CAPACITY REMUNERATION MECHANISM FOR ESTONIA: MODELS AND ASSESSMENT

A report to Elering AS

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MODELS AND ASSESSMENT

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EXECUTIVE SUMMARY

Context

Estonia has been self-sufficient in terms of electricity supply in the past thanks to its abundant oil shale resources. However, the Estonian electricity system is facing substantial changes over the coming years:

- majority of existing thermal capacity will be closed down;
- renewable electricity generation is growing; and
- importance of interconnection capacity is increasing.

The changing landscape of the energy sector in Estonia has prompted discussion in relation to future resource adequacy. Studies in relation to Estonian security of supply have concluded that there is a very low probability of security of supply issues in the near- to mid-term, but moving towards the 2030s the probability for loss of load increases. The potential adequacy issues identified by the studies are linked to non-availability of several pieces of interconnector infrastructure, i.e. simultaneous interconnector outages. These outages are expected to be infrequent, although if they do occur they could be for an extended period.

The situation is being monitored by the electricity transmission operator Elering, the Estonian Competition Authority and the Ministry of Economic Affairs and Communications. Although all three favour retention of the energy only market design, the parties have decided to establish a back-up plan to call into action in the event that resource adequacy issues do arise in the future. This includes potential for introduction of an explicit Capacity Remuneration Mechanism (CRM) to ensure adequacy, as has happened in many other markets.

The spread of CRMs has, in many cases, been driven by the 'missing money' problem for the conventional thermal investment paradigm, linked to the introduction of large volumes of renewable generation. As renewable penetration has increased, volumes generated by thermal operators have decreased, and instead of meeting system demand, conventional plants now need to meet system demand less weather variable renewable generation. This results in increasing price and volume risk, which means that conventional plants are less able to secure adequate revenue from the wholesale market to cover their capital expenditure.

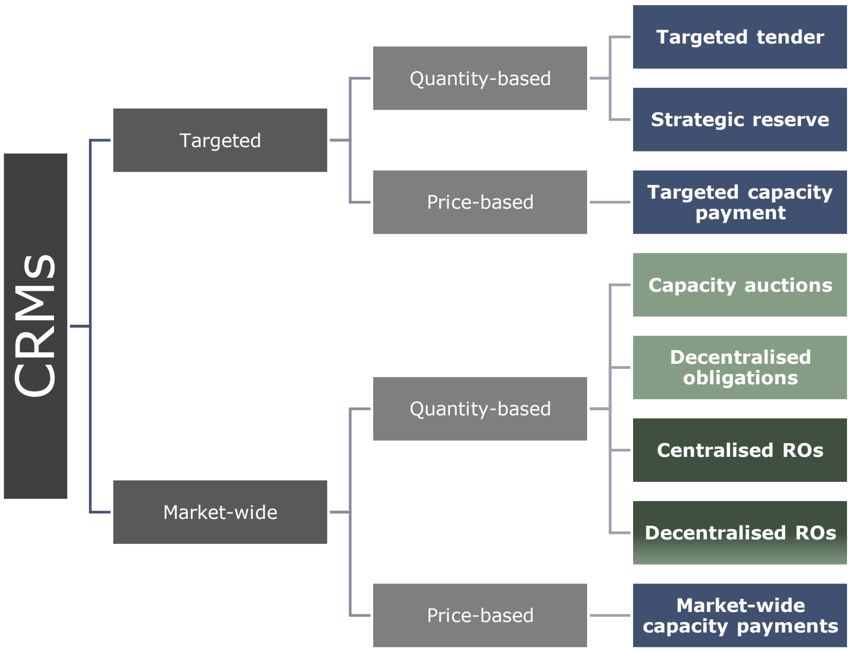
CRMs have been introduced in response to provide a distinct capacity related revenue stream specifically intended to improve certainty for prospective projects in terms of the investment environment, as well as for existing providers, to support efficient entry and exit decisions. This is intended to improve security of supply by ensuring that resource is made available to the system, thereby reducing the potential for system stress events to occur.

This report considers the potential suitability of several CRM options for the Estonian context.

CRM models considered

CRMs can take many forms. In general, CRMs can be categorised into targeted and market-wide mechanisms and into quantity-based and price-based mechanisms. Targeted mechanisms apply only to a subset of capacity in the market, while a market-wide mechanism remunerates all capacity. In quantity-based schemes the capacity is determined beforehand and the price follows. Quantity-based schemes can have many designs. In price-based mechanisms, the price or pricing mechanisms is set and the quantity follows. Figure 1 provides a taxonomy of CRMs based on these distinctions.

Figure 1 – Taxonomy of CRMs



Taking CRM variations within this taxonomy, the following four conceptual CRM models are considered for potential application in the Estonian context:

- **Strategic Reserve**: A limited quantity of capacity needed to support the system in extreme conditions is defined and secured by the TSO. The contracted capacity is held outside the normal market arrangements for potential use by the TSO as a last resort in extreme circumstances only.
- **Capacity auction for reliability option capacity contracts**: A reliability option approach involves procurement via auction of option contracts from capacity providers who then have a financial incentive to deliver energy at times of high prices. Capacity providers sell call options for an upfront fee and then when the reference market price exceeds a defined strike price, the capacity provider makes a difference payment back to a direct counterparty or the system more broadly.
- **Capacity auction for non-option capacity contracts**: This model has many similarities with the reliability option model, with the focus on

market-wide procurement of contracts for available capacity needed to address the resource adequacy concern. The main difference between the two stems from the nature of the underlying obligations associated with the product. Under this approach, the underlying obligation is physical. Contract holders are expected to make their capacity available or else they face penalties for non-availability.

- **Decentralised obligations**: The decentralised obligation route allocates responsibility for securing the capacity requirement onto retailers, who need to secure capacity tickets from eligible providers such that each retailer secures sufficient capacity to meet the overall demand of their consumers. Here, the emphasis is upon bilateral trade between retailers and capacity providers, rather than a central procurement mechanism, to provide reliability.

Qualitative appraisal of CRM options

Insights from the qualitative appraisal of the four CRMs are as follows:

- **Strategic Reserve**: As the driver for a potential adequacy issue relates to concurrent outages on interconnectors, it is efficient for the focus to be on securing a targeted quantity of capacity needed to support the system in such cases rather than seeking to cover peak demand in a broader range of circumstances. The process for securing capacity can be competitive and allow for participation from multiple resource types. However, there may be limitations on the extent to which particular resource can reliably provide availability over an extended interconnector outage period (e.g. CO_2 emission restrictions may limit participation from existing thermal fleet and there may be limitations on duration of demand side response), suggesting that diversity in terms of capacity providers will be needed.

Of the CRM options available, the Strategic Reserve is seen as the least-worse option by the European Commission (EC) potentially making it the most compatible with EC requirements, assuming that a case for intervention can be demonstrated. With good design, it also offers the route with least potential for distortion of energy market functioning and outcomes[1]. As a targeted

[1] The risk of wholesale market distortion stems from two main aspects. The first is often referred to as the ‘slippery slope’ problem. The issue is that the existence of a strategic reserve has an undermining effect on confidence in market-led investment, which potentially exacerbates any resource shortfall and increases the need for some form of intervention to support adequacy. More specifically, market investors are concerned that plant held in strategic reserve could be used in a broader range of circumstances than intended, reducing the scope for earning rent from price spikes. This can be mitigated by well-defined and rigorously enforced parameters for strategic reserve usage.
The second element relates to the activation price for strategic reserve and its

solution, it also limits the potential administrative burden compared to requirements under a broad CRM solution.

- **Capacity auction for reliability option capacity contracts**: The main challenge for the broad CRMs in general, reliability option capacity auctions included, is that they are better suited to supporting general peak demand conditions than providing coverage for the possibility of concurrent interconnector outages. Broad procurement of capacity to cover for low probability network related issues risks inefficiency, as the solution is not well tailored to the problem.

  As for all of the broad CRM models, the reliability option solution involves a more extensive intervention, which is challenging in terms of EC sign-off and involves administrative complexity to implement and operate. However, it has the potential to be less intrusive than other broad CRMs in terms of the functioning of the wholesale market.
- **Capacity auction for non-option capacity contracts**: As outlined above in respect of capacity auctions for reliability options, this approach seems more appropriate for general peak demand coverage rather than providing support in the event of simultaneous interconnector outages. Again, the risk is that broad procurement of capacity to cover for low probability network related issues will not provide an efficient solution.

  Like for reliability options, this route is more onerous in terms of EU compliance and has associated administrative complexity. However, unlike the reliability option approach, the penalty arrangements here are not tied into wholesale energy prices, so there may be less of an emphasis on reflection of scarcity value in energy prices.
- **Decentralised obligations**: The decentralised obligation route faces similar challenges to other broad CRMs in terms of its suitability for mitigating risks linked to interconnector outages, achieving EU sign off and administrative complexity. An additional issue with decentralised obligations is that they place responsibility for covering the adequacy issue on retailers, who are not best placed to manage the risks of concurrent interconnector issues.

Quantitative assessment of CRM options

Our quantitative assessment attempts to capture the welfare differences and change in cost to consumers for two types of CRM options – a Strategic Reserve and a market-wide CRM (with the use of a Reliability Option contracts). The underlying assumptions of the scenarios we have explored are

knock-on effects on market prices. If this price is too low, the incentives for market led actions to solve adequacy issues are dampened. This can be mitigated by pricing strategic reserve activation at the value of lost load.

based on the ENTSO-E National Trends scenario and we have used our electricity market mode, BID3, to model the Estonian electricity system.

The results from our quantitative analysis provide for insights with respect to the advantages and the disadvantages of the two CRM option, but none of options stands out solely on the basis of the quantified results. The key messages of our quantitative analysis are:

- both CRM options appear to deliver an overall net benefit (and a more efficient system) assuming extended interconnector unavailability – this improvement in social welfare is primarily driven by the reduction of the cost associated with unserved energy;
- on the other hand, there appears to be no benefit from the introduction of a CRM assuming that interconnector availability remains intact – if anything, there is a reduction in total social welfare with both CRM options; and
- the Strategic Reserve option delivers more moderate results in both directions – net benefit improvements assuming extended interconnector unavailability may not be as high as those in the market-wide CRM but net dis-benefits in other cases are also more muted.

Recommendations

Our quantitative assessment of the CRM design options provides a mixed picture with the following outcomes evident:

- **No net benefits in a 'typical' year**: In the absence of interconnector availability concerns, our modelling indicates that introducing either form of CRM will lead to a net cost to Estonia in the years considered. Given this, the anticipated likelihood of extended concurrent interconnector failures is a key factor in balancing whether the additional cost of a CRM in 'typical' conditions outweighs the cost associated with energy unserved in the event of interconnector failures.
- **Sensitivity to capacity additions elsewhere**: The addition of capacity in Finland has a negative effect on the cost-benefit outcome for any CRM in Estonia, even once oil shale units have been decommissioned. With additional Finnish nuclear capacity expected by the early 2030s, the potential merits of any CRM in Estonia may, therefore, prove to be time-limited.
- **No clear winner between CRM options**: Both forms of CRM considered are expected to result in reduced loss of load expectation and costs of energy unserved in the event of interconnector unavailability. However, each approach offers different relative advantages, with the Strategic Reserve option providing a lower cost route for achieving this, while a market-wide CRM delivers greater net benefit in the case of interconnector unavailability by virtue of more efficient capacity provision.
- **Sensitivity to commercial decisions made by oil shale units:** Oil shale units can opt to restrict their operating profile in exchange for a capacity contract. On the one hand, this would significantly reduce

Estonia's carbon footprint, but at the same time, it may result in a net welfare loss and higher cost to consumers, in particular in 'typical' years with expected interconnector availability.

However, the insights from our qualitative appraisal suggest that a Strategic Reserve model appears to be the best fit for the Estonian context. Importantly, the targeted solution is considered to work better than the broad CRM options to cover low probability concurrent interconnector outage risks and, if designed well, it minimises the potential for distortion to the wholesale market. In addition, the Strategic Reserve style solution is the starting model for CRMs from the EC perspective, while also offering the least administratively intensive solution.

Table 1 provides a summary overview and ranking of suitability of the CRM models considered for the Estonian context.

Table 1 – Summary overview of potential CRM options for Estonia based on qualitative assessment

<table>
<tr><th>Rank</th><th>Model</th><th colspan="2">Compatibility of solution with problem</th><th colspan="2">Appropriate allocation of responsibilities</th><th colspan="2">Relative ease of EC clearance</th><th colspan="2">Minimising energy market impact</th><th colspan="2">Administrative ease</th></tr>
<tr><td>1</td><td>Strategic reserve</td><td>✓</td><td>Targeted solution to alleviate adequacy concerns linked to low probability risk of simultaneous interconnector outages</td><td>✓</td><td rowspan="3">Central management of risks of low probability interconnector outages is appropriate</td><td>✓</td><td>EC’s starting option if the need for intervention to introduce some form of CRM is demonstrated</td><td>✓</td><td>Good design minimises distortion and market-led investment continues</td><td>✓</td><td>Simplest of the CRM options to implement and operate</td></tr>
<tr><td>2</td><td>Capacity auction for reliability option capacity contracts</td><td>✗</td><td rowspan="3">Models better suited to coverage of peak demand conditions, rather than interconnector outages</td><td>✓</td><td>✗</td><td rowspan="3">More challenging than strategic reserve in terms of EC approvals</td><td>✓</td><td>Investment driven by CRM, but CRM penalties encourage effective price formation</td><td>✗</td><td rowspan="3">Centralised schemes with associated administrative complexities</td></tr>
<tr><td>3</td><td>Capacity auction for non-option capacity contracts</td><td>✗</td><td>✓</td><td>✗</td><td>✗</td><td rowspan="2">Investment driven by CRM and administered CRM penalties do not support effective wholesale price formation</td><td>✗</td></tr>
<tr><td>4</td><td>Decentralised obligation</td><td>✗</td><td>✗</td><td>Retailers not best placed to manage risks of concurrent interconnector outage risks</td><td>✗</td><td>✗</td><td>✗</td></tr>
</table>

Drawing together the insights from both the qualitative and quantitative assessment our findings are as follows:

- a **Strategic Reserve approach is a better fit for the Estonian context** if a CRM is needed to alleviate interconnector unavailability related adequacy issues; and
- there is **nothing to indicate that a Strategic Reserve model will not resolve Estonia's adequacy issues** if a CRM is demonstrated to be required.

The Electricity Regulation 2019 states that a Member State shall **assess whether a strategic reserve is capable of addressing its resource adequacy concerns** and that **only where this is not the case** may a different type of CRM be implemented[2]. Taking this requirement and insights from our assessment together, **our recommendation is that a Strategic Reserve model should be selected in the event that a CRM is considered to be needed in Estonia to protect against interconnector unavailability**.

If strategic reserve implementation in Estonia is to be considered further, underlying design details need to be defined, with a requirement for supporting analysis. This includes features including the follows:

- capacity requirement needed to alleviate adequacy issues;
- notice period for response of contracted capacity;
- response duration requirements and minimum running times;
- criteria for utilisation and market pricing arrangements;
- contracting process; and
- commercial arrangements.

[2] Electricity Regulation 2019 Article 21.

1. INTRODUCTION

1.1 Purpose of this report

The Estonian electricity market is an example of an energy only market, in which market participants respond to electricity market pricing signals to deliver resource adequacy in order to meet customers' reliability requirements. In many other countries, explicit capacity remuneration mechanisms (CRMs) have been introduced as a supplement to electricity market arrangements to ensure resource adequacy.

The changing landscape of the energy sector in Estonia has prompted discussion in relation to future resource adequacy. The situation is being monitored by the electricity transmission operator Elering, the Estonian Competition Authority and the Ministry of Economic Affairs and Communications. Although all three favour retention of the energy only market design, the parties have decided to establish a back-up plan to call into action in the event that resource adequacy issues do arise in the future.

This report considers and provides an assessment of potential CRM models in the Estonian context.

1.2 Conventions

All monetary values are in real 2018 money terms.

1.3 Structure of this report

The report has the following structure:

- Section 2 provides an overview of the Estonian adequacy context within which potential CRM models could be applied and objectives against which possible options will be assessed;
- Section 3 considers the requirements of the European Union in respect of CRMs;
- Section 4 outlines several possible CRM approaches in the Estonian context and provides qualitative assessment of them against agreed objectives;
- Section 5 details our modelling approach and assumptions used in our analysis and highlights the results of our quantitative analysis;
- Section 6 summarises the findings of the study and our recommendations for a potential Estonian CRM; and
- Annex A provides information to support a potential implementation plan.

2. ESTONIAN ADEQUACY CONTEXT

2.1 Anticipated changes on the Estonian electricity system

Estonia has been self-sufficient in terms of electricity supply in the past thanks to its abundant oil shale resources. The Narva oil shale power plants have contributed nearly 85% of domestic production during recent years and Estonia has traditionally exported electricity to Latvia and Lithuania. The domestic generation capacity has also been able to cover the Estonian peak demand of about 1.5GW with a wide capacity margin.

However, the Estonian electricity system is facing substantial changes over the coming years, which significantly recasts the nation's energy landscape. The three most important trends are the following:

- **Majority of existing thermal capacity will be closed down**. Tightening climate ambitions and high carbon prices have already reduced competitiveness of the Narva power plants. Many of the plants will also reach the end of their lifetime in 2020s and domestic generation capacity will consequently be reduced by hundreds of megawatts.
- **Renewable electricity generation is growing**. Renewable generation technologies have developed rapidly and wind power is being deployed extensively across Europe, including in Estonia. The nature of the electricity system becomes more stochastic with increasing intermittent generation.
- **Importance of interconnection capacity increases**. Estonia is already a well-connected power market with 1GW of interconnector capacity towards Finland and about 1GW towards Latvia. Interconnection already plays a significant role in delivering morning ramps in demand and in meeting demand more generally.

A combination of renewable expansion within Estonia and cheap imported electricity from the Nordic region could put downward pressure on electricity prices resulting in more uncertain and volatile margin potential for conventional thermal plant. New ancillary services[3] combined with the Baltics joining of the European balancing energy markets provide additional revenue streams for flexible capacity. Nonetheless, as explored further in the next Section, there is active consideration of the ability to ensure security of supply in Estonia over longer periods or in all circumstances.

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[3] New ancillary services are being introduced to manage frequency deviations in normal operation and after disturbances in anticipation of the upcoming de-synchronisation of the Baltic power system from the Russian power system.

2.2 Outlook for future Estonian security of supply context

Several studies have been conducted in relation to Estonian security of supply in 2018/19[4][5][6]. The conclusions from them are that there is a very low probability of security of supply issues in the near- to mid-term, but moving towards the 2030s the probability for loss of load increases. Based on this analysis, situations in which the existing resources are not sufficient to meet load in all possible cases are linked to instances of multiple concurrent technical failures.

Specifically, the potential adequacy issues identified by the studies are linked to non-availability of several pieces of interconnector infrastructure, i.e. simultaneous interconnector outages. These outages are expected to be infrequent, although if they do occur they could be for an extended period.

In short-term time horizons, system failures like sudden interconnector or power plant outages are handled via ancillary services and finally by the market participants themselves, as follows:

1. Frequency Containment Reserve (FCR) is immediately activated as a result of frequency deviation.
2. Frequency Restoration Reserves (FRR), including from the emergency power plant Kiisa, are activated soon after FCR to recover the energy imbalance and release FCR.
3. Market participants have incentives to react and adjust their positions through the intraday market or by self-balancing for the next market time unit, reducing need for the system operator's actions.

If the market is not able to adjust e.g. due to technical limitations[7], there might be a need for additional adequacy measures to free the emergency reserve. In theory, high scarcity prices are expected to deliver sufficient investments to satisfy the reliability standards. However, it might be difficult to foresee market led investment being justified on the back of limited expected instances of interconnector outage. Therefore, a CRM, even as a transitional measure, could ensure security of supply if the prospects for

4 ENTSO-E, Mid-term adequacy report, 2019. https://www.entsoe.eu/outlooks/midterm/main-findings-of-maf-2019/#download

5 Elering, Estonian electricity system security of supply report 2019. https://elering.ee/sites/default/files/public/varustuskindluse%20konverentsid/SOS%202019%20ENG.pdf

6 Estonian Competition Authority, Electricity and gas markets in Estonia 2018, 2019. https://www.konkurentsiamet.ee/sites/default/files/electricity_and_gas_markets_estonia2018.pdf

7 The slow reaction might be due to technology that is not flexible enough to ramp up (generation) or ramp down (demand).

adequacy issues grow. In this context, having a ready-to-go CRM is considered a prudent measure just in case, even though, ideally, the CRM will not be used.

2.3 Needs to be addressed by a potential CRM in Estonia

To recap and summarise, the nature of the 'needs' to be addressed by a possible CRM given the potential future adequacy issue in Estonia are as follows:

- **Nature of need**: Based on analysis, hours of potential lost load are linked to concurrent interconnector failures, particularly when demand is high during winter. There is, therefore, a need for availability of capacity that can respond and deliver energy in the event of interconnector outage issues.
- **Notice of need**: Forced outages are not predictable in terms of timing and occur without notice. This makes it difficult to ex-ante set time periods in which resource is expected to be needed. Resource is needed, therefore, on standby in case of outage issues.
- **Response time**: Two factors affect required response time: (1) trips have an instantaneous impact and (2) the reliability standard[8], which sets expectations for what is 'acceptable' in terms of hours of lost load. The former potentially creates a need for rapid response, while the reliability standard potentially creates a time buffer within which response can be activated. An appropriate balance needs to be struck between these two factors.
- **Duration of need**: It takes 16 hours on average to repair interconnection, but might take even up to one month or longer. Therefore, the stress situation is likely to last for at least several hours but with the potential to stretch over an extended period.

2.4 Objectives for Estonian CRM

While a CRM is only being considered as a last resort measure and the hope is that it will not need to be implemented, it remains important for there to be clearly defined objectives for the CRM that can influence its design. It is also important for the objectives to be suited to the Estonian context specifically.

With these points in mind, the following objectives have been agreed upon to guide the design and assessment of different CRM options:

- **Efficiency**: meaning that the CRM arrangements should:
  - support delivery of security of supply requirements in an economic and efficient manner;

[8] Work is ongoing to set a reliability standard for Estonia, with the current working estimate being 9 hours loss of load per year. However, this is yet to be finalised.

  - promote effective competition between different resource types (e.g. technology types, age), including avoiding undue discrimination and minimising entry/exit barriers; and
  - provide appropriate incentives and allocation of risk to allow economic investment.
- **Compatibility with EU requirements**[9]: meaning that the CRM arrangements need to adhere to EU conditions relating to CRM design and operation.
- **Minimising energy market impact**: meaning that the CRM arrangements should minimise distortion of energy only market operation, both before potential implementation and afterwards in the event that a scheme is adopted.
- **Administrative proportionality**: meaning that arrangements should not be unduly burdensome and should be suited to the Estonian context and requirements.

These objectives are referred to again in Section 3, which contains a qualitative assessment of different CRM models.

[9] EC requirements in respect of CRMs are outlined in Section 3.

3. EU REQUIREMENTS IN RESPECT OF CRMs

EU legislation provides a framework for electricity market design intended to ensure fair competition in the internal energy market. This framework influences the potential for a CRM to be implemented and, where a CRM is possible, the design of the CRM.

The main legislative structures setting the framework are as follows:

- **State Aid**: the State Aid rules set by the Treaty on the Functioning of the European Union (TFEU)[10] Articles 107, 108 and 109 and the Guidelines on State Aid for environmental protection and energy 2014-2020[11] (Guidelines); and
- **Regulation**: specifically, the EU Electricity Regulation 2019/943[12].

The Sections below draw out important features of the EU frameworks that influence CRM implementation and design.

3.1 State Aid requirements

The intention of State Aid rules is to prohibit Member States from granting any aid that would distort or threaten to distort competition by favouring certain participants. Therefore, the TFEU applies a general prohibition on State Aid.

However, the TFEU provides for exceptions to be made in certain cases. This includes the potential for exemption to be applied to 'aid to facilitate[s] the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest'[13]. Using this route, the Guidelines outline the conditions under which aid for energy and environment may be considered compatible with the internal market. The Guidelines were originally intended to expire as of the end of 2020. However, the Commission has announced its intention to extend the existing provision to allow them to apply until the end of 2022, with the Commission conducting a 'fitness check' on the provisions in the interim[14].

10 https://ec.europa.eu/competition/state_aid/legislation/compilation/a_01_03_11_en.pdf

11 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN

12 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=EN

13 TFEU Article 107(3)(c)

14 https://ec.europa.eu/competition/consultations/2019_eeag/index_en.html

The existing Guidelines include **specific provision for aid for generation adequacy measures**[15]. These provisions specify, amongst others, the following requirements in relation to aid for generation adequacy measures:

- The precise objective, at which the measure is aimed, should be clearly defined, including when and where the generation adequacy problem is expected to arise. The identification of a generation adequacy problem should be consistent with the generation adequacy analysis carried out regularly by ENTSO-E.
- The nature and causes of the generation adequacy problem, and therefore of the need for State aid to ensure generation adequacy, should be properly analysed and quantified, for example, in terms of lack of peak-load or seasonal capacity or peak demand in case of failure of the short-term wholesale market to match demand and supply.
- The reasons why the market cannot be expected to deliver adequate capacity in the absence of intervention should be clearly demonstrated.
- The measure should be open and provide adequate incentives to both existing and future generators and to operators using substitutable technologies, such as demand-side response or storage solutions. The aid should therefore be delivered through a mechanism which allows for potentially different lead times, corresponding to the time needed to realise new investments by new generators using different technologies. The measure should also take into account to what extent interconnection capacity could remedy any possible problem of generation adequacy.
- The measure should:
  - (a) not reduce incentives to invest in interconnection capacity;
  - (b) not undermine market coupling, including balancing markets;
  - (c) not undermine investment decisions on generation which preceded the measure or decisions by operators regarding the balancing or ancillary services market;
  - (d) not unduly strengthen market dominance; and
  - (e) give preference to low-carbon generators in case of equivalent technical and economic parameters.

3.2 Electricity Regulation

The Electricity Regulation reinforces that a capacity mechanism can be introduced as a **last resort** to eliminate resource adequacy concerns and, in alignment with the State Aid provisions, defines the hurdles that need to be passed to support CRM implementation. Before implementing any CRM, the steps including the following have to be taken:

- Member States must ensure that there are no undue market distortions prohibiting efficient functioning of energy only markets that may be

15 Guidelines Article 3.9

causing security of supply concerns. A plan setting out additional measures to improve market functioning and the appropriateness of the CRM design needs to be submitted to the Commission for review and opinion. Measures relating to improved market functioning need to be adhered to on an ongoing basis.

- European or national resource adequacy assessments must demonstrate (or, the absence of a national assessment the European assessment only must demonstrate) that there is a resource adequacy concern. If the conclusions of the European and national security of supply assessments diverge, an explanation has to be provided to ACER, although ACER cannot obstruct the CRM implementation process.
- A comprehensive study of the effects on neighbouring member states needs to be conducted.
- Assessment of whether a CRM in the form of strategic reserve is capable of addressing the resource adequacy concerns is needed and only if this is not the case can an alternative form of CRM be implemented.
- CRM shall be temporary and approved by the Commission for no longer than 10 years.

The recent EU Commission approval decisions for CRM implementation highlight the importance of clear identification and quantification of security of supply risks. Clear definition of the risks helps to ensure that the CRM design addresses the issue and that it distorts the market as little as possible.

The Commission may contest the CRM design under the State aid process. It is advisable to start the dialogue with the Commission early to avoid undue delays. The opinion of the implementation plan is required before a CRM can be implemented. To avoid this, Finland and Sweden have started the notification process before introduction of the new design of their strategic reserves.

3.3 General principles intended to promote competition

The '*design principles for capacity mechanisms*' under Article 22 of EU electricity regulation sets general principles that apply to all CRMs and define a few additional requirements that concern specifically strategic reserves or other types of CRMs.

3.3.1 All capacity mechanisms

CRMs shall be **technology neutral**, implying that all technologies, including energy storage and demand side management should be allowed to participate if they otherwise are capable of meeting the technical criteria defined to address the system needs. In practice, a CRM for demand side resources can mean an agreement of an interruptible load that is activated at times of system stress when balancing resources are not sufficient.

Competitiveness of a CRM is important in many aspects. The capacity providers have to be selected in a transparent, non-discriminatory and competitive process. In centralised capacity schemes, the process is typically an auction and in decentralised schemes the competing market participants source the capacity by themselves. In addition, the remuneration has to be determined through the competitive process. This requirement excludes price-based CMRs. The remuneration can be marginal pricing or pay-as-bid.

Capacity mechanisms should be **limited in time and in size**. The scheme should be temporary and able to be phased out administratively if the need has been cleared out. The Commission approves a CRM for 10 years at maximum. The volume should address the need and not go beyond that.

CRM design needs to **provide incentives to be available** in times of expected system stress. Appropriate penalties shall be given to the capacity providers that are not available when they should be.

3.3.2 Strategic Reserve

Strategic Reserve is a CRM in which the participating capacity must be held outside the market during the contracted period. The capacity can only be dispatched in the likely event of TSO exhausting all other balancing resources. In those imbalance settlement periods when the strategic reserve has been dispatched the imbalance price shall be at the value of lost load[16] or at the intraday price cap (whichever is higher). Output volumes of the reserves shall be allocated to balance responsible parties during the periods of activation but not during the ramp-up periods.

The requirement of imbalance settlement prices have led to changes in designs of some strategic reserves. In Finland and Sweden the strategic reserves have been activated through day ahead market but this would significantly impact behaviour of the market participant in the delivery period. Therefore the activation will happen through balancing market in the future.

3.3.3 Other CRM designs

Other CRMS than strategic reserves should be compensated based on the availability of selected capacity while ensuring that the capacity compensation does not impact the generation decision.

Procurement of new capacity under the scheme should be designed in such a way that the price for availability will become zero when there will no longer be lack of capacity. This can mean that there is a backstop for new capacity auctions if the reliability standard does not fall under the critical limit.

Capacity obligations should be transferable between eligible capacity providers. Obligation can be interpreted as a mandatory procurement of reliable capacity by a market participant or by a central entity, covering

[16] Value of lost load is the estimation of the price that customers are willing to pay to avoid outages. The regulatory authorities are responsible of determining it for each bidding zone.

multiple CRM designs. The new provider needs to fulfil the same requirements as the original provider.

3.4 CRMs need to adhere to CO_2 emission limit requirements

CRMs need to incorporate **stringent CO_2 emission limit requirements** that prevent participation from generation capacity that do not comply with emission limit thresholds. The thresholds depend on the commission of the power plant and on the implementation date of the CRM:

- **New plant**: generation capacity coming online on or after 4 July 2019 is not eligible if it emits more than 550g of CO_2 of fossil fuel origin per kWh.
- **Existing plant**: from 1 July 2025, generation capacity that was online before 4 July 2019, is not eligible if it emits:
  - more than 550g of CO_2 of fossil fuel origin per kWh; and
  - more than 350kg CO_2 of fossil fuel origin on average per year per installed kWe.

In practice, the maximum limit of 550gCO_2/kWh excludes coal and oil shale power plants but allows for natural gas-fired power plants. However, for power plants that were online before 4 July 2019, the annual emissions limit of 350kgCO_2/kWe can open an opportunity to participate in a CRM if the running hours are limited such that emissions are compatible with the aforementioned annual limit. An ACER opinion[17] indicates that capacity may be able, with approval from the national regulatory body, to participate in a strategic reserve if it can commit to meeting the annual emissions limit.

According to the same ACER opinion, biomass and other bio-based fuels are calculated as emissions-free fuels and each generation unit can be calculated individually if they can be run separately. For a generation unit that uses mainly oil-shale this could mean some 200-400h running at nominal capacity depending on its efficiency and the share of co-fired biomass. Biomass is not counted as negative emissions.

3.5 Cross-border participation

The general requirement is that a CRM should be open to direct cross-border participation by the foreign capacity capable of providing equivalent technical performance to domestic capacity. Only Strategic Reserve schemes can be exempted from this requirement if cross-border participation is not technically

17 ACER opinion no: 22/2019. https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER%20Opinion%2022-2019%20on%20the%20calculation%20values%20of%20CO2%20emission%20limits.pdf

feasible (the exemption does not apply if cross border participation in strategic reserve is technically feasible).

A Member State establishing the CRM can limit the cross-border participation to other Member States with which it has a direct network connection, but otherwise European-wide participation is possible in principle. A maximum entry of foreign capacity is determined according to a common European methodology which takes into account the availability of the interconnection and the probability of concurrence of system stresses in both countries. ENTSO-E is responsible for drafting the methodology and has proposed that the maximum participation of foreign capacity would be the average imports during scarcity hours. The evaluation is done as part of the European resource adequacy assessment. The proposal has not yet been accepted by ACER.

A resource is entitled to participate in multiple capacity mechanisms simultaneously. A participant in a foreign Member State is registered by the relevant TSO, which facilitates coordination and monitoring of availability. The neighbouring TSO is responsible for conducting availability checks according to a bilateral agreement. If participating in multiple CRMs, the market participant carries the risk of non-availability payments if it is unable to fulfil multiple commitments and penalty fees are applied proportionally in case of non-availability.

While interconnectors are active in some CRMs currently, this is an interim measure and they will be ineligible in a couple of years. The emphasis is on direct participation from capacity providers themselves.

3.6 Main implications

The EU requirements have important implications for the potential development and design of a CRM, including the following:

- Need to demonstrate adequacy issue, which cannot be alleviated by market reforms, in either national or European adequacy assessments.
- CRMs can be introduced as a last resort only and should be considered as temporary only.
- CO_2 emissions limits will limit participation from the current generation fleet, even with biomass co-firing, although there may be scope for its participation in a strategic reserve with a limit on running hours to comply with annual emissions limits.
- Participation from foreign capacity must be accommodated in a CRM, including in a strategic reserve where it is technically feasible.

4. POTENTIAL CRM MODELS FOR ESTONIA AND QUALITATIVE ASSESSMENT

This section sets out possible CRM models for Estonia, taking different conceptual approaches as the basis, and then provides a qualitative assessment of each of them relative to the objectives set out in Section 2.4. The models are:

- Strategic Reserve;
- market-wide capacity auction to allocate contracts structured as options, termed reliability options;
- market-wide capacity auction to allocate non-option structured contracts; and
- decentralised obligations.

4.1 Strategic Reserve

4.1.1 Model overview

Under a strategic reserve style model, a limited quantity of capacity needed to support the system in extreme conditions is defined and secured by the TSO. The contracted capacity is held outside the normal market arrangements for potential use by the TSO as a last resort in extreme circumstances only.

The ring-fencing of strategic reserve capacity from the market is intended to allow the market to operate unfettered and for market led investment to continue. Achieving this outcome is closely linked to two important features of the strategic reserve arrangements:

- **conditions surrounding use of strategic reserve** (and perceptions about adherence to these conditions): participants need to be comfortable that any strategic reserve capacity will only be used in exceptional circumstances to avert extreme security of supply issues that the market is unable to resolve; and
- **effects of strategic reserve utilisation on market pricing**: if strategic reserve utilisation is priced at least at the value of lost load (or at a value higher than any intraday price limit, whichever is higher) for the purpose of imbalance pricing, the scarcity value available to the market is high and the incentive to make market-led investment is stronger.

The sections below consider the potential nature of an Estonian Strategic Reserve model with reference to key design building blocks.

Capacity requirement

For Estonia, features relating to setting and securing the capacity requirement under a strategic reserve could include the following:

- **Capacity requirement volume**:

  - The overall volume of capacity needed under an Estonian strategic reserve scheme will be based on assessment of requirements needed to maintain the reliability standard, most likely to cover the anticipated scale of energy shortfall in a situation of two concurrent/overlapping interconnection failures.
  - Additionally, there is the possibility that some of this capacity may need to be able to respond quickly to allow for the gap left by outages to be swiftly plugged. This depends on assessment of need for fast acting capacity within the overall strategic reserve requirement to maintain the reliability standard.
  - The capacity requirement, both in terms of the overall volume and, if applicable, the speed of response for some or all of this volume, will be informed by Elering as TSO. The final decision in respect of the capacity requirement may reside with the Ministry or Competition Authority depending on who has the appropriate jurisdiction in the Estonian context.
- **Securing capacity**:
  - Responsibilities have yet to be defined, but a central body, potentially Elering as TSO, will have responsibility for securing capacity needed under the strategic reserve. Procurement is likely to be via a competitive tender exercise, held potentially 12 months ahead of requirement (which is a similar timeframe to that used in Finland for its strategic reserve procurement).

Product definition

In the Estonian context, strategic reserve product definition features could entail the following:

- **Product**:
  - The product will entail provision of access to available capacity for Elering to call upon in defined extreme situations expected to be linked to concurrent/overlapping interconnection failures. Depending on the issue, remedying outages on an interconnector can take several months. Access to available capacity under a strategic reserve will, therefore, be expected to be required for an extended period, following the initial outage, to allow time for rectification of interconnector outages.
  - As mentioned above, there is the possibility that some of this capacity may need to be able to respond quickly if it is needed to maintain the reliability standard. For example, if at the time of a trip incident, all contracted capacity is cold and will take 8 plus hours to ramp, energy unserved issues will be more significant than if some of the capacity had faster start capabilities. Nevertheless, the basic product is for MW availability in the defined shortage conditions.
- **Eligibility**:

- Only a sub-set of capacity will participate in the strategic reserve mechanism, with Elering's sizing of the capacity requirement determining the scale of capacity contracted under the strategic reserve. Factors affecting participation include the following:
  - **Existing generation capacity**: Existing thermal capacity is expected to be eligible for participation in principle. However, CO_2 emission limit requirements specified in the Electricity Regulation[18] as conditions of eligibility for capacity payments, including under strategic reserve, will limit operational hours. Therefore, assessment of the likely duration of emergency situations relative to potential operational hours that allow existing thermal plant to stay within emissions limits may have a bearing on eligibility or, at least, relative reliability of higher emitting plant.
  - **Demand response**: Demand response is expected to be eligible for participation. Accessing sufficient interruptible load to be able to cover an extended interconnection failure may require some form of rolling utilisation across demand response resource. But this can be factored into assessment of requirements and of the likely contribution of different resource types.
  - **Non-domestic**: Under the Electricity Regulation[19], non-domestic participation in strategic reserve is required unless it can be demonstrated that this is not technically feasible. As the issue that the Estonian strategic reserve is seeking to address stems from non-availability of interconnectors, it may be reasonable to argue that non-domestic capacity cannot reliably support the Estonian adequacy issue and so may potentially be excluded. On the other hand, it may be that access to resource in markets that are still coupled, despite outages elsewhere, may be necessary to maintain Estonia's reliability standard. Therefore, the potential for participation from non-domestic resource requires further consideration.

    Considerations in relation to this issue include:
    - **Potential for cross jurisdictional strategic reserve**: If neighbouring markets or markets in the same region identify a need for some form of strategic reserve to maintain the reliability standard in their own markets or to address a regional adequacy issue, a multi-market strategic reserve could be considered. A coordinated approach could take a number of forms. For example, the relevant markets could identify and procure their own reserve requirements, with the collective contracted capacity then available for use across the markets (in limited defined circumstances only). This is similar to the approach in Finland and Sweden, where the respective TSOs procure peak load reserves to meet their own

[18] Regulation 2019/943, Article 22.

[19] Regulation 2019/943, Article 26.

requirements but resource from either jurisdiction can be activated by the TSOs if there is an issue in either market. An alternative model could involve coordinated procurement of reserves. The route for potential cross-border co-operation will be driven by the requirements of national legislation in relation to securing security of supply.

  - **Potential for cross border participation absent a coordinated strategic reserve scheme**: If a neighbouring market does not have a linked strategic reserve, then any resource potentially seeking to participate in an Estonian strategic reserve scheme will need to maintain connection to its own TSO system, with the potential for associated commitments (e.g. testing) and liabilities (e.g. grid charges). While not insurmountable, it is easier to deal with these types of practical issues for domestic resource connected to the TSO's own system than it is for non-domestic resource.
  - **Reliability of non-domestic resource**: As mentioned previously, the adequacy issue in focus here relates to unavailability of interconnection, which, if it materialises, prevents non-domestic resource connected via the affected interconnection from physically responding. Therefore, there is likely to be a need for de-rating of non-domestic resource based on the probability of an interconnector needed to provide it with a physical route to Estonia being unavailable, with different de-ratings likely for different neighbouring markets. Alongside de-rating, the overall capacity requirement may need to be higher than would otherwise be the case to account for different potential combinations of interconnector outage.

- New capacity may be eligible. However, it may be unlikely to be economically advantageous to contract for new capacity over existing capacity or demand side resource. As capacity under strategic reserve is ring-fenced from the market, a new build project would require full recovery of costs and generation of a return from is strategic reserve contract alone. This is likely to leave it 'out of the money' in a tender exercise compared to existing generation and demand side resource, which do not have the same capital recovery requirement.
  If, however, some new build capacity is needed because existing generation and demand side resource is unable to fully cover the capacity requirement, the technology selection can be tailored to meeting the residual requirement only and based on the expectation that it runs very infrequently, potentially limiting the costs associated with any new build need.

- **Duration**:
  - Strategic reserve contracts are likely to be somewhere in the region of 1-3 years. This gives some surety to Elering in terms of access to resource for the near-term horizon and to the providers in terms of a potential revenue stream. This duration range is also short enough to be responsive to evolving circumstances in the medium term.
- **Obligations**:
  - Linked to the product definition, contracted resource will be obliged to be physically available in the defined extreme N-2 circumstances for utilisation by Elering if required. Given the potential for an N-2 outage to have a long duration, this physical obligation may last for an extended period.
  - Non-availability is expected to lead to application of penalties of some form. The penalty arrangements could include any one or a combination of forfeiture of availability payments whenever unavailable, additional non-availability penalty, revocation of contract and/or ineligibility in future tenders. An appropriate risk-reward balance will need to be struck in this respect.
- **Wholesale market participation**:
  - The contracted capacity is expected to be held outside and ring-fenced from participation in wholesale and ancillary service markets for the duration of strategic reserve contracts. In the extreme circumstances when strategic reserve capacity is 'armed' for potential utilisation, the route for activation may make use of market infrastructure, such as the balancing market. However, strategic reserve will only be used as a last resort once market offers have been exhausted.

4.1.2 Pricing

Pricing arrangements for an Estonian strategic reserve could be structured as follows:

- **Capacity price**:
  - Potential capacity providers bid availability and utilisation payment requirements into the tender process. Successful parties receive an availability payment on a pay-as-bid basis[20]. In the event of activation, options for payment for activation include payment:
    - on the basis of bid;
    - based on a derived price calculated with reference to input fuel and carbon price and efficiencies (e.g. for generation providers); or
    - set with reference to a market price (e.g. for demand response providers).

    It is not expected that payments to resource in the event of utilisation will be not be at the utilisation price, discussed below.
- **Utilisation price**:
  - In the case of activation, for purpose of imbalance pricing, strategic reserve utilisation volumes will be priced at least at the value of lost load (or at a value higher than any intraday price limit, whichever is higher) in line with the Electricity Regulation[21].

Cost recovery

Costs linked to contracting for and potential utilisation of strategic reserve will be recovered by Elering through its network charges.

4.1.3 Qualitative assessment

A qualitative assessment of a strategic reserve approach is provided in Table 2. This assessment is made with reference to the objectives set out in Section 2.4. Overall, a type of strategic reserve model is considered to perform relatively well in respect of the assessment objectives.

As the driver for a potential adequacy issue relates to concurrent outages on interconnectors, it is efficient for the focus to be on securing a targeted quantity of capacity needed to support the system in such cases rather than seeking to cover peak demand in a broader range of circumstances. The

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20 Pay-as-bid has tended to be the selected basis for payment under strategic reserve because (a) with limited capacity requirement, the benefit of price discovery offered by a cleared price is reduced (b) again, with limited capacity requirement, the risks of strategic bidding, which can be mitigated with a cleared price approach, are lessened and (c) costs of provision are likely to vary significantly between resources and a cleared price would provide potentially large rents to some providers and increase costs to consumers.

21 Regulation 2019/943, Article 22.

process for securing capacity can be competitive and allow for participation from multiple resource types. However, there may be limitations on the extent to which particular resource can reliably provide availability over an extended interconnector outage period (e.g. CO_2 emission restrictions may limit participation from existing thermal fleet and there may be limitations on duration of demand side response), suggesting that diversity in terms of capacity providers will be needed.

Of the CRM options available, strategic reserve is seen as the least-worse option by the EC potentially making it the most compatible with EC requirements, assuming that a case for intervention can be demonstrated. With good design, it also offers the route with least potential for distortion of energy market functioning and outcomes[22]. As a targeted solution, it also limits the potential administrative burden compared to requirements under a broad CRM solution.

22 The risk of wholesale market distortion stems from two main aspects. The first is often referred to as the 'slippery slope' problem. The issue is that the existence of a strategic reserve has an undermining effect on confidence in market-led investment, which potentially exacerbates any resource shortfall and increases the need for some form of intervention to support adequacy. More specifically, market investors are concerned that plant held in strategic reserve could be used in a broader range of circumstances than intended, reducing the scope for earning rent from price spikes. This can be mitigated by well-defined and rigorously enforced parameters for Strategic Reserve usage.
The second element relates to the activation price for strategic reserve and its knock-on effects on market prices. If this price is too low, the incentives for market led actions to solve adequacy issues are dampened. This can be mitigated by pricing strategic reserve activation at the value of lost load.

Table 2 – Qualitative assessment: strategic reserve

Objective	Pros	Cons
Efficiency	▪ Efficient to have targeted procurement of limited capacity requirement to cover a low probability, high impact event (concurrent interconnector outages) that market participants are not well placed to cover. ▪ Tender process can allow for competition between different resource types (most likely that existing generation and demand response will be most economically viable, however).	▪ If existing thermal capacity is contracted via strategic reserve, its utilisation in the event of extreme circumstances may be constrained by need to adhere to CO_2 limits, which may increase overall procurement requirement. ▪ Potential for lengthy duration of interconnector outages may introduce some difficulties for demand response availability on an extended basis, which may increase overall procurement requirement. ▪ If non-domestic resource is required to be able to participate, this may increase overall procurement requirement as the risk being covered is one of interconnector unavailability. ▪ Not expected to deliver new build capacity that could improve overall efficiency of the market, but this approach is intended to leave such investment decisions to the market reducing the relevance of this point.
Compatibility with EU requirements	▪ If there are demonstrable adequacy concerns, EC requires evaluation of suitability of strategic reserve as a first option before an alternative CRM is considered. ▪ Limited duration contracts compatible with EC requirement for any CRM to be temporary.	▪ May be difficult to allow for cross-border participation, given that the risk to be covered is one of concurrent interconnection outages. May need to make case for technical infeasibility of cross border participation if the design is not intended to accommodate this.
Minimising energy market impact	▪ Tight specification of conditions for use of strategic reserve and credible commitments to only use it in the defined, extreme circumstances provide comfort that can support market-led investment otherwise. ▪ Utilisation pricing at/near to value of lost load allows process to reflect scarcity and allows market participants access to scarcity value in the extreme circumstances when strategic reserve is called.	▪ If contracted via strategic reserve, potential demand response that could otherwise potentially play a role will be sterilised from the market.
Administrative proportionality	▪ Limited in scope and administrative burden.	▪ n/a.

4.2 Capacity auction for reliability option capacity contracts

4.2.1 Model overview

A reliability option approach involves procurement via auction of option contracts from capacity providers who then have a financial incentive to deliver energy at times of high prices. Capacity providers sell call options for an upfront fee and then when the reference market price exceeds a defined strike price, the capacity provider makes a difference payment back to a direct counterparty or the system more broadly. Retailers and consumers are, therefore, insured against wholesale prices in excess of the strike price. The capacity provider forgoes revenue in excess of the strike price in exchange for the upfront option fee, which contributes to fixed cost recovery.

Reliability option contracts are typically allocated to a quantity of capacity required to cover peak demand requirements on the system. Unlike strategic reserve, this is a market-wide rather than a targeted procurement exercise.

The Sections below consider the potential nature of an Estonian reliability option model with reference to key design building blocks.

Capacity requirement

For Estonia, features relating to setting and securing the capacity requirement under a reliability option approach could include the following:

- **Capacity requirement volume**:
  - The overall volume of capacity needed under an Estonian reliability option scheme will be based on assessment of the level of capacity needed to maintain the reliability standard.
  - The capacity requirement will be informed by Elering as TSO, based on its assessment of the volume of capacity needed to deliver the reliability standard. The final decision in respect of the capacity requirement may reside with the Ministry or Competition Authority depending on who has the appropriate jurisdiction in the Estonian context.
- **Securing capacity**:
  - A centralised procurement approach is anticipated, with Elering (or another central body as appropriate) procuring and acting as the

counterparty to the option contracts[23]. Procurement expected to be delivered through auctioning.

- To allow scope for new build to offer capacity, the primary option contract procurement process is expected to take place 4 years ahead of delivery, with the potential for a supplementary year ahead procurement process to additionally be held. These timescales are consistent with international case studies.

Product definition

In the Estonian context, reliability option product definition features could entail the following:

- **Product**:
  - Capacity providers will offer their availability capacity, de-rated to reflect expected actual contribution potential, into the auction process[24]. Capacity de-rating allows for installed capacity to be modified downwards to account for planned outages, probability of forced outages and also expected contribution of a resource type in times of system tightness.
  - As discussed further below, providers that hold a reliability option contract do not have a physical obligation to either be available or deliver energy at any specific times, but rather they have a financial obligation to make difference payments when the market price exceeds the contract strike price and so a financial incentive to be delivering energy at these times.
- **Eligibility**:
  - As the scheme is a market-wide CRM, eligibility of different resource types is expected to be broad, with existing and new resource able to participate. Certain factors will affect participation, including the following:
    - **Generation capacity**: Generation capacity that does not meet CO_2 emissions limits specified by the EU[25] will not be eligible for any CRM payments, which is expected to block participation from

23 Alternatively, a decentralised approach could be employed in which retailers and capacity providers bilaterally trade reliability option contracts with each other. Evolution from a centralised to a decentralised approach is a possibility and scope for this transition could be built into the design as appropriate.

24 A related, more detailed design choice is whether existing capacity is obligated to offer into the auction process (and if so on what basis) or whether there is choice in this regard.

25 Regulation 2019/943, Article 22.

the vast majority of existing thermal plant. Any eligible plant will be de-rated to reflect expected availability.
  - **RES**: Any RES receiving renewable support is expected to be excluded from participation in the CRM on the basis that it cannot receive two forms of support concurrently. Following cessation or in the absence of RES support, participation will be possible, with appropriate de-rating.
  - **Demand response**: Demand side resource is expected to be eligible, subject to appropriate de-rating.
  - **Storage**: Different forms of storage are expected to be eligible, subject to appropriate de-rating.
  - **Non-domestic**: The Electricity Regulation[26] requires that foreign capacity capable of providing equivalent technical performance to domestic capacity has the opportunity to participate. Participation can be restricted to foreign capacity in a directly connected market only and TSOs will set the maximum entry capacity available for participation of foreign capacity. This takes into account expected interconnector availability and the likely concurrence of system stress in the market. **This is important for the Estonian context**. The adequacy issue that a CRM is seeking to address stems from the potential for concurrent interconnector outages. This may be expected to translate into significant de-rating of foreign capacity.

- **Duration**:
  - Standard contract duration is expected to be one year. Other jurisdictions offer multi-year commitment terms for new (and in some cases) refurbishing capacity. The relative merits of multi-year contracts for new capacity in the Estonian context needs specific consideration as part of any detailed design.

- **Obligations**:
  - Reliability option holders will be required to have physical capacity to back their contract, but they do not have a physical obligation to be available or delivering energy at any time.
  - Instead, contract holders will have a financial obligation to make a difference payment when the market reference price exceeds their contract strike price. This, in turn, creates a financial incentive to be delivering energy at times of high prices so that capacity providers capture the high energy price before having to make the difference payment, rather than missing out of the energy market revenue in these periods.

[26] Regulation 2019/943, Article 26.

- **Wholesale market participation**:
  - The contracted capacity participates in the wholesale market as normal.

Pricing

Pricing arrangements under an Estonian reliability option approach could be structured as follows:

- **Capacity price**:
  - Successful bidders into an auction will receive the auction clearing price as the option fee.[27]
- **Strike price**:
  - The strike price sets the threshold at which difference payment obligations are triggered. Once the market reference price exceeds the defined strike price, the obligation to make difference payments kicks in. The strike price should be set at a level intended to be high enough to avoid distorting dispatch in the spot market. To achieve this, the strike price should be set at an agreed level above the marginal cost of the most expensive capacity resource (including demand side)[28].
- **Market reference price**:
  - Reliability options need to be settled against a liquid reference price, which is accessible to capacity providers. The most obvious choice of reference market is day-ahead based on the Euphemia day-ahead market coupling arrangements. However, system scarcity will rarely emerge this far ahead and is, instead, more likely to manifest from real-time issues such as unexpected outages and forecast error. Intraday and balancing prices will pick up these issues and so be more reflective of system scarcity, but there is limited liquidity in these timeframes and the potential for basis risk for sellers if trade is predominantly conducted day-ahead. A compromise solution[29] is to apply a blended market reference price, reflecting the weight of trading activity over different timeframes by the capacity provider.

Cost recovery

Costs linked to contracting for reliability options reserve will be recovered from suppliers based on their share of demand over a selection of trading periods.

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27 There are related, detailed design choices regarding pricing which could affect pricing outcomes e.g. auction price caps, individual bidding caps.

28 Under a centralised scheme, there is a single strike price across contracts. However, if there is an evolution towards decentralised reliability options, then the parties involved can bilaterally agree on the strike price to apply.

29 As adopted in the I-SEM arrangements.

4.2.2 Qualitative assessment

A qualitative assessment of a capacity auction for reliability options approach is provided in Table 3. This assessment is made with reference to the objectives set out in Section 2.4.

The main challenge for the broad CRMs in general, reliability option capacity auctions included, is that they are better suited to supporting general peak demand conditions than providing coverage for the possibility of concurrent interconnector outages. Broad procurement of capacity to cover for low probability network related issues risks inefficiency, as the solution is not well tailored to the problem.

As for all of the broad CRM models, the reliability option solution involves a more extensive intervention, which is challenging in terms of EU sign-off and involves administrative complexity to implement and operate. However, it has the potential to be less intrusive than other broad CRMs in terms of the functioning of the wholesale market.

Table 3 – Qualitative assessment: capacity auction for reliability option capacity contracts

Objective	Pros	Cons
Efficiency	▪ The difference payment exposure in instances of high prices provides a clear financial incentive for capacity providers to be delivering energy at times of system tightness, which should help to mitigate or alleviate potential adequacy issues. ▪ Linked to the above, the nature of the difference payment obligation encourages efficient wholesale energy price formation which is reflective of scarcity conditions. This encourages delivery in times of high prices from option holders and non-option holders alike. ▪ Auction process can allow for competition between different resource types and for competitive capacity price outcomes.	▪ Broad capacity procurement to cover peak demand situations is not well suited to the potential adequacy issues in Estonia, which stem from a low probability, high impact event (concurrent interconnector outages) that the market is not best placed to cover. Absent interconnector outages, assessment indicates that Estonia does not face adequacy issues, so broad procurement risks being inefficient and appears ill-suited to the potential problem. ▪ Majority of existing thermal plant expected to be ineligible due to CO_2 emission restrictions, which may hasten its closure (as unable to access option fee) and potentially exacerbate adequacy concerns. This capacity could, however, be useful for supporting the system in the case of concurrent interconnector outages (whether through the wholesale market or an alternative mechanism). There is potential for this to skew investment/closure decisions towards new investment, even though this is not required in normal market circumstances. ▪ Fulfilling capacity requirement expected to be dependent on contributions from non-domestic capacity, given domestic supply-demand balance. But as the adequacy risk to be mitigated relates to concurrent interconnection outage: (a) ability to rely on foreign capacity is compromised and (b) foreign capacity likely to be more significantly de-rated than equivalent domestic capacity. This brings into question the ability to rely on non-domestic capacity.
Compatibility with EU requirements	▪ Less disruptive to energy market operation than other broad CRM models. ▪ Has the potential to evolve from a centralised to a decentralised option model, with the latter a bilateral commercial tool rather than a centrally coordinated intervention. ▪ Design can be made to comply with EU requirements, but requires specific design choices and justification.	▪ Model is a step beyond a strategic reserve, which requires additional justification and demonstration of need. ▪ Compliance with EU requirements restricts ability for existing thermal capacity to contribute due to CO_2 emission limits. ▪ Open question whether potentially significant de-rating of foreign capacity contributions will be compatible with EU requirements.
Minimising energy market impact	▪ As outlined above, the reliability option approach encourages effective price formation in the wholesale market and also provides incentives to deliver energy at times of system tightness.	▪ Investment and closure decisions will be strongly linked to the CRM and the balance of risk and reward offered by potential option fee revenue and difference payment exposure, rather than revenue expectations from the wholesale market alone.
Administrative proportionality	▪ n/a.	▪ This coordinated, centralised model requires processes and systems to support activities including prequalification, de-rating, auction operation, monitoring and settlement. The administrative set up needs to cater for domestic and foreign capacity alike. As such, this is likely to complex to administer.

4.3 Capacity auction for non-option capacity contracts

4.3.1 Model overview

This model has many similarities with the reliability option model, with the focus on market-wide procurement of contracts for available capacity needed to address the resource adequacy concern.

The main difference between the two stems from the nature of the underlying obligations associated with the product. Under this approach, the underlying obligation is physical. Contract holders are expected to make their capacity available or else they face penalties for non-availability. As flagged previously, reliability option holders instead have a financial obligation to make difference payments and commercial incentives to deliver energy in times of high prices. In the former, penalties are administrative in nature while in the latter penalties are related to and driven by market prices.

The Sections below consider the potential nature of an Estonian capacity auction model for non-option capacity contracts with reference to key design building blocks. Where there is commonality with the envisaged approach under a reliability option, we highlight this and cross-refer to the reliability option section rather than replicating the text here.

Capacity requirement

Features relating to setting and securing the capacity requirement under a capacity auction for non-option capacity contracts could include the following:

- **Capacity requirement volume**:
  - Expected to be similar to the reliability option approach, with the capacity requirement determined based on assessment of the level of capacity needed to maintain the reliability standard.
- **Securing capacity**:
  - Expected to be similar to the reliability option approach, with a central body (potentially Elering as appropriate) running a centralised auction to procure the capacity requirement in timeframes that allow for participation of new alongside existing resource.

Product definition

In the Estonian context, product definition features under a capacity auction could entail the following:

- **Product**:
  - As for reliability options, capacity providers will offer their availability capacity, de-rated to reflect expected actual contribution potential, into the auction process. The obligations associated with the product differ from those under a reliability option, however, as set out below. Whether there are any additional delivery requirements, such as

response time and response duration, will need consideration as part of a detailed design.

- **Eligibility**:
  - Participation is expected to be broad, as under the reliability option, with the same factors also influencing the nature of participation for different resource types.
- **Duration**:
  - As for the reliability option, the standard product will be one year in duration with the option for multi-year commitment for new capacity a possible detailed design consideration.
- **Obligations**:
  - Contract holders will have a physical obligation to make contracted capacity available either on an enduring basis or in specific windows linked to pre-defined timeframes or system stress events. Non-availability, either on a blanket basis or in the relevant windows as appropriate, will result in exposure to administered penalties.
- **Wholesale market participation**:
  - The contracted capacity participates in the wholesale market as normal.

Pricing

Pricing arrangements under an Estonian capacity auction approach could be structured as follows:

- **Capacity price**:
  - Successful bidders into an auction will receive the auction clearing price as the capacity availability fee.[30]

Cost recovery

Costs linked to capacity contracts will be recovered from suppliers based on their share of demand over a selection of trading periods.

4.3.2 Qualitative assessment

A qualitative assessment of a capacity auction approach for non-option capacity contracts is provided in Table 4. This assessment is made with reference to the objectives set out in Section 2.4.

As outlined above in respect of capacity auctions for reliability options, a capacity auction solution for non-option based capacity contracts seems more appropriate for general peak demand coverage rather than providing support

30 There are related, detailed design choices regarding pricing which could affect pricing outcomes e.g. auction price caps, individual bidding caps.

in the event of simultaneous interconnector outages. Again, the risk is that broad procurement of capacity to cover for low probability network related issues will not provide an efficient solution.

Like for reliability options, this route is more onerous in terms of EU compliance and has associated administrative complexity. However, unlike the reliability option approach, the penalty arrangements here are not tied into wholesale energy prices, so there may be less of an emphasis on reflection of scarcity value in energy prices.

Table 4 – Qualitative assessment: capacity auction for non-option capacity contracts

Objective	Pros	Cons
Efficiency	▪ Auction process can allow for competition between different resource types and for competitive capacity price outcomes.	▪ Broad capacity procurement to cover peak demand situations is not well suited to the potential adequacy issues in Estonia, which stem from a low probability, high impact event (concurrent interconnector outages) that the market is not best placed to cover. Absent interconnector outages, assessment indicates that Estonia does not face adequacy issues, so broad procurement risks being inefficient and appears ill-suited to the potential problem. ▪ Majority of existing thermal plant expected to be ineligible due to CO_2 emission restrictions, which may hasten its closure (as unable to access option fee) and potentially exacerbate adequacy concerns. This capacity could, however, be useful for supporting the system in the case of concurrent interconnector outages (whether through the wholesale market or an alternative mechanism). There is potential for this to skew investment/closure decisions towards new investment, even though this is not required in normal market circumstances. ▪ Fulfilling capacity requirement expected to be dependent on contributions from non-domestic capacity, given domestic supply-demand balance. But as the adequacy risk to be mitigated relates to concurrent interconnection outage: (a) ability to rely on foreign capacity is compromised and (b) foreign capacity likely to be more significantly de-rated than equivalent domestic capacity. This brings into question the ability to rely on non-domestic capacity.
Compatibility with EU requirements	▪ Design can be made to comply with EU requirements, but requires specific design choices and justification.	▪ Model is a step beyond a strategic reserve, which requires additional justification and demonstration of need. ▪ Compliance with EU requirements restricts ability for existing thermal capacity to contribute due to CO_2 emission limits. ▪ Open question whether potentially significant de-rating of foreign capacity contributions will be compatible with EU requirements.
Minimising energy market impact	▪ n/a.	▪ Compared to reliability option approach, less emphasis on / requirement for effective price formation and reflection of scarcity value in the energy price, as the penalty arrangements are administered in nature rather than linked to market prices. ▪ Investment and closure decisions will be strongly linked to the CRM and the balance of risk and reward offered by potential option fee revenue and penalty exposure, rather than revenue expectations from the wholesale market alone.
Administrative proportionality	▪ n/a.	▪ This coordinated, centralised model requires processes and systems to support activities including prequalification, de-rating, auction operation and settlement. The administrative set up needs to cater for domestic and foreign capacity alike. As such, this is likely to complex to administer.

4.4 Decentralised obligation approach

4.4.1 Model overview

The decentralised obligation route allocates responsibility for securing the capacity requirement onto retailers, who need to secure capacity tickets from eligible providers such that each retailer secures sufficient capacity to meet the overall demand of their consumers. Here, the emphasis is upon bilateral trade between retailers and capacity providers, rather than a central procurement mechanism, to provide reliability.

The Sections below consider the potential nature of an Estonian decentralised obligation model with reference to key design building blocks. Where there is commonality with possible approaches under a reliability option or a capacity auction, we highlight this and cross-refer to the reliability option section rather than replicating the text here.

Capacity requirement

Features relating to setting and securing the capacity requirement under a decentralised obligation approach could include the following:

- **Capacity requirement volume**:
  - Expected to be similar to the reliability option/capacity auction approaches, with the capacity requirement determined centrally based on anticipated needs to cover peak demand while maintaining reliability standards.
- **Securing capacity**:
  - Unlike the preceding options, under this model retailers have an obligation to ensure they have a certain volume of capacity certificates to cover for their consumers' demand. There is a detailed design choice to be made in respect of the timeframe attached to this obligation. It could be a blanket obligation applying to all timeframes or alternatively it may be targeted to specific windows, which could be identified in ex-ante or associated with the occurrence of system stress events.
  - Procurement of capacity certificates will be facilitated by bilateral trade between capacity providers and retailers, with the potential for coordinated auctions to support bilateral trade as an additional option.

Product definition

In the Estonian context, decentralised obligation product definition features could entail the following:

- **Product**:
  - Capacity providers will have their capacity eligibility certified centrally, most likely by Elering. As under reliability option and capacity auction approaches, installed capacity will be de-rated to account for planned outages, probability of forced outages and also expected contribution of a resource type in times of system tightness. This will determine a provider's certified capacity availability, which then form the basis of trade with retailers.
- **Eligibility**:
  - Participation is expected to be broad, as under the reliability option and capacity auction approaches, with the same factors also influencing the nature of eligibility from a certification perspective for different resource types.
- **Duration**:
  - Capacity certificates will have an annual validity. There is detailed design choice regarding the potential for any supplemental arrangements to provide longer term arrangements to engender delivery of new build.
- **Obligations**:
  - Capacity certificate holders will be required to be physically available in line with their certified capacity. As mentioned above, this could be applied on an enduring basis or, more likely, in specific periods of anticipated or actual system tightness. Availability shortfalls on behalf of capacity providers will result in penalty exposure.
  - Retailers have an obligation to secure sufficient certificates to cover their specified capacity requirement. Failure to secure sufficient certificates will result in an administered penalty e.g. exposure to a buy-out price.
- **Wholesale market participation**:
  - The contracted capacity participates in the wholesale market as normal.

Pricing

Pricing of capacity certificates will be determined by the outcome of bilateral trade, plus potentially outcomes from any supplemental auctions.

Cost recovery

Suppliers directly pay for capacity certificates through their trading with capacity providers.

4.4.2 Qualitative assessment

A qualitative assessment of a decentralised obligation approach is provided in Table 5. This assessment is made with reference to the objectives set out in Section 2.4.

The decentralised obligation route faces similar challenges to other broad CRMs in terms of its suitability for mitigating risks linked to interconnector outages, achieving EU sign off and administrative complexity. An additional issue with decentralised obligations is that they place responsibility for covering the adequacy issue on retailers, who are not best placed to manage the risks of concurrent interconnector issues.

Table 5 – Qualitative assessment: decentralised obligation

Objective	Pros	Cons
Efficiency	▪ Bilateral trade process allows for competition between different resource types and for competitive capacity price outcomes. ▪ The decentralised nature could incentivise suppliers to implicitly find demand side response solutions that may have otherwise been more difficult to uncover.	▪ Broad capacity procurement to cover peak demand situations is not well suited to the potential adequacy issues in Estonia, which stem from a low probability, high impact event (concurrent interconnector outages) that the market is not best placed to cover. Absent interconnector outages, assessment indicates that Estonia does not face adequacy issues, so broad procurement risks being inefficient and appears ill-suited to the potential problem. ▪ Additionally, it is not appropriate to place responsibility for covering this network infrastructure risk on retailers to manage. ▪ Majority of existing thermal plant expected to be ineligible due to CO_2 emission restrictions, which may hasten its closure (as unable to access option fee) and potentially exacerbate adequacy concerns. This capacity could, however, be useful for supporting the system in the case of concurrent interconnector outages (whether through the wholesale market or an alternative mechanism). There is potential for this to skew investment/closure decisions towards new investment, even though this is not required in normal market circumstances. ▪ Fulfilling capacity requirement expected to be dependent on contributions from non-domestic capacity, given domestic supply-demand balance. But as the adequacy risk to be mitigated relates to concurrent interconnection outage: (a) ability to rely on foreign capacity is compromised and (b) foreign capacity likely to be more significantly de-rated than equivalent domestic capacity. This brings into question the ability to rely on non-domestic capacity.
Compatibility with EU requirements	▪ Design can be made to comply with EU requirements, but requires specific design choices and justification.	▪ Model is a step beyond a strategic reserve, which requires additional justification and demonstration of need. ▪ Compliance with EU requirements restricts ability for existing thermal capacity to contribute due to CO_2 emission limits. ▪ Open question whether potentially significant de-rating of foreign capacity contributions will be compatible with EU requirements.
Minimising energy market impact	▪ n/a.	▪ Compared to reliability option approach, less emphasis on / requirement for effective price formation and reflection of scarcity value in the energy price, as the penalty arrangements are administered in nature rather than linked to market prices. ▪ Investment and closure decisions will be strongly linked to the CRM and the balance of risk and reward offered by potential option fee revenue and penalty exposure, rather than revenue expectations from the wholesale market alone.
Administrative proportionality	▪ n/a.	▪ This coordinated, centralised model requires processes and systems to support activities including certification and monitoring. The administrative set up needs to cater for domestic and foreign capacity alike. As such, this is likely to complex to administer.

5. QUANTITATIVE ASSESSMENT

Building on the insights from the qualitative assessment, we have considered the following CRM designs as part of our quantitative assessment:

- **Strategic Reserve**:
  - targeted capacity requirement needed to maintain reliability standard identified;
  - all resource types eligible (subject to CO_2 emissions limit restrictions); and
  - domestic resource only.
- **Capacity auction for reliability option capacity contracts (market-wide CRM)**:
  - broad capacity requirement needed to maintain reliability standard identified;
  - all resource types eligible (subject to CO_2 emissions limit restrictions); and
  - non-domestic resource eligible, potentially subject to additional de-rating to reflect interconnector outage probabilities and implications.

5.1 Modelling approach and assumptions

5.1.1 *Modelling approach*

The introduction of a CRM can help improve the security standard of a country or region, but may, at the same time, affect the underlying energy markets. Different generation mixes will inevitably result in different wholesale electricity prices, plant dispatch and interconnector flows. It is therefore important to consider a CRM within the wider electricity market context.

We have used our own electricity model, BID3, to model the Estonian and neighbouring electricity markets. BID3 is a holistic electricity market model able to model European electricity markets with hourly resolution.

We have assessed the different CRM options against a counterfactual option – this is an energy-only option. In our Baseline Case, we assume that there is no introduction of a CRM in Estonia. This then allows us to define and compare the differences in a range of metrics and the overall economic welfare between the 'status quo' and the different CRM options.

5.1.2 *Modelling assumptions*

Modelled future years

We have chosen 2027 and 2031 as two representative years to explore the different CRM options. This choice was based on the following reasons:

- we wanted to look at years where the full effects of the desynchronisation can be captured (i.e. avoid looking at the very short term) arising from;

- the Harmony cable being operational;
- LitPol being 'converted' into an AC interface (and used for frequency control) with no commercial flows taking place; and

- we wanted to explore a year where significant oil shale capacity would no longer be connected to the system (i.e. 2031).

Commodity prices

For our analysis we have used commodity prices in line with the 2020 ENTSO-E TYNDP National Trends scenario (as shown in Table 6).

Table 6 – Commodity price assumptions

Commodity	Unit	2027	2031
Gas	€/MWh	23.9	25.0
CO_2	€/tonne	24.7	31.8
Coal	€/MWh	14.4	16.4
Lignite	€/MWh	4	4
Oil Shale	€/MWh	8.7	9.7

The commodity prices included in this table are presented in real 2018 money terms and are based on trended values from the 2020 ENTSO-E TYNDP National Trends scenario

Demand evolution assumptions

When it comes to demand we have used:

- the projected annual demand as per the 2020 ENTSO-E TYNDP National Trends scenario for all countries modelled with the exception of Estonia;
- the projected annual demand as per the 2019 Elering Security of Supply report for Estonia; and
- historical demand profiles based on the years 1995-2014.

Table 7 shows the assumed annual demand for the Baltics and Poland.

Table 7 – Annual demand projection (TWh)

	Unit	2027	2031
[1]Estonia	TWh	9.4 *(8.6)*	9.5 *(8.7)*
Latvia	TWh	7.6	7.8
Lithuania	TWh	13.2	13.6
Poland	TWh	181.0	181.6

Geographical scope and 'weather years'

We have modelled Estonia and its neighbouring countries to capture the effects of and on interconnector flows. The Nordics, Baltic and Poland are fully optimised in all 'main' modelling runs, as shown in Figure 2.

Figure 2 – Optimised geography

To fully capture the effects of weather on hydrology, demand and intermittent generation we model each future year under a set of 20 weather years (1995-2014).

The rest of continental Europe (including GB and Ireland) have only been modelled in a 'preliminary' model run with the use of 5 weather years, but on the basis of the commodity prices assumptions used in the National Trends scenario of the 2020 ENTSO-E TYNDP.

Oil shale capacity evolution

Oil shale capacity in Estonia is expected to gradually decommission. In 2027 we assume that around 660MW of oil shale capacity will be operational, and in 2031 we expect that only 274MW will continue to be connected to the Estonian system. The resultant capacity mix is shown in Figure 3.

Modelled scenarios

We consider three different 'scenarios' with respect to interconnector availability:

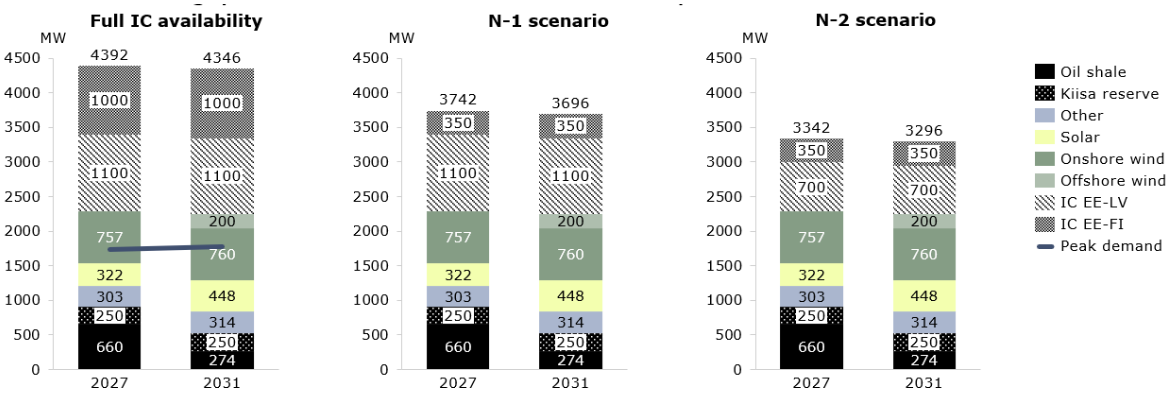
- a 'Full IC availability' scenario;
  - in this case all interconnector capacity with Finland and Latvia is assumed to be fully available throughout the year;
- an N-1 scenario;
  - in this case, one of the links with Finland (650MW) is assumed to be in an extended outage throughout the winter months (December-February); and
- an N-2 scenario;
  - in this case we assume that one of the links with Finland (650MW is unavailable) and there is a 30% reduction in the available capacity on the Latvian interconnection.

The focus of this assessment is to compare different CRM options, and, in particular, inform the relative assessment in terms of welfare impacts and suitability to the Estonian context. This analysis should, by no means, be viewed as a capacity adequacy study. The Estonian TSO, Elering, performs dedicated and detailed studies that look at resource adequacy, and this study is not intended to replace these. The scenarios considered here are intended to be extreme in order to test the effects of a CRM in such circumstances.

We do, however, need to take a view of the potential future generation mix and demand evolution for the purposes of our scenario analysis. We have chosen a set of scenarios that capture a wide range of outcomes in terms of 'system tightness', including an extreme case where there is simultaneous extended unavailability of two interconnectors.

Figure 3 shows the Estonian installed capacity alongside the available interconnector capacity over the winter months (December – February) in the different scenarios.

Figure 3 – Installed capacity in Estonia (MW)



Deterministic and probabilistic model runs

We typically use our BID3 electricity model to perform deterministic runs for European electricity markets. BID3 does, however, has the ability to determine the Loss of Load Expectation on a probabilistic basis as well. For this analysis we perform both runs. This allows us to:

- to capture all metrics that are needed to determine system costs and social welfare (plant dispatch, operating costs, prices etc.); and
- determine the associated LOLE in terms of hours as well as volume of expected energy unserved(MWh).

5.2 Quantitative assessment approach

5.2.1 CRM options

We have explored two CRM options in the quantitative analysis:

- a Strategic Reserve option;
  - in this design we assume that Elering procures a certain level of capacity, which is ring-fenced from the market (and does not participate in the spot energy markets);
- a centrally organised market-wide CRM based on the use of a Reliability Options; and
  - in this design Elering procures capacity on a market-wide basis with all qualifying eligible capacity being in a position to capture a capacity contract.

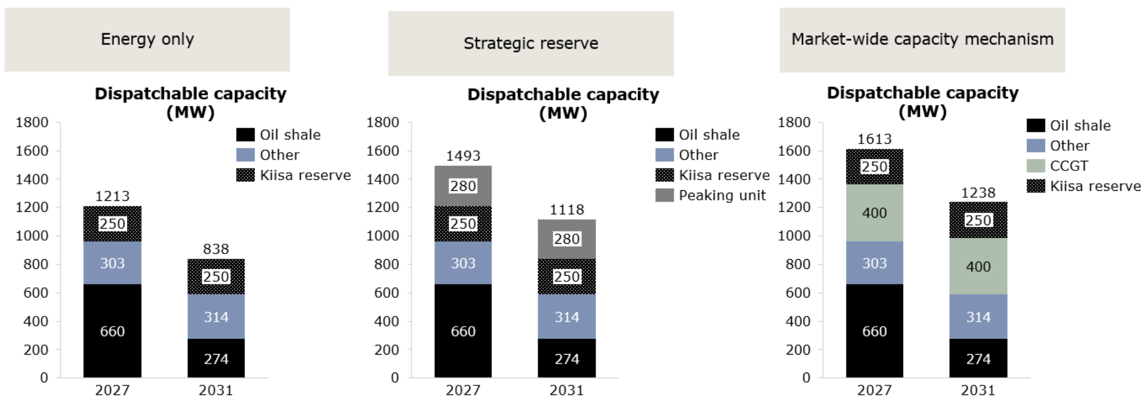
We allow for all potential capacity providers (existing and prospective) to participate. This also includes capacity providers from across the borders. However, our analysis suggests that there is limited capacity credit for the overall interconnection with some of neighbouring countries in some years.

Stress periods in Finland coincide with stress period in Estonia and with a very tight Finnish system in 2027, there is limited potential for Finnish capacity providers to contribute to Estonian capacity adequacy. Further to this, interconnector availability appears to be the key driver of potential adequacy issues in Estonia, and it would therefore appear counterintuitive to contract capacity across borders to manage capacity adequacy issues linked to interconnector availability.

Demand side response can be a very important and efficient way of ensuring capacity adequacy. Any CRM options put forward should cater for and facilitate demand side participation. For the purposes of our quantitative analysis, we have chosen to exclude demand side response as a potential source for 'capacity' provision. This should however not be seen as a recommendation to block demand side response from participating. On the contrary, we believe that demand side response should be encouraged and may end up being the most efficient way of ensuring capacity adequacy. We simply use more conventional solutions with well-known cost structures for the purposes of our quantified analysis. Should demand side response be in a position to provide the same service at a lower cost, then the associated cost may be lower than what we have determined.

Figure 4 presents an overview of the dispatchable capacity under the various CRM options. The following subsections describe the modelled CRM options.

Figure 4 – Dispatchable capacity under the three main CRM options in Estonia (MW)



Energy-only

In this case we model Estonia assuming the absence of a CRM. This means Estonia continues to rely on an energy-only market. Energy-only markets can deliver security of supply with scarcity pricing (i.e. spot electricity prices rising to a level that provides for new entry signals or retaining existing capacity).

However, for the purposes of this analysis we have assumed that spot pricing does not rise to a level that is sufficient to deliver new entry, and that the lack of revenue certainty in the absence of a capacity contract is seen as an additional hurdle for commissioning new capacity.

Strategic Reserve

In this case, we assume that a Strategic Reserve is put in place. Capacity with a Strategic Reserve contract does not participate in the spot energy markets and is only used as a 'last resort', and once all other available capacity has been depleted. This means that Strategic Reserve capacity does not influence spot electricity price formation or cross-border flows.

With the introduction of a CRM, oil shale units would be faced by a commercial choice:

- continue operating without any restrictions in terms of operating hours; or
- opt for a restricted operating profile and a CRM contract (i.e. give up on spot energy market revenues).

It is difficult to predict the future choices made by oil shale units, and this commercial choice depends on the underlying cost structure and wider socioeconomic considerations. We have, therefore, chosen to explore both worlds as described below. In both cases, however, additional capacity (beyond the existing oil shale capacity that may opt for a Strategic Reserve) is needed.

The amount and type of additional capacity is a result of our analysis. In both CRM options we deploy capacity (if needed) to ensure that the security standard is met, and the type of capacity delivers the most efficient outcome from a system perspective. As already discussed, we have assumed that additional capacity provision does not come from demand side response for the purposes of the analysis, but, in reality, demand side response may prove to be a more efficient solution.

1. Strategic Reserve (without oil shale)

In the first case, we assume that all oil shale units, which continue to be operational in 2027, do not restrict their operating profile and, given the CRM emissions restrictions, are not eligible for a CRM contract. this means that Balti 11 (192MW), Eesti 8 (194MW) and Auvere (274MW) do not have a Strategic Reserve contract and continue to operate in the energy markets until they are decommissioned in 2030.

In the remainder of this section this case is referred to as 'SR w/o shale'.

2. Strategic Reserve (with oil shale)

This case is similar to the previous Strategic Reserve option in terms of the assumed CRM design. The difference is that we assume that some of the oil shale units choose to limit their operating hours to become eligible for a CRM contract. Balti 11 (192MW) and Eesti 8 (194MW) opt for a restricted operating profile until they are decommissioned in 2030.We assume that Auvere (274MW) continues to operate in the energy market and does not have a Strategic Reserve contract.

In the remainder of this section this case is referred to as 'SR with shale'.

Market-wide CRM

The market-wide CRM takes the form of a centrally organised tender for procuring capacity to deliver capacity adequacy in Estonia. All eligible capacity providers are assumed to be in a position to capture a capacity contract. Interconnection capacity is also taken into account with the applicable de-rating factor.

There is, however, also capacity that may not be eligible for a capacity contract:

- capacity that does not meet certain emissions limits; or
- capacity that is receiving other forms of support (for example renewables with a support contract).

Such capacity is not included in the CRM auction, but its capacity contribution is accounted for the purposes of setting the capacity requirement.

Similar to the Strategic Reserve option, although we expect demand side response to be key for delivering security of supply, we only assess more conventional solutions for meeting the security standard. If demand side response is in a position to deliver the same services at a lower cost, we would expect a higher net benefit than what we have estimated in our analysis.

As with the Strategic Reserve, we also consider two options for oil shale participation as below. In both cases, however, additional capacity (beyond the existing oil shale capacity that may opt for a CRM contract) is needed.

The amount and type of additional capacity is again a result of our analysis. In both CRM options we deploy capacity (if needed) to ensure that the security standard is met, and the type of capacity delivers the most efficient outcome from a system perspective. As already discussed, we have assumed that additional capacity provision does not come from demand side response for the purposes of the analysis, but, in reality, demand side response may prove to be a more efficient solution.

The amount of additional capacity with the market-wide CRM option is slightly higher. This is a result of the 'typical' design of centrally organised market-wide schemes. A capacity demand curve allows for more (or less) than the target capacity to be procured at a lower (or higher) clearing price.

1. Market-wide CRM (without oil shale)

In the first case, we assume that all oil shale units, which continue to be operational in 2027 do not limit their operating hours and, as a result, are not eligible for a CRM contract. We therefore assume that Balti 11 (192MW), Eesti 8 (194MW) and Auvere (274MW) continue to operate in the energy markets (without a CRM contract) until, in the case of Balti 11 and Eesti 8, they are decommissioned in 2030.

In the remainder of this section this case is referred to as 'Market-wide w/o shale.'

2. Market-wide CRM (with oil shale)

This case is similar to the previous Market-wide CRM option in terms of the assumed CRM design. The difference is that we assume that some oil shale units choose to limit operating hours and capture a CRM contract. This means that Balti 11 (192MW) and Eesti 8 (194MW) opt for a restricted operating profile until they are decommissioned in 2030. We assume that Auvere (274MW) continues to operate in the energy market and does not have a CRM contract.

In the remainder of this section this case is referred to as 'Market-wide with shale'.

5.2.2 Metrics for Cost Benefit Analysis

We have used a set of common metrics to determine the costs and benefits associated with the introduction of a CRM. These include:

- **Short-run consumer surplus**;
  - this is the difference between the Value of Lost Load (VoLL) and the spot electricity price in a given settlement period multiplied by the corresponding demand, and is formulated mathematically as follows:

$$\boldsymbol{Consumer\ surplus} = \sum_{i} \boldsymbol{VoLL \times D_i} - \sum_{i} \boldsymbol{P_i \times D_i}$$

where

i indicates a settlement period

$VoLL$ is the Value of Lost Load

D_i is the demand in settlement period i

P_i is the spot electricity price in settlement period i

For the purposes of our analysis, we have not considered costs linked to the use of the network, RES subsidies and/or other payments linked to system services. The cost of energy unserved is presented as a separate cost item.

- **Short-run producer surplus;**
  - this is the sum of difference between the spot electricity price and the short-run cost of operation of each individual production unit generating in a given settlement period multiplied by the corresponding output, and is formulated mathematically as follows:

$$\boldsymbol{Producer\ surplus} = \sum_{i,j} \boldsymbol{P_i \times G_{ij}} - \boldsymbol{Variable\ Production\ Costs}$$

where

i indicates a settlement period

j indicates a generating unit

P_i is the spot electricity price in settlement period i

G_{ij} is the level of output of generating unit j in settlement period i

$Variable\ Production\ Costs$ are the Variable Production Costs across the entire production horizon and include variable costs (such as fuel and CO2 costs) and quasi-fixed costs such as start-up costs

- **Congestion rent;**
  - this is the income capture by an interconnector owner as a result of the price differential between the connecting price areas, and is mathematically formulated as follows:

$$\boldsymbol{Congestion\ rent} = \sum_{\boldsymbol{kl,i}} (\boldsymbol{P_k} - \boldsymbol{P_l}) \times \boldsymbol{Flow_{kl,i}}$$

where

i indicates a settlement period

k indicates Price Area k

l indicates Price Area l

P_k is the spot electricity price in Price Area k in settlement period i

P_l is the spot electricity price in Price Area l in settlement period i

$Flow_{kli}$ is the interconnector flow from Price Area k to Price Area l in settlement period i

- **Cost of expected energy unserved;**
  - this is the cost associated with all energy that is expected to be disconnected or not be met due to lack of capacity adequacy. And can be mathematically expressed as follows:

$$\boldsymbol{Cost\ of\ energy\ unserved} = \boldsymbol{Energy\ unserved}\ (\boldsymbol{MWh}) \times \boldsymbol{VOLL}$$

where;

$VoLL$ is the Value of Lost Load

$Energy\ Unserved\ (MWh)$ is the total annual expected volume of energy unserved

- **Annualised capex and annual avoidable fixed costs;**
  - further to costs associated to short run operation of the system, electricity system costs also include fixed costs (capex and opex of a generating unit).

Another important consideration when introducing a new policy is to understand the impact on consumers. The total cost to consumers in terms of wholesale purchasing costs (excluding the costs associated with a CRM and other cost elements such a use of system charges and renewables subsidies) can be defined as:

$$\boldsymbol{Cost\ to\ consumers}\ (€)\ =\ \boldsymbol{Sum}\ (\boldsymbol{D_i} * \boldsymbol{P_i})$$

where

i indicates a settlement period

D_i is the demand in settlement period i

P_i is the spot electricity price in settlement period i

The average unit wholesale electricity price faced by the demand (demand-weighted average price) is then defined as:

$$\boldsymbol{DWA\ electricity\ price}\ (€/\boldsymbol{MWh})\ =\ \boldsymbol{Cost\ to\ consumers}(€)\ /\boldsymbol{D_i}(\boldsymbol{MWh})$$

With the introduction of a CRM, consumers have to also pay for the cost of the capacity contracts. We assume that the entirety of the payment towards capacity providers is funded indirectly by end-users.

In our analysis we focus on the **differences** of the different metrics between each CRM option and the energy-only case (counterfactual).

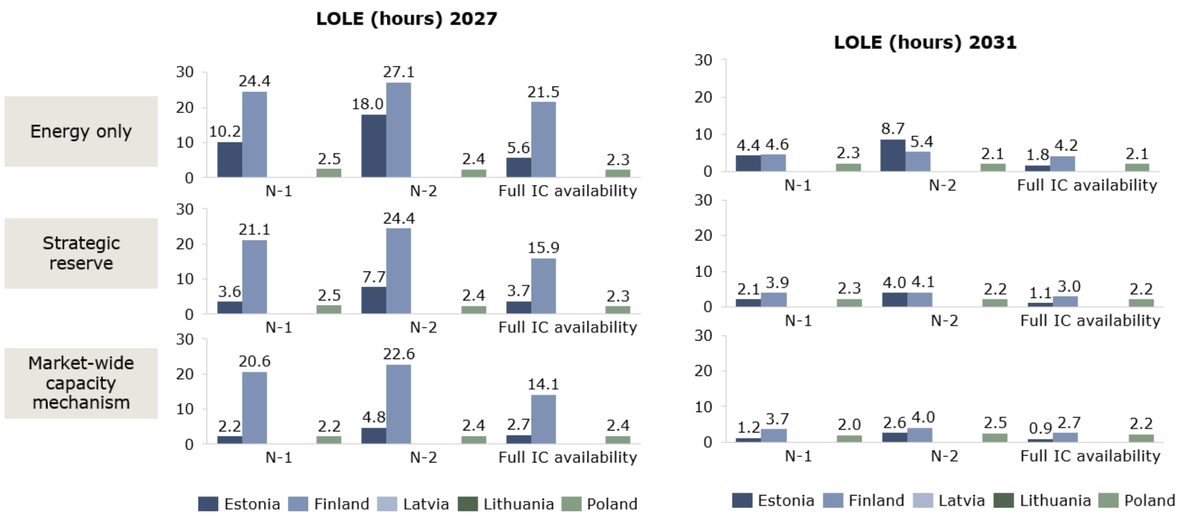
5.3 Quantitative assessment outcomes

5.3.1 Security of supply results

Loss of Load Expectation

Figure 5 shows the Loss of Load Expectation (LOLE) for Estonia and the neighbouring countries.

Figure 5 – Loss of Load Expectation for Estonia and neighbouring countries (hours)



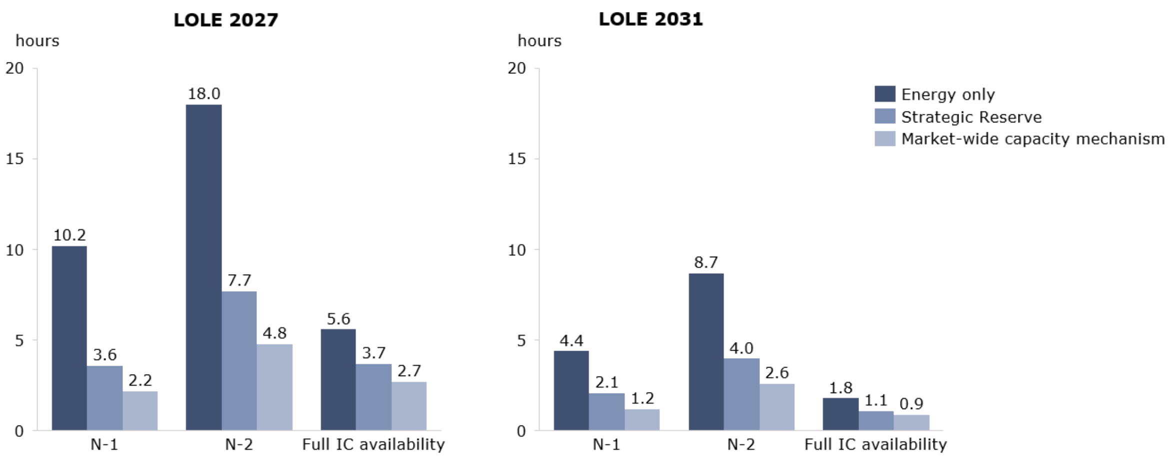
The two CRM options are structured in a way such that across all 'scenarios' Estonia meets its expected security standard, namely 9 hours of LOLE. We need to re-iterate, however, that our analysis and assumed scenarios should not be viewed as a capacity adequacy assessment – Elering undertakes detailed resource adequacy studies and our scenarios are not meant to replace such analysis.

The Finnish system appears to be the 'tightest' in 2027 based on our scenarios, and this has some spillover effects for Estonia. The capacity adequacy situation in Finland improves in 2031 with the addition of a new nuclear reactor in 2030. This then also helps decrease the LOLE in Estonia.

As shown in Figure 6, in the absence of a CRM, our analysis suggests that:

- Estonia is expected to have an LOLE of 5.6h in 2027 if there is no extensive outage on any of the interconnectors, meaning that it meets its 9h target in 2027;
- an extended outage on one of the interconnectors over high demand periods (winter months) may result in capacity adequacy issues with an estimated 10.2h of LOLE in the N-1 scenario and 18h of LOLE in the N-2 scenario in 2027; and
- with the expected commissioning of the new Finnish nuclear unit, capacity adequacy in Estonia is also enhanced, with the LOLE in 2031 being within the 9h security standard even in the N-2 scenario.

Figure 6 – Loss of Load Expectation for Estonia (hours)



We then include sufficient capacity in the different CRM options modelled to ensure that the security standard is met in both modelled years even under the N-2 scenario. For 2027 this means:

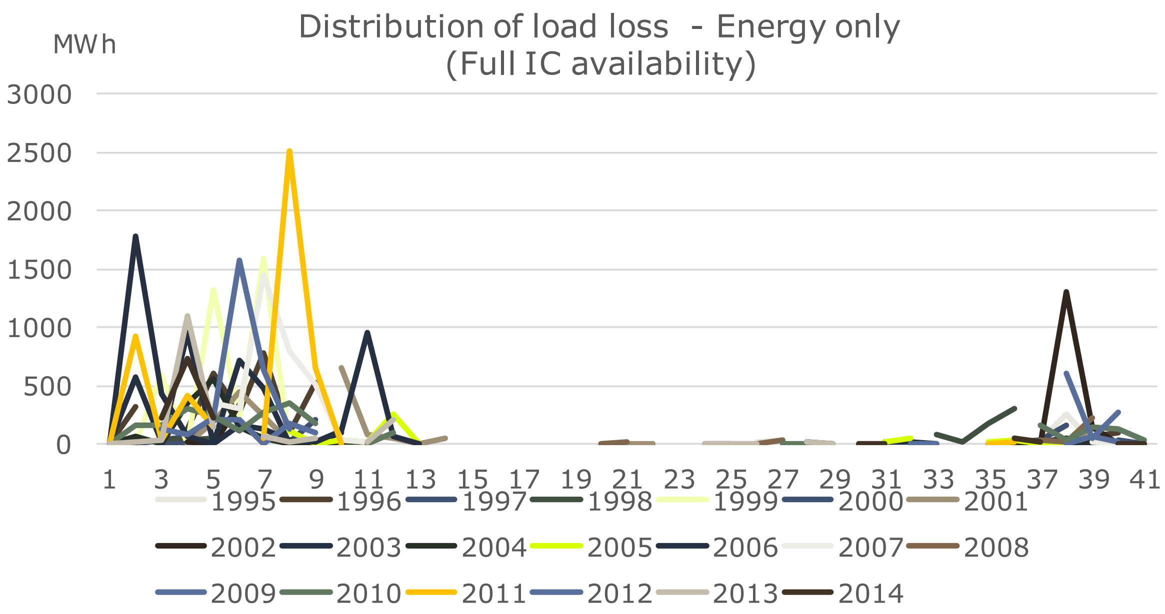
- a LOLE of 7.7h with the use of a Strategic Reserve; and
- a LOLE of 4.8h with the use of a market-wide CRM;
  - the lower LOLE in the market-wide CRM is because we account for the indivisibility of capacity and new entry is based on an efficiently sized unit.

Our modelling suggests that there is no difference in the resulting LOLE that would stem from the commercial decision by oil shale unit to opt for a capacity contract (or continue unrestricted operation in the energy markets). The ''system stress' events are concentrated in a small number of periods and the oil shale units would be in a position to support the system at those times.

Figure 7 gives an overview of the weekly distribution of the load loss across the 20 modelled weather years (1995-2014) for the energy-only case in the Full IC availability scenario. The periods with high loss of load probability are concentrated in winter months and over evening periods. This is also the case for the Strategic Reserve and Market-wide capacity mechanism CRM options across the different scenarios.

The Estonian system appears to be most 'stressed' in cold weather years (such as 2011), and not in dry years (such as 1996) when the Nordic hydrological balance is low. In contradiction to common expectations hydrology has a smaller impact on Estonian capacity adequacy.

Figure 7 – Distribution of load loss across weather years



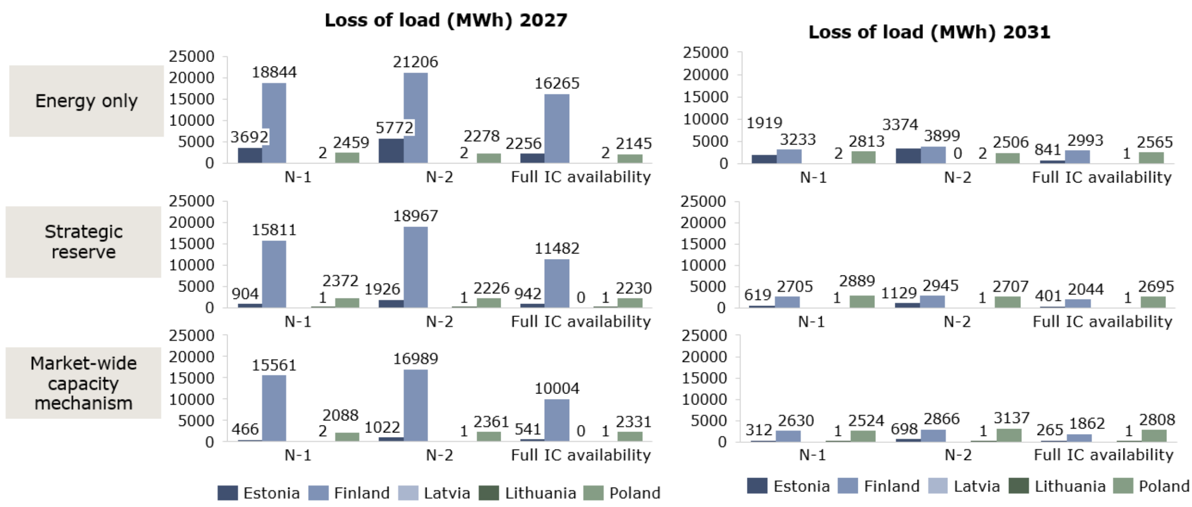
Ramping performance is an additional consideration. Oil shale units have quite 'slow' start-up times, and may be unable to meaningfully respond to short notices to deliver. Our modelling suggests that the available interconnection capacity and synchronised generation (other than oil shale units) would be sufficient to cope with such events with oil shale units (from an 'off' state) used only for dealing with more predictable and expected system tightness.

That said, in the case of a Strategic Reserve we would expect that the Estonian system would need additional fast-ramping strategic reserve to deliver the desired security standard in the N-2 and N-1 cases. This means an additional 280MW of fast-ramping capacity on top of the oil shale in the case of Strategic Reserve adoption (this applies to both SR w/o shale and SR with shale cases). With the market-wide CRM this flexibility is covered by a new CCGT, which from a part-loaded state can help with the system ramping requirements (again, this applies to both Market-wide w/o shale and Market-wide with shale cases).

Expected Energy Unserved

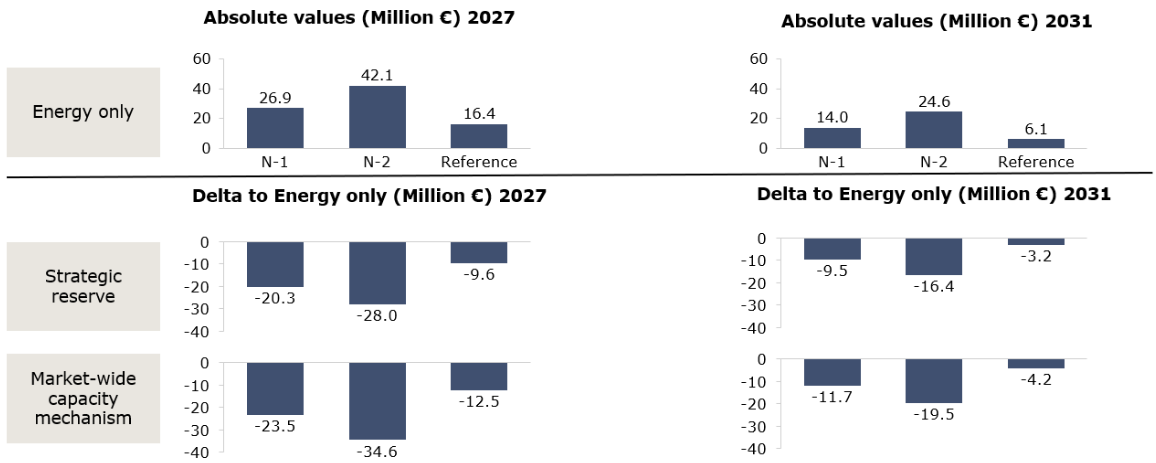
Figure 8 shows the expected energy unserved for the different scenarios in 2027 and 2031.

Figure 8 – Expected energy unserved (MWh)



Any energy unserved has a cost to society. The exact value of energy depends also on the type of demand that is curtailed. Given the difference in the value of different types of demand, a form of 'weighted' value that is commonly used is the Value of Lost Load. In Estonia the Value of Lost Load (VoLL) is assumed to be equal to €7287/MWh.

Figure 9 – Cost of expected energy unserved for Estonia



5.3.2 *General market metrics*

Wholesale electricity prices

The introduction of a CRM can have an impact on spot electricity price formation as it can:

- influence the underlying capacity mix; and

- implicitly or explicitly have an impact on market participant bidding in the markets.

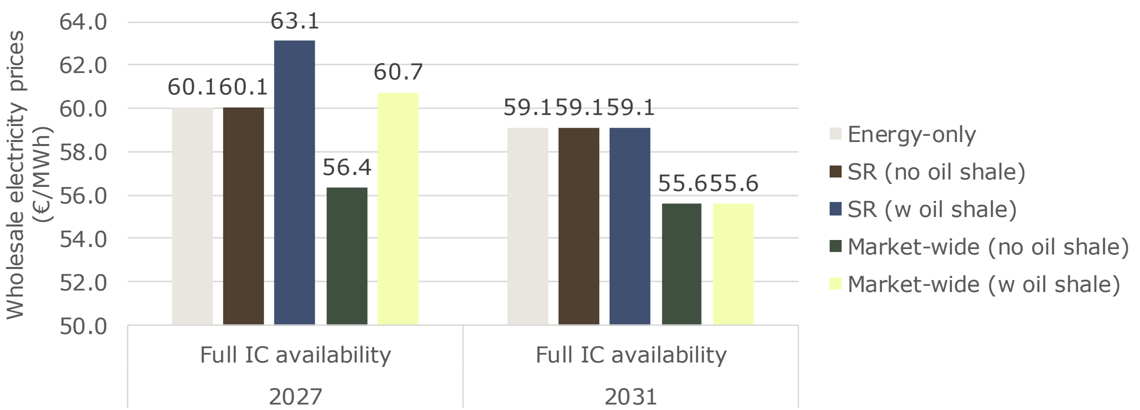
A Strategic Reserve scheme is designed to have no impact on underlying spot energy market price formation, as all capacity with a Strategic Reserve contract is 'ring-fenced' from the energy markets. This is also supported by our results in our Strategic Reserve (without oil shale) case – the baseload wholesale electricity price is similar to that from the energy-only market.

Wholesale electricity prices are, however, expected to change if oil shale units were to opt for a Strategic Reserve contract. This would mean less 'cheap' (in terms of short run marginal cost) generation available in the spot energy markets and a need to import more from neighbouring markets.

The market-wide CRM cases include the introduction of new CCGT capacity with relatively lower short run operating cost. Similarly, with oil shale units opting for limiting their operating hours, wholesale prices are expected to increase (Market-wide with oil shale).

Figure 10 shows the projected baseload wholesale electricity prices for the different CRM options modelled for the full IC availability scenario. Compared to the full IC availability scenario, the wholesale prices are higher in the N-1 and N-2 scenarios by €1MWh and €2/MWh respectively compared to each case. The general trend in the wholesale prices in the N-1 and the N-2 scenario is consistent with the full IC availability case.

Figure 10 – Projected wholesale electricity prices for different modelled CRM cases in the full IC availability case



Net flows

Assuming an energy-only market in Estonia, our modelled results suggests 2TWh of annual net imports in 2027, increasing to more than 2.7TWh in 2031 as additional oil shale capacity decommissions and Estonia is even more reliant on cross-border flows.

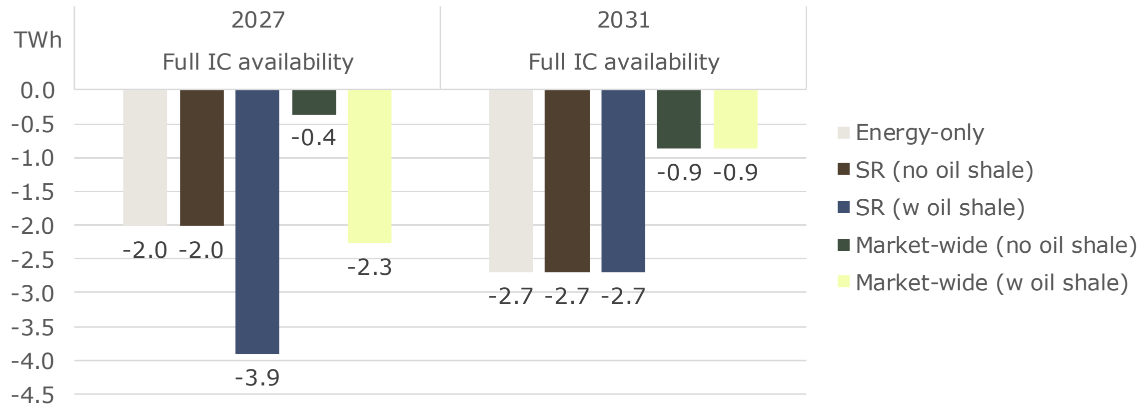
The introduction of a Strategic Reserve may either:

- have no impact on cross-border flows assuming that oil shale generating units opt out of the CRM and continue to operate without restrictions in the spot markets in terms of operating hours; or
- could see a significant increase in imports from neighbouring markets in 2027, should oil shale units choose to operate as strategic reserve assets with limited hours of operation.

The introduction of a market-wide CRM scheme, on the other hand, is very likely to result in more substantial changes to cross-border flows:

- if a market-wide scheme ends up delivering additional efficient (and non-peaking) capacity in Estonia, imports into Estonia would drop and exports would rise; and
- this will, however, not be the case if oil shale units choose to opt for a capacity contract and to limit their operating hours, with the net import position of Estonia increasing in 2027.

Figure 11 – Projected net flows (TWh) in the full IC availability case



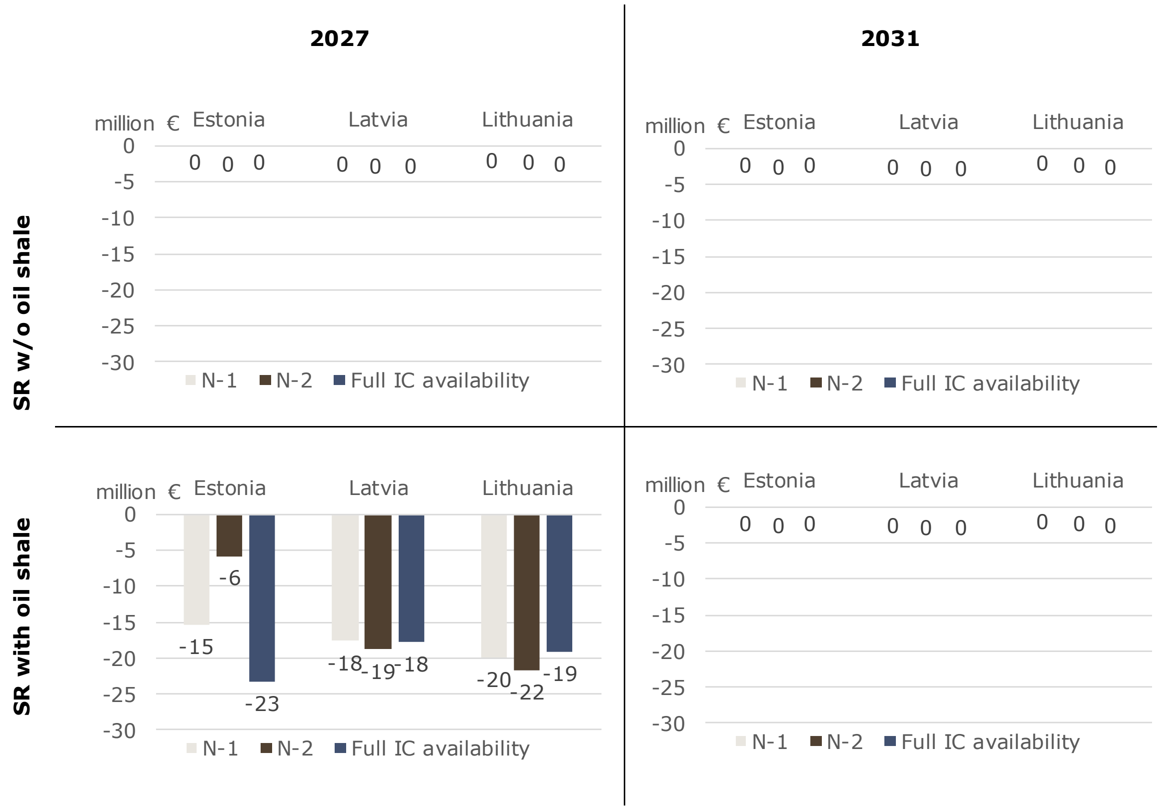
5.3.3 Changes in social welfare metrics

Consumer surplus

The introduction of a Strategic Reserve, as already discussed, has no impact on underlying spot price formation in the case where oil shale unit continue to operate without a capacity contract. All Strategic Reserve is additional capacity beyond what would otherwise operate under an energy-only market, and there is no change in the consumer surplus, as shown in Figure 12.

If, on the other hand, some of the oil shale capacity opts for a Strategic Reserve contract, we would expect spot electricity prices to rise as additional flows are needed to compensate for the oil shale generation, which is no longer available, and this results in higher electricity prices. Consumer surplus in Estonia is, therefore, lower in 2027, and this also spills over to Latvia and Lithuania. This is not the case for 2031, however, as these oil shale units are assumed to decommission in 2030.

Figure 12 – Change in consumer surplus with Strategic Reserve

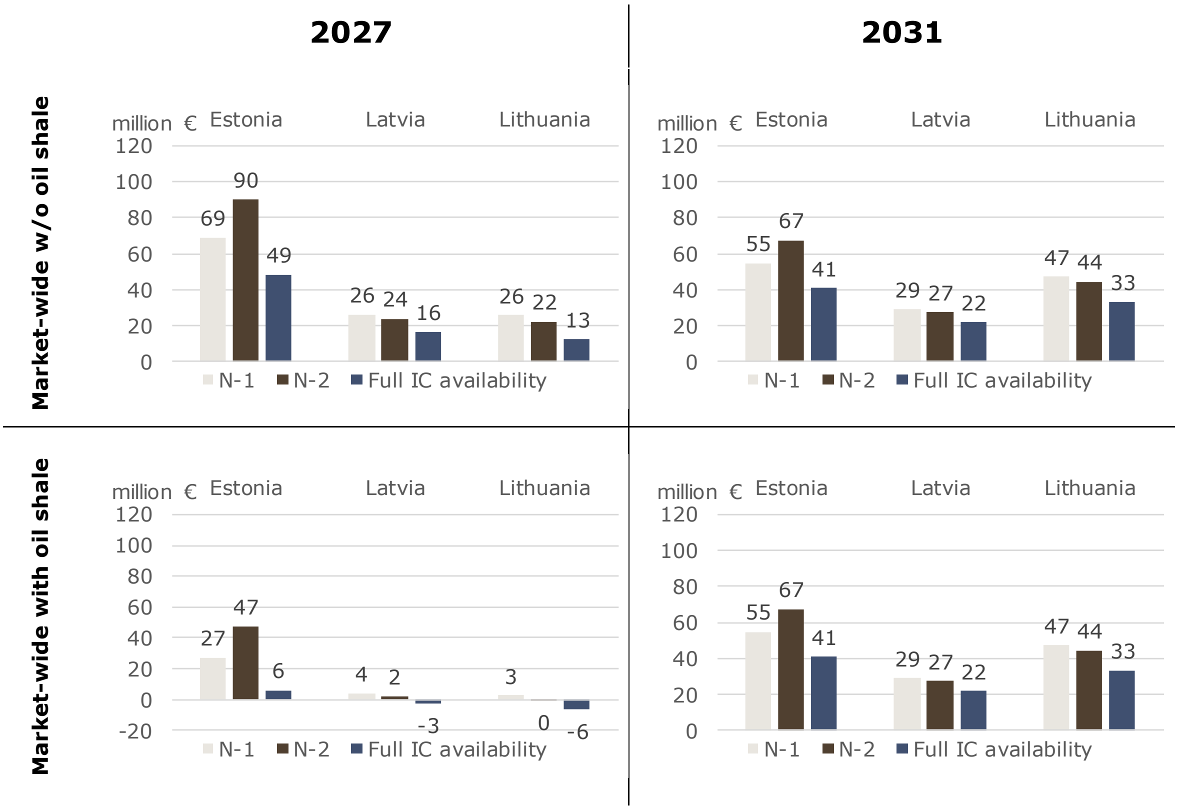


Estonian consumers are expected to see some benefit from the introduction of a market-wide CRM, on the other hand, in terms of wholesale electricity purchasing as spot electricity prices come down.

The increase of consumer surplus is more pronounced when oil shale units continue to operate without any operating restrictions. Assuming, however, that oil shale units choose to restrict their operating hours for a capacity contract, the positive impact on consumer surplus is significantly lower in Estonia, and, in fact would result in very little change for Latvian and Lithuanian consumers.

When comparing the different interconnector availability cases, we see that the benefit to Estonian consumers is the highest in the N-2 case. Over the winter months in the N-2 case, access to cheap production resources is more restricted – the presence of a more efficient and cost-effective unit under a market-wide CRM can help displace expensive production more frequently when compared to the full IC availability case (and the N-1 case).

Figure 13 – Change in consumer surplus with a market-wide CRM



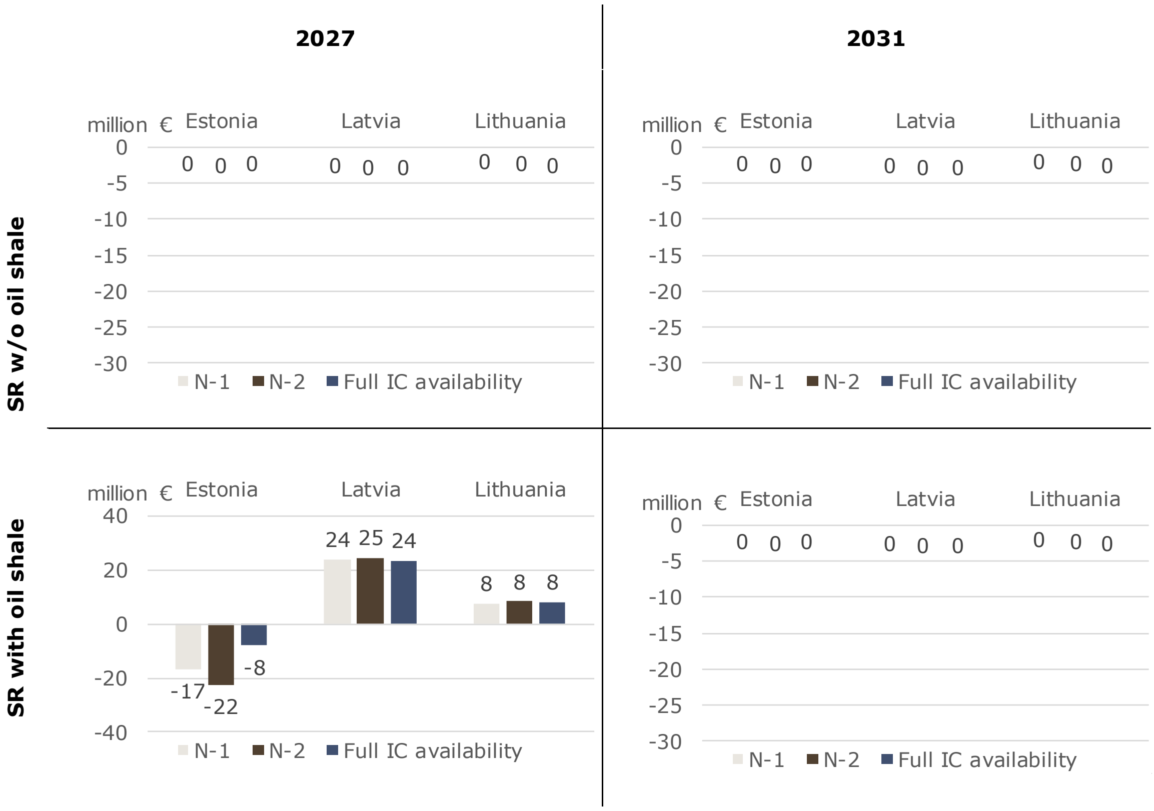
The change is consumer surplus presented in this section, however, ignores the additional cost and associated impact on (drop in) consumer surplus linked to payments for supporting capacity contracts. Once the cost associated with capacity payments is taken into account, the positive impact on the consumer surplus would be more limited, and in some cases this may even mean a reduction in Estonian consumer surplus.

Producer surplus

As already discussed, a Strategic Reserve is meant to have limited impact on the underlying functioning of the energy markets. With oil shale units continuing to operate in the energy markets, the overall producer surplus remains unchanged when compared to an energy-only market.

With some oil shale units opting for a Strategic Reserve contracts instead, the total producer surplus for Estonian producers is expected to drop. However, this does not account for the additional income earned under the capacity contract, which would be equal to the corresponding drop in consumer surplus for the part of the domestic capacity. Latvian and Lithuanian producers, on the other hand, would see an increase in their surplus in 2027 as flows from the other Baltic countries to Estonia increase.

Figure 14 – Change in producer surplus with Strategic Reserve



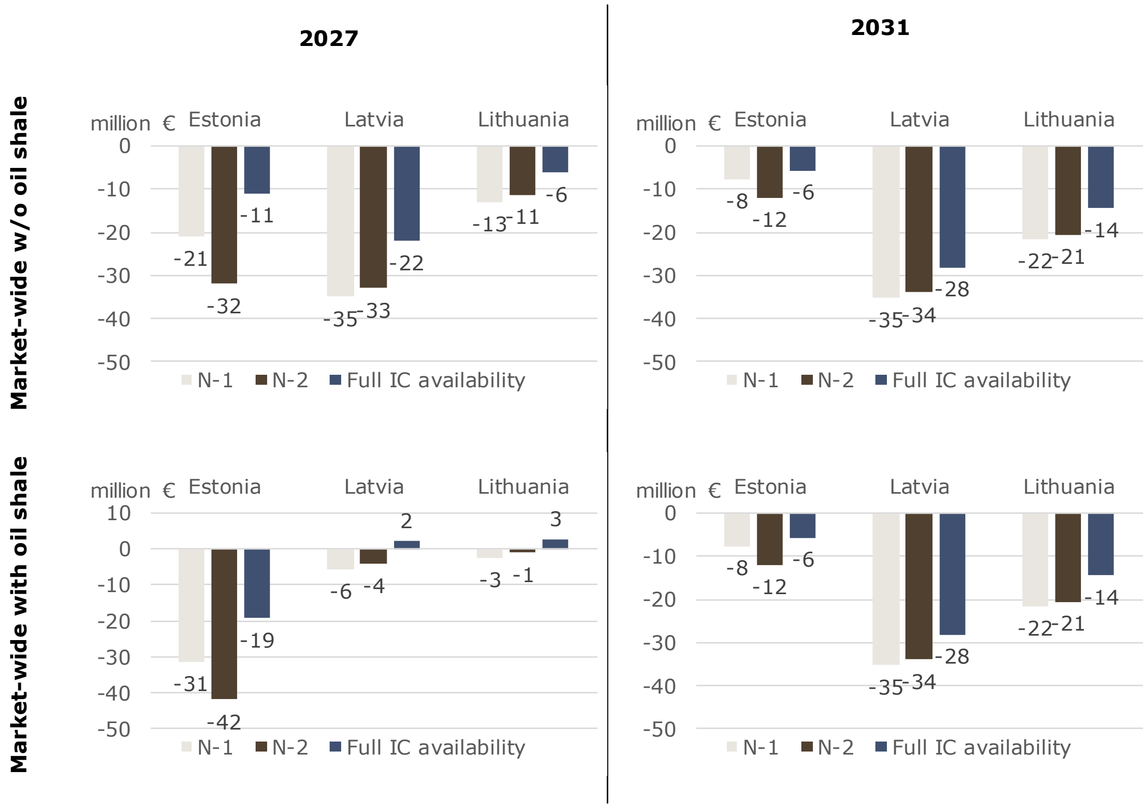
Lower prices in the presence of a market-wide CRM would however reduce the total producer surplus in Estonia. This reduction in the producer surplus is more pronounced in 2027, and comes despite an increase in overall domestic production in Estonia (as additional domestic generation comes online).

A relatively lower change in wholesale electricity prices in 2031 when compared to the energy-only scenario, means a smaller reduction in Estonian producer surplus.

As is the case with the consumer surplus, the producer surplus presented here excludes the CRM income for producers. It also does not account for the additional fixed costs incurred (considered as a separate item in our overall welfare analysis). With the inclusion of the CRM payments and the fixed costs, the producer surplus (for Estonian producers) would drop with a market-wide CRM.

This reduction in producer surplus with the introduction of a market-wide CRM is rather counterintuitive – typically the introduction of a market-wide CRM would mean a transfer of surplus from consumers to producers. This does not appear to be the case in our analysis for Estonia, and is linked to the underlying generation mix in Estonia. Most of the domestic capacity would not be eligible for CRM payments, and it is interconnectors and foreign capacity providers that would capture additional surplus.

Figure 15 – Change in producer surplus with market-wide CRM



Fixed costs

Further to the changes in short-term social welfare metrics, changes in the underlying capacity mix also mean different fixed costs. The introduction of new capacity under both the Strategic Reserve and the market-wide CRM add to system costs. Estonia is a small electricity system and the assumed different CRM design would result in relatively small changes in the capacity mix. In our analysis we have estimated that:

- an additional 280MW of capacity would be needed to ensure that Estonia can meet its security standard even under an N-2 situation; and
- although 280MW of further capacity is sufficient is sufficient to deliver the desired security standard, under a market-wide CRM we would expect that the traditional 'elastic' demand for capacity will likely deliver an additional 400MW of capacity.

To re-iterate, this study is not a capacity adequacy study and is not aimed at quantifying the level and type of new capacity needed in Estonia. It is, rather, intended to quantify the differences between the alternative CRM designs. To achieve this, it is, however, impossible to not take a view with respect to the capacity needed to meet a certain security standard.

We have assessed different types of additional capacity, including thermal generation and battery storage, and in our scenarios we commission the 'best new entrant' in both CRM options:

- in the case of the Strategic Reserve, the associated capacity does not capture any margins from the provision of energy in the spot markets – the resulting 'best new entry', therefore, ends up being a 'peaking' unit with relative low efficiency, fast start-up ramping and low capex; and
- in the case of a market-wide CRM the resulting new entry is a new Combined Cycle Gas Turbine – we have to note, however, that battery storage could also be in a position to deliver the desired security standard, albeit at a slightly higher cost given our assumed capex and opex for the different technologies.

We have used the cost assumptions shown in Table 8 in our analysis for determining the differences in fixed costs across scenarios.

Table 8 – Cost assumptions for new entrants

	OCGT	CCGT
Capex - €/kW	450	650
Opex - €/kW	10	25
Economic life	20	20
WACC	7%	9%
Annualised cost - €/kW	52.5	96.2
Capacity - MW	280	400
Total annual cost - m€	14.7	38.5

Administrative costs

The administrative costs account for implementation and non-recurrent market costs faced by the central body, and exclude costs faced by market participants. Implementation costs have been assuming a 15-year operation of the scheme and a discount factor of 5%. For the market-wide CRM these are based on the impact assessment of the I-SEM CRM[31] – Ireland is also a relatively small electricity system and the scheme used takes the form of a centrally organised Reliability Option.

There is much less literature review in terms of administrative costs for a Strategic Reserve. We would expect however that the administrative costs will be significantly lower given the narrower scope. For the purposes of our cost-

31 https://www.semcommittee.com/sites/semcommittee.com/files/media-files/SEM-14-085b%20I-SEM%20SEMC%20decision%20on%20HLD%20Impact%20Assessment.pdf

benefit analysis we have assumed that the administrative costs for a Strategic Reserve are equal to 50% of a market-wide CRM.

Total net benefit

Table 9 shows the total net benefit of different CRM options in 2027. In the without oil shale variants, both CRM options appear to deliver an overall net benefit in the N-1 and N-2 cases – this means the system would be more efficient in the presence of a CRM assuming extended interconnector unavailability. This improvement in social welfare is primarily driven by the reduction of the cost associated with unserved energy.

However, were some of the oil shale units to opt for more limited operating hours, then we would not expect to see an improvement in social welfare under either CRM, even in an N-2 scenario, as shown in the with shale oil cases. The cost associated with significant levels of energy unserved may be avoided, but this would come alongside a significant reduction in producer surplus and a somewhat more limited increase of consumer surplus.

Comparing the two CRM types, it is apparent that the Strategic Reserve options deliver more moderate results in both directions. Net benefit improvements in the N-2 case may not be as high as those in the market-wide CRM but net dis-benefits in other cases are also more muted.

Across all options, however, there is one commonality – there appears to be no benefit from the introduction of a CRM assuming that interconnector availability remains intact. If anything, there is a marginal reduction in total social welfare. In the case of the market-wide CRM this reduction is actually significant (a loss of 45 m€).

Table 9 – Total net benefit of different CRM options in 2027

	Strategic Reserve w/o oil shale			Market-wide CRM w/o oil shale		
m€	N-1	N-2	Full IC	N-1	N-2	Full IC
Producer surplus	0	0	0	-21	-32	-11
Consumer surplus	0	0	0	69	90	49
IC rent	0	0	0	-17	-23	-17
EEU	20	28	10	24	35	12
Fixed cost	-15	-15	-15	-38	-38	-38
Admin cost	-1	-1	-1	-2	-2	-2
Net benefit	**4.7**	**12.4**	**-6.0**	**14.3**	**29.5**	**-7.1**
	Strategic Reserve with oil shale			**Market-wide CRM with oil shale**		
	N-1	N-2	Full IC	N-1	N-2	Full IC
Producer surplus	-17	-22	-8	-31	-42	-19
Consumer surplus	-15	-6	-23	27	47	6
IC rent	8	5	9	-6	-11	-4
EEU	20	28	10	24	35	12
Fixed cost	-15	-15	-15	-38	-38	-38
Admin cost	-1	-1	-1	-2	-2	-2
Net benefit	**-19.1**	**-10.4**	**-28.3**	**-26.4**	**-11.3**	**-44.9**

Our analysis suggests that the relative merits and benefits delivered from the introduction of a CRM depend on the probability assigned to the potential interconnector infrastructure unavailability. These results should therefore be viewed in that context.

The key conclusions in terms of welfare distribution from the 2027 analysis are:

- a ‘narrow’ Strategic Reserve (that would exclude ‘slow ramping’ oil shale units) would deliver an improvement for consumers in the case of extended interconnector unavailability as the avoided EEU costs is greater that the relative payments to capacity providers;
- in years with ‘typical’ interconnector availability, on the other hand, consumers would be paying for the Strategic Reserve, but would see little improvement in terms of EEU and the associated cost;
- interconnectors (and by extension capacity outside Estonia) would benefit from a market-wide CRM scheme primarily as a result of the presence of CRM payments (which are not included in the IC presented above); and
- Estonian producers (as a whole) would actually see a reduction in their surplus with a market-ide CRM as prices drop and most of the domestic generation is not eligible for CRM payments.

Table 10 – Alternative presentation of welfare estimates in 2027

	Strategic Reserve w/o oil shale			Market-wide CRM w/o oil shale		
m€	N-1	N-2	Full IC	N-1	N-2	Full IC
Producer surplus	0	0	0	-43	-54	-30
Consumer surplus	6	13	-5	33	67	-8
IC rent	0	0	0	26	19	32
Admin cost	-1	-1	-1	-2	-2	-2
Net benefit	**4.7**	**12.4**	**-6.0**	**14.3**	**29.5**	**-7.1**
	Strategic Reserve with oil shale			**Market-wide CRM with oil shale**		
	N-1	N-2	Full IC	N-1	N-2	Full IC
Producer surplus	-17	-22	-8	-41	-53	-30
Consumer surplus	-10	8	-28	-49	-15	-80
IC rent	8	5	9	65	58	67
Admin cost	-1	-1	-1	-2	-2	-2
Net benefit	**-19.1**	**-10.4**	**-28.3**	**-26.4**	**-11.3**	**-44.9**

The need for a CRM is less pronounced in 2031. As further nuclear capacity comes online in Finland, there is a less of a need for Estonia to support Finland in tight periods and Finland can contribute more to the Estonian security standard. This is despite the further reduction in domestic available capacity.

As can be seen in Table 11, in 2031, as most oil shale capacity has retired, there is no longer a difference in the CRM options depending on oil shale participation. With fully available interconnection, both CRM options result in a welfare loss. The market-wide CRM yields an even greater loss when compared to the Strategic Reserve option.

In the N-1 and N-2 cases, however, the market-wide CRM outperforms the Strategic Reserve Option. This is primarily driven by a strong increase in the consumer surplus.

Table 11 – Total net benefit of different CRM options in 2031

	Strategic Reserve w/o oil shale			Market-wide CRM w/o oil shale		
m€	N-1	N-2	Full IC	N-1	N-2	Full IC
Producer surplus	0	0	0	-8	-12	-6
Consumer surplus	0	0	0	55	67	41
IC rent	0	0	0	-17	-23	-18
EEU	9	16	3	12	19	4
Fixed cost	-15	-15	-15	-38	-38	-38
Admin cost	-1	-1	-1	-2	-2	-2
Net benefit	**-6.1**	**0.8**	**-12.4**	**1.6**	**12.1**	**-18.7**
	Strategic Reserve with oil shale			**Market-wide CRM with oil shale**		
	N-1	N-2	Full IC	N-1	N-2	Full IC
Producer surplus	0	0	0	-8	-12	-6
Consumer surplus	0	0	0	55	67	41
IC rent	0	0	0	-17	-23	-18
EEU	9	16	3	12	19	4
Fixed cost	-15	-15	-15	-38	-38	-38
Admin cost	-1	-1	-1	-2	-2	-2
Net benefit	**-6.1**	**0.8**	**-12.4**	**1.6**	**12.1**	**-18.7**

5.3.4 Impact on consumers

Every CRM option will have an impact on consumer bills. We have calculated the impact of each CRM option against the energy-only case. Figure 16 shows the change in the unit price faced by consumers with a Strategic Reserve in place.

If oil shale units do not have a Strategic Reserve contract, consumers only bear the cost of the additional Strategic Reserve capacity. Electricity costs are however significantly higher should oil shale units to opt for a Strategic Reserve contract. In such case, we expect to see higher wholesale electricity prices and the additional cost of the Strategic Reserve contracts.

Figure 16 – Change in unit cost to consumers with Strategic Reserve

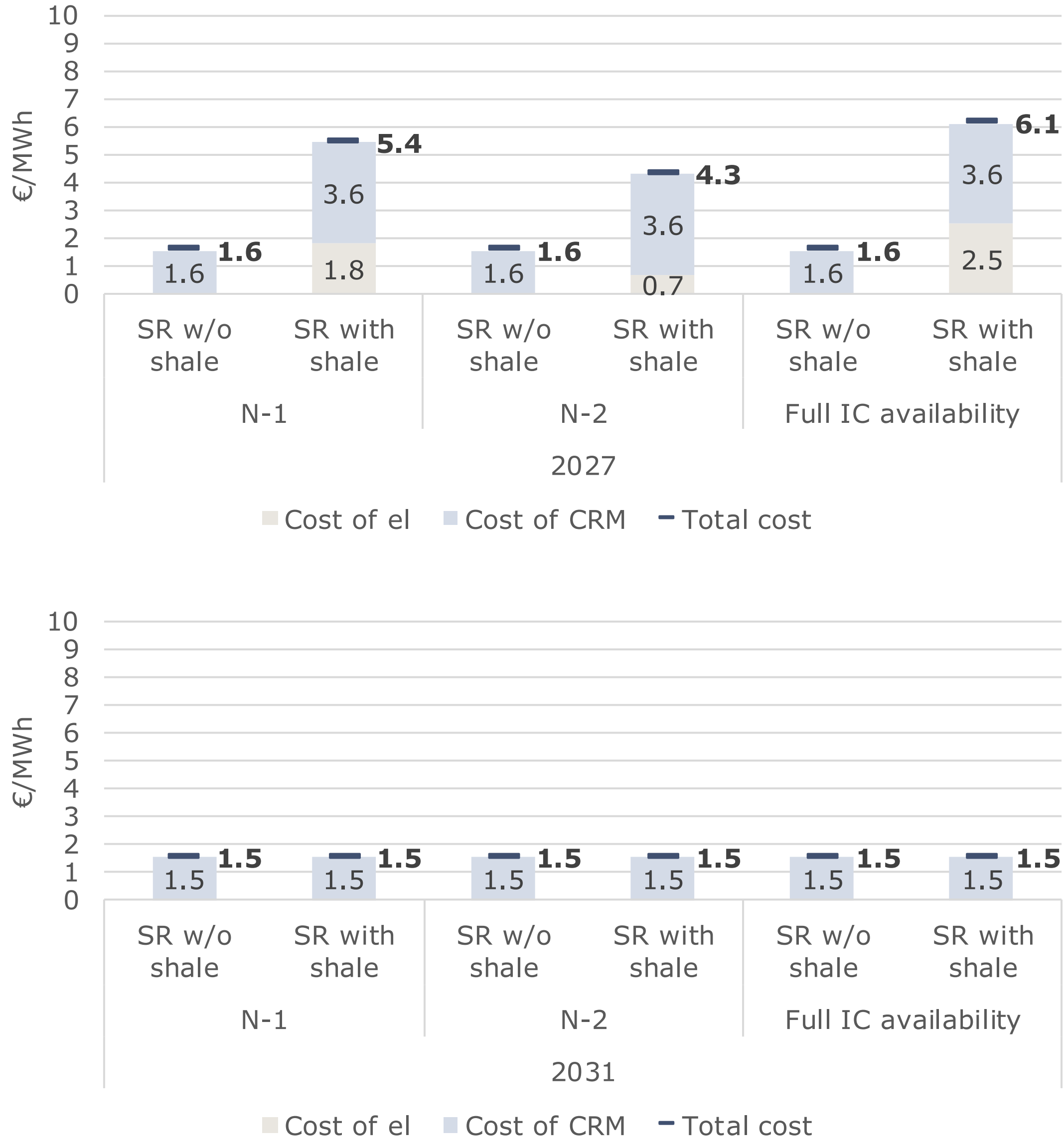


Figure 15 shows the change in unit cost to consumers under the market-wide CRM option.

The market-wide CRM places a greater burden on consumers when compared to the Strategic Reserve option when oil shale units opt for a capacity contract. Wholesale electricity costs may be lower with the market-wide CRM option, but the costs associated with the CRM itself are higher. There are however circumstances that would actually deliver a lower cost to consumers – this is the case in years with extended interconnector unavailability and with no CRM contracts for oil shale units.

Figure 17 – Change in unit cost to consumers with market-wide CRM

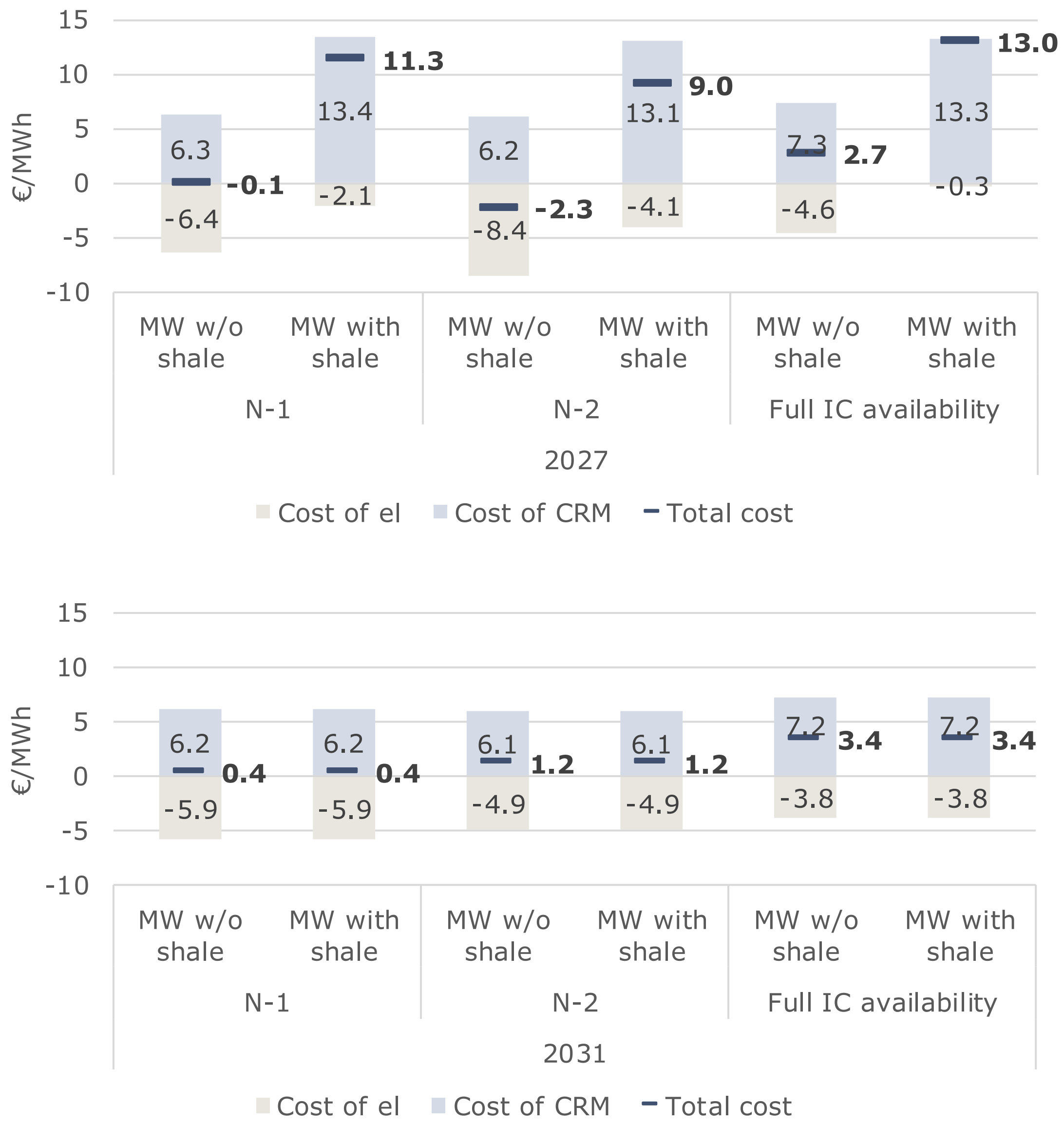


Figure 18 and Figure 19 show the change in total cost to consumers in the different CRM options compared to the energy-only case. As described above, the consumers pay an additional 122 million euros in the market-wide CRM option in 2027 (and in the case with no interconnector unavailability).

Figure 18 – Change in total cost to consumer with Strategic Reserve

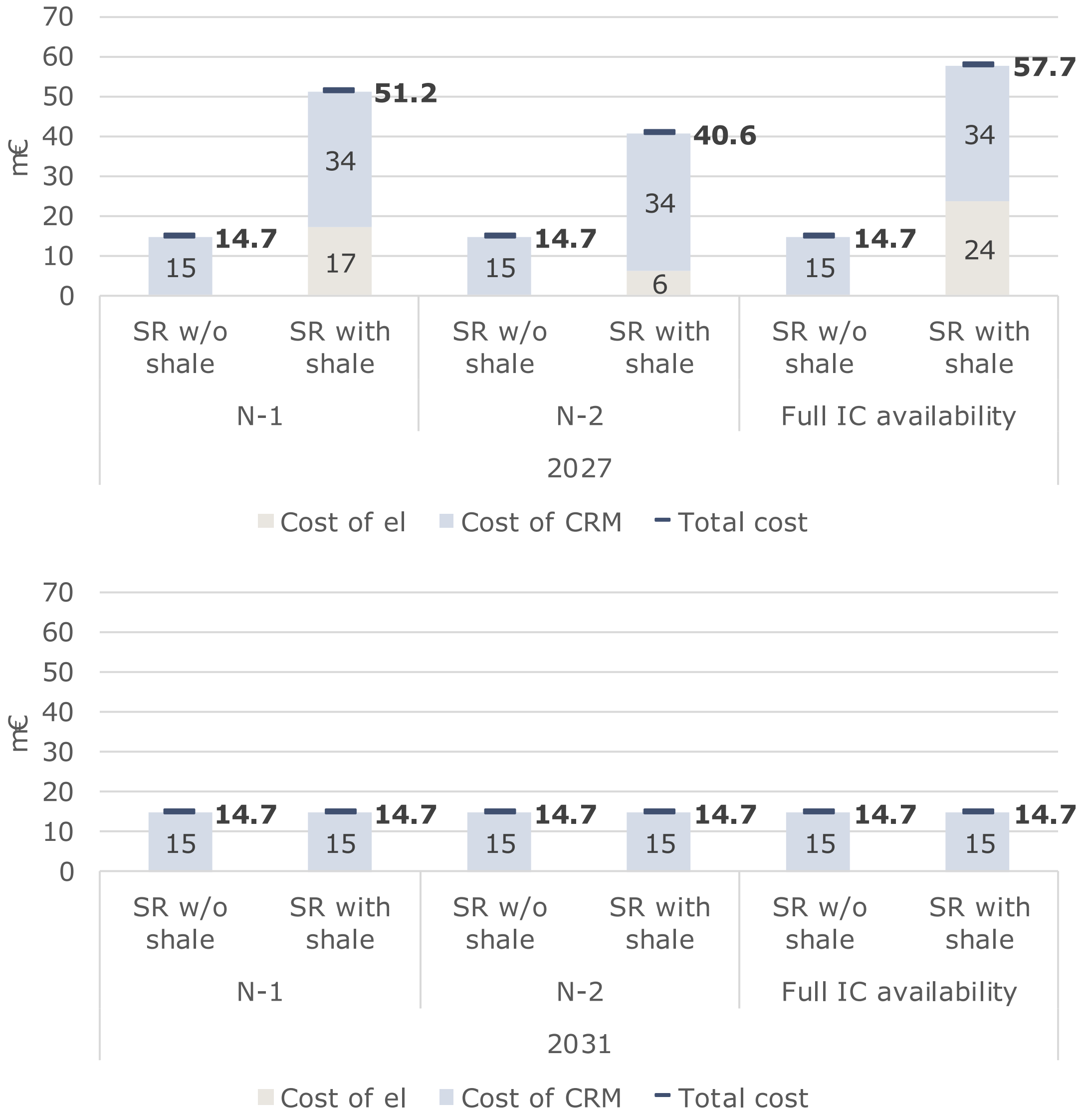
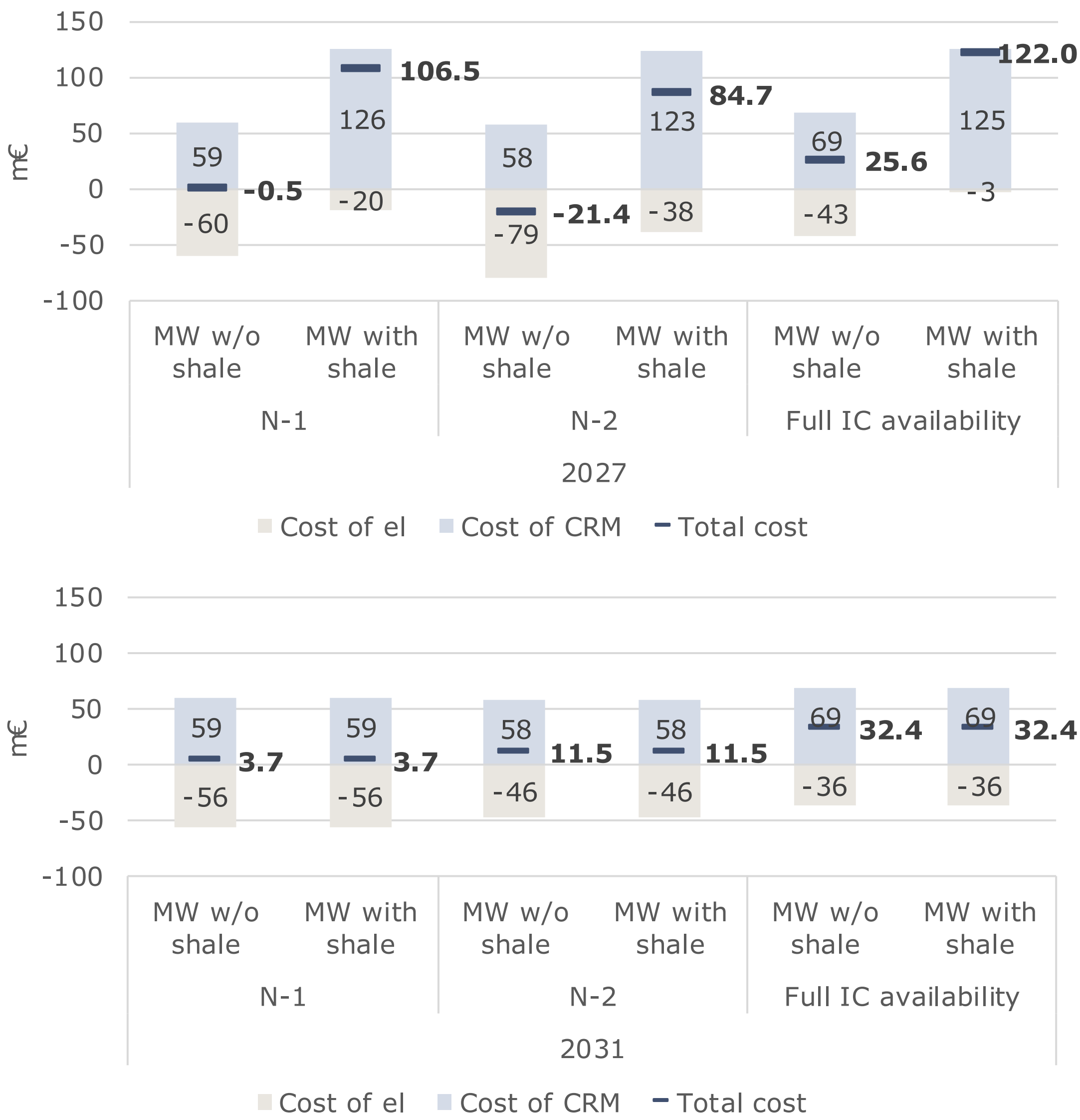


Figure 19 – Change in total cost to consumer with market-wide CRM



5.3.5 Sensitivity to different parameters

Policy interventions can have different results depending on the underlying circumstances. Our analysis has been based on assumptions from the ENTSO-E National Trends scenario in terms of commodity prices and future demand evolution.

We recognise that deviations from these assumptions may deliver different results in terms of costs and benefits. We have, therefore, considered the potential impact of change in some of the key parameters, including demand and carbon prices.

Higher electricity demand

A faster increase in electricity demand in Estonia would most likely strengthen the case for a CRM. Energy markets may still be in a position to deliver the required capacity, but, on the basis that there is an argument for a CRM in the first place, a higher electricity demand would further support this position.

Wholesale electricity prices may also increase as less efficient and more expensive resources are used. At the same time, scarcity pricing may also be more pronounced. Higher wholesale electricity prices could then in their turn incentivise oil shale units to continue to operate in the energy market, opting out of the CRM.

Higher demand will also mean an increase in the volume of additional capacity needed, and a market-wide CRM may be better suited to deliver capacity adequacy than a more limited in scope Strategic Reserve scheme.

Lower electricity demand

If electricity demand turns out to be lower than expected, then the case for a CRM may be much weaker. A Strategic Reserve may then appear to be the ‘least regret’ option as the corresponding expenditure is limited.

Higher CO_2 prices

A rise in CO_2 prices would significantly affect oil shale economics and their operation could become increasingly challenging. Oil shale units would effectively be encouraged to stop operating in the energy markets and opt for a capacity contract, if available. This may then result in an overall welfare loss in a ‘typical’ year under both CRM schemes.

Lower CO_2 prices

Conversely, lower CO_2 prices would support oil shale economics and the operation in the energy markets may continue to be attractive. When it comes to the welfare differences between the two CRM options, the overall welfare change may be greater for the Strategic Reserve than the market-wide CRM option.

6. SUMMARY AND RECOMMENDATIONS

Studies in relation to Estonian security of supply have concluded that there is a very low probability of security of supply issues in the near- to mid-term, but moving towards the 2030s the probability for loss of load increases, with potential issues linked to unavailability of several pieces of interconnector infrastructure, i.e. simultaneous interconnector outages. While such outages are expected to be infrequent, if they do occur, they could be for an extended period. In this context, the potential for the introduction of some form of CRM is relevant as a possible route for achieving security of supply.

Our assessment has considered the merits of different CRM designs qualitatively and quantitatively, with the latter specifically comparing forms of strategic reserve and market-wide CRM to the energy-only market baseline. The quantitative assessment provides a mixed picture with the following outcomes evident:

- **No net benefits in a 'typical' year**: In the absence of interconnector availability concerns, our modelling indicates that introducing either form of CRM will lead to a net cost to Estonia in the years considered. Given this, the anticipated likelihood of extended concurrent interconnector failures is a key factor in balancing whether the additional cost of a CRM in 'typical' conditions outweighs the cost associated with energy unserved in the event of interconnector failures.
- **Sensitivity to capacity additions elsewhere**: The addition of capacity in Finland has a negative effect on the cost-benefit outcome for any CRM in Estonia, even once oil shale units have been decommissioned. With additional Finnish nuclear capacity expected by the early 2030s, the potential merits of any CRM in Estonia may, therefore, prove to be time-limited.
- **No clear winner between CRM options**: Both forms of CRM considered are expected to result in reduced loss of load expectation and costs of energy unserved in the event of interconnector unavailability. However, each approach offers different relative advantages, with the Strategic Reserve option providing a lower cost route for achieving this, while a market-wide CRM delivers greater net benefit in the case of interconnector unavailability by virtue of more efficient capacity provision.
- **Sensitivity to commercial decisions made by oil shale units:** Oil shale units can opt to restrict their operating profile in exchange for a capacity contract. On the one hand, this would significantly reduce Estonia's carbon footprint, but at the same time, it may result in a net welfare loss and higher cost to consumers, in particular in 'typical' years with expected interconnector availability.

These outcomes combine to mean that there is no clear cut preferred option for a potential Estonian CRM in 'hard' monetary terms. There is a need to form a judgement informed by the balance of pros and cons linked to different options, including qualitative criteria as shown in Table 12.

Table 12 – Summary overview of potential CRM options for Estonia based on qualitative assessment

<table>
<tr><th>Rank</th><th>Model</th><th colspan="2">Compatibility of solution with problem</th><th colspan="2">Appropriate allocation of responsibilities</th><th colspan="2">Relative ease of EC clearance</th><th colspan="2">Minimising energy market impact</th><th colspan="2">Administrative ease</th></tr>
<tr><td>1</td><td>Strategic reserve</td><td>✓</td><td>Targeted solution to alleviate adequacy concerns linked to low probability risk of simultaneous interconnector outages</td><td>✓</td><td rowspan="3">Central management of risks of low probability interconnector outages is appropriate</td><td>✓</td><td>EC’s starting option if the need for intervention to introduce some form of CRM is demonstrated</td><td>✓</td><td>Good design minimises distortion and market-led investment continues</td><td>✓</td><td>Simplest of the CRM options to implement and operate</td></tr>
<tr><td>2</td><td>Capacity auction for reliability option capacity contracts</td><td>×</td><td rowspan="3">Models better suited to coverage of peak demand conditions, rather than interconnector outages</td><td>✓</td><td>×</td><td rowspan="3">More challenging than strategic reserve in terms of EC approvals</td><td>✓</td><td>Investment driven by CRM, but CRM penalties encourage effective price formation</td><td>×</td><td rowspan="3">Centralised schemes with associated administrative complexities</td></tr>
<tr><td>3</td><td>Capacity auction for non-option capacity contracts</td><td>×</td><td>✓</td><td>×</td><td>×</td><td rowspan="2">Investment driven by CRM and administered CRM penalties do not support effective wholesale price formation</td><td>×</td></tr>
<tr><td>4</td><td>Decentralis ed obligation</td><td>×</td><td>×</td><td>Retailers not best placed to manage risks of concurrent interconnector outage risks</td><td>×</td><td>×</td><td>×</td></tr>
</table>

Drawing together the insights from both the qualitative and quantitative assessment our findings are as follows:

- a **Strategic Reserve approach is a better fit for the Estonian context** if a CRM is needed to alleviate interconnector unavailability related adequacy issues; and
- there is **nothing to indicate that a Strategic Reserve model will not resolve Estonia's adequacy issues** if a CRM is demonstrated to be required.

The Electricity Regulation 2019 states that a Member State shall **assess whether a strategic reserve is capable of addressing its resource adequacy concerns** and that **only where this is not the case** may a different type of CRM be implemented[32]. Taking this requirement and insights from our assessment together, **our recommendation is that a Strategic Reserve model should be selected in the event that a CRM is considered to be needed in Estonia to protect against interconnector unavailability**.

If strategic reserve implementation in Estonia is to be considered further, underlying design details need to be defined, with a requirement for supporting analysis. This includes features including the follows:

- capacity requirement needed to alleviate adequacy issues;
- notice period for response of contracted capacity;
- response duration requirements and minimum running times;
- criteria for utilisation and market pricing arrangements;
- contracting process; and
- commercial arrangements.

32 Electricity Regulation 2019 Article 21.

ANNEX A – HIGH-LEVEL IMPLEMENTATION PLAN

A.1 Introduction

This Annex considers a high-level roadmap for CRM implementation, in the event that a decision is taken to embark upon adoption of a CRM. This identifies the high-level decision points and processes that will need to be followed in order to implement the CRM, as well as roles and responsibilities in the Estonian context.

A.2 Parties involved

At a high level, the parties with primary responsibilities for aspects of a potential CRM implementation process are as follows:

- Ministry of Economic Affairs and Communications (referred to as 'Ministry' below);
- Estonian Competition Authority (referred to as 'NRA' (National Regulatory Authority) below);
- Estonian TSO, Elering;
- ENTSO-E; and
- European Commission, Competition department.

In addition, market participants, including electricity consumers and potential new market entrants are an important stakeholder group to ensure fit-for-purpose details of the potential CRM design.

Additionally, stakeholders in neighbouring member states are required to be heard in the implementation process as stated in the European Electricity Regulation, due to cross-border impacts that need to be taken into account. Similarly, stakeholders in other Member States need to be factored into the implementation processes if the CRM design allows cross-border participation.

The main focus in the sections below is on activities that need to be undertaken by Estonian institutions and pan-European agencies.

A.2.1 Overview

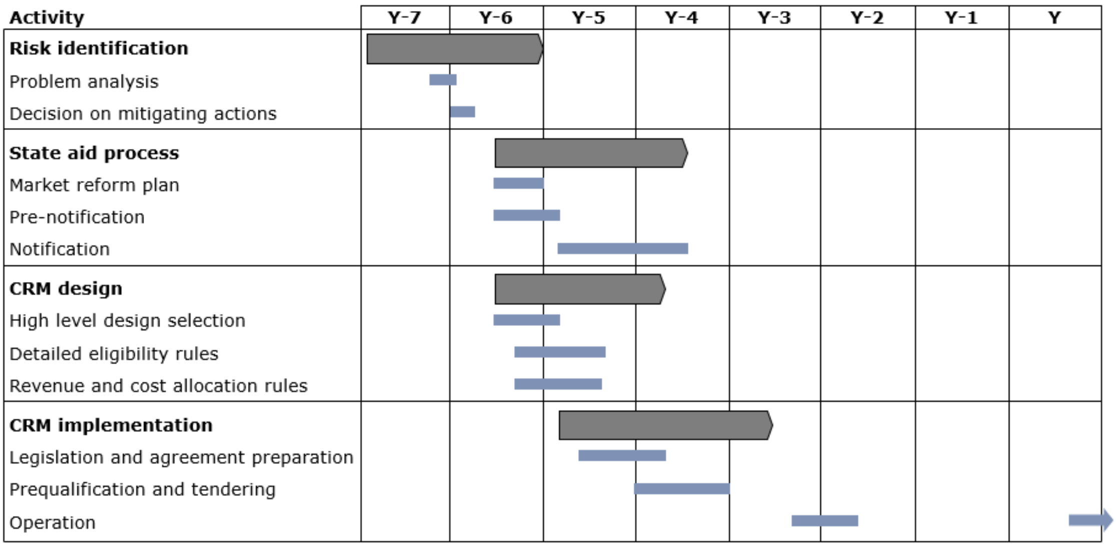
The high-level timeline for a potential CRM implementation process is illustrated in Figure 20. This timeline culminates at the point from which resources contracted under the CRM are expected to be operationally available – this is denoted as year Y. The timeline then works backwards to allow for activities needed to allow operational go-live in year Y. In order to allow for possible new build to become operational in year Y through the CRM, the activities timeline actually commences around Y-7/Y-6 and includes the following over-arching activity clusters:

- risk identification;

- State Aid process;
- CRM design; and
- CRM implementation.

These activities, sub-tasks under them and associated responsibilities are outlined in the following sub-sections.

Figure 20 – High level timeline



A.2.2 Actions

A.2.2.1 Risk identification

The first cluster of activities revolve around assessment and demonstration of a security of supply issue that is sufficient to trigger potential implementation of a CRM. This cluster is referred to as 'risk identification'. Table 13 sets out actions falling under the risk identification cluster, along with primary responsibility for progression and an estimate of time needed to complete.

The initial activities listed in Table 13 are regular, ongoing activities that will act as the trigger for initiation of subsequent activities. If these ongoing activities do highlight security of supply issues, then progression to subsequent activities can be initiated. These post-trigger activities are estimated to run over 3 quarters starting Q4 Y-7 and ending Q2 Y-6.

Table 13 – Risk identification actions

Action	Origin of requirement	Responsibility	Timing/duration
Establish a national reliability standard	EU electricity regulation	Ministry	Process to establish underway already, so will be in place in any event
Conduct the European security of supply assessment	EU electricity regulation	ENTSO-E	Ongoing regular assessment undertaken in any event
Conduct the national security of supply assessment with a regional scope	Estonian electricity market act	TSO	Ongoing regular assessment undertaken in any event
Observe a security of supply risk that is greater than the reliability standard in one of the security of supply assessments	Estonian electricity market act	NRA	Will stem from the security of supply assessments, providing the trigger for subsequent activities
Notify Ministry of a potential adequacy problem	Estonian electricity market act	NRA	Q4 Y-7
Assess potential market failures and regulatory distortions	EU electricity regulation	NRA	Q4 Y-7
Identify the underlying cause of the adequacy issue, quantify the adequacy risk and define the objectives of the potential CRM	EU electricity regulation	NRA	Q4 Y-7
Decision to start preparing capacity mechanism	EU electricity regulation	Ministry	Q1 Y-6
Conditional: Prepare an explanation to ACER if conclusions of the national and European assessments diverge	EU electricity regulation	TSO / NRA	Q1 Y-6

Action	Origin of requirement	Responsibility	Timing/duration
Conditional: Finalisation of ACER process	EU electricity regulation	TSO / NRA	Q2 Y-6

A.2.2.2 State aid process

Following a Ministry decision to start preparing a CRM, engagement with the European Commission must be undertaken with the objective of securing State Aid clearance. There is a degree of parallel running between this process and CRM design activities. Activities associated with this process are set out in Table 14.

Table 14 – State Aid process actions

Action	Origin of requirement	Responsibility	Timing/duration
Pre-notify Commission of the CRM implementation	State aid	Ministry	Q2 Y-6 to Q4 Y-6
Develop an implementation plan of market reforms with a timeline as a part of State Aid process for Commissions' review	State aid / EU electricity regulation	Ministry	Q2 Y-6
Public consultation of the implementation plan	State aid / EU electricity regulation	EU Commission	Q3 Y-6
Receive Commission's opinion of the implementation plan	State aid / EU electricity regulation	Ministry	Q4 Y-6
Potential amendment of the implementation plan	State aid / EU electricity regulation	Ministry	Q1 Y-5
Notify the EU Commission of the CRM implementation	State aid	Ministry	Q1 Y-5[33]
Potential clarification or amendment of the CRM based on Commission's request	State aid	Ministry	Q1 Y-5 to Q3 Y-5[34]
Approval of CRM according to state aid rules	State aid	EU Commission	Q1 Y-5 to Q2 Y-4
Monitoring of the implementation plan through annual reporting	EU electricity regulation	Ministry	Annual reporting

A.2.2.3 CRM design

Following a Ministry decision to start preparing a CRM, the CRM design process also begins (along with State Aid related activities). The activities associated with CRM design are set out in Table 15.

Table 15 – CRM design actions

Action	Origin of requirement	Responsibility	Timing/duration
Assessment of whether strategic reserve is sufficient to address the issue	EU electricity regulation	TSO	Q2 Y-6
If strategic reserve is not sufficient: assess which CRM design addresses the identified issue	EU electricity regulation	TSO	Q2 Y-6
Decision if strategic reserve is sufficient to address the issue	EU electricity regulation	NRA	Q2 Y-6
Propose a high level CRM design	Estonian electricity market act	Ministry	Q3 Y-6
If strategic reserve: Assess whether cross-border participation is technically feasible	EU electricity regulation	TSO	Q4 Y-6

33 Duration of the notification process is maximum of 18 months according to Commission's Code of best practices for the conduct of State aid control procedures.

34 State aid decision is granted in no more than six months after Commission has received the last piece of information.

Action	Origin of requirement	Responsibility	Timing/duration
Other CRM (and strategic reserve if cross border participation is considered technically feasible): Design rules cross-border participation in cooperation with the relevant countries	EU electricity regulation	TSO / NRA	Q4 Y-6
Public consultation of the proposed CRM design; including impact of a CRM to other member states and stakeholders there	EU electricity regulation	NRA	Q4 Y-6 to Q1 Y-5
Decision of the CRM design	Estonian electricity market act	Ministry	Q1 Y-5
Preparation of technical requirements including CO_2 limits	EU electricity regulation / national needs	TSO	Q3 Y-6 to Q3 Y-5
Other than strategic reserve: obligation transfer rules	EU electricity regulation	TSO	Q3 Y-6 to Q3 Y-5
Preparation of cost recovery principles (tariff design)	Estonian electricity market act	TSO	Q3 Y-6 to Q3 Y-5
Preparation of availability monitoring and penalties for non-availability	EU electricity regulation	TSO	Q3 Y-6 to Q3 Y-5

Action	Origin of requirement	Responsibility	Timing/duration
If cross-border participation: preparation of operational agreement with the neighbouring TSO	EU electricity regulation	TSO	Q3 Y-6 to Q3 Y-5
If cross-border participation: Agreement of cross-border revenue sharing among the 2 TSOs - NRAs included in the agreement design	EU electricity regulation	TSO	Q3 Y-6 to Q3 Y-5, Q3 Y-4 to Q4 Y-4
Preparation of tendering and selection rules	National action, aligned with EU regulation	TSO	Q3 Y-6 to Q3 Y-5
Public consultation of the detailed CRM rules	National / regional action	TSO	Q3 Y-5
Decision of the detailed CRM rules	National action	NRA	Q4 Y-5

A.2.2.4 Final implementation

The final cluster of activities relates to implementation. These activities partially run in parallel with the CRM design phase, extending to the commencement of operation. These activities are summarised in Table 16.

Table 16 – Final implementation actions

Action	Origin of requirement	Responsibility	Timing/duration
National legislative implementation on the CRM	Estonian electricity market act	Ministry	Q1 Y-5 to Q1 Y-6
Foreign capacity participating: registering the interested and eligible participants	EU electricity regulation	TSO	Q1 Y-6 to Q2 Y-6
Prequalification	Estonian electricity market act / Contract rules	TSO	Q1 Y-6 to Q2 Y-6
Tendering	Estonian electricity market act	TSO	Q3 Y-6 to Q4 Y-6
Contracting	Estonian electricity market act / EU electricity regulation	TSO	Q1 Y-3
Operation, including monitoring, cash flow management, data updates, reporting etc.	Estonian electricity market act / contract rules	TSO	Q4 Y (lead time from above activity caters for delivery of new build)
Potential amendments or phase out	EU electricity regulation / national needs	Ministry	After Q4 Y

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