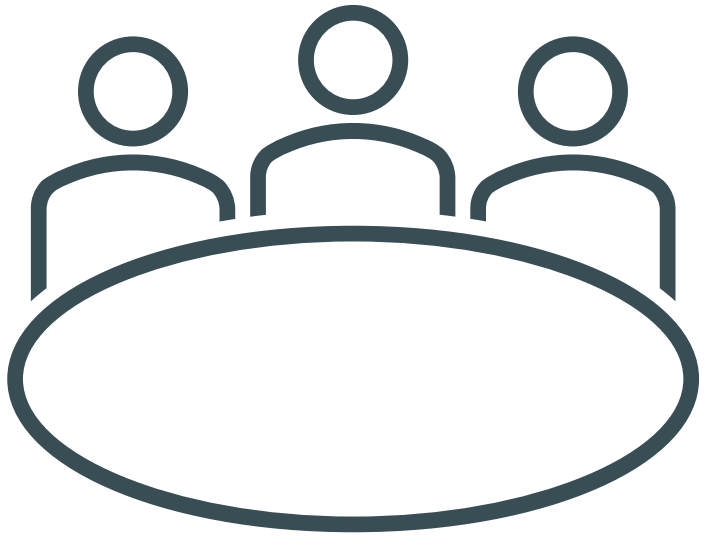
MVAR service evolutions

workshop – 10/12/2024

10/12/2024 | Carsten Bakker

Agenda

1. Introduction
2. Context for the project
3. MVAr market design evolutions
4. Planning for design evolutions
5. IT Implementation
6. Planning for IT implementation



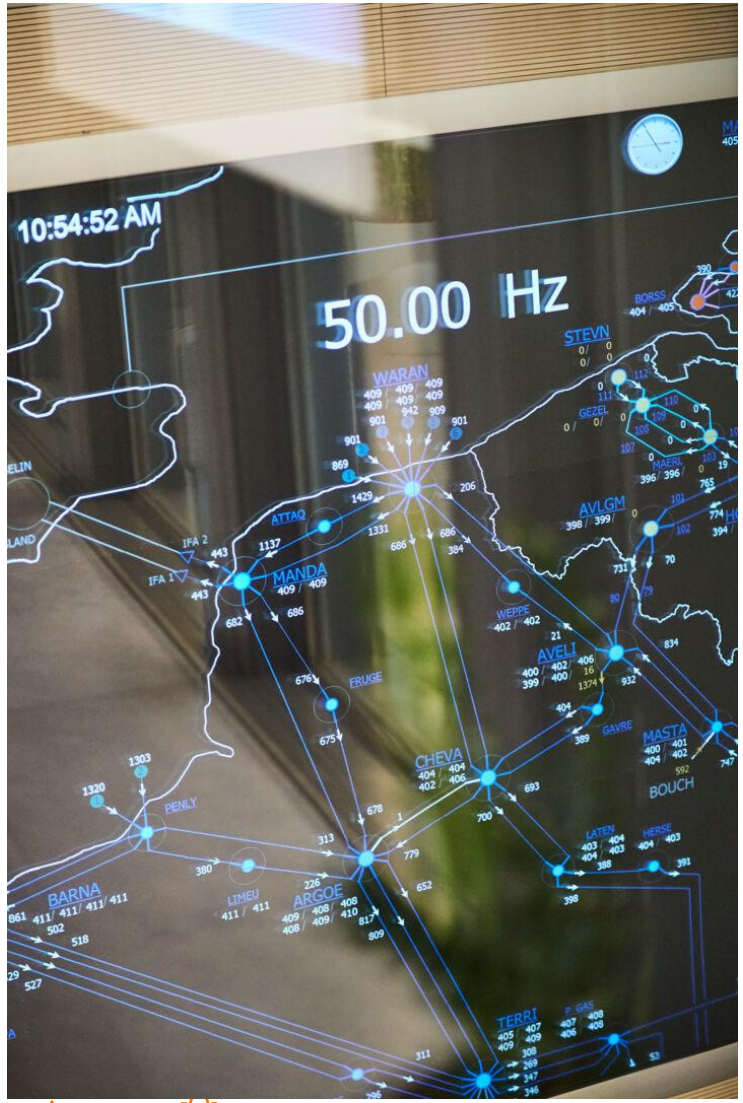
Introduction

Purpose of the service

- Elia is responsible to **stabilize the voltage** in the event of an incident and **maintain it within limits** ensuring grid security

- To maintain grid voltages at a suitable and stable level, Elia relies on **reactive power supplied by grid-connected units** via the service provided by the **Voltage Service Providers (VSP)**

Allowed steady state voltages [in kV and in % of the target normal operating voltages]								
Voltage level (reference voltage in EU NCs) Unc			400	220	150	110	70	36	30
Maximum normal Limits	All conditions (N, N-1)	107.5% of Uexpl[2] (105% for 400kV)	420	242	167	118	75.3	38.7	32.3
Target normal operating voltages (Uexpl)		100%	400	225	155	110	70	36	30
Minimum normal Limits	All conditions (N, N-1)	92.5%[3] of Uexpl	370	208	143	102	64.8	33.3	27.8



Voltage and reactive power control services

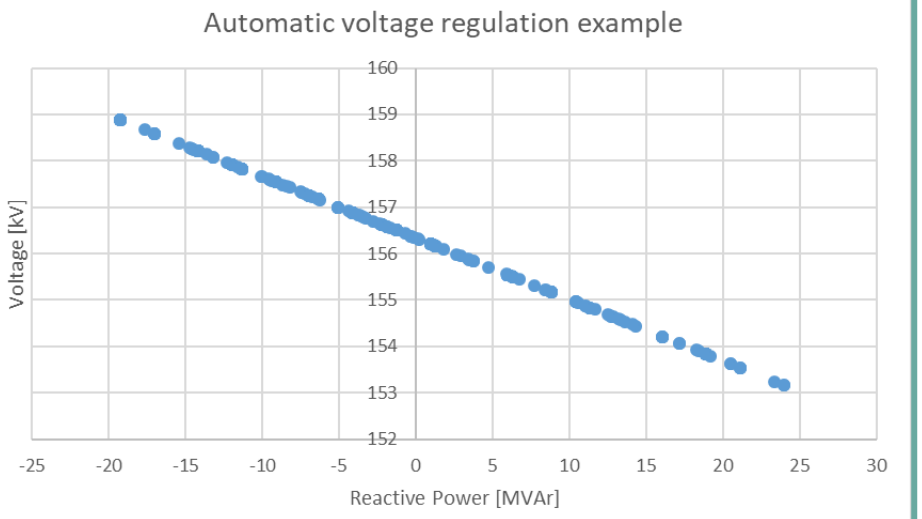
Controlling Unit

Non controlling Unit

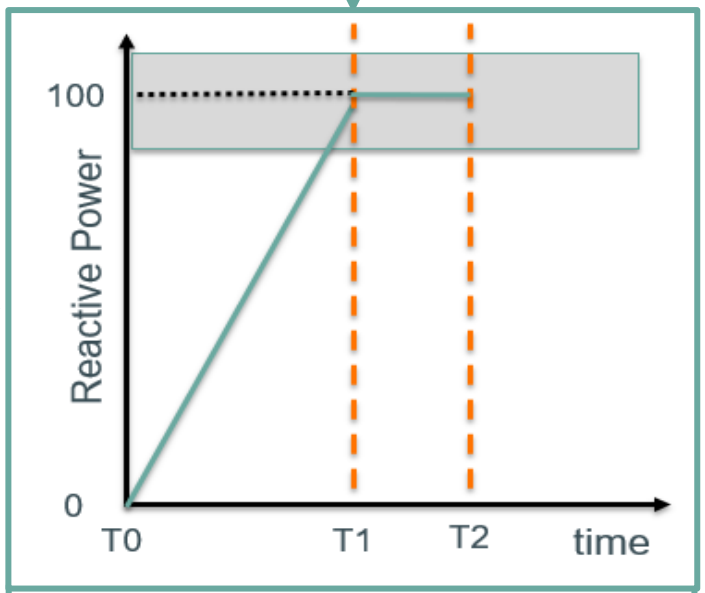
Automatic Control service Type

Manual Control service Type

Manual Control service Type



Automated and continuous modulation of the production/absorption of reactive power in function of the voltage



Stepwise modulation of the production/absorption of reactive power following an explicit signal (setpoint) by Elia

Participation to the service

Who is obliged to participate to the service?

- ✓ According to both the EU regulation and the implementation of these regulations in the Federal Grid Code units B, C, D have the obligation to be able to regulate their reactive power injection and absorption within a certain range and with requirements depending on their type (B, C, D).
- ✓ In addition, the CREG CoC imposes all Technical Units capable to deliver the service to participate to the reactive power control Service
- ✓ This is valid if at least 1 MVAr can be provided

Who can become a Voltage Service Provider?

- ✓ The Grid User of a technical unit himself
- ✓ A third party* designated by the Grid User

How to participate?

- ✓ Participation to voltage services starts with submitting an offer in the **(multi-)year tender** organized for the procurement of the service
- ✓ Relevant documents are published on the Elia website
- ✓ Submitted offers are subject to a **reasonability analysis of the price** by the regulator

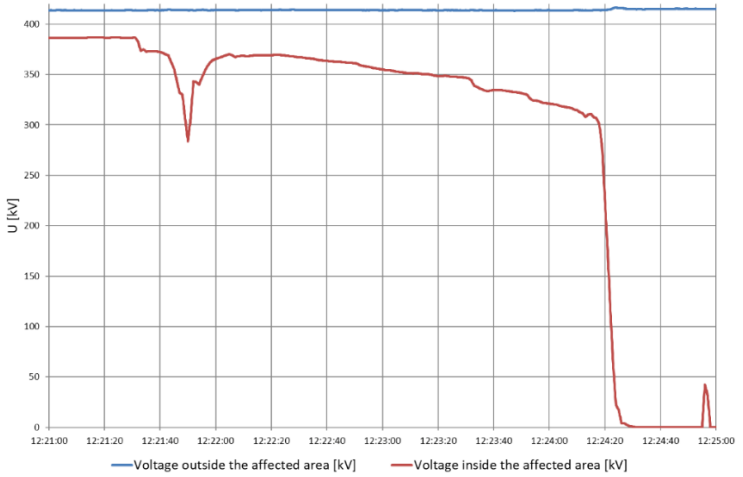
	Grid User	Federal level (connection > 110 kV)	Regional level
Elia grid	New Type B,C,D SPGM	Mandatory	Mandatory
	New Type B,C,D PPM		
	New Type B, C, D SPM		Voluntary
	New HVDC interconnector		n.a.
	New generators connected on a HVDC link		
	New HVDC conversion stations at isolated extremity		
	New offshore PPM with onshore connection points		
	New offshore PPM with offshore connection points		
	Existing SPGM and PPM type C,D		Voluntary
	Existing SPGM and PPM type B		
	Existing HVDC interconnector	Voluntary	
	Demand facilities directly connected to Elia grid		
Non- Elia grid	DSO	Voluntary	
	CDSO	Voluntary	

* In case of participation of a unit connected to a public distribution grid or closed distribution grid, the DSO/CDSO is the VSP

The impact of not having sufficient Reactive Power Control assets can be very significant

- Grid incident in south-eastern part of the Continental Europe power system – Update (June 2024)
- Due to 2 trips, the voltage decreased significantly in a wide area
- This voltage drop led to high currents
- These high currents triggered the protection devices to disconnect the affected lines
- The disconnected lines led to a further decrease in voltage leading to a voltage collapse and a black-out in south-eastern part of the Continental Europe power system

The voltage service plays a very important role in the overall security of our grid.



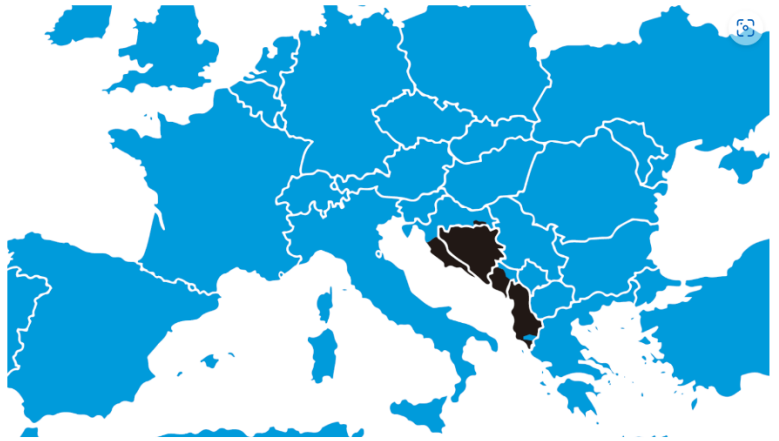


Figure 1 – Geographic area affected by the incident of 21 June 2024 (in black).

Reactive power control Service – Evolutions in the previous years

2016

FROM

- For CIPU units only

- Service provider =BRP
- No regulated contract

- Yearly tendering
- Free prices (ex-post price reasonability assessment via Royal Decree)

Drivers for change:

- Alignment with EU network codes (higher requirements)
- EU benchmark
- Evolution of the energy landscape : New actors on the electricity market
- Alignment with other T&Cs

2023

TO

- Open to the everyone
  - Technology neutral (batteries, selfs owned by GU's…)
  - All grids (Elia grid, DSO grid, CDS)

- New role: VSP designated by GU
- Regulated contract

- (Multi-)year tender
- Free prices (ex-post price reasonability assessment via public Service obligation)

Context for the project

Incentive 2023

In 2023, an incentive study was performed to identify design improvements, realize a European benchmark and investigate options to facilitate the participation of non-mandatory units.

The improvements identified in this incentive are planned to be implemented in the coming two years (2025 -2026).

Introduction

Incentive of 2023

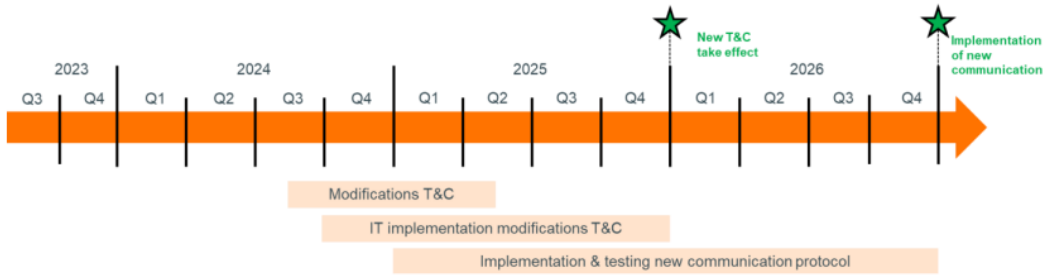
Context and goals of the incentive

- Following entry into force of the new design in 2020, some **return of experience** is available
- This study intends to analyze **further possible design improvements** for the voltage and reactive power control service in order to:
  - Optimize the efficiency of the service and the remuneration
  - Increase participation to the service

Content of the study

- Identification of **design improvements** together with market parties and the CREG and proposal of solutions
  - Based on **return of experience** from the current design
  - Including at least a review of the modalities for the penalties
- Realization of a **EU benchmark** concerning the components (fixed or variable) for an **ideal remuneration** of the service
- Specific analysis of the potential improvements that **might facilitate the participation of non mandatory units** (such as demand response) to the service
  - Identification of **evolutions of the market design** to facilitate the participation of non-mandatory units
  - Adequate procurement mechanism for the participation of non-mandatory units
  - Other aspects: type of service allowed/recommended (automatic, manual or other), simplified prequalification/communication process/tools for non mandatory units…

➔ This analysis will consider a **ratio between the potential** that represent these units for the voltage and reactive power regulation as well as their added value for the service **compared to the additional costs and complexity**



MVAr evolutions

Futureproof the MVAr service

The MVAR evolutions project can be split up into three blocks. These blocks are dependent on each other.

Modifications to the T&C (Market design)

First part of the presentation

Modifications to the procurement (Tender design)

No/limited impact of the incentive, will be addressed at a later point in time

Modifications to the interactions (communication design)

Second part of the presentation

Modifications to the T&C (Market design)

Modifications to the T&C (Market design)

In the incentive last year, general improvements to the market design were identified to improve the functioning of the market design.

1. **Continuous** activation control for manual and automatic activation
2. **Penalties** need to be in line with the continuous activation control.
3. **Communication** with Elia
4. **Price setting** during the tendering process *(already implemented)*
5. Update the Terms and conditions of the MVAr service to be **more technology-neutral**
6. **Simplification** of the participation for non-mandatory units
7. Adding an **additional bandwidth** to compensator mode
8. ***Start-up*** *of assets not available for the service (in stand-by)*

Discussed in the incentive

Additional topic

Topics described in the incentive

Activation control

MVAr service – Review and recommendations for design optimisations

Current market design

ART. II.7 ACTIVATION CONTROL

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.

- The activation control is done on some selected time windows
  - Manual service control
    - 6 samples of activation demands (reaching the setpoint within 5mins)
  - Automatic service control
    - 6 samples of 5 hours per month (checking the discrepancy between the expected and measured activations)

Activation control

MVAr service – Review and recommendations for design optimisations

Proposed new market design

Continuous activation control for manual and automatic activation

Instead of only using a select number of samples, Elia proposes to check all samples.

- This would remove the issues regarding penalizing momentary failures that do not represent the overall delivery of the service.
- This needs to be accompanied by a **revision of the penalties** associated with not delivering the service

MVAr service – Review and recommendations for design optimisations

Proposed new market design

Continuous activation control for manual and automatic activation

Instead of only using a select number of samples, Elia proposes to check (almost) all samples.

Immediately after every setpoint request

- The setpoint request will be handled as currently in the market design
  - 10 seconds to confirm
  - 5 mins to reach the setpoint
- If not reached within 5mins, the quarter hour will be considered failed

Quarter hour after the setpoint request

- This quarter hour will not be considered for controlling units to be able to do a reset

First quarter hour of every day

- This quarter hour will not be considered for controlling units to be ablet do a reset

All other timesteps

- For controlling units: current market design for all time steps
- For non-controlling units: Check every quarter hour against the Qrequested

MVAr service – Review and recommendations for design optimisations

Current market design

ART. II.9 PENALTIES

Automatic

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

Manual

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

Average setpoint duration = 10 hours

Qfailed [%]	Penalty
0 – 30	/
30 – 80	25% reduction of remuneration
80 – 100	100% reduction of remuneration

- Given the change in activation control, a change in penalties is required as well.

MVAr service – Review and recommendations for design optimisations

Proposed new market design:

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

Automatic

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

Manual

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

- This incentivizes the VSP to deliver the service to the best of its ability whilst still controlling incorrect activations

MVAr service – Review and recommendations for design optimisations

Current market design

The current communication is done via Revolt and is limited in the type of messages that can be sent. For example, there are only 2 types of messages can be sent towards Elia:

1. Confirmation of the reception of the new setpoint
2. Error code

- This creates issues for market parties that can only partly deliver the service
- This doesn't give all the information that could be useful in the optimization of the dispatch of the units

MVAr service – Review and recommendations for design optimisations

Proposed new market design

Proposal for additional interactions:

1. Updating the available capacities beforehand
   - This is **currently done via email** to the market engineers at Elia. To integrate this feedback in a better way, this will be directly integrated in the Elia environment
   - Information from other resources (e.g. OPA) will be integrated automatically
2. Provide feedback to Elia when a setpoint is not feasible
   - This provides a quick and efficient way **to identify issues,** and Elia will be able to react quickly on these
3. Zerotage communication
   - See next slides
4. Start-up message
   - See next section
5. Update communication protocol
   - **Alignment with the communication** protocols of other services

MVAr service – Review and recommendations for design optimisations

Current market design

Zerotage communication

- Allow for Elia to send a zero setpoint while below the Pmin (already in the current market design). However, some clarifications and additional implementation are needed to be able to use this functionality. Currently, there is no definition of start-up and shut down in the T&C. The goal is to align with the MPs on these in order to be able to use the functionality.

II.5.9	When the Technical Unit is injecting (or offtaking) less than its Minimum Active Power Threshold in Injection (or in Offtake) (as agreed in Annex 1) and is not providing the Service in Compensator Mode Elia may request via an explicit order that the Technical Unit stops producing or absorbing Reactive Power. This is not applicable during moments where the Technical Unit is starting up or shuting down.

- No definition of “starting up” and “shutting down” was included.

MVAr service – Review and recommendations for design optimisations

Proposed new market design

Zerotage communication

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Elia proposes to link this to the Pmin for injection mode. In the current proposal, 5% of the Pmin for active power is taken into account.

Proposal for definition:
"starting up": For the purposes of the zerotage communication, a Technical Unit is considered to be starting up when they **are below *5%* of their Pmin for injection mode** as defined in this contract.

"Shutting down": For the purposes of the zerotage communication, a Technical Unit is considered to be shutting down when **they are below *5%* of their Pmin for injection mode** as defined in this contract.

MVAr service – Review and recommendations for design optimisations

Simplification for the participation of smaller units

Prekwalificatietest

e) Vóór de aanvang van de Dienstverlening vraagt Elia een Prekwalificatietest om de kenmerken van de levering van de Dienst door elke Technische Eenheid te controleren.

f) Deze test moet minstens de activering inhouden van de Dienst waarin de VSP de Dienst moet verlenen volgens de in dit Contract voorziene voorwaarden. De precieze testmodaliteiten worden beschreven in Bijlage 13.

g) De Prekwalificatietest zal het beschikbaar gestelde Technische Regelbereik van het Reactief Vermogen bevestigen, evenals de meetmodaliteiten en de modaliteiten voor de berekening van Q_{req} (volgens Bijlage 2).

h) De Prekwalificatietest wordt niet beschouwd als een activering van de Dienst.

i) Elia behoudt zich het recht voor de Prekwalificatietest op elk ogenblik af te breken indien hij de veiligheid van het Elia-net in gevaar brengt.

Conformiteit

j) In het geval van niet-conformiteit met een of meer van de verplichtingen in Art. II.3.3, a) tot i), zal de VSP alle nodige maatregelen treffen om zijn conformiteit zo snel mogelijk te herstellen.

→ Allow for aggregations

Make all operational communication requirements and software/hardware modifications clear from the start:

- Currently multiple interactions are needed between Elia and market parties
- This increases the cost, since multiple interactions with 3 rd parties are required
- By creating a document with the main occurring issues, a large part of these questions can be mitigated

T&C

MVAr service – Review and recommendations for design optimisations

Change

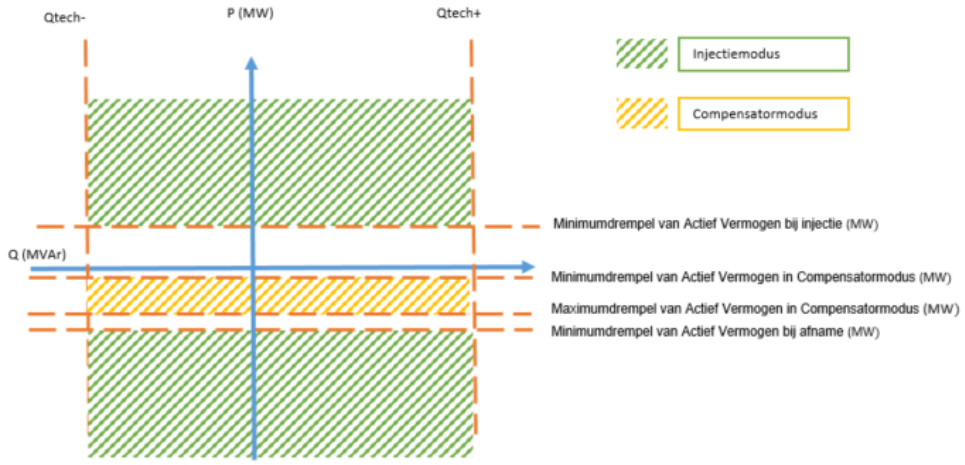
Update the Terms and conditions of the MVAr service in order to be written **more technology-neutral**.

- The current terms and conditions are at some points written from the perspective of large power plants. This does not hinder other units to participate but creates some unclarities. The goal is to rewrite these sections of the T&C in order to remove these barriers.

MVAr service – Review and recommendations for design optimisations

Current market design

Compensator modus is currently only described in 1 direction (either when injecting active power or when consuming active power)



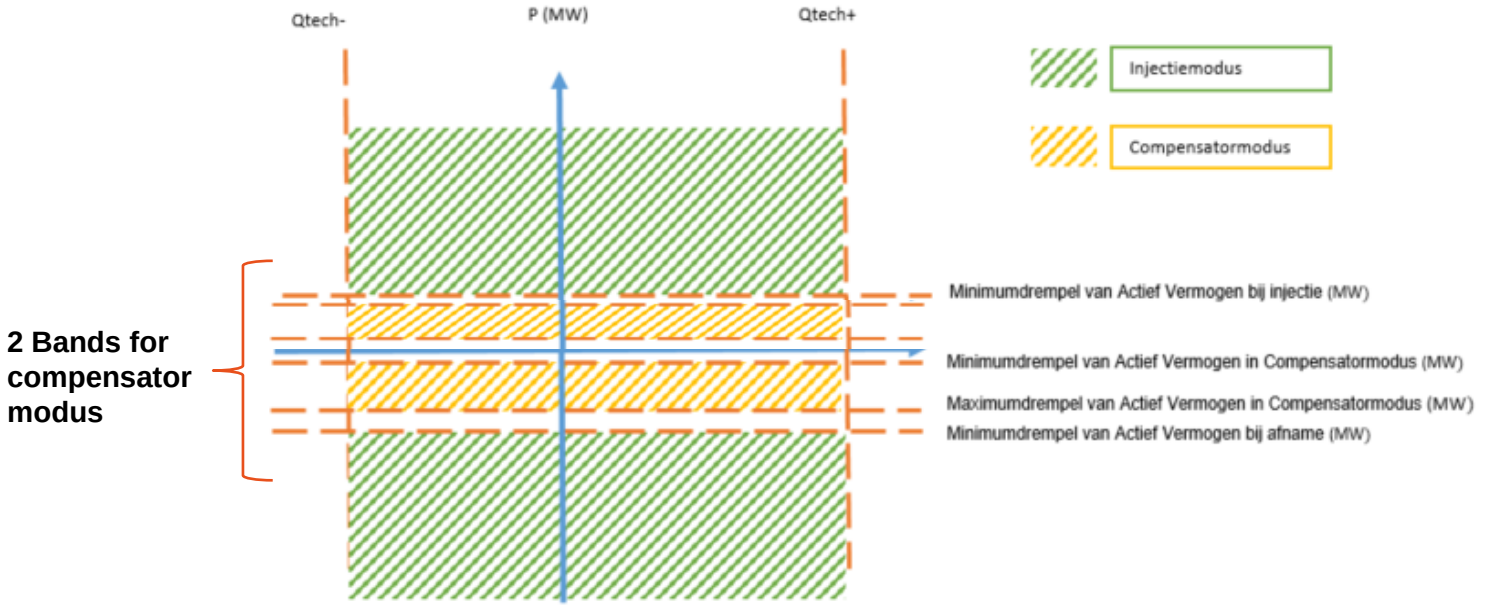
Compensator mode

MVAr service – Review and recommendations for design optimisations

Proposed new market design

Allow for an additional band of compensator modus

- If the compensator modus is possible in both directions, it would allow for this mode to operate both when injecting and consuming active power whilst avoiding the band around 0MW
- This design was added to increase the availability of assets



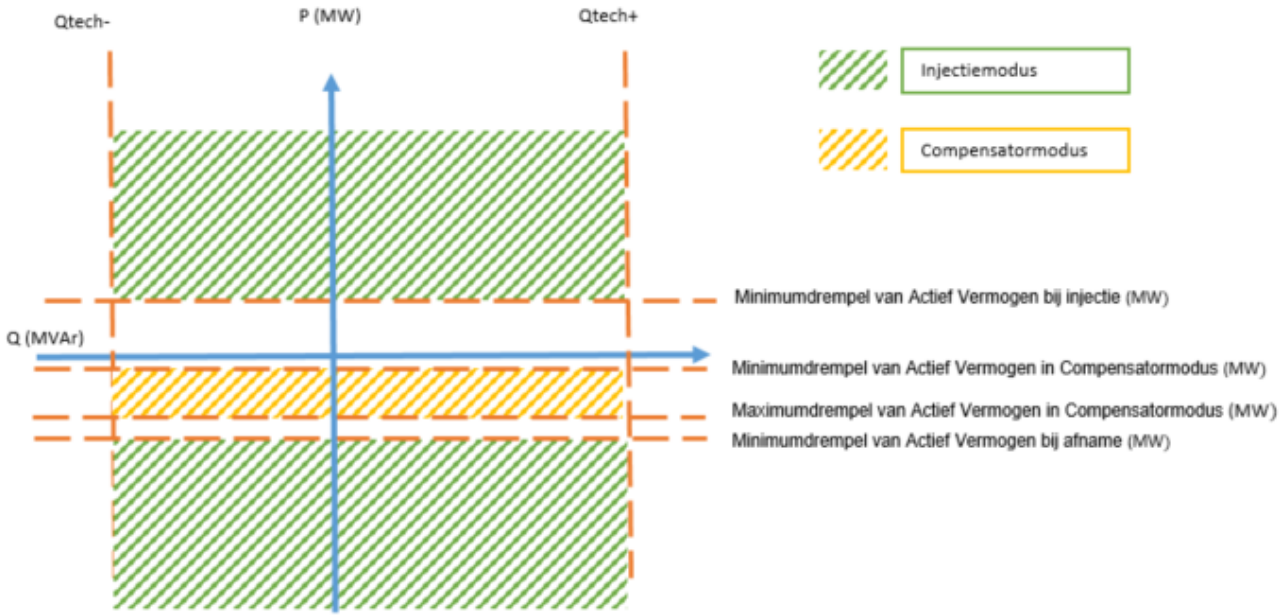
Given the introduction of a new design (presented in the next slides), these changes are superfluous and will not be implemented

Start-up of assets
– additional topic after incentive

As-is design

Currently, assets need to be available when their active power is in the green or yellow zone. This means that the asset is stable, and that reactive power can be provided.

When they are outside of these zones (with the exception of a zerotage message) no activations can be sent by Elia.



Flowchart

A system engineer and or supporting tool sends a message via the communication tool that the technical unit needs to start up. A flag is included here as well to indicate that the TU needs to remain above its Pmin in compensator modus.

A system engineer and or supporting tool does an optimization and sees that the utilization of a technical unit is the most techno-economic solution

The Technical Unit receives the message and starts up

x mins later

The Technical Unit is above their Pmin in compensator modus and starts to deliver the automatic/manual voltage control service until the flag is removed (a new message is sent)

The VSP receives a remuneration for the start up and is afterwards remunerated at compensator modus price

The Technical Unit remains available until an “end” message is sent.

Start-up of assets

Description

Technical Units that are *“available”* but **below their Pmin** for compensator modus (and as such cannot deliver the reactive power control service), can be **sent a start-up message**. This message will request the Technical Unit to **go above their Pmin** for compensator modus. Once above their Pmin for compensator modus, the Technical Unit will be **able to deliver the reactive power control Service**. The start-up message will include **a flag** that indicates that the Technical Unit needs to **remain available for the reactive power control service** until a new message is sent that they are no longer required to remain available. This has **no impact on the Technical Unit to act in the active power market**.

Advantages

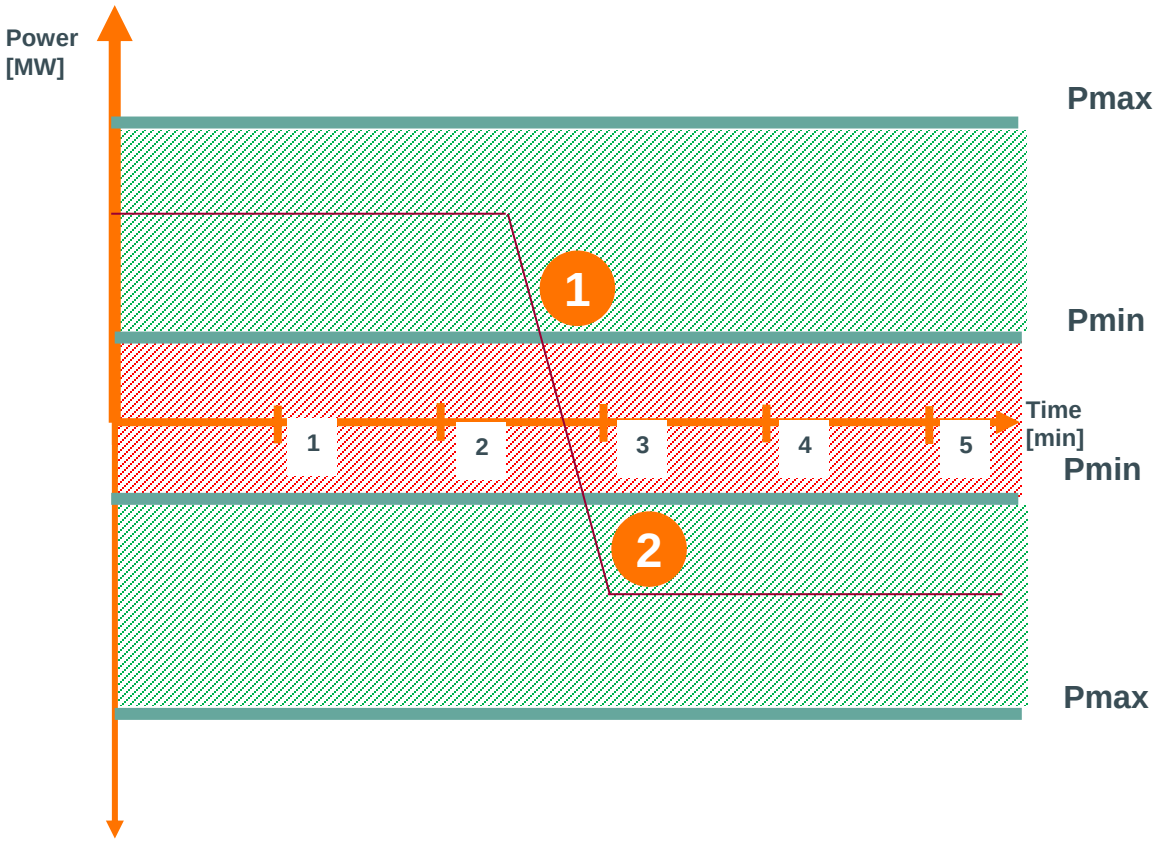
+ More possibilities for the VSP to be remunerated for the reactive power control service
+ Active power losses can be avoided in case the Technical Unit is not needed for the reactive power control service
+ There is a higher general availability of Technical Units delivering the service. This will lead to an improved voltage control in the grid
+ Improved voltage stability

Implications of the market design

No large changes are needed in comparison to the new design. A couple of elements need to be introduced/clarified:

1. Option to send a start-up request to a market party in order to be able to make them go above the Pmin in compensator modus. This message includes a flag, which indicates that the Technical Unit will need to remain available until a new message is sent.
2. Forgetting the manual setpoint and voltage reference (currently a TU needs to forget its manual setpoint and the voltage reference when going below Pmin). This would no longer be desired in the new version of the T&C when you come above your Pmin again within a limited timeframe.

Forgetting a setpoint

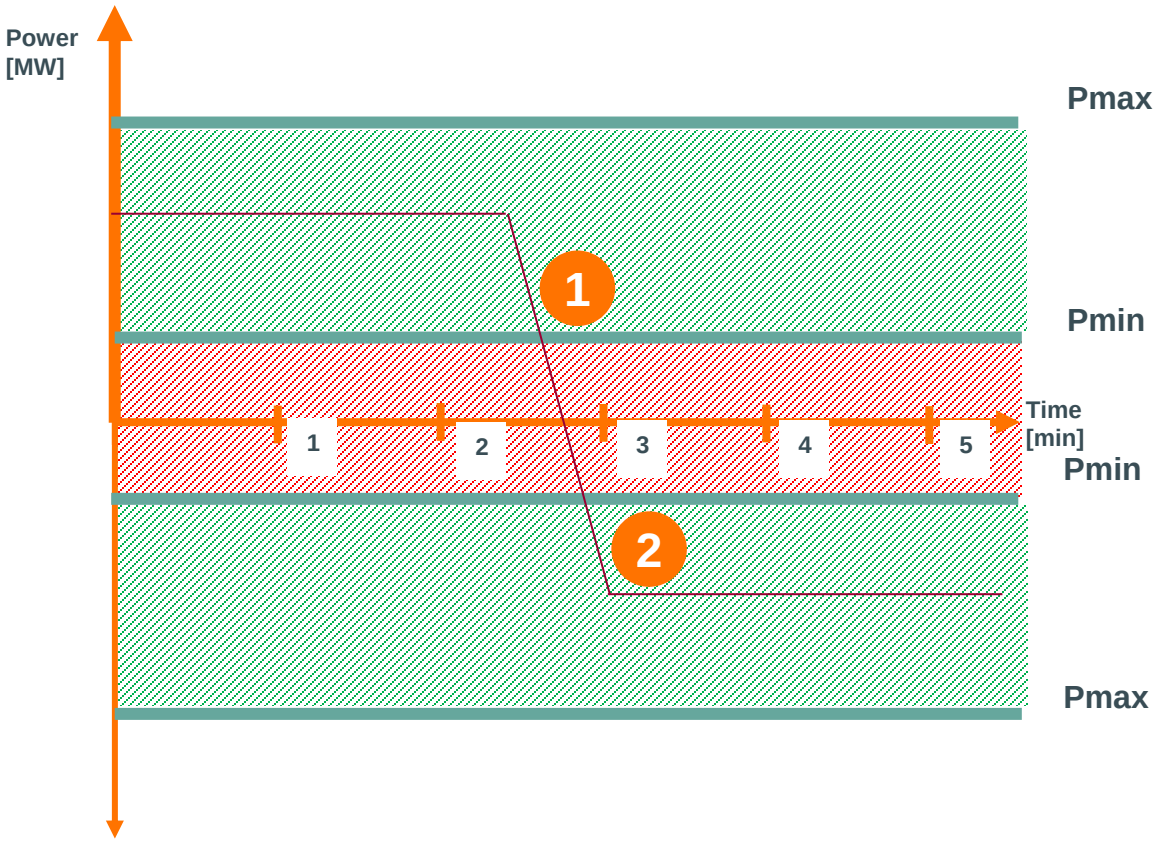


1 The asset drops below their Pmin and thus needs to forget the manual setpoint that was sent and their voltage reference.

2 The asset goes again above their Pmin and takes a new voltage reference based on the local voltage. A new manual setpoint would need to be sent by Elia

The reference voltage and the manual setpoint that were used before 1 are lost when the asset comes back online in 2

No longer forgetting a setpoint



1. The asset drops below their Pmin and remembers the voltage reference and the manual setpoint

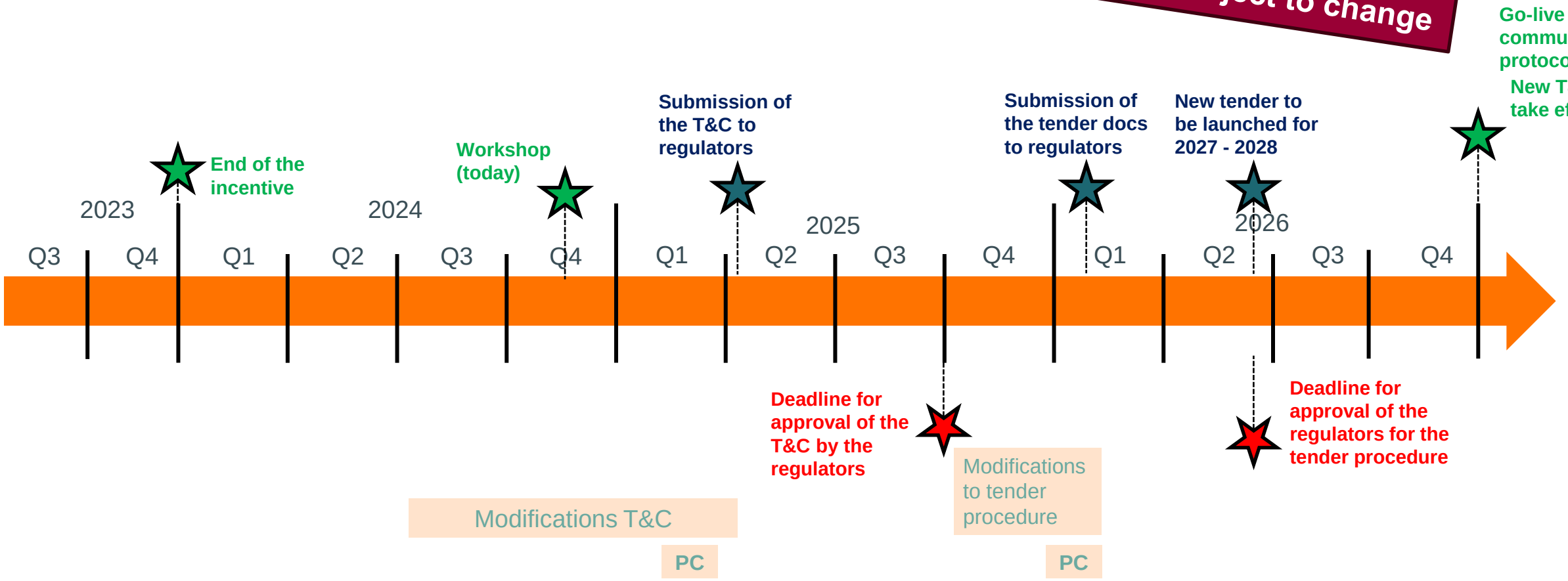
2. The asset goes again above their Pmin within *15 mins* (to be determined) and reuses the reference voltage it “remembered” as well as the manual setpoint

The reference voltage and the manual setpoint that were used before 1 are kept when the asset comes back online in 2

Planning for the modifications

Timeline for next years

Preliminary timeline, still subject to change



Modifications to the interactions (communication design)

Modifications to the interactions (communication design)

How and which information is communicated by both Elia and the VSP

In the incentive, the market parties requested to be able to **interact in a bilateral way with Elia** and to be able to provide additional information.

1. Allowing **more flexibility** by introducing **new information** streams:
   a) Updating the available capacities beforehand
   b) Provide feedback to Elia when a setpoint is not feasible
   c) Zerotage communication
   d) Start-up message

2. **Modernization** of **the application** suite used for the Mvar service
   a) Usage of the ECL (external communication layer) to align the communication with other products

IT Implementation – technical design

Technical Guide: table of content

1. Overview of communication requirements
2. External Communication Layer
3. Generic message specifications
4. Acknowledgement and answer messages
5. Notification messages
6. Voltage Service Provider Guide
7. Validation rules description
8. Market Documents

Main goal is to align the technical design with the protocols implemented in the scope of Icaros

Voltage Service Provider

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1. **Overview of communication requirements**
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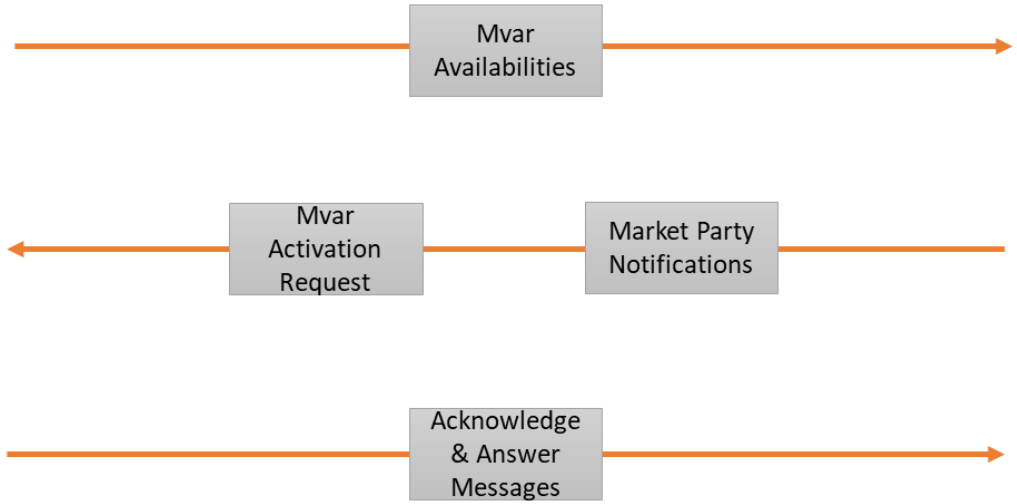

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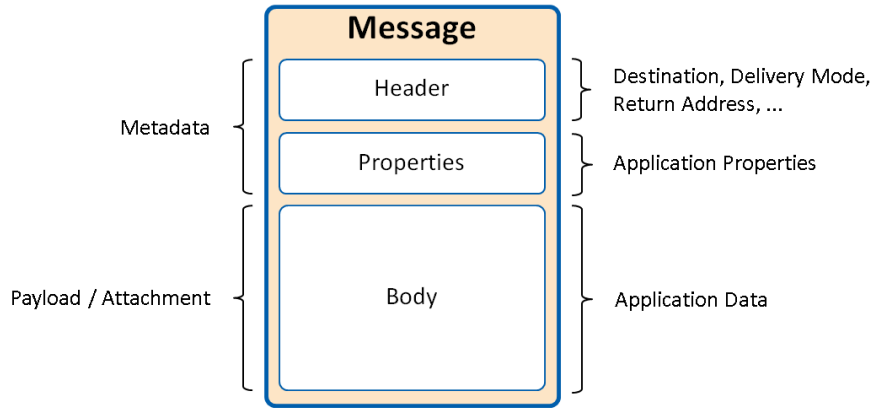
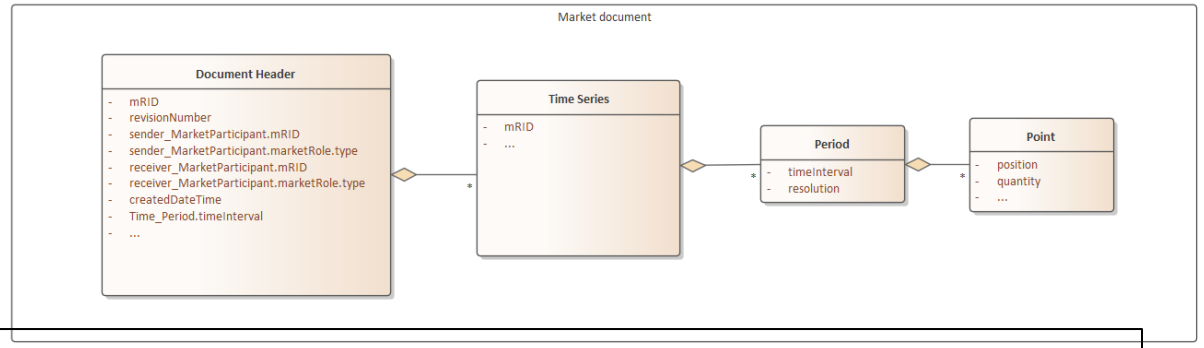
Dedicated queues for message exchange



- **Authentication and Authorization**
- **Protocols**
- **URLS and ports**

Technical Guide: table of content




```
{
        "Example_MarketDocument": {
                "mRID": "4e7791aa-df87-4cac-9ee7-3d6c218a0579",
                "revisionNumber": 1

                ...
                <other contents of the message>
                ...
        }
}
```

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Acknowledgement_MarketDocument (exactly one element per message)		
Field	**Mandatory**	**Description**
mRID	Y	Unique identifier for the MarketDocument
type	Y	Code for type of the MarketDocument **A17** = Acknowledgement Document
createdDateTime	Y	The timestamp on which the message was sent
sender_MarketParticipant.mRID	Y	The identification of the sender (EIC code)
sender_MarketParticipant.marketRole.type	Y	The role code associated with the sender **A27** = Resource Provider
receiver_MarketParticipant.mRID	Y	The identification of the receiver (EIC code)
receiver_MarketParticipant.marketRole.type	Y	The role code associated with the receiver **A04** = System Operator
received_MarketDocument.mRID	Y	The MarketDocument identification (mRID) to which is acknowledged
received_MarketDocument.revisionNumber	Y	The MarketDocument revision number to which is acknowledged. If the Market Document being acknowledged does not have a revision number, 1 should be used here.
Reason	Y	Indicates a status for the acknowledgement. This list that can only contain one element.
code	Y	The code that represents the acknowledgement **A01** = Accepted **999** = Rejected (only allowed in case of technical error)

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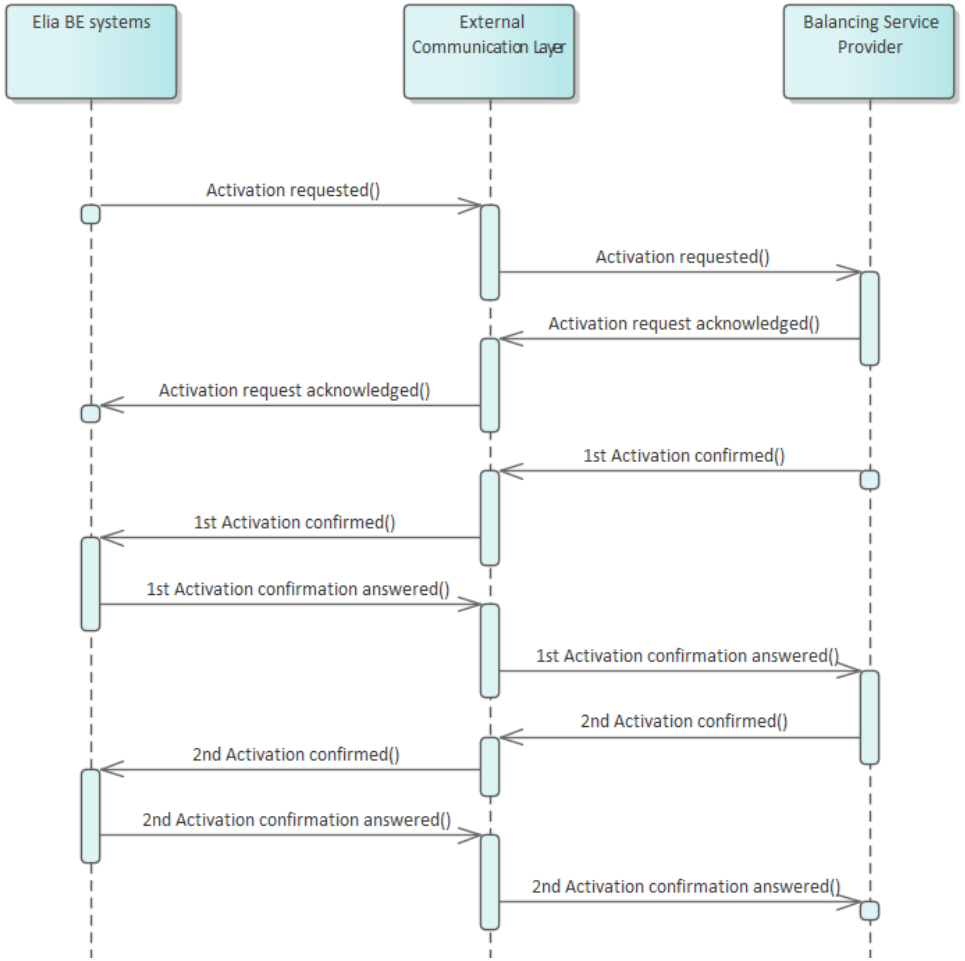
6. **Voltage Service Provider Guide**
7. Validation rules description
8. Market Documents



Example: Mfrr activation request

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ID	Validation Rule	Reply Status	Reason Code	Level
GEN_001	Message format must be correct	Reject message	Not applicable. Message will be transferred to error queue	Not applicable
GEN_002	Mandatory fields must be present	Reject message	A69	**MarketDocument**
GEN_003	Data formats must be respected	Reject message	Y29	**MarketDocument**
GEN_004	Value of fields must be known	Reject message	Y28	**MarketDocument**
GEN_005	Time interval start date and time must be smaller than the end date and time	Reject message	Y97	**MarketDocument** **Timeseries**
GEN_006	The timeseries mRID must be unique within the MarketDocument	Reject message	A55	**Timeseries**
GEN_007	Timeseries period must fall within the MarketDocument period	Reject message	A81	**Timeseries**
GEN_008	No overlap of periods allowed for the same timeseries within the message	Reject message	Y96	**Timeseries**

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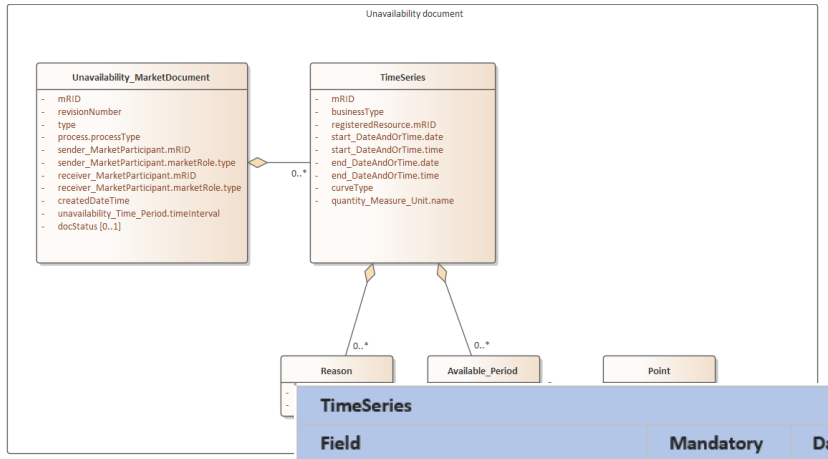
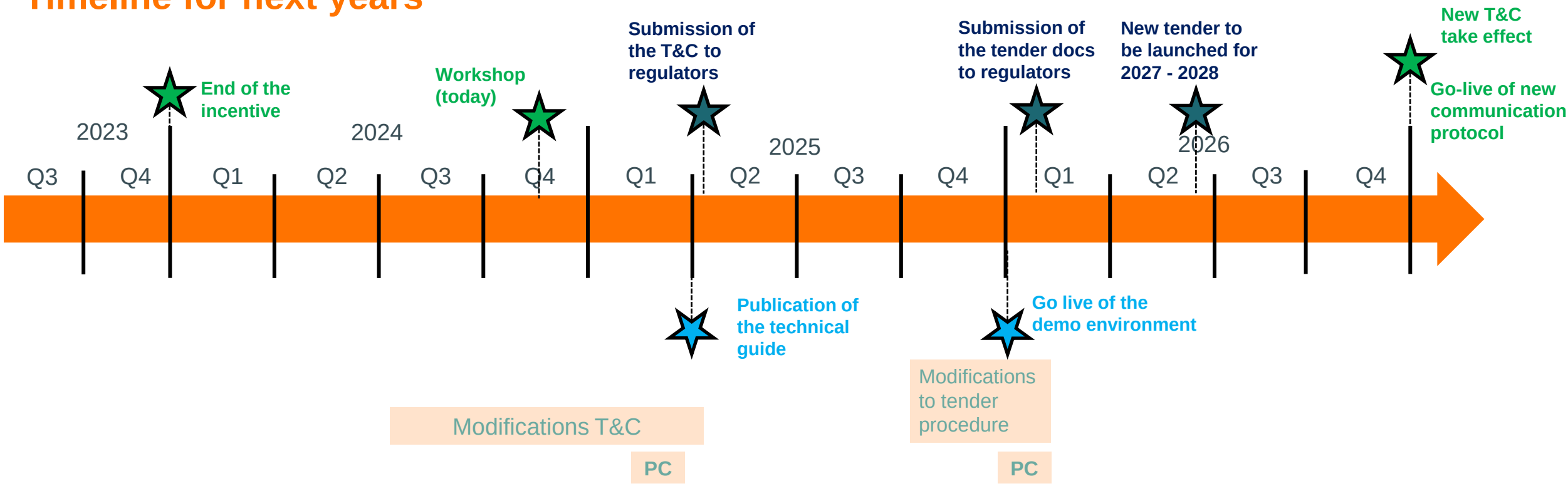


TimeSeries

Field	Mandatory	Data Type	Description
mRID	Y	string	Identification of the timeseries
businessType	Y	string	The identification of the nature of the timeseries
registeredResource.mRID	Y	string	The delivery point EAN representing the point for which the unavailability is sent
start_DateAndOrTime.date	Y	date	The start date
start_DateAndOrTime.time	Y	time	The start time
end_DateAndOrTime.date	Y	date	The end date
end_DateAndOrTime.time	Y	time	The end time
curveType	Y	string	Type of period
quantity_Measure_Unit.name	Y	string	The identification of the formal code for a measurement unit
Reason	N	List of Reason	List of reasons associated to the timeseries
Available_Period	N	List of Period	List of periods associated to the timeseries

Planning and next steps

Timeline for next years



Preliminary timeline, still subject to change

Implementation modifications T&C

E2E integration and testing

Implementation modifications Tender procedures

Annex