FINAL STUDY REPORT

Voltage service and reactive power control review and recommendations for design optimisations

23RD OF DECEMBER 2023

1. Executive summary

The reactive power control and voltage service is an integral part a well-functioning power system. In order to make sure that this service can be delivered as efficiently as possible, several improvements are being proposed. This report has been created following CREG decision (B)658E/79 in the framework of the incentives to promote the system balance.

These modifications and improvements are:

1. Switch towards continuous activation control
2. Penalty system that reflects the continuous activation control
3. Updated communication between Elia and the Market Parties
4. Indication of the need for the MVAr service
5. Price setting for the MVAr service during the tendering process
6. Participation of non active power related assets
7. Adding an additional bandwidth to compensator mode
8. Change in the application of the MVAr tariffs
9. Furthering the technology neutrality of the T&C VSP
10. Facilitating the participation of non-mandatory units

One specific focus area of this incentive is to facilitate the participation of non-mandatory units. Modifications are being proposed in this document to make this a reality, however going beyond these modifications would not lead to a more cost-effective service. Both the time and money spent on these additional efforts would be better spent on improvements of other aspects of the service and is therefore not recommended.

In terms of implementation, 5 distinct packages can be identified (all timings are based on the current roadmap):

- the modifications to the T&C VSP (these will be performed in the second half of 2024 with a Public Consultation in the beginning of 2025);
- the IT implementations to enable the new T&C VSP (except for the communication, see lower) (these will be executed in the second half of 2024 and 2025)
- the IT implementations for the communication (will run from the beginning of 2025 until the end of 2026);
- the publication of supporting documents (will be done at the end of the second quarter of 2024); and
- the publication of the MVAr needs map on the Elia website (by the end of 2024).

The current state of the MVAr service in Belgium has also been compared to the operation of the MVAr service in other countries. From this analysis many similarities between the European countries can be found, certainly when looking at the activation, remuneration and participating assets.
Focusing on the remuneration, we see that other European countries also use a variable remuneration based on either the activated volume or on the requested volume by the TSO. This leads Elia to the conclusion to also maintain the current remuneration principle, having a variable remuneration based on the amount of requested reactive power.
The major difference with other European countries is the procedure to acquire the service. Belgium is one of the few countries where a tendering procedure is used. However, given the push from European legislation, more countries are developing a tender based procurement of (non-) mandatory units. For this reason, Elia proposes as well to maintain the current tendering procedure to acquire the assets for the MVAr service.

Table of Contents

2. Introduction

This report has been created following CREG decision (B)658E/79 in the framework of the incentives to promote the system balance.
In the introduction a description of the incentive will be given, as well as a short overview of voltage control.
The next sections go deeper into the content of the incentive itself. It starts with the European benchmark of the reactive control and voltage service. Following this, the proposed changes to the current service are detailed. This is followed up by the main conclusions of the report. The final section is the annex.

2.1. Description of the incentive

The goal of the incentive is to investigate how the voltage service and reactive power control could be improved to minimize the overall cost and maximize both the efficiency of the service and the offered volume. An investigation into the optimal remuneration is performed as well. This analysis starts from the current MVAr service and looks to determine aspects that need to be adapted or improved. This consists of:

- the identification, together with the market parties and the CREG, of the elements of the existing design that need to be investigated for improvements based on their experience with the current market design. This list includes at least a revision of the application of the penalties. On the basis of these inputs, the identified elements will be discussed and modifications will be proposed and discussed;
- on the basis of a European benchmark, a study on the possible elements of the remuneration for the service in order to rationalize the fixed and variable costs in the current market design;
- a specific analysis of the potential improvements to the current market design that can facilitate the participation of voluntary units or volumes to the voltage service and reactive power control;
- the most appropriate acquisition procedure to facilitate the participation of units whose participation in the service is not mandatory;
- the study will also take into account the ratio between on the one hand the efforts to implement the improvements identified to facilitate voluntary participation, and on the other hand, the gains for the efficiency of the service (for example in terms of additional settings and the cost of making them available for the MVAr service).

Deliverables

Within the framework of the incentive several deliverables have been set out in order to judge the correct execution of the incentive and sufficient involvement of all interested market parties:

- during the year 2023: at least 2 workshops with market players (connected to the transport, local transport and distribution networks) to (i) identify the priority design elements that it would be appropriate to improve and (ii) to consult market players on the proposed changes;
- September 30, 2023: deadline for launching a public consultation on the study;
- December 23, 2023: submission to the CREG of the above study adapted according to the comments resulting from the public consultation as well as a consultation report. In the event that the study recommends the implementation of improvements for the voltage maintenance and reactive power regulation service, submission to the CREG of a proposal for an implementation plan for these adaptations.

Context and justification

The voltage maintenance and reactive power regulation service was reviewed during a study carried out by Elia in 2018. This study showed in particular that a change in the general organization of the service was necessary and proposed an evolution of the mechanism for purchasing the service via a voluntary participation mechanism only, to a call for tenders at a competitive price (subject to an analysis of reasonableness by the regulator). This includes a compulsory participation mechanism for certain units and is voluntary for the rest.

The current study is an opportunity to question, on the basis of feedback on the current design and in consultation with market players and the CREG, the design elements for which it would be interesting to seek improvements in order to optimize the efficiency of the service, the volumes that can be offered and the remuneration.

2.2. Voltage control[4]

The transmission of electrical power is subject to one principle of good practice: to limit losses, the voltage level must be as high as possible[1] while the current must be as low as possible, within the limits imposed by the grid and by voltage limitations of each node[2]. These conditions enable maximum power to be transmitted while safeguarding the production units from ageing prematurely. However, the limited insulation capacity of the relevant lines and cables means that it is essential that the voltage in the grid does not exceed a certain level locally. Elia is responsible for controlling voltage and relies on the assistance of all grid users connected to its grid in order to do so.
Injection or absorption of MVAR's at each node induces voltage differences between nodes; Elia must regulate reactive power injection and absorption to:

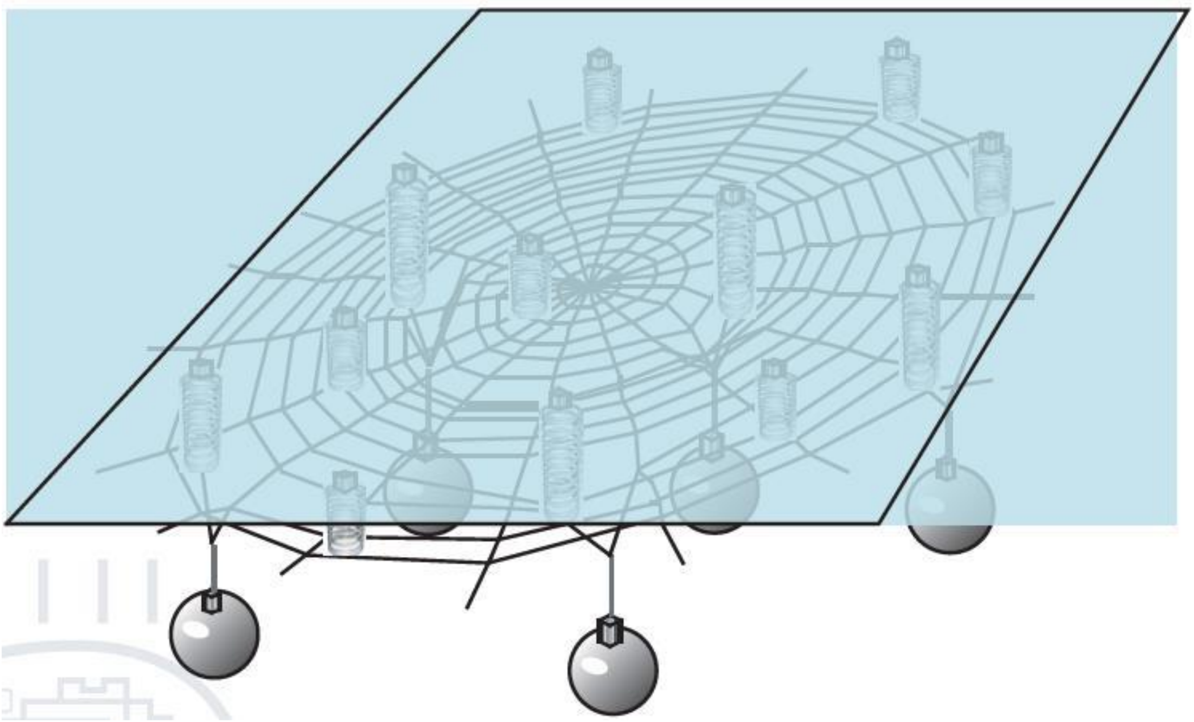
1. Maintain voltage within operational limits at each node;
2. Maintain the reactive balance at 0 within limited zones;
3. Maintain the reactive balance for the Belgian system at 0.

In any situation, Elia must dispose of sufficient regulation capacity to be able to stabilize voltage as mentioned above in case of a dimensioning incident[3] and, once stabilized, maintain it within safe ranges.
Voltage fluctuations are inevitable due to the influence of:

- the fluctuations in power that are caused by the offtakes and injections that industrial activity and intermittent generation in Belgium entail;
- flows from the transmission-connected distribution grids, to which (very volatile) residential, other demand/production grid users and prosumers are connected;
- electrical flows and topological changes in the grid.

The grid's reaction to such fluctuations is similar to a web, which must be supported by a flexible force (illustrated by the springs in the drawing[4] below) so that it can withstand the tugging to which it is subjected. In Elia's meshed grid the springs represent reactive energy. As for the "nodes" attached to the web, these symbolize various operations affecting the grid, such as injections, offtakes and foreign electrical flows.

[1] Albeit contained within specific operational limits
[2] Also depending on the grid users connected to it.
[3] I.e., the loss of a nuclear reactor that would define the grid's capability to react.
[4] Reference: Study on the future design of the ancillary service of voltage and reactive power control



Whereas the frequency in the grid is influenced by the behavior of active energy, the voltage is affected by reactive energy. As active energy is very easy to transport, frequency can be managed at national and European levels. However, due to transmission losses of reactive power the influence on voltage and network loading is reduced for lower voltage levels. In general, the lower the considered voltage level, the more the voltage has to be managed locally. This means that all technical units that take part in controlling voltage have to be strategically located.
This energy is currently partially supplied by the VSPs: in line with the voltage level measured in the grid, technical units stabilize the voltage by absorbing or generating reactive energy. This service, supplying reactive energy to Elia, is governed by a MVAR service contract between Elia and the VSP concerned.
In addition to managing the reactive energy supplied by the VSPs, Elia makes use of a number of means of its own to stabilize grid voltage, such as manual or automatic control service type of transformers or management of the park of reactor and capacitor banks in the Elia grid.
There are several factors causing reactive power offtakes or injections which need to be covered with regulation means that are at Elia's disposal as explained in *Table* 1.
Such may be injection or offtakes of reactive power from distribution grids or neighboring transmission grids, reactive loads connected to the Elia grid or even volatile injections from intermittent renewable energy sources (RES). On the other hand, Elia may regulate reactive power using its own reactive controlling elements or contracted elements belonging to third parties connected to the Elia grid (contracted production units, batteries, demand response,…).

Factors causing needs	Regulation means
Reactive load	TSO owned reactive controlling elements
Inherent behaviour transmission grid	Production units with a contract for MVAR ancillary services (if P≠0)
Intermittent generation (RES)	Non-active power related assets
Coupled distribution grids	Demand facilities
Neighboring transmission grids	

Table 1: Factors causing reactive power needs and the means to regulate

Elia uses a series of technical regulation means and/or techniques to cover its needs in voltage control as shown in *Table* 2:

Increasing voltage	***Decreasing voltage***
Capacitor	Reactor (self)
Generation MVAR production	Generation MVAR absorption
Limit active flows, to keep lines in capacitive range	Increase active flows, to push lines further into inductive range
Outage planning (cancel planned outage of cables)	Taking cables and long lines out of service
MVAR import from neighbouring grids	MVAR export to neighbouring grids
…	…

Table 2: Means to regulate voltage

Technical units that absorb or generate reactive power remain key contributors to reactive power management to this day. Similarly, reactors and capacitor banks installed at substations of transmission-connected distribution grids or demand facilities may also help in managing reactive power in the transmission grid in the future.

When evaluating the need for investments into new assets, Elia prioritizes to use reactive energy that comes:

1. as a by-product of generation of active energy, or:
2. from Reactive Power Management (RPM) assets installed by grid users for their own voltage regulation and that have an additional unused capacity to put at Elia's disposal.

Elia prioritizes above resources because they do not require specific investments.

Elia regularly performs power planning studies to verify whether existing capacities from third parties suffice to satisfy the grid's regulation needs, and if not it identifies certain nodes in the grid which require reinforcements in years to come by installing its own reactors and/or capacitor banks.

3. European benchmark

The MVAr service is an important facet of all power systems. Each country has its own way of covering the need with either assets from market parties, or by SO-owned means. In order to get a better insight in how the service operates in other countries, a benchmark was performed. This next section details the aspects that were discussed with other TSOs and the specific questions that were asked. Afterwards a list of contacted TSOs is given to give an overview of the countries that responded to the inquiry. It is followed by a summary of the responses to the aforementioned questions. Finally, the chapter provides with the conclusions of the study.

3.1. Aspects discussed during the interviews with TSOs

These next sections detail the topics and questions that were discussed with the contacted TSOs. These topics go into the general delivery of the MVAr service, the legal framework, asset types participating to the service and activation principles, remuneration, settlement and the current developments.

3.1.1. General aspects regarding fulfilment of reactive power demand

- What is the overall experience with reactive power needs and provision? Do you see an increase in MVAr service need?
- What issues exist regarding the procurement of MVAr service?
- What developments have occurred in the past and are expected for the future?
- Who are the main providers of MVAr service, both currently as a in the past?
- Do you rely on the participation of smaller, decentralized units for the provision of the service?
- Do you expect an increase in complexity in the future?

3.1.2. Existing legal/regulatory framework for delivery of MVAr service

- What are the obligations for producers to deliver reactive power?
- What are the obligations for loads and/or distribution grids?
- In which way does the TSO request reactive power provision from market participants?
- What types of MVAr service contracts do exist?

3.1.3. Asset types participating and activation principles

- Which types of assets provide MVAr service today?
- How is the location of the assets taken into consideration for participation?
- What is the activation principle?
- What changes are expected in the future?
- How/when are TSO-owned assets activated?

3.1.4. Remuneration

- What are the structural principles of the remuneration of MVAr service?
- What are prequalification requirements?
- How are prices for MVAr service being determined?
- What are the structure, components and the level of prices for the MVAr service?
- What changes are expected for the future?
- Is there an initial capital investment remuneration foreseen?

3.1.5. Settlement

- How is availability and provision of contracted MVAr service verified?
- What is the measurement and billing principle?
- What are typical settlement periods?

3.1.6. General experience and developments

- What are the reasons for the present system design?
- How is the experience with the current system? What are the biggest challenges?
- What are the opinions of other stakeholders (providers, regulatory authority) on the MVAr service?
- What changes are planned for the next few years and for the long term?

3.2. Participating TSOs

In Table 3 below a list of the TSOs that responded to the inquiry can be found. These TSOs cover a large part of Europe but are mainly concentrated in Northern and Central Western Europe.

Participating TSOs
Denmark, energinet
Netherlands, TenneT
Germany, Amprion
Great Britain, Nationalgrid
Germany, 50 Hertz
Germany, TransnetBW
Norway, statnett
Switzerland, Swissgrid
France, RTE
Sweden, SVK

Table 3: Participating TSOs

3.3. Responses

This section summarizes the responses that the participating TSOs have given, together with some specific insights into some particular cases. These analyses were done in cooperation with an external consultant.

3.3.1. Sources and obligations for the MVAr service

There is a high similarity between the European countries in which units provide the MVAr service. Historically the service was provided by large power plants connected to the TSO grid and until this day they represent the largest part in volume that delivers the service. This is in part due to the fact that there is typically an obligation for these assets to deliver the service to the system operator. This obligation is only valid at times that the units are scheduled for commercial dispatch.

However, given the current shift towards more decentralized units, an increasing part of the MVAr service is being supplied by wind turbines, batteries, solar energy parks, … This shift on the one hand increases the complexity to keep the voltage at the right level, but the distributed assets also allow to absorb or inject the reactive power closer to the location where it is needed. This increases the impact of the activation.

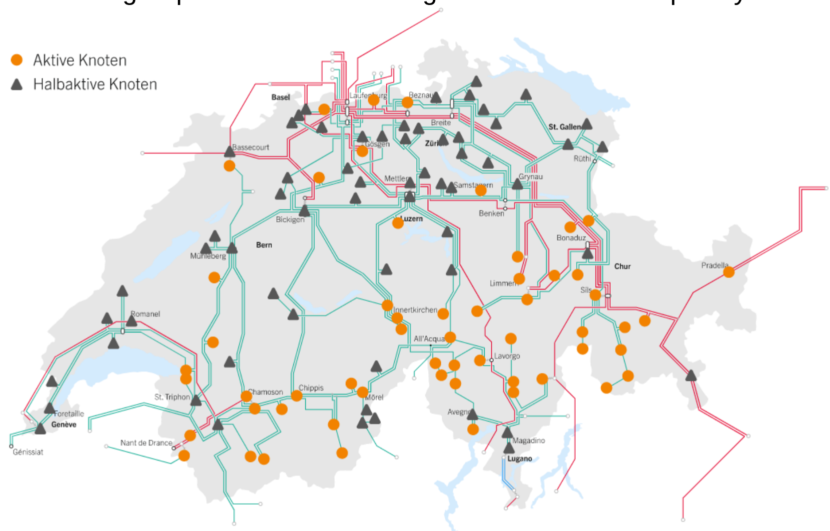
Looking at the investigated countries, the assets participating in the MVAr service are almost exclusively connected to the transmission grid. Assets at lower voltage level, managed by the DSO, typically do not participate to the MVAr service. There are only two TSOs that have exceptions to this: TransnetBW and Swissgrid.

TransnetBW reactivated some older contracts with conventional power plants in High Voltage (110 and 150 kV) grids that are connected close to the TSO grid. Given their location, these assets can still provide the MVAr service efficiently, without significantly impacting the voltage on the DSO grid. Swidssgrid on the other hand holds contracts with DSOs, who provide the MVAr service. Even though Swissgrid is currently the only TSO that holds contracts with DSOs, multiple TSOs are in discussion with the respective DSOs to realize this as well.

The procurement of these assets is also very similar in most European countries. Since there is an obligation, they will automatically be enrolled in the service (however the terms can still be discussed as mentioned in section 3.2). Only Belgium and the Netherlands differ here. A tendering procedure is used to procure the assets for the MVAr service. However, in Belgium there is still an obligation to participate to this tender for many assets. Other countries (Great Britain and Germany) are also thinking of or starting to introduce tendering procedures. These are specifically aimed at units that are not obligated to participate to the service (non-mandatory units).

FOCUS ON SWISSGRID (CH): PARTICIPATION OF DSOS

- First established in 2011, today DSOs and demand facilities directly connected to Swissgrid's system can choose between having an active or a so-called semi-active role at voltage regulation
  - Active: Delivery of compliant reactive energy according to Swissgrid's operating requirements (rules and remuneration identical to power plants that always have an active role)
    - compensation for reactive energy exchanged in compliance with the requirements / voltage schedule
    - billing of non-compliant exchange of reactive energy including penalty payment
  - Semi-active: No duty but financial incentive for system-suitable reactive energy input
    - Participants receive voltage schedule and must aim to meet the schedule according to their ability
    - If reactive energy flow is suitable for reaching target voltage, reactive energy exchange is remunerated, otherwise billed; compliant energy tariff ≈ 10% of uncompliant tariff
    - Tolerance band / free exchange (no remuneration, no billing) established to avoid switching off idle running transformers
- Currently, a significant share of DSO nodes having an active role (see graphics)
- Prequalification is required for active participation in voltage control
  - Reaching of reactive power limits, meeting of voltage set points for short and longer periods and with higher and lower frequency of change is checked



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3.3.2. Remuneration

In most European countries, the MVAr service is renumerated. Only Denmark and Sweden are the exception. In both countries the service has to be provided free of charge. This remains a point of contention between the service providers and the TSO/regulator, since the service providers find that they offer value for the power system and thus they should be fairly remunerated for the mandatory delivery.

Even though in all other European countries the MVAr service is remunerated, the design of the remuneration system differs between all TSOs. These differences can come from what is remunerated (remuneration of the total reactive power supplied or only the actively requested amount), the pricing (symmetric or asymmetric), the price components (variable remuneration, fixed remuneration, or a combination of the two), …

The contract type used by the different TSOs is similar as well, using a bilateral contract for all assets that are delivering the MVAr service. The difference here lies in the way the prices are set. Typically, this is done by the TSO, but as mentioned previously, in Belgium, the Netherlands, Great Britain and Germany a tendering procedure is/will be used. However, for the last two, these tenders are/will be only used for assets that are not obligated to provide the service. The overall limited use of tendering procedures is caused by the difficulty to achieve an adequate level of competition. The MVAr service is a local product, of which the activations have a limited range. So in order to achieve a high level of competition, many assets need be located in the same area and operated by independent actors.

In case the remuneration price is not set via a tendering procedure, but proposed by the TSO, scientific analyses and expert opinions on the costs for reactive power provision are used to determine the price. This results in most of the TSOs considered within this study having uniform prices for all plant types, operators and voltage increase/decrease.

When analysing the remuneration in European countries, the overall trend is to use a variable remuneration based on the measured reactive energy, (e.g. in €/MVArh). The main component that is remunerated is the active loss of energy to deliver the MVAr service. Typically, investment costs and ramp up costs (costs to ramp up towards a certain level of active power, in order to be able to deliver the MVAr service) are not taken into account for the remuneration. The regulator typically also needs to approve the MVAr service procurement rules but is not necessarily deeply involved in the execution of the remuneration system.

3.3.3. Activation and verification

After the contracting process is over, the assets can be used for the delivery of the MVAr service. Most of the TSOs manually request MVAr service via the national control center. Only Swissgrid (CH) also provides a voltage schedule. The TSO determines ex ante which assets should be activated at what time. However, given the unpredictability in the power system, Swissgrid still has the option to deviate from this voltage schedule in case the situation requires it.

Of course, verifying if the service was delivered correctly is as well an important aspect in order to assure the quality of the service delivery. Currently, only Elia and Swissgrid penalize incorrect delivery of the MVAr service explicitly. The other TSOs do not actively verify and penalize MVAr service provision but this is implicitly included in the remuneration system.

Focus on Swissgrid (CH): Type of Activation Request & Active Verification of Requested MVAr service

- Activation of all MVAr service sources is done electronically
- Swissgrid provides a voltage schedule per node for each quarter hour of the year
- Scheduled values are calculated based on Day Ahead Congestion Forecast files (DACF) and expectations of Swissgrid
- Schedule is updated every 4 hours intraday; furthermore, intraday adjustments are also possible within the 4-hour window
- Swissgrid provides tariffs for active voltage control and uncompliant reactive energy
- Active participants are remunerated for reactive energy exchanged if compliant with requested voltage set point
    - Total amount of measured reactive energy will be remunerated if
        - actual voltage meets the requested voltage set point including a free/tolerance band (220kV: ±2kV, 380kV: ±3kV)
        - actual voltage is outside tolerance band, but reactive power is aiming to reach the set point
- Uniform remuneration price each for compliant and uncompliant reactive energy
- DSOs: If quarter-hourly values of reactive power are less than 70% compliant for 2 consecutive months
    - Remuneration scheme is switched to non-active model retroactively from the first month of the 2 consecutive months
    - New prequalification required to re-enter the active model

3.3.4. Developments

Most TSOs are facing a rising need for MVAr service or at least are expecting a rising need due to the ongoing shift from central to distributed generation. These estimations are based on ex-post monitoring of MVAr service needs and the evolutions of the previous years. As a reaction on these estimations, TSOs are expanding the number of assets at their disposition to control the voltage. These assets can come from the market (e.g. the tendering in GB for non-mandatory units) or by investing in TSO-owned voltage regulating assets.

Even with the rising need, for the moment almost no TSO actively uses the capacity that is available on DSO level or distributed generation for MVAr service purposes. However, some TSOs have taken initial steps to develop an active participation of DSOs directly connected to TSO's systems (high voltage level, 110 kV).

3.3.5. Summary and conclusions

Most of the considered countries acknowledge that a competitive pricing for MVAr service based on tenders is challenging, but as EU legislation pushes towards market-based procurement of ancillary services the number of countries / TSOs using tenders rises. However, to mitigate the risk of limited competition, TSOs that have recently introduced or are in the process of introducing bidding procedures will require longer contract lead times in order to have sufficient time to set up their own compensation elements, if bid prices appear not sufficiently competitive. Generally, a liquid market seems to be possible only at those nodes where many different generation units are connected and when those units belong to different companies. Even so, the number of potential bidders will likely be very limited and therefore might be too small for real competition.

The benchmarks show that, in most of the considered countries, assets providing MVAr service are compensated: either the sum of metered reactive energy is remunerated or the amount of MVAr service that is explicitly requested by the TSO, is compensated. In both cases this means a variable remuneration. This variable renumeration based on delivered/requested MVArhs is the same as currently applied by Elia in Belgium.

In general, the participation to the MVAr service is mandatory and is currently arranged bilaterally via the connection contract for the lifetime of the unit. In the countries where tenders for non-mandatory units are conducted, the lead times and the contract durations differ in length (from days up to multiple years).

TSOs already faced but also expect a further increase in volumes and volatility and therefore a need for additional MVAr service sources. Currently, contracting of MVAr service sources in grids of other system operators (DSOs) exists mainly in Switzerland but a number of other TSOs are discussing an active participation of directly connected DSOs (usually high voltage level, 110 kV) for the near future.

4. Proposed changes

This chapter describes the proposed changes to the current MVAr service. The topics that will be discussed are the following:

1. Activation control
2. Penalty system
3. Communication between Elia and the Market Parties
4. Indication of the need for the MVAr service
5. Price setting for the MVAr service
6. Participation of non active power related assets
7. Compensator mode
8. Change in the application of the MVAr tariffs
9. Furthering the technology neutrality of the T&C VSP
10. Participation of non-mandatory units

For every topic, the current situation will be presented, along with some excerpts from the T&C that are in application. Thereafter, a description of the proposed changes is given. This also includes a comparison with the current situation. For some topics, multiple proposals are given.

4.1. Activation control

The activation control is an important aspect of the MVAr service to check if the requested volumes have been correctly delivered. This section is split into the manual and automatic control service type, the two types of service that the VSP can deliver.

4.1.1. Current situation

In the current situation the activation control for the voltage service and reactive power control is split up into two different categories. There is the control for the manual control service type and the control for the automatic control service type.

4.1.1.1 Manual control service type

The activation control for the manual control service type is currently done via 6 random activation samples on a monthly basis on 6 different days. These samples use 30-second measurements of the reactive power consumption/injection at the measurement point. These measurements are then compared to the requested reactive power (Qreq). If the measurements show that the Qreq was achieved within the predefined timeframe (5mins), the service is considered to be delivered. However, if this is not the case Elia shall apply a penalty.

II.7.2 Manual control service type

b) To ensure that a Controlling or Non-Controlling Technical Unit provides the Manual Control Service Type correctly, Elia shall check whether the corresponding Reactive Power was supplied correctly at the Service Measurement Point by the selected Technical Unit within the timeframe mentioned in Art. II.5.4. To this end, Elia shall use the 30" remote measurements (or the most precise measurements available) at the Service Measurement Point of the Reactive Power supplied (Q).

c) Elia shall carry out this verification monthly for each Technical Unit for delivery in Month M-2 on six samples of activation requests by Elia over six different days. Elia shall apply a penalty as described in Art. II.9.1 where necessary.

4.1.1.2 Automatic control service type

The activation control for the automatic control service type is currently performed using 6 random activation samples. These samples are taken from 6 different days with a duration of 5 hours. They pertain to quarter hourly measurements of the reactive power consumption/injection at the measurement point. These measurements are then compared to the expected reactive power based on the formula described in Section 4.2.1 If the measurements show that the reactive power was within the tolerance band, the service is considered to be delivered. However, if this is not the case Elia shall apply a penalty.

II.7.2 Automatic control service type

b) To ensure that the automatic regulator of a Controlling Technical Unit provides the Automatic Control Service Type correctly, Elia verifies whether the Reactive Power actually supplied by the Technical Unit corresponds to the Reactive Power that should have been supplied in response to variations of the Grid Voltage measured at that same Service Measurement Point.

c) Elia uses quarter-hourly metering data to carry out this verification monthly for each Technical Unit for delivery in Month M-2, starting out with six samples. Each sample pertains to a 5-hour period. Elia applies the penalty described in Art. II.9.1 where necessary.

4.1.2. Proposed changes

Elia proposes to create one type of control for both the automatic and manual control service types. This revised control will not be based on a limited amount of samples but will take (almost all) 15 minute timesteps into account. This will result in a fairer penalization, as momentary failures that do not represent the overall delivery of the service can no longer incur a disproportional penalty.

<u>The manual control service type</u>

For the manual control service type the measured reactive power (Qmeas) of all timesteps except for the ones mentioned below, will be compared to the requested reactive power (Qreq) for every quarter hour. For reference, the equations used to determine the correct delivery of the manual control service type are given here:

$$Limit\ inf. \leq\ Q_{req} = Q_{req_{manual}} \leq Limit\ sup$$
$$Limit\ \mathrm{inf.} =\ Qreq - Tolerance$$
$$Limit\ \mathrm{sup} = Qreq + Tolerance$$

$$Tolerance = 7.5\% * Q_{tech,max}$$

With a tolerance of:

- minimum value of 1 MVAr
- maximum value of 25 MVAr

The timestep(s) that are not considered for the manual control service type are:

- The timestep (quarter hour) of the setpoint request

The obligations for this timestep remain the same as in the current market design: The VSP has 10 seconds to confirm the reception of this setpoint. Following this, the VSP needs to attain this setpoint within the tolerance band defined by Limit inf. and Limit sup. for at least two successive 30'' Reactive Power measurements within the requested timeframe. If one of these obligations is not achieved, the timestep (quarter hour) will be considered as failed and a value of zero will be used for the Qmeas in the activation control and penalty scheme (see next section).

- The timestep (quarter hour) of the setpoint request, in case it spans 2 timesteps

If the request spans 2 quarter hours, only the second timestep can be considered as failed (put to a zero value) if the requested setpoint was not achieved within the requested timeframe. This means that the first timestep and thus the timestep in which the setpoint request was received will not be modified for the activation control. If however, the requested setpoint was already achieved during the first timestep, the setpoint request will be considered to be correctly executed.

The automatic control service type

The rules applied to the manual and automatic control service types are the same. However, instead of comparing the measured values to a static Qreq, which is the case for the manual control service type control, the formula below is used to calculate the Qreq. for the automatic control service type.

$$Q_{req} = -\frac{\alpha_{eq} * \left(GV\ (t) - V_{startup}\right) * 0{,}45 * P_{tech,max}}{U_{norm_{expl}}} + Q_{initial}$$

$$Limit\ inf. \leq\ Q_{req} = Q_{req_{manual}} \leq Limit\ sup$$

$$\alpha_{eq} = -\frac{\frac{\Delta Q}{0{,}45 x P_{nom}}}{\frac{\Delta GV}{U_{norm\_expl}}}$$

- Ptech max: the maximum technical power
- GV(t): 15-minute measurements of the Grid Voltage
- Vstartup: the average Grid Voltage value of the quarter hour during which the unit started up
- ΔGV: the difference between the Grid Voltage before and after the network voltage variation;
- ΔQ: the absolute difference between the Reactive Power measured at Qh_n and the Reactive Power Measured at $Qh_{(n-1)}$). This volume corresponds to the additional Reactive Power that must be supplied by a Technical Unit during the 15-minute interval considered after a variation of the measured voltage (ΔGV) on this same 15-minute interval, calculated by applying the formula above.
- $U_{norm\ expl}$: The standard operational Grid Voltage under which the Technical Unit is foreseen to operate, as agreed in the Technical Unit's Connection Contract.
- Qh_n: the considered quarter-hour

This calculated Qreq is then as well compared to the measured reactive power (Qmeas) using the tolerance bands as explained for the manual control service type control.

In order to implement the changes to the activation control, a revision of the penalty scheme is required as well. The proposed changes are described in the next section.

4.2. Penalties

The penalties are the second aspect of the activation control, penalizing when the service is not delivered correctly. The goal of the penalty is to give a clear incentive to deliver the service as well as possible, without penalizing the VSP too severely.

4.2.1. Current situation

In the current situation the penalties for the voltage service and reactive power control are split up into two different categories. There is the penalty for the manual control service type and the penalty for the automatic control service type.

4.2.1.1 Manual control service type

The penalty for the non-delivery of the manual control service type is based on the difference between the Qreq and the Qmeas, multiplied with 1.5 time the price for the last MVAr supplied and multiplied by the average setpoint duration which is set to 10 hours.

ANNEX 7: Penalty for non-delivery of the Manual Control Service Type (excerpt)

When the VSP fails to activate the Service (as established from the delivery control procedure described in Annex 4), Elia will apply a reduction of the monthly remuneration.

The penalty shall be proportional to the missing volume (Qmanual_missing) i.e. the Reactive Power volume that has not been provided during the activation of Manual Control Service Type according to the following formula:

$$\text{Remuneration reduction} = Q_{\text{manual\_missing}} * \text{price of the last MVAr supplied} * 1{,}5 * \text{Average Setpoint duration}$$

Where:

- the Average Setpoint duration is set to 10 hours
- The price of the last MVAr supplied is based on the price structure as defined in 0

ANNEX 6: Penalty for non-delivery of the Automatic Control Service Type (excerpt)

When the VSP fails to activate the Service (as established from the delivery control procedure described in Annex 4), Elia will apply a reduction of the monthly remuneration.

The penalty shall be proportional to the missing volume (Qmanual_missing) i.e. the Reactive Power volume that has not been provided during the activation of Manual Control Service Type according to the following formula:

$$\text{Remuneration reduction} = Q_{\text{manual\_missing}} * \text{price of the last MVAr supplied} * 1{,}5 * \text{Average Setpoint duration}$$

Where:

- the Average Setpoint duration is set to 10 hours
- The price of the last MVAr supplied is based on the price structure as defined in ANNEX 12

4.2.1.2 Automatic control service type

The penalty for the non-delivery of the automatic control service type depends on the percentage of quarter hours that are not compliant with the supply conditions in the monthly samples, divided by the total number of quarter hours in the monthly samples. If this ratio is between 0% and 30%, no reduction of the remuneration will be applied. If the ratio is between 30% and 80%, a reduction of 25% on the monthly remuneration will be applied and if the ratio is higher than 80%, the full remuneration for the month will be withheld.

ANNEX 6: Penalty for non-delivery of the Automatic Control Service Type

Elia shall deem the Automatic Control Service Type to have not been supplied for a given 15-minute interval when the variation in Reactive Power measured for a certain Service Measurement Point does not fall within the margin of error defined in ANNEX 3.

If the conditions for the supply of the Automatic Control Service Type are not satisfied, Elia will calculate reductions to be applied to each monthly remuneration based on the following rule:

$$\%Q_{\text{failed}} = \frac{\#\ \text{QHs not compliant with the supply conditions in the monthly samples}}{\#\ QHs\ analysed\ in\ the\ monthly\ samples}$$

- Where $\%Q_{failed}$ is between 0 and 30% included, Elia shall not apply the remuneration reduction.
- Where $\%Q_{failed}$ is above 30% and below or equal to 80%, a 25% reduction shall be applied to the remuneration for the Service for this Technical Unit as set in Art.II.8.3, for the entire month as of which the sample was constituted.
- Where the $\%Q_{failed}$ is above 80% and below or equal to 100%, Elia shall deem that the Service has not been supplied and shall therefore not remunerate the VSP for the Technical Unit concered, for the entire month as of which the sample was constituted.

4.2.2. Proposed changes

Because of the shift towards a continuous activation control and away from a sample-based approach, a revision of the penalty scheme is required as well. In the current penalty system, an additional tolerance band was added for the automatic control service type in order to avoid over penalizing assets for momentary failures. For the manual control service type on the other hand, a significant penalty was applied when not achieving the setpoint within the given timeframe. The newly proposed penalties below will penalize the market party proportionately to the quality of the service that they deliver at all times.

As was the case for the activation control, Elia proposes to align the methodology as much as possible between the manual and automatic control service type. Initially Elia envisaged one proposal (proposal 1 below). However, after the discussion with the market parties during the second workshop, an alternative proposal was added (see proposal 2 below).

4.2.2.1 Proposal 1

The first proposal is similar to the current design for the automatic control service type. The calculation of the penalty would, as in the current design, be based on the ratio between the number of quarter hours failed and the total number of quarter hours analysed. However, as stated before, it is proposed to perform the calculation on almost all quarter hours in the month instead of a limited amount of samples.

$$\%\mathrm{Q}_{\mathrm{failed}} = \frac{\#\ \mathrm{QHs\ \ not\ compliant\ with\ the\ supply\ conditions\ in\ the\ monthly\ samples}}{\#\ QHs\ analysed\ in\ the\ monthly\ samples}$$

However, the way %Qfailed is used will change. Instead of using 3 different buckets, as stated in the excerpt of annex 6 of the T&C here above, which is the case in the current design, a continuous penalty will be applied.

$$Total\ penalty = (\%Q_{failed}) * \mathrm{remuneration[month]}$$

$$\%Q_{failed} = \frac{\#\ QHs\ not\ compliant\ with\ the\ supply\ conditions}{\#\ QHs\ analysed}$$

4.2.2.2 Proposal 2

A second proposal also takes inspiration from the current penalty scheme for the automatic control service type. However instead of calculating the percentage of quarter hours that have failed, the difference between the Qreq and the Qmeas is used for the penalty calculation. This difference is multiplied with the cost for the last MVAr supplied and an additional penalty factor. This is done for every quarter hour and afterwards summed up. The difference is only counted if the absolute value is larger than the tolerance and will only start from the tolerance band (e.g. for a difference of 6MVArh with a tolerance of 5MVArh, only 1 MVArh will be penalized).

Additionally, a distinction will be made between over- and underdelivery (in absolute terms). A penalty scheme contains two components:

1. Recuperation of the “overpaid” remuneration, since the Qreq is used for this purpose (this is the “1” in the price formula)
2. Incentive for the VSP to maintain their obligations (this is the “0.5” in the price formula).

However, in case of an overdelivery (the absolute value of the Qmeas is higher than the absolute value of the Qreq), there is no need to recuperate the “overpaid” remuneration since the Qreq was exceeded. This leads to the following penalty formulas.

<u>Penalty for underdelivery</u>

$$Discrepancy = \ Qrequested - Qmeasured - tolerance$$

$$Penalty = |Discrepancy * 1.5 * priceLastMVArSupplied|$$

$$Total\ penalty = \sum_{month} |Discrepancy * 1.5 * priceLastMVArSupplied|$$

<u>Penalty for overdelivery</u>

$$Discrepancy = \ Qrequested - Qmeasured - tolerance$$

$$Penalty = |Discrepancy * 0.5 * priceLastMVArSupplied|$$

$$Total\ penalty = \sum_{month} |Discrepancy * 0.5 * priceLastMVArSupplied|$$

This penalty is slightly more complex, but also takes the partial delivery into account. This means that VSPs will only be penalized for the non-delivered MVArhs and thus will incentivize the VSP to deliver the service to the best of their abilities at all times.

4.2.2.3 Comparison between the proposals

In terms of complexity, the first penalty proposal is slightly less complex than the second proposal, as there is only a determination if the service was delivered correctly. If this is not the case, the VSP will be penalized for the full quarter hour. On the other hand, the second penalty does represent the impact on the system better and incentivizes the market party to deliver the requested reactive power to the best of their abilities. Additionally, a distinction between over- and underdelivery can be considered in the second proposal, but not in the first.

4.2.2.4 Conclusion

Elia considers that the added incentives for the VSP of the second proposal outweigh its higher complexity and thus will retain this proposal. This will lead to market parties delivering the service to the best of their abilities, even at times where they are not able to fully deliver the service.

4.3. Communication with Elia

The communication with Elia enables market parties to send and receive messages to be able to correctly deliver the service when Elia requests an activation. The application that currently is being used to communicate with the market parties is Revolt. This application allows Elia to send setpoints, which the market parties need to achieve. The communication requires a hardware/software setup on the market party side and is tested during the communication test.

4.3.1. Current situation

In the current communication setup, the type of messages that can be sent by the market party via Revolt is limited.

The only possible messages are:

1. Confirmation of the reception of a given setpoint
2. An error message

This means that other useful messages that the market party would like to send (the inability to achieve a setpoint, availability of the asset,…), cannot be sent via Revolt.
On top of that, Revolt uses a communication protocol that is not up to the latest standards. This could lead to security issues and complexifies the setup at market party side, since the older communication protocol requires a tailor-made setup to comply with the communication requirements. This results in third party involvement (often the producer of the technical unit) to implement changes in the software.

4.3.2. Proposed changes

The proposition is twofold. On the one hand, Elia would like to allow additional types of messages that can be sent via Revolt in order to be able to obtain all relevant information from the market parties. On the other hand, Elia proposes to evolve the communication protocol. The current technology (exchange via XML files) is outdated in comparison with the current standards, given the complexity of this exchange.

Additional interactions

1. Sending the available capacities 24h beforehand for each quarter hour (for both active and non-active power related assets). The goal for the non-active power related assets is to be able to more efficiently activate these types of assets, since they cannot be linked to a Pmin.
2. Proposition for new setpoint if current setpoint is not feasible (for non-active power related assets)
3. Rejection of the setpoint with a reason why it cannot be achieved. This does not remove the obligation to achieve the setpoint, nor the penalty of not achieving it.
4. Up-to-date reactive power capacities for the current day, in case the previously sent capacities are no longer feasible. This also does not reduce the contractual obligations.
5. Zerotage communication (sending a zero setpoint to an asset that is not starting-up or shutting down)

Update communication protocol

The update of the communication protocol would allow for an easier interaction with Elia for the market parties. The current setup requires a lot of third-party changes (often by the original producer of the asset) in order to be able to send and receive the messages. This complexifies the entry into the market for new units. A newer, more up-to-date communication protocol would simplify the setup.
However, this update of the communication protocol has received some comments from market parties regarding the additional investments required for units that currently already deliver the service, both in terms of time as well as financially. On the timing, Elia confirms that sufficient time will be foreseen for market participants to do the implementation and testing. This will also be reflected in the implementation plan, presented in Section 5 of this report. On the financial aspect, Elia understands the position of the market participants, but still believes that the changes are needed and will increase the participation to the service. However, to try the limit the impact on the existing VSPs, throughout the IT implementation phase Elia will explore all options to enable this.

4.4. Indication of the need for reactive power control

The reactive power control and voltage service is a relatively local product. The reason for this is the limited distance that reactive power can travel through the grid. This in turn means that the resources that Elia uses for the MVAr need to be well-distributed in the grid.

4.4.1. Current situation

In the current situation, market parties have little to no visibility on the (local) need for reactive power control. This renders it more difficult to estimate the number of activations requests that the market party will receive to determine a correct pricing for the MVAr service, or to take an investment decision.

4.4.2. Proposed changes

In order to be able to better estimate the number of activations for a certain unit, Elia will provide the following information:

1. A map for the voltage levels above 30kV per area showing what the needs are for MVArs after the utilization of the TSO owned assets and giving an indication of the amount of obligated assets and their approximated size, both for absorption and injection of reactive power.
2. The needs will be categorized in 3 different levels:
    1. No/low need
    2. Medium need
    3. High need
3. The data will be published based on historical data

This information should give all market parties a better insight into the overall use of the assets included in the MVAr service. Like mentioned before, this should enable them to make better investment decisions and give a more detailed insight into the number of activations during the year. During the public consultation, Elia received comments from the market parties to make sure that no confidential information could be derived from this publication. Elia indeed confirms that this will be closely surveilled. Given this constraint, Elia will make as much information as possible available to the market parties. For concrete projects, Elia invites all stakeholders to take contact.
Of course, since the map is based on historical data and it is not possible to predict the exact activations, the map does not give any assurances on the number and volume of activations.
Elia will also explore options to provide additional indicators, on top of the need for reactive power, to show the amount of assets participating in a certain area.

4.5. Price setting

The MVAr service is remunerated per requested MVArh. The price for these MVArhs is set for every supplying unit during the tendering procedure, after a price reasonability check by the CREG. This price can differ depending on the total MVAr requested, the type of service delivered and the absorption or injection of reactive power.

4.5.1. Current situation

The current market design only allows for one type of price: a price that can only vary depending on the “activation percentage” (e.g. X €/MVarh between 0 and 80% of maximum activation power, and Y€/MVarh above).

A relatively long time (typically 6 months) is needed between the tender organised by Elia and the start of the delivery of the service, in order for Elia to establish a tender report and for the CREG to assess the reasonability of the costs, resulting in an additional price risk for the market parties. Given the current electricity price volatility, which is one of the factors which determines the MVAr costs, an additional risk premium will be added in the pricing. This risk premium increases the overall costs for society, whilst not even assuring a complete cost recovery for the market party. This ex ante price also makes the price judgement more complex, given the determination of the risk premium is difficult to assess. .

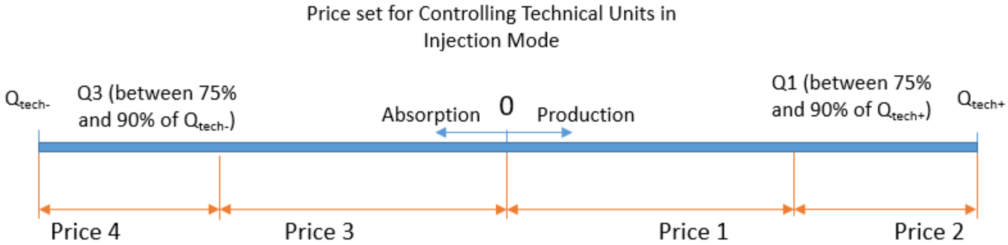
ANNEX 12. Remuneration for Activation (excerpt)

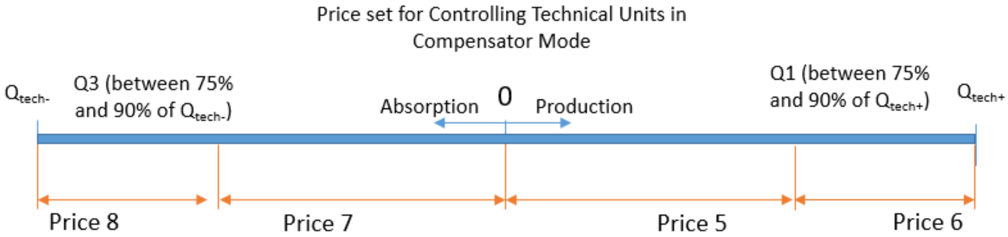
…

The VSP has the right to set different sets of prices according to the aforementioned criteria.

In particular:

For Controlling Technical Units, the VSP may set up to 2 prices for production or absorption. Technical Units that can provide the Service within Technical Control Bands equal to or larger than 20 MVAr (whether in production or absorption) may split their Technical Control Band (in the side of production and/or absorption) in 2 price bands. The value of the Reactive Power defining the limit between the two price bands (referred as "Q1" and "Q3" in the following figure) can be chosen by the VSP between 75 % and 90% of $Q_{tech\ max}$ in production and between 75 % and 90% of $Q_{tech\ min}$ in absorption upon technical justification of the chosen limit. The VSP may propose different prices for Injection Mode and Compensator Mode as follows:





Where:

- Q1 and Q3 are set for each Technical Unit in Annex 1;

  For Controlling Technical Units that have Technical Control Bands lower than 20MVAr on the production and/or absorption side, VSP's may propose 1 price per side:

  - Price 1 (P1) for the production side of Controlling Technical Units in Injection Mode ;
  - Price 3 (P3) for the absorption side of Controlling Technical Units in Injection Mode;
  - Price 5 (P5) for the production side of Controlling Technical Units in Compensator Mode;
  - Price 7 (P7) for the absorption side of Controlling Technical Units in Compensator Mode;

For Non-Controlling Technical Units, the VSP may set one price for production (P9) and one for absorption (P10) of Reactive Power.

4.5.2. Proposed changes

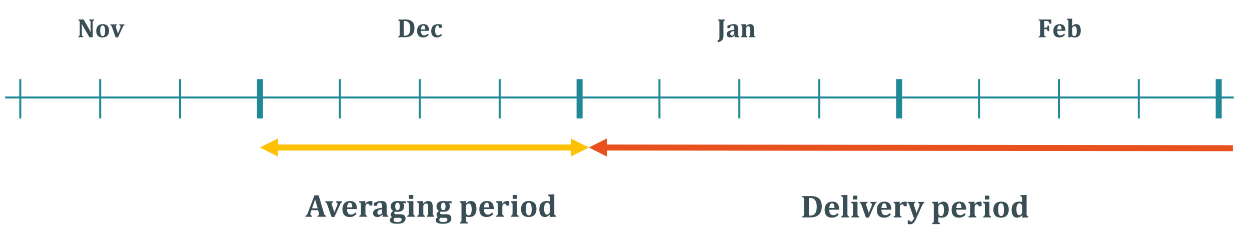
<u>Tender-based variable price formula</u>

In addition to the current design, where fixed price(s) determined ex ante as described above can be offered, Elia proposes to add the possibility for the supplier to define a price formula that can be updated during the tender. The goal of this option is to reduce the risk associated with setting the price 6 months before the start of the delivery period.

The form of the formula needs to follow the following design:

$$P = X + Y * \text{ price index}$$

The determination by the CREG of the price reasonability of this formula during the tendering procedure will be done based on the value of the defined product that is available at the time of evaluation. The value that will be used by Elia for the remuneration of the service will depend on the chosen price index. In case a futures price is selected, the average of the price index during the month before the start of the delivery period will be used.



$$\text{Future price index} = \frac{\sum_{Dec\ 1}^{Dec\ 31} \text{Daily future price index}}{\text{Number of days in December}}$$

In case spot prices (e.g. EPEX spot, Nord Pool) are used for the price formula, the exact value of the spot price will be used.

The formula is allowed to differ between the different price levels. So, for controlling units P1, P2, P3, P4, P5, P6, P7 and P8 may be different, and for non-controlling units P9 and P10 may be different as well.

The way the total remuneration for the service per price level will be calculated will remain the same:

$$\text{Total monthly remuneration} = \sum_{Month} \sum_{Price\ level} (X + Y * \text{price index}) * Q_{requested}$$

This variable price formula reduces the risk associated with the timing issue faced with the ex-ante definition of a fixed price, since the time between determining the final price and price setting is significantly reduced. This in turn means that the need for the additional risk premium is decreased. A variable price also creates the option of multiple year contracts, reducing the operational burden for all involved stakeholders. On top of that, the tender timing has more flexibility, allowing for a timing which can consider additional constraints from market parties. These advantages also come with some additional complexity, certainly to compare variable prices with fixed prices and amongst each other during the tendering procedure.

Lifetime price formula

During the workshop in July, an additional option was proposed by Elia. In this option, a “fixed” price formula per technology would be determined in order to simplify the yearly tendering process. However, given the complexity to determine a correct formula, taking also local constraints (measurement point, local grid configuration,…) into account, and based on the feedback from the attendees of the workshop, this proposal has not been further explored in this context.

Given the outcome from the European benchmark, which showed that variable remuneration based on activated/requested energy is the norm, Elia maintains this as well for the remuneration.

4.5.3. Recommendation

Based on the feedback from the market parties, given the possibilities to reduce the price risks for the market parties, the option to extend the duration of the contract to multiple years and the possibility to change the tender timing, all addressing market party concerns, Elia will retain the tender-based variable price formula. From Elia’s point of view, these advantages outweigh the additional complexity to compare the offers. In order to limit the complexity as much as possible, Elia will discuss during the implementation phase of the variable price, with the market parties and the CREG, a limited set of indices that can be utilized.

4.6. Participation of non active power related assets (like capacitor banks or shunt reactors)

The availability of an asset is judged via the measurement of active power injection or consumption. If these assets are operating above their Pmin, they are available for the service. If they are operating below their Pmin, they are not available to deliver the service (unless they also operate in compensator mode). However, the availability of non active power related assets is not characterized by the Pmin. As such, a different system is required to assess the availability of these asset types.

4.6.1. Current situation

In the current market design, non-mandatory non-active power related assets can join the current tendering procedure but should be available at all times at their contractually defined Qtech- and Qtech+. However, since these assets are often required to regulate the voltage behind the access point, they do not have a full availability to provide the MVAr service. To address this situation, a derogation on this obligation to be available is allowed.

4.6.2. Proposed changes

It is proposed to allow non-mandatory non-active power related assets to declare their hourly availability on beforehand (24h) via Revolt, which enables their participation to the voltage service. This relaxes the obligation and resolves the issue that they need to have full availability at all times, whilst leaving sufficient time for Elia to consider their activation. These changes can only take effect from the moment that the communication system has been updated.
However, given the difficulty to predict the local reactive power requirements ex ante, a possibility to refuse a setpoint without penalization will be maintained. This means that if a setpoint cannot be reached and Elia is informed either before the setpoint is sent, or within 10 seconds after the setpoint request, no penalization (but also no remuneration) occurs.

4.7. Compensator mode

The “compensator mode” allows assets that are operating below their Pmin to still participate to the MVAr service. Two additional levels (the Pmin and Pmax for compensator mode) are defined for assets that are capable of operating in this mode during the tendering process.

4.7.1. Current situation

Compensator mode is currently only described in 1 direction (either when injecting active power or when consuming active power), as described in *Figure* 1. However, for some assets (e.g. batteries) this means that the VSP can only use compensator mode when injecting <u>or</u> when consuming active power. This limits the technical band that these assets can offer.

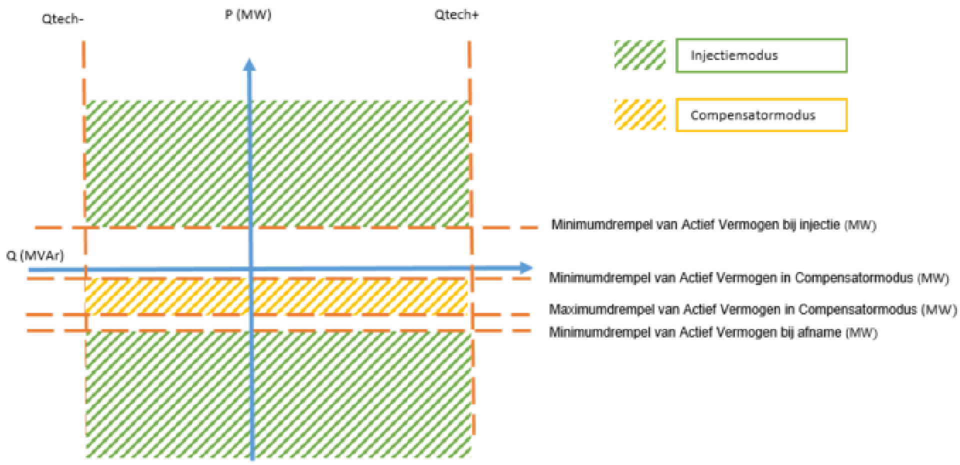


Figure 1: Compensator mode in the current market design

4.7.2. Proposed changes

In order to further increase the range in which market parties can participate to the service, an additional band for compensator mode is proposed. This means that both when injecting a limited amount of energy or consuming a limited amount of energy, assets can be available to provide the MVAr service. So on top of the existing levels, two additional levels (the Pmin and Pmax for the additional compensator mode), are defined during the tendering process. This is shown in Figure 2.

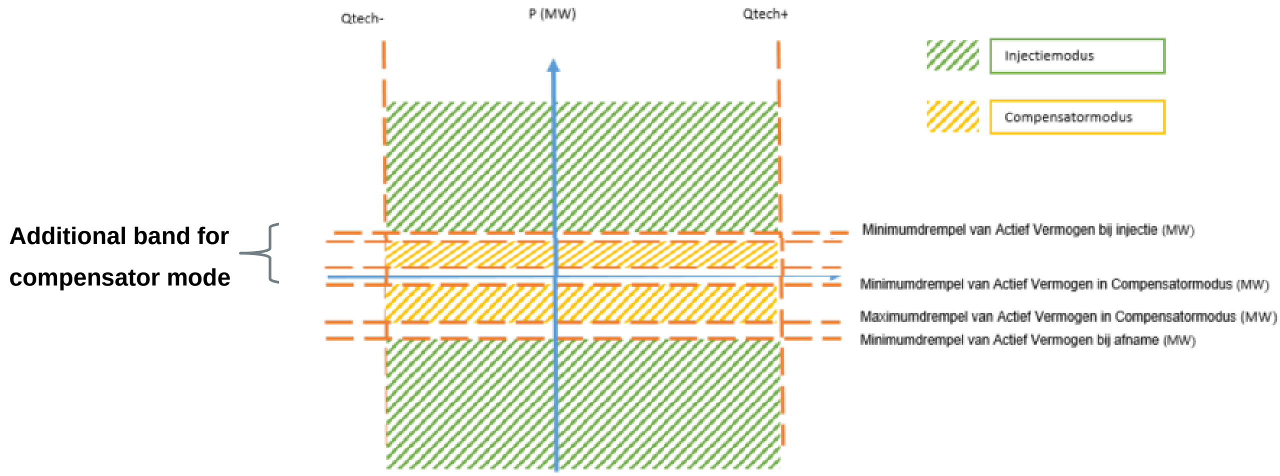


Figure 2: Proposed design for compensator mode

4.8. Change in the application of the MVAr tariffs

An industrial site can have both consumption and production behind the same access point. This means that the level of active power consumption is not necessarily linked to the level of reactive power consumption. This in turn means that the “butterfly bands” (see Figure 3) used in the MVAr tariff can create challenges to remain within the tolerance band when both active power consumption and production occur at the same time behind one access point.

4.8.1. Current situation

Next to the MVAr service, there is also a MVAr tariff. This is a tariff that needs to be paid by the grid user depending on the level of MVAr that are absorbed or injected at the access point. In the current design, the tariff is calculated using a butterfly band as shown in Figure 3. So, at low active power consumption/injection, the tariff for an inductive or capacitive load will shift more quickly to a new level in comparison with the tariff at high active power consumption/injection. Units that provide the MVAr service are excluded from this tariff when delivering the service.

When there is both production and consumption of active power behind the access point, this design can lead to higher MVAr tariff costs (since the net consumption/injection would be low and thus a smaller tolerance band is available at the access point). This can also create issues when starting up a unit on an industrial site with active power consumption and production, since it is still operating below the Pmin (not yet delivering the MVAr service and subject to the MVAr tariff) during the start-up and thus has a limited tolerance band available for the MVAr tariff.

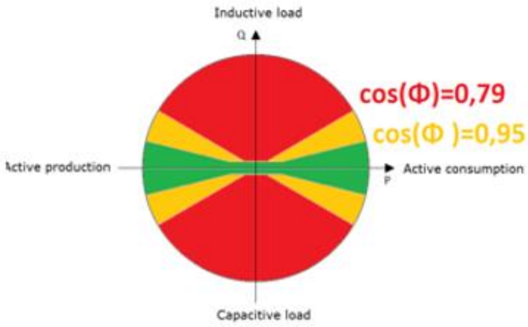


Figure 3: "Butterfly bands" for the current MVAr tariff

4.8.2. Proposed changes (in tariff file)

There is a change in the MVAr tariff adapoted in the tariff proposal for the period 2024-2027. Instead of using the “butterfly band” as presented before, a flat band will be used as the differentiator for the MVAr tariff, as shown in Figure 4. The design was chosen in alignment with article 324 of the Federal grid code, which also defines the limits. This effectively solves the issue for sites with both consumption and injection since the dependency on active power consumption/injection has been removed. For further details, please refer to the tariff proposal for the period 2024-2027.

Figure 4: The proposed new bands for the MVAr tariff

4.9. Update the T&C VSP to become more technology neutral

The goal of the T&C VSP is to be as neutral as possible to allow the participation of all assets. In an ever-changing energy market, modifications are sometimes required in order to maintain this neutrality.

4.9.1. Current situation

In the current version of the T&C VSP, there are still articles that are written from the perspective of large production sites. Given the changes in the energy landscape, more and different types of units have become able to deliver the MVAr service. The T&C VSP should also reflect these changes in the power system and thus an update needs to be performed.

However, even though the articles have been written from the perspective of large production sites, this does not inhibit other assets from participating to the service. The current phrasing can however create points of contention and complexifies their participation.

4.9.2. Proposed changes

It is proposed to rewrite the sections of the T&C VSP, which are written from the perspective of large production sites, to become more technology-neutral and thus more easily understood by all actors. Specific examples of this are Art. II.5.1 and Art. II.5.3.

4.10. Additional facilitations for the participation of non-mandatory units

Non-mandatory units can play an important role in the MVAr service. However, in the current tendering procedures their participation remains limited.

4.10.1. Prequalification

Every unit has to do a prequalification test before delivering the MVAr service. This prequalification test checks the characteristics of the unit, asses the reactive power potential, etc. These tests can take time and effort from market parties, so simplifications could enable further participation to the service.

4.10.1.1 Current situation

The excerpt from the T&C VSP below describes the current situation:

Art II.3.3

…

Prequalification Test

e) Before the beginning of Service delivery, Elia shall request a Prequalification Test to verify the characteristics of the Service delivery by each Technical Unit.

f) This test will at least involve an activation of the Service in which the VSP must provide the Service under conditions foreseen in the present Contract. Exact test modalities are described in ANNEX 13.

g) The Prequalification Test will confirm the Reactive Power Technical Control Band made available, measurement modalities together with the modalities for calculation of Q_{req} (as per ANNEX 2)

h) The Prequalification Test will not be considered as an activation of the Service.

i) Elia reserves the right to abort the Prequalification Test at any moment if it jeopardizes the security of the Elia Grid.

Compliance

j) In case of non-compliance with one or more of the obligations in Article II.3.3 a) to i), the VSP shall take all necessary actions to become compliant again as soon as possible.

4.10.1.2 Proposed changes

There was no specific feedback from the market parties on the current prequalification process before the public consultation. During the public consultation, one market arty identified an entry barrier in the current prequalification process. The T&C VSP require each asset to be prequalified individually, even if they are located behind the same Service Measurement Point. This creates challenges to prequalify a significant number of smaller assets. Elia recognizes this barrier and will propose a modification to this in the next update of the T&C VSP.
In order to further enable the participation of non-mandatory units, Elia also commits to provide additional documentation to make the communication requirements easier to understand and implement. Since the software/hardware modifications to the technical unit make up a large part of the current challenges, simplifying this via the new communication protocol proposed in Section 4.3 will also reduce the complexity.

4.10.2. Cost

An important aspect to increase the participation of non-mandatory units, is their overall profitability. Since upfront investments are needed to comply with the requirements to deliver the MVAr service, a return on these investments needs to be possible before participation can be considered.

4.10.2.1 Current situation

No remuneration for the investment costs is currently set out in the T&C VSP.

4.10.2.2 Proposed changes

It is proposed to provide for units without an obligation to participate the possibility to recover the investment costs via the MVAr service tender procedure. Only investments required to comply with the communication standards that are set out in the T&C VSP would be taken into account. These costs per MVAr will then be compared to the cost to cover the MVAr needs in a different way to determine whether they are manifestly unreasonable.

4.10.3. Understanding of the voltage service and reactive power control

The MVAr service is a complex product which is not always well understood. This potentially creates challenges for the participation of market parties.

4.10.3.1 Proposed actions

In order to remedy this, Elia proposes to:

- Create additional documents that explain the MVAr service in a simple way. This will also help with the risk assessment of the market parties considering to participate to the MVAr service;
- Add FAQ to the available document to already answer many of the questions that the market parties may have.

4.10.4. Cost-effectiveness of the participation of the non-mandatory units

Given the local character of the MVAr service, increased participation helps the service in two ways. First of all, the effectiveness of activations is improved since the assets are more likely to be close to the area where the need for compensation is. Furthermore, the additional competition should also result in a lower offered prices, which reduces the need for regulatory intervention.

However, the participation of these non-mandatory units also comes with some hurdles. In order to be able to comply with the requirements set out in the T&C VSP to provide the MVAr service, investments to update the hardware and software are required. Typically, the original manufacturer of the asset will need to make these updates. These modifications often come at a high cost and require both a lot of time and effort, from the market party and from Elia. And overall, this time and efforts results in a limited additional value. Since these assets are typically only able to provide static compensation and are located on a lower voltage level, the value that they represent for the power system is relatively low.

In addition, when the cost to execute the updates for these non-mandatory units is compared to the cost for Elia to invest in their own assets, the latter comes at a lower cost. Therefore, no additional changes on top of the ones already described are proposed.

5. Implementation plan

This chapter shows the indicative timing for the changes that were described in the previous chapter. The planning is developed based on the roadmap for 2024 and is subject to modifications of the roadmap. The changes have been split up into 5 different actions to be taken:

1. Implementation of modifications to the T&C VSP
2. IT implementation to enable the new T&C VSP (except for the communication protocol, see lower)
3. Implementation and testing of the communication protocol for the MVAr service
4. Creation of supporting documents
5. Creation MVAr service needs map

The first point consists of the additional and changed functionalities that are described in the previous chapter and that require a change in the T&C VSP. As shown in the timeline in Figure 5, these modifications are planned for the second half of 2024, with a public consultation planned in the first quarter of 2025. These changes will take effect starting from the first contractual period that is tendered for after the approval of the CREG, except for the changes that require additional implementation on the VSP side (specifically concerning point 3, the implementation and testing of a new communication protocol for the MVAr service).

In order to enable the modifications to the T&C VSP, IT developments need to be executed on Elia side. These modifications are planned to take place between the middle of 2024 and the end of 2025 in order to be in place before the application of the new T&C.

The third point focusses on the IT implementation and testing of the communication protocol for the MVAr service. As described in point 4.3, this concerns both the messages that are sent between Elia and the VSP, as well as the way the communication is done. Since these changes also require testing on market parties' side, additional time is provided to perform this. The full implementation of these changes are planned to be finalized by the end of 2026.

Fourthly, additional documents will be created in order to better explain the need for reactive power and its challenges, the operational processes at Elia and the MVAr service itself. These documents are planned to be published on the website by the end of the second quarter of 2024.

Finally, as described in point 4.4, the need for the MVAr service per area in the grid will also be published on the Elia website. This publication is currently planned for the end of 2024.

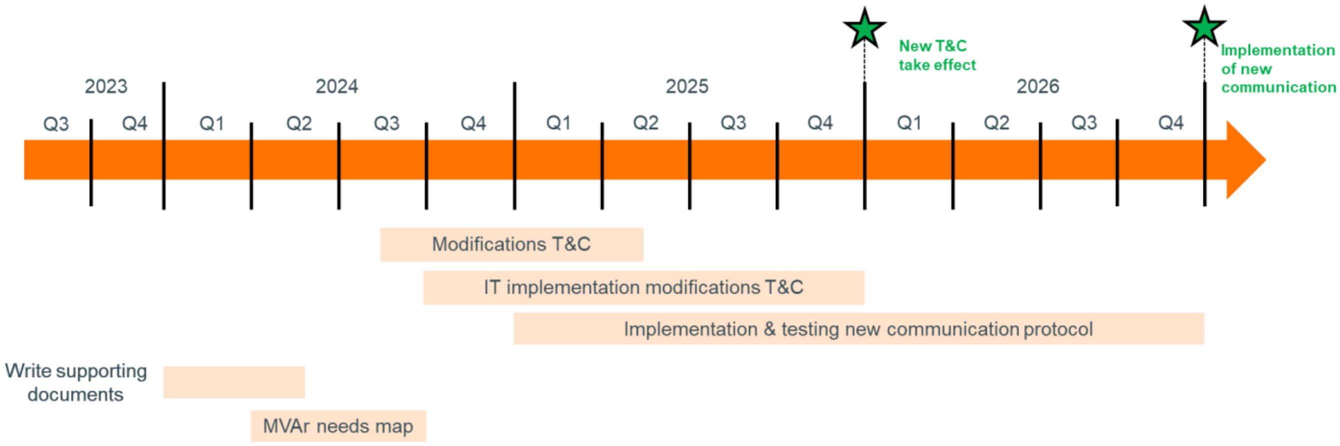


Figure 5: Timeline of the implementation plan

6. Conclusions

Based on the feedback Elia received from the market parties during the interactions that took place throughout this incentive, Elia understands that the current market design for the MVAr service works well. Even so, several improvements have been identified. These are:

1. Switch towards continuous activation control

The switch towards continuous activation control eliminates the risk that market parties will be unfairly penalized for momentary failures in the samples. As such, the real quality of the service delivered is used as a reference and as a basis for the penalization.

2. Penalty system that reflects the continuous activation control

With a change in activation control, the penalty scheme also needs an update. The two proposals presented in Section 4.2 have their advantages and disadvantages. The first proposal is simple to understand, but incentivizes the correct delivery less than the second proposal, which takes the difference between the requested and delivered reactive power into account and incentivizes VSPs to deliver the service to the best of their abilities. Given these reasons and the feedback from the market parties, Elia will retain the second proposal.

3. Updated communication between Elia and the market parties

Updated communication should allow more participants, given of the updated communication protocol and changes to facilitate the participation of non active power related assets and improve the participation of all other assets.

4. Indication of the need for the MVAr service

Indicating the need for reactive power allows market parties to better judge the expected number of activations, both when making the decision to participate as well as when setting the prices during the tendering procedure.

5. Price setting for the MVAr service during the tendering process

Given the fact that there is a large time difference between the price setting during the tendering procedure, the confirmation of the contract and the activation of the service there is a risk on the cost for active power. In order to alleviate this risk, the option of a price formula indexed on forward or spot prices is added.

6. Participation of non active power related assets

In order to enable the participation of non active power related assets, the possibility to declare their availabilities is added. As such, they do not need to be available at all times and can thus still react on the changes behind their access point.

7. Adding an second bandwidth to compensator mode

Adding an second bandwidth to compensator mode allows for market parties to increase the technical bandwidth that they offer in the MVAr service.

8. Change in the application of the MVAr tariffs

In the new tariffs, a change in the bandwidth used for the application of the MVAr tariff has been adopted. Instead of using the current “butterfly band”, a fixed value for both the injection and absorption of reactive power at the access point is used.

9. Furthering the technology neutrality of the T&C VSP

In the T&C VSP, there are still some articles that complexify the participation of some assets. These articles will be rewritten in order to resolve these challenges.

10. Facilitating the participation of non-mandatory units

Finally, there was an analysis to determine if and what changes can be implemented in order to increase the participation of non-mandatory units. From this analysis, a couple points became apparent:

1. First of all, creating a better understanding of the MVAr service will enable the market parties to make a well-informed decision whether they want to participate to the service. This is both on the prequalification process, as well as the MVAr service as a whole. Additional clarification documents will be created in order to improve this.
2. Specifically for the prequalification process, a modification has been proposed to ease the prequalification of a large number of smaller units located behind one Service Measurement Point. No individual prequalification will be required in this case.
3. Next to that, the investment cost to participate to the service has been identified as a hurdle as well. So the possibility to introduce these costs during the tendering procedure will be added in the T&C VSP. However, these costs will need to be compared and be more cost-effective then other ways to procure the required reactive power, since investing in smaller, static units on lower voltage levels is not always the most cost-effective option.

The timing for the implementation of these modifications is explained in chapter 5 (timings based on the roadmap).

- The modifications to the T&C VSP will be performed in the second half of 2024 with a Public Consultation in the beginning of 2025,
- the IT implementation to enable the new T&C VSP will start in the second half of 2024 and will run until the end of 2025,
- the IT implementations for the communication will run from the beginning of 2025 until the end of 2026,
- the publication of supporting documents will be done at the end of the second quarter of 2024 and
- the publication of the MVAr needs map on the Elia website by the end of 2024.

7. Annex

7.1. European benchmark

Below the detailed response from the market parties on the questions in the European benchmark can be found.

7.1.1. Sources and obligations for the MVAr service

TSO	asset types basically used for MVAr service (today)	voltage level and/or typical size	obligations for provision of MVAr service
50Hertz – GER	• power plants (lignite, pumped storage) • PV, wind farms • compensatory devices (TSO-owned)	≥ 220kV	• mandatory for power plants scheduled for commercial dis-patch
Amprion – GER	• power plants (thermal, pumped storage) • converters (TSO-owned) • compensatory devices (TSO-owned)	≥ 220kV	• mandatory for power plants scheduled for commercial dis-patch
Elia – BEL	• power plants (thermal, pumped storage) • wind parks	≥ 30kV, ≥ 25MVA	• Units connected to ≥ 110 kV that can deliver MVAr service obliged to submit bids, provision only by contracted units
Energinet.dk – DEN	• power plants (thermal) • compensatory devices (TSO-owned)	≥ 132kV	• mandatory for power plants scheduled for commercial dis-patch
National Grid – GBR	• power plants (thermal, pumped storage) • wind parks • compensatory devices (TSO-owned) • converters (TSO-owned)	400kV (England, Wales) 132kV (Scotland)	• mandatory for power plants >47 MW scheduled for commer-cial dispatch
RTE – FRA	• power plants (nuclear, thermal, hydro) • wind parks, batteries • compensatory devices (TSO-owned) • converters (TSO-owned)	≥ 63kV	• mandatory for power plants scheduled for commercial dis-patch

Swissgrid – SUI	• power plants (nuclear, water) • DSOs • compensatory devices (TSO-owned)	≥ 220kV	• mandatory for power plants scheduled for commercial dispatch • Incentive based for DSOs and demand facilities
Statnett – NOR	• power plants (hydro) • converters (TSO-owned) • compensatory devices (TSO-owned)	≥ 132kV	• mandatory for generation units ≥ 10 MVA scheduled for commercial dispatch
Svenska Kraftnät - SWE	• power plants (thermal, pumped storage) • converters (TSO-owned) • compensatory devices (TSO-owned)	≥ 220kV	• mandatory for power plants scheduled for commercial dispatch
TenneT DE – GER	• *power plants (thermal, pumped storage)*	*≥ 220kV, 300-800 MVA*	• *mandatory for power plants scheduled for commercial dispatch*
TenneT NL – NED	• power plants (thermal) • wind parks + PV (in preparation) • Shunts & HVDC-VSC (TSO-owned)	≥ 110kV	• only for contracted units, no mandatory participation at MVAr service
TransnetBW – GER	• power plants (thermal) • converters (TSO-owned and contracted) • compensatory devices (TSO-owned)	≥ 110kV	• technical minimum requirements for connection • power plants >100 kW as well as remotely controllable plants must follow requests by TSOs for reactive procurement (German law)

TSO	power plants, directly connected to Extra high volage transmission grid (220 & 380 kV)	local production units	DSOs	demand facilities / CDSO
50Hertz – GER	• mandatory for units scheduled for commercial dispatch	• no contracts	• no contracts (in discussion for future)	• no contracts
Amprion – GER	• mandatory for units scheduled for commercial dispatch	• no contracts	• no contracts (in discussion for future)	• no contracts
Elia – BEL	• only for contracted units	• some local production facility contracted	• no contracts (in discussion for future)	• few contracts
Energinet.dk – DEN	• mandatory for units scheduled for commercial dispatch	• no contracts	• no contracts	• no contracts
National Grid – GBR	• mandatory for units > 47MW scheduled for commercial dispatch	• no contracts	• no contracts	• no contracts
RTE – FRA	• mandatory for units scheduled for commercial dispatch	• no contracts (general request for seasonal reactive power behavior in discussion)	• no contracts	• no contracts

Statnett – NOR	• mandatory for units ≥ 10MVA scheduled for commercial dispatch	• no contracts	• no contracts	• no contracts
Swissgrid – SUI	• mandatory for units scheduled for commercial dispatch	• no contracts	• ~ 25 DSO nodes participating in "active role"	• no contracts, but remuneration scheme exists
Svenska Kraftnät – SWE	• mandatory for units scheduled for commercial dispatch	• no contracts	• no contracts	• no contracts
TenneT DE – GER	• *mandatory for units scheduled for commercial dispatch*	• *no contracts*	• no contracts (in discussion for future)	• *no contracts*
TenneT NL – NED	• only for contracted units	• no contracts	• no contracts (in discussion for future)	• few contracts
TransnetBW – GER	• technical minimum requirements for connection; • power plants >100 kW as well as remotely controllable plants have to follow requests by TSOs for reactive procurement (German law)	• contracts with units in HV (110 & 150 kV) grids	• no contracts (in discussion for future)	• no contracts

7.1.2. Remuneration

TSO	type of price	initial price proposal	remuneration characteristics	type of contract	contract duration and updates
50Hertz – GER	• variable	• TSO	• sum of metered reactive energy remunerated	• dedicated contract	• lifetime, annual indexed prices according to energy market
Amprion – GER	• variable	• TSO	• sum of metered reactive energy remunerated	• dedicated contract	• lifetime, annual indexed prices according to energy market (base price average of last 3 months of a year determines the price of next year)
Elia – BEL	• variable & fixed part	• provider	• sum of metered reactive energy at contracted units remunerated • Investment costs e.g. for communication devices remunerated	• tender	• 1 year
Energinet.dk – DEN	• none	• none	• mandatory service is not remunerated	• connection contract	• lifetime
National Grid – GBR	• Variable • (NSP: fixed fee)	• Regulated price • Tenders: bidder/provider	• sum of metered reactive energy remunerated while MVAr service actively requested	• connection contract • tender for non-mandatory service,	• lifetime, monthly indexed prices • tender period (days..years)

			• Network Service Procurement (NSP): Availability fee for effective Mvar provided during contract length	NSP tenders to solve specific local grid issues (long-term contracts)	
RTE-FRA	• variable & fixed part	• TSO & provider	• fixed yearly fee + operating hours based fee	• connection contract	• lifetime, yearly indexed prices
Statnett – NOR	• fixed	• TSO	• fixed yearly fee	• connection contract	• Lifetime
Swissgrid – SUI	• variable	• TSO	• sum of metered reactive energy remunerated if compliant to request	• connection contract • operating agreement	• lifetime, yearly updated prices
Svenska Kraftnät - SWE	• none	• none	• mandatory service is not remunerated	• connection contract	• lifetime
TenneT DE – GER	• *variable*	• *TSO*	• *sum of metered reactive energy less free range (inductance of transformer, generator) remunerated*	• *connection contract*	• *lifetime, annual indexed prices according to energy market*

TenneT NL – NED	• fixed • variable	• provider	• variable: volume (Mvarh) of requested MVAr service remunerated	• tender	• 1 year
Trans-netBW – GER	• variable	• variable / negotiation mainly cost-based	• sum of metered reactive energy remunerated • depending on type/source of delivered reactive power	• dedicated contract	• long-term (multiple years or open-ended) • can be cancelled/updated ~yearly

7.1.3. Activation and verification

TSO	type of activation request	activation periods and behaviour outside activation	active verification of requested MVAr service provision	(beforehand) determination of MVAr service needs
50Hertz – GER	• manual request by control center or via SCADA	• permanently active	• no	• no
Amprion – GER	• manual request by control center	• permanently active	• no	• no
Elia – BEL	• manual request by control center	• active, if requested	• yes, penalty scheme exists	• no

		• otherwise and non-contracted assets cos phi rule		
Energi-net.dk – DEN	• manual request by control center	• permanently active	• no	• yes, monthly
National Grid – GBR	• manual request by control center	• active, if requested • otherwise cos phi rule	• no	• yes, monthly
RTE – FRA	• real time request by control center • fixed voltage set-point	• permanently active	• yes, penalty scheme exists	• yes, winter/summer outlook, day-ahead prognosis
Statnett – NOR	• fixed voltage set-point at generation units, no regular change requests by control center	• permanently active	• no	• no
Swissgrid – SUI	• voltage schedule per node, quarter-hourly values	• permanently active	• yes, penalty scheme exists	• no
Svenska Kraftnät - SWE	• N/A	• N/A	• no	• N/A

TenneT DE – GER	• *manual request by control center*	• *permanently active*	• *no*	• *no*
TenneT NL – NED	• manual request by control center	• active, if requested • otherwise and non-contracted assets cos phi rule	• manually via control center • verification on a random basis	• yes, yearly
Trans-netBW – GER	• manual request by control center	• some permanently active • some partly active as required	• yes (active ex-post mon-itoring but no impact on remuneration)	• no