming need for new capacity to complement renewables while a missing money problem was present.	▪ **State aid approval:** SA.54915 (initial decision), SA.104336 (amendments) ▪ **Legal basis:** Electricity Act. In addition, several implementing provisions were prepared to further elaborate the CRM provisions, such as Royal Decrees, Ministerial Decrees and regulatory approved market rules and contracts (see SA. 104336, p. 4 for an overview). ▪ **Motivation:** Planned phase-out of nuclear power leads to need for new secured capacity, missing money problem & political and regulatory uncertainty.
Stakeholders & responsibilities	▪ The **government (DESNZ)** has the overall responsibility for the operation of the mechanism and determines the demand. ▪ The **regulator (Ofgem)** regulates the capacity market by implementing and managing the CM rules and providing reports on its operation. ▪ The **System Operator (National Grid)** advises on the required capacity amount, runs the pre-qualification process and the auctions, determines de-rating factors, ensures availability of contracted CMUs and publishes 'Capacity Market Notices'.	▪ The **minister of energy** is in charge of determining the final demand curve. ▪ The **regulator** (CREG) proposes the amount of capacity to procure, taking into account data provided by the TSO. The scenarios used are proposed by CREG. ▪ The **TSO** (Elia) is in charge of the pre-qualification process, holding the auctions, operating the secondary market and conducting availability monitoring.
Definition of capacity requirement	▪ **Total capacity demand** (to be covered by new and existing assets) is **determined "top down" by National Grid and confirmed by the government (DESNZ).** ▪ Total capacity demand is estimated **usually 5 years ahead for the T-4 auction** by a resource adequacy analysis considering a **LOLE of threshold of 3 h** (The Electricity Capacity Regulations 2014, Regulation 6 & DESNZ 2025).	▪ A first proposal and simulation is done by the TSO and provides the basis for the proposal of the regulator. Final total capacity demand is determined by the Ministry. ▪ Total capacity demand is estimated **usually 4-5 years ahead** by a security of supply analysis considering a **LOLE of threshold of 3 h.** ▪ **For more details see next slide**

If not indicated otherwise, the information in this section is taken from European Commission (2019 for the UK and Elia (2025): Capacity Remuneration Mechanism. General Info Session, as well as supportive documents, which can be found here.

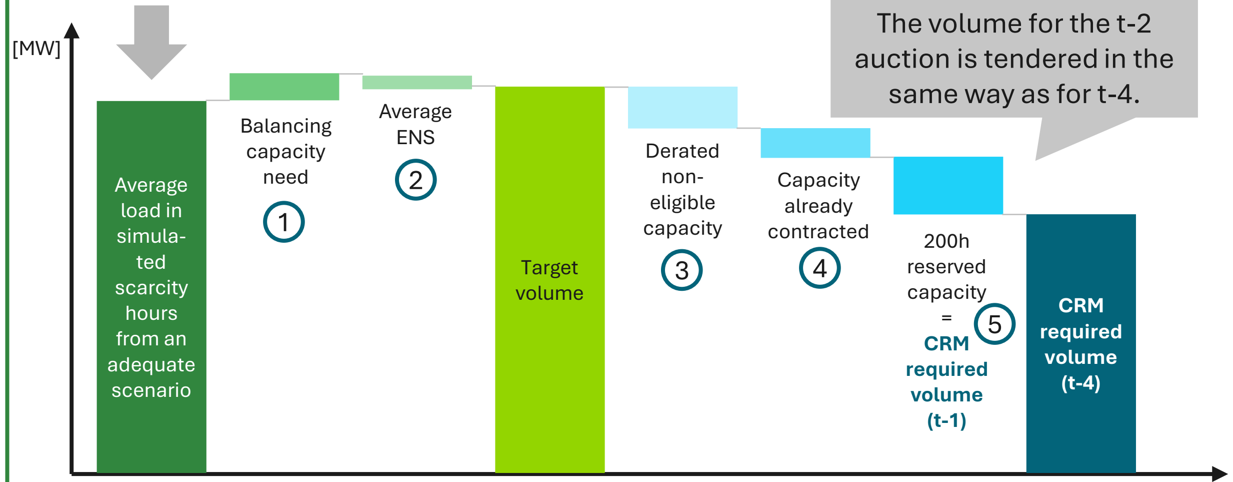
Excursus: Dimensioning of demand in the central CRM in Belgium

Process ▶ Proposal and simulation by **TSO** (Elia) → Proposal by the **regulator** (CREG) → **Ministry** determines final demand curve

Determination of the tendered load demand

- **Reliability standard** to be met**: "loss of load expectation" (LOLE) < 3 hours** in a statistically normal year.
- Development of a **scenario in which the reliability standard** is **met**.
- **Simulation** based on market equilibrium model **determines peak hours.**
- **Total demand to cover congestion hours** is contracted.

Calculation of required volume of auctions



The volume for the t-2 auction is tendered in the same way as for t-4.

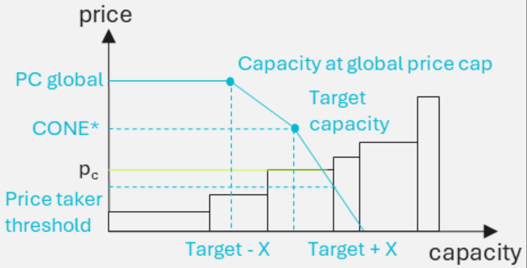
Source: Frontier Economics based on Elia (2025): Capacity Remuneration Mechanism. General Info Session

1. **Balancing capacity need**: Required balancing energy during congestion hours defined as the sum of the FCR and FRR requirements for the respective delivery periods.
2. **Average Energy Not Served (ENS)**: Since the LOLE is not 0, a certain amount of energy is not provided during the hours of scarcity. The average amount of energy that cannot be provided in each simulated scarcity situation is considered.
3. **De-rated non-eligible capacity**: Capacities that receive State aid during the delivery period (in particular RES and CHP, deduction of derated MW!) or whose installed capacity multiplied by the derating factor is < 1 MW.
4. **Capacity already contracted**: Capacity already contracted in previous auctions.
5. **200 h reserved capacity**: At t-4, 50% of the capacity required to cover the entire peak capacity on average for less than 200 operating hours per year is reserved for the auction in t-1. The motivation for this was to incorporate flexibility that is available at short notice. At t-2, the "200h capacity" minus the capacity prequalified for the delivery period t-4 is set aside.

Any adjustment to the volume tendered in t-1 allows for uncertainties to be taken into account.

Example UK: For the final determination of T-1 demand, NationalGrid recalculates, among other things, the peak load. This allows demand to be adjusted upwards or downwards at short notice. In the past, it has not been necessary to procure new capacity at this stage.

Central CRM: Country Case Studies UK and Belgium (2/5)

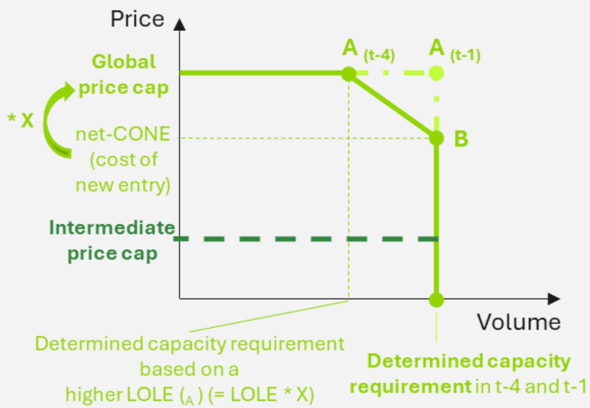
Design	United Kingdom	Belgium
Timing & no. of auctions	▪ In general, **two joint auctions for all technologies** (incl. DSR). ▪ One auction in **t-4** (with pre-determined demand curve and range of multi-year inflation indexed contracts), and one in **t-1** (with updated demand curve and single year indexed contracts). ▪ **In 2016 and 2017, two additional "limited eligibility" auctions** aimed at building capacity in **smaller flexibility**, contracting ca. 800 MW (but 200 dropped out) and 300 MW. In the 2016 auction lower credit cover and reduced obligations in stress events were foreseen.[1]	▪ **Three joint auctions for all technologies** (incl. DSR). ▪ Auctions take place in **t-4, t-2 and t-1**.
Auction design	▪ **Descending clock auction**: multi-round auction that starts at a high price, which is gradually lowered until the amount of supply offered by bidders matches the demand. ▪ **Pay-as-clear:** Bids are paid at the 'clearing price', i.e. the marginal price.  *Figure:* Demand and supply curve Source: Frontier Economics based on Ofgem (2024) ▪ **Global price cap for all assets (£75/kW/y)**[2]. ▪ **Price threshold for existing assets and interconnectors (£25/kW/y)**[2]**:** Existing capacity providers are by default 'price takers', i.e. they can only place exit bids when the auction price drops below a certain threshold. ▪ **Bid selection** based on **maximising economic surplus.** ▪ **No locational incentives.**	▪ Sealed bid auction: auction where all bidders submit their offers confidentially and simultaneously, without knowing others' bids, and the winner is determined once bids are revealed. ▪ **Pay-as-bid**: Bids are paid at the 'bid price', i.e. the offer price. **Potentially moving to pay-as-clear in future.**[3] ▪ **Global price cap** for all assets. ▪ **Intermediate price cap (IPC)** – relevant **for 1-y products** in order to limit inframarginal rents especially for existing assets. ▪ **Bid selection** based on **grid constraints and maximising economic surplus** ▪ **No locational incentives.** *For more details on determination of demand and bid curves as well as award rules see next slide.*

[1] Legislation UK (2014): The Electricity Capacity Regulation 2014, §29, for more details consult https://www.gov.uk/government/collections/transitional-arrangements-auction
[2] DESNZ (2025): Website; [3] In its application to the EU COM for approval of the Belgium capacity market, Belgium cited the transition from pay-as-bid to pay-as-cleared for 2026.

Excursus: Auction procedure in Belgium and the effect of global and intermediate price caps

1 Determination of demand curve (represents willingness to pay for adequacy)

Figure: Demand curve is set through the global price cap, net-CONE, target capacity & a capacity with a higher LOLE



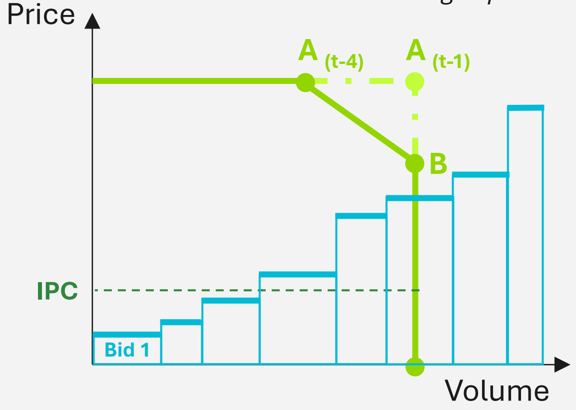
Source: Frontier Economics based on Elia (2025): CRM Design Note: Auction Process

- **<u>Global price cap</u>** is the **product of**
  - **net new construction costs**, approx. €63-69/kW/y;
  - **factor X** (approx. 1.25-1.5), which takes into account uncertainties in estimating the net CONE
  - → approx. €80-105/kW/y
- **<u>Intermediate price cap</u>** for 1-year contracts
  - **Missing money** (= fixed operating costs + costs for availability tests) * (1+WACC) – revenues
  - **Divided by the de-rating factors**
  - → approx. €21-26/kW/y

Determination based on the highest missing money of the technologies considered (CCGT, OCGT, batteries and DSM for 4 hours) across three cost and revenue scenarios, i.e. high cost + low revenues

2 Determination of the bid curve

Figure: Bid curve is determined by ranking of bids submitted according to prices



Source: Frontier Economics based on Elia (2025): CRM Design Note: Auction Process

- **Ranking of bids submitted by suppliers according to their prices**, taking into account
  - the intermediate price cap (IPC) for existing capacity
  - the global price cap for multi-year contracts (A)
- **Bids contain three parameters**
  - Capacity volume (in MW)
  - Price (in €/kW/a)
  - Contract duration (in # years) – taking into account investment thresholds for 1 year (see products contract duration)

3 Award rules

t-4

Welfare maximisation (sum of consumer and producer surplus)

Lowest weighted average CO_2 emissions (if several clearing solutions are equivalent)

Lowest weighted average contract term to limit lock-in effects (if the first two criteria are equivalent)

t-1

Cost minimisation

+

Consideration of network restrictions in bid combinations

Central CRM: Country Case Studies UK and Belgium (3/5)

Design	United Kingdom	Belgium
Reliability options	▪ **No reliability option** in place	▪ **Strike price: Fixed and variable components** (compared to the alternative of variable cost of a reference technology) Example: For the t-4 auction with delivery 2025-26, a strike price of €300/MWh was determined.[1] This consists of: ○ fixed component: remains stable throughout the delivery period ○ a variable component: determined from the ex post monthly average of day-ahead prices, which is continuously adjusted ▪ **Reference market: day ahead** ▪ **Explicit penalties** and **fixed capacity obligation** (instead of load-following)
Participation & pre-qualification	▪ **Eligibility** for **existing and new generators, storage, DSR and interconnectors**, but not for capacity providers receiving support from other measures, such as e.g. CfDs. ▪ **Participation in the pre-qualification process is mandatory for all eligible capacity** (even if there is no intention to bid). ▪ **Mandatory participation in auctions if no opt-out after prequalification.** ▪ **General and technology-specific prequalification requirements**, including min. size of 1 MW (before de-rating) and simplified criteria for DSR . ▪ **Technology-specific de-rating factors** published for each auction. ▪ **Emission limit in line with EU regulation**, i.e. 550 grCO_2/kWh and 350 kg CO_2/kW/y.	▪ **Eligibility:** ○ **for existing and new generators, storage, DSR and foreign capacity** ○ **for 'unproven capacity'** – less mature projects, e.g. aggregators/DSR providers that still need to finalise agreements or are considering multiple prospects (max. 200MW/auction). ○ not for capacity providers receiving variable subsidies in the delivery period. ▪ **Participation is mandatory** for ○ existing capacities (generation/storage) with de-rated capacity > 1 MW and ○ "additional capacity" with signed technical agreement & generation/storage licence or signed grid connection contract. ▪ **General and technology-specific prequalification requirements**, including min. capacity of 1 MW (aggregation permitted) and financial securities. ▪ **Technology-specific de-rating factors** published for each auction. ▪ **Stricter emission limits than EU regulation** of 550 g CO_2/kWh or for plants with commissioning before 4 July 2019 306 kg CO_2/kW/y and < 600g CO_2/kWh.

1 Elia (2025): CRM Design Note: Payback Obligation).

Central CRM: Country Case Studies UK and Belgium (4/5)

Design	United Kingdom	Belgium
Products	▪ **Fixed remuneration in exchange for a capacity obligation** ▪ **1 year contracts for existing capacity**, bids up to intermediate price cap ▪ **Up to 15 years for providers (incl. DSR) undertaking significant investments, max. length depending on invesmt. thresholds:** ○ £65/kW for 3y agreements (typically for refurbishing units). ○ A £0/kW threshold applies to specific cases e.g. for prospective generating Capacity Market Units (CMUs) or unproven DSR CMU with a low-carbon declaration. ○ £205/kW for 9y contracts (only for eligible declared low carbon CMUs). ○ £350/kW for 15y contracts (for new builds meeting this threshold). Bids up to global price cap.	▪ **Fixed remuneration** in exchange for an **availability obligation.** ▪ **Existing assets:** ○ 1 year contracts for existing capacity, imports and virtual capacity (capacity which have no delivery points yet). ○ Bids up to the intermediate price cap. ▪ **Retrofits:** ○ Up to 8 years if recurring and one-off investments exceed €30/kW. ○ Exemption required to bid above the intermediate price cap (IPC). ▪ **New construction** ○ Up to 15 years if certain CAPEX thresholds are exceeded: €360/kW for 15 years; €239/kW for 8 years; €106/kW for 3 years. ○ Bids up to the global price cap.
Obligations	▪ The **obligation is 'load-following'**, i.e. if 70% of the total contracted capacity are required during a stress event, each capacity provider must fulfil 70% of their total capacity obligation. ▪ **Secondary market:** capacity providers can sell obligations to other pre-qualified providers that have remaining eligible capacity volume.	▪ **Availability obligation & payback-obligation** (in form of a reliability option), i.e. availability is monitored in relation to the contracted capacity, not a load-propor-tional delivery quantity. Pay-back independent of EOM participation in stress events. ▪ The availability obligation has a **different design for energy constrained and non-energy constrained units:** (see table below) ▪ **Secondary market:** capacity providers can sell obligations to other pre-qualified providers that have remaining eligible capacity volume.

Energy Constrained	Non-Energy Constrained
At the level of non-derated capacity	At the level of de-rated capacity
For a limited set of MTUs (market time units)	For an unlimited set of MTUs
1 activation of consecutive MTUs per day	Unlimited number of activations per day
De-rating based on the availability of the energy reservoir during scarcity moments	De-rating based on outage rates or esti-mated production levels during scarcity

Central: CRM Country Case Studies UK and Belgium (5/5)

Design	United Kingdom	Belgium
Activation and testing	■ **Trigger for activation** ○ The capacity obligation is triggered when the system operator publishes a Capacity Market Notice, indicating high risk of a system stress event. This is done at least **4 hours before delivery** and confirmed ex post. ○ **Forecasted difference between available generation capacity and expected demand.** ■ **Testing** ○ **Regular performance demonstrations** must be carried out over the course of the delivery period, otherwise capacity agreements can be suspended or terminated. ○ **Site audits** can be conducted if non-compliance is suspected	■ **Trigger for activation** ○ TSO can activate availability of capacity when the **day-ahead price** exceeds a certain level (the 'AMT price'). ■ **Testing** ○ **Pre-delivery control** after the auction to ensure that contracted capacity becomes/remains available for the start of the contract period. ○ **Unannounced availability tests** (communicated the day before they are carried out).
Penalties	■ Penalties apply if capacity is **unavailable 4 hours after the issue of a capacity market notice.** ■ Penalty rate set at **1/24th of the clearing price.** ■ Penalty rate **capped at 200% of monthly capacity payments** and **100% of annual payments.**	■ Penalties apply if contracted capacity is **unavailable during pre-delivery control, AMT hours or availability tests.** ■ Penalty rate **calculated based on the provider's capacity remuneration and a penalty factor** (higher penalties in winter). ■ Penalty rate **capped at 100% of annual capacity payments and at 20% for any given month.** ■ Participants must provide a **financial security** of €20,000/MW for new CMUs and €10,000/MW for existing CMUs.
Financing	■ The CRM is financed through a **levy on electricity suppliers.**	■ The CRM is now financed through the **special excise duty on electricity consumed** instead of through a surcharge on electricity network tariffs (see European Commision (2023): State aid Decision SA.104336).

Strategic Reserve: Country Case Study Germany (1/4)

Design	Germany
Motivation and legal basis	▪ **State aid approval in 2018** (SA.45852) with first **delivery period** in **Winter 2020/2021.** ▪ **Motivation** for introduction: current transition of the German electricity system to renewable generation as well as the exit of nuclear production, indicating political and regulatory uncertainty. ▪ **Legal basis: §13e Energy Industry Act** ("Energiewirtschaftsgesetz", EnWG) with more details regulated in the **capacity reserve regulation** ("Kapazitätsreserveverordnung", KapResV).
Definition of capacity requirement	▪ The **federal Ministry for Economic Affairs and Energy** determines the amount to be held in the Strategic Reserve. Currently, it is set at **2 GW** (for comparison: total peak load in Germany is around 75 GW). ▪ The amount is **reviewed** by the ministry **every two years** based on the monitoring report on security of supply for electricity (§ 63, paragraph 2, sentence 1, no 2 EnWG). The report is published by the BNetzA (the regulator). ▪ There is a **hard cap in the law** (§ 13e, 5 EnWG): in case the bound reserve would be above 5% of Germany's average annual peak load, the increase can only be implemented by **consent of the German parliament**. ▪ TSOs may not take the reserve capacity provided by the capacity reserve into account when determining the scope of primary, secondary control power and minute reserve power to be procured. However, insofar as assets of the capacity reserve can also fulfil the function of the grid reserve, TSOs shall take them into account accordingly when determining the scope of the grid reserve to be procured.
Timing & no. of auctions	▪ Total capacity required is **tendered centrally in a joint auction.** ▪ There is one tender per delivery period, which is **11 months in advance** (→ for the current delivery period 01.10.2024-30.09.2026 the tender date was 01.12.2023). ▪ The **delivery period is 2 years** (currently: 01.10.2024-30.09.2026).

If not indicated otherwise, the information in this section is taken from two acts that can be accessed under the following links: EnWG and KapResV

Strategic Reserve: Country Case study Germany (2/4)

Design | **Germany**

Auction design

- Procurement is organised through **centralised one-sided auctions in a competitive, transparent, and non-discriminatory manner.** These are organised by the four German TSOs together. The rules for the tender are set by the TSOs in cooperation with the BNetzA (regulator).
- The final contracts are concluded between the TSOs and the successful bidder based on standard terms approved by the BNetzA.
- If the bid is successful, the suppliers receive a **reservation fee (EUR/MW/a)** for their reservation obligation. The fee covers up to 16 reserve activations lasting for 12h per contract year and function tests, probe calls and required corrections. If the reserve is needed more than 16 times per year, extra reimbursements will be paid (§19 KapResV).
  - The amount is **paid-as-cleared** in Germany. In the last tender, the plants in the Strategic Reserve received 99,990 EUR/MW/a.[1]
  - There is a **bid cap of 100,000 EUR/MW/a**. Furthermore, if the marginal bid has been > 10% below the cap in each of the previous tenders, the cap would be reduced by 5% (§12 KapResV). However, as in the last tender, the clearing price was 99,990 EUR/MW/a, this conditions does not affect the current bid cap.
  - In addition, some **extra reimbursements** are foreseen e.g. for additional costs incurred from use as grid reserve, for establishing/maintaining the black start capability or reactive power feed-in and in some cases for balancing energy.
- There are no **locational restrictions** apart from the fact that the asset must be connected in Germany or Luxembourg, i.e. no cross-border participation takes place.

Participation & pre-qualification

- Participation is allowed for **generation and storage outside the EOM under the following conditions (§ 9 KapResV):**
  - The asset has to be no more than two transformer levels away from a high-voltage network.
  - Start-up time of maximum 12 hours from a cold state.
  - Adjustment of active power feed-in from the time of the call by at least 30% of the reserve power within 15 min.
  - Minimum partial load of no more than 50% of the bid quantity .
- Participation is allowed for **DSR [or max. 20 DSRs as a pool, § 15 KapResV] outside the EOM** under the following conditions **(§ 9 KapResV):**
  - The asset has to be no more than two transformer levels away from a high-voltage network.
  - Start-up time of maximum 12 hours.
  - Adjustment of active power consumption (DSR) from the time of the call by at least 30% of the reserve power within 15 min.
  - **DSR must not have received any remuneration for flexibility in the 36 months prior to the announcement of the tender.**
  - DSR must provide uninterrupted power consumption at least equal to the bid quantity.
  - The energy offered to the Strategic Reserve has to be physically secured six months bevor the delivery date (§3, 3 KapResV).
- **New plants** are theoretically allowed, but **highly unlikely due to a no-return rule** (§ 3, 2 KapResV), i.e. after reserve contract ended, the capacity cannot return to the EOM, and the rather short contract duration of 2 years.

In Germany, DSR participated for the first time in the last auction with 0.75% of awarded capacity[1]

1 Netztransparenz: Veröffentlichungen zum Erbringungszeitraum 2024-2026

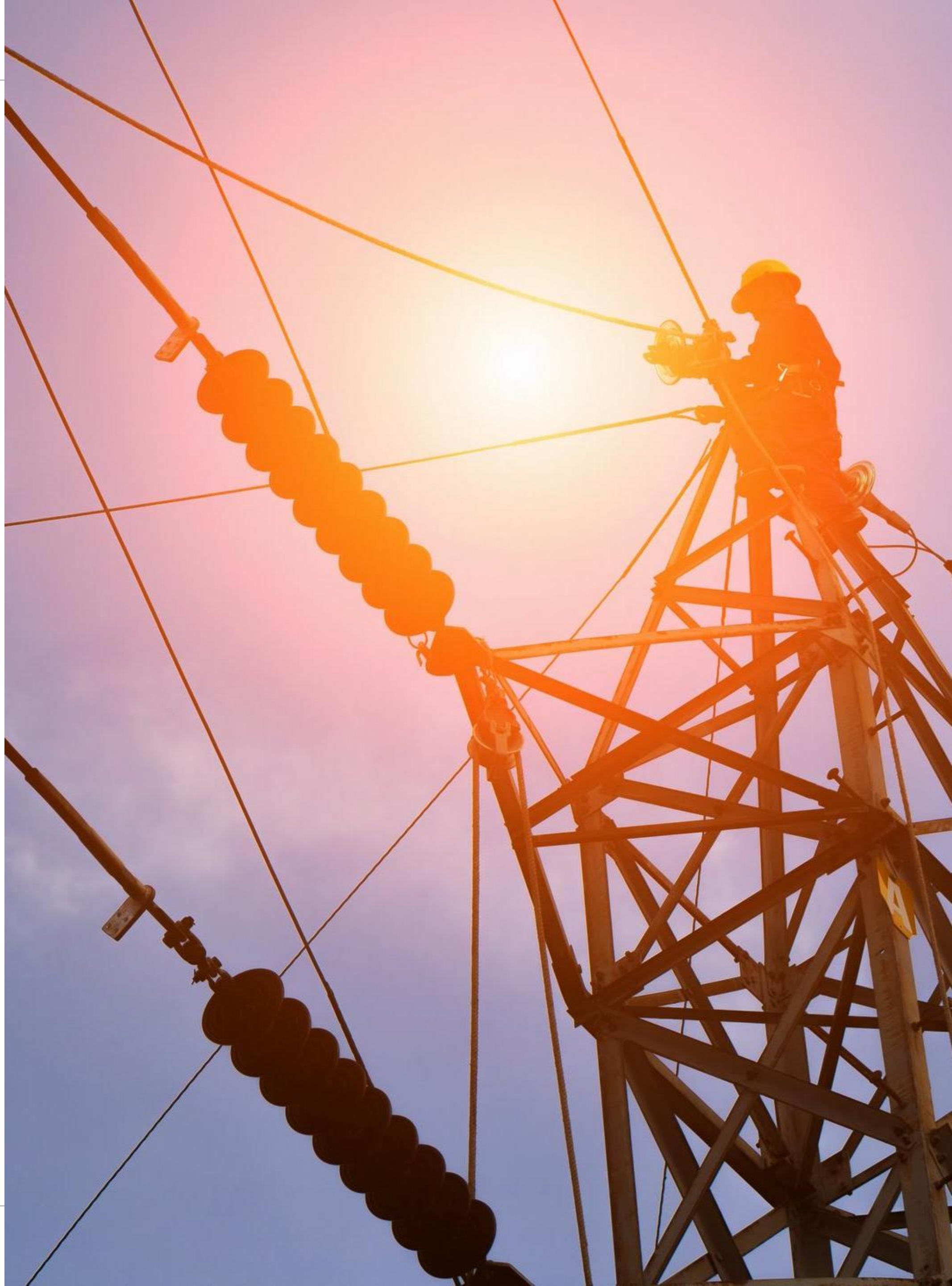
Strategic Reserve: Country Case study Germany (3/4)

Design	Germany
Products	▪ The reserve contracts **remunerate the availability of capacity** that is withheld from the wholesale market. Activation is included 16 times per year, if the reserve is activated more often activation is remunerated separately [for details see the box on auction design]. ▪ The reserved capacity is excluded from the wholesale market and **only released if e.g. the day-ahead market or intra-day market fails to clear** [see technical availability details in obligations and penalties box]. ▪ The typical **contract duration / delivery period** is 2 years (current period: 01.10.2024-30.09.2026).
Obligations and activation	▪ **Providers receive a fixed reservation fee (€/MW/year)** (and sometimes additional reimbursements, see box on auction design) and have to fulfil the following obligations (§ 24-30 KapResV): o Providers must guarantee **technical availability of the reserve during scarcity**. Retrieval time up to 12 hours/call, minimum 6-hour break before a new call. o Planned unavailability (revisions) must be reported by 31 July for the following year (up to 3 months/year). o The operational readiness of the contracted capacities is **verified via test calls**, e.g. an announced test call up to two month before the delivery period and/or a certain number of unannounced test calls can be foreseen. o The provider is not allowed to offer the capacity outside the Strategic Reserve. ▪ **Activation:** o The Strategic Reserve is **triggered** if there is **no market clearance at the last day ahead auction or** in the opening auction of **intraday trading**, or if intraday continuous trading open purchase bids reach the technical price limit and are not fully fulfilled within one hour. The call is subordinate to other measures (including the use of balancing energy). o TSOs must activate all reserve capacity facilities. However, they are authorised to activate only some of these facilities if their forecasts indicate that this will be sufficient to prevent or eliminate any threat to, or disruption of, the security or reliability of the electricity supply system. These facilities must be selected on the basis of technical suitability and economic criteria.

Strategic Reserve: Country Case study Germany (4/4)

Design	Germany
Penalties and securities	■ **Penalties (§ 34-36 KapResV)**: ○ In case a provider does not meet the conditions that should be met during a test call before the delivery period, they have to pay 20% of the amount agreed upon for the full delivery period. The same applies if the provider is responsible for no test call taking place. The penalty can be reduced if the reserve fulfills the requirements in the first six months of the delivery period. ○ In case a provider fails to activate the reserve and fulfill the requirements during the delivery period (in case of activation or a test call), a penalty of 15% of the amount for 1 year has to be paid. ○ If the capacity is offered outside the reserve, 100% of the amount received for the full delivery period need to be paid to the TSO. ■ **Securities (§ 10 & 34-36 KapResV):** ○ The operator shall provide initial security amounting to 15% of the maximum remuneration achievable for a contract year (EUR 100,000/MWa). ○ Secondary security after award: 20% of the total remuneration offered.
Financing	■ The costs for the reserve are **a pass-through to grid users** as TSOs recover the reserve costs via network charges (§ 33 KapResV). ■ However, TSOs are required to reduce the amount by the additional imbalance-settlement revenues that arise in intervals when the reserve is activated, the collected penalties, and the retained securities.

Content



CRM assessment framework

Set-up of a framework to assess the shortlisted CRM options for detailed analysis in the Dutch context

Set-up of an assessment framework

An assessment framework is used for evaluation of the shortlisted CRM types along the assessment criteria defined in phase 1 (including effectivity for the Dutch situation), based on literature and expert judgement.

The framework lists the conditions for receiving a positive, negative or neutral rating for each criteria. The pre-defined conditions ensure fair and equal assessment of all short-listed CRM options. As add additional nuance was desirable for the assessment, positive-neutral and neutral-negative ratings have been used to create a 5-point scale.

Evaluations in the framework are largely qualitative but can be complemented with quantifications where possible (e.g. ranges for design parameters).

The detailed evaluation can serve as an effective framework for further discussions and decision-making.

Criteria	+ Positive rating conditions	− Negative rating conditions
Accuracy SoS Effectivity Efficiency Complexity Locational signals Financing Timeline Decarb. system Flexibility	For each criterion: + Conditions the CRM must largely be able to meet for a positive rating.	For each criterion: - Conditions that show that the CRM does not comply to this criterion, meaning it will receive a negative rating.

~ If the CRM meets some of the positive rating conditions and some of the negative rating conditions, it will be awarded a neutral rating.

CRM assessment framework

Rating conditions

Criterion	Positive rating conditions	Negative rating conditions
Accuracy SoS	+ The CRM can be calibrated so that the reliability standard can precisely be met, i.e. no chronic over-achievement (LOLE < 4 hr/yr) or under-achievement (LOLE > 4 hr/yr). + The CRM can be regularly assessed and adjusted for adequacy, to adjust procurement volumes. + There are clear mechanisms to monitor Security of Supply reliability outcomes and enforce the standard, for example if in events the awarded capacity is not able to generate.	- The CRM is ineffective; even with the CRM in place the reliability criteria cannot be met. - The CRM does not provide sufficient flexibility and adaptability, leading to consistent over- or under procurement and therefore over- or underachievement of LOLE. - There is no accountability for tracking and enforcing the Security of Supply reliability standard, creating a governance gap.
Effectivity	+ The CRM provides a bankable revenue stream that addresses the “missing money” issue, enabling operators to keep existing capacity or invest in new capacity (generation, long-duration storage or DSR). There are no resource gaps over the CRM timeline as there is no missing money problem on short-, medium- and long term. + The effectivity upholds under different circumstances while maintaining high accuracy, for example under delayed RES roll-out, various demand growth pathways and accelerated mothballing of dispatchable capacity. + Hence, the mechanism is expected to procure enough firm capacity to close the expected adequacy gap.	- The CRM does not incentivise keeping existing capacity online or building out new capacity. I.e. the CRM does not provide sufficient (long-term) revenue certainty for asset owners or developers to base their business case on, instead only capacity is contracted that would not shut down without the CRM in place anyway. - The CRM is not sufficiently attractive under different circumstances, creating reluctance of participants or low participation, even more visible in changing market conditions. - Hence, the mechanism procures insufficient capacity to fill the identified resource gap.

CRM assessment framework

Rating conditions

Criterion	Positive rating conditions	Negative rating conditions
Efficiency	+ Capacity is procured through a competitive process (e.g. auctions) to ensure prices are no higher than necessary at short term (static efficiency). + Incentives for innovation are included (dynamic efficiency) to enable new innovations into the system and drive down costs. + Market distortion (e.g. impact on prices and other technologies in the EOM) is minimal, there is no incentive for producers to withhold energy.	- The CRM has a technology bias, excluding or undervaluing certain capacity sources. - The CRM has a lock-in effect, crowding out emerging solutions and reducing the dynamic efficiency. - The CRM distorts the market, leading to high prices, unfavourable bidding behaviour or leads to gaming in the energy or capacity markets.
Complexity	+ All stakeholder responsibilities, obligations and penalties are well defined and understandable; there is no ambiguity. + The CRM has a manageable administrative burden, with proportionate monitoring and compliance efforts. Parameterisation and data collection are not overly complex. + Implementation can be timely and with moderate implementation cost. + No complex coordination with other countries required (e.g. market and CRM designs align). + The mechanism design can fit within national legal and regulatory frameworks and complies with EU regulations (incl. State aid guidelines).	- The design is overly complex in terms of responsibilities, product and obligations, creating uncertainty over market party obligations. - The CRM has a heavy administrative overhead for implementing, operation and monitoring. - Significant regulatory changes or exemptions would be required for implementation, for example demanding lengthy notifications. - Complex coordination with other countries required (e.g. due to diverging CRM designs creating undesired market effects between countries). - Compliance with national legal regulatory frameworks and EU regulation (incl. State aid guidelines) is expected to be challenging and complex.
Locational signals	+ The mechanism considers grid constraints and availability and can help to meet the reliability standard across the whole of the Netherlands. + The CRM has the flexibility to easily implement a local component and to target locational capacity requirements or auctions, even after initial implementation of the CRM mechanism. + Local signals do not affect cross-border participation negatively	- The mechanism does not consider grid constraints, potentially increasing congestion problems. - Adding a locational element during implementation of the CRM and/or at a later stage would be highly complex. - The (local signals of the) CRM create market distortion across borders, e.g. depleting capacity in regions across borders.

CRM assessment framework

Rating conditions

Criterion	Positive rating conditions	Negative rating conditions
Financing	+ Costs are allocated fairly among market participants according to their need for the CRM, e.g. based on contribution to peak load during scarcity periods, i.e. based on the polluter-pays principle. + Financing of the CRM can be through public financing or electricity market or tariffs (or a mix), to balance avoiding reliance on political budget cycles and electricity price impact. + The CRM includes a risk-sharing mechanism on long-term cost risks, e.g. a claw-back or periodic price review to adjust pricing over the long term – but interdependencies with effectivity and investment certainty must be considered. + Mechanism can be implemented in conjunction with existing subsidies.	- The CRM lacks a price signal to market participants to adjust demand during scarcity, e.g. when costs are socialised without consideration of CRM usage. - The mechanism relies on government subsidies or state funding, making financing unsure (political dependency) and potential breaching State aid (CISAF). - The mechanism has overall high costs compared to the achieved adequacy, creating a high financial burden or distort costs signals for the market. - Interdependencies with existing subsidies are difficult to integrate.
Timeline	+ The CRM implementation timeline has a clear , including milestones and next steps, and State aid approval if required. + The CRM's first operational year aligns with the adequacy needs. This may imply sufficiently swift design and approval. + There are options to short-track CRM implementation if adequacy needs unexpectedly increase, i.e. capacity is required earlier. + The timeline for new build capacity aligns with the CRM timeline, e.g. T-4 or longer auctions. At the same time, the CRM timeline can accommodate for interim capacity, e.g. T-2 if the requires.	- The CRM implementation timeline is unclear or unrealistic, deteriorating market confidence in the mechanism, with difficult State aid timelines. - The CRM implementation timeline is longer than the expected adequacy needs, for example due to long legislative procedures. I.e. a exists in the interim before the CRM is effective. - There are no options to short-track CRM implementation if required. - The lead times for awarding capacity within the CRM are (unnecessarily) long, risking missing timely responds to market needs. The CRM offers insufficient short-term adaptability.

CRM assessment framework

Rating conditions

Criterion	Positive rating conditions	Negative rating conditions
Decarb. system	+ The CRM ensures that emissions reduce over time, e.g. by including (prequalified) requirements to reduce emissions over time. + The emission limit is on a technology neutral base, e.g. allowing for demand response, long-term storage and facilitating new zero-emissions firm capacity. + The mechanism avoids lock-in of emission-intensive capacity technologies. E.g. the mechanism includes flexibility to evolve towards lower emissions capacity over time. + The mechanism has synergies with renewable energy and flexibility goals and legislation, supporting the sectors' energy transition.	- The CRM does not ensure that emissions reduce over time, e.g. as including (prequalified) requirements are difficult to implement. - The mechanism does not exclude capacity providers with high emissions. The mechanism is not in line with CO_2 thresholds set in EU Electricity Regulation 2019/943, article 22(4), if applicable.[1] - The mechanism has an emissions lock-in effect, for example by awarding long term auctions to high emission capacity without decreasing emissions limits. - The CRM conflicts with other policies, for example hindering the buildout of renewable capacity.
Flexibility	+ The CRM is flexible to adjust to changing external circumstances and includes an exit strategy. With this, the mechanism can be scaled up, down or exited depending on needs. + The mechanism does not create a market reliability on the CRM, i.e. it allows for returning to an energy-only market. Regular reviews of generation gap signal the temporary status and avoid market reliance.	- The CRM is not flexible and can not be adjusted to external circumstances, creating an unwanted reliance. This makes a potential phase-out hard or impossible. - The mechanism provides only very rigid products, hindering the participation opportunities for providers. E.g. providing either only short duration or long-duration capacity contracts.

[1] The EU Electricity Regulation 2019/943, article 22(4) sets that a value of above 550 gr/CO_2 kWh and 350 kg CO_2/kW_e/yr would violate the regulation. (Link)

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