Manual aFRR for BSPs

Rules and procedures for aFRR delivery

Foreword and reader's guide

TenneT[1] uses Frequency Restoration Reserves (FRR) to maintain the Dutch power balance in real time. A distinction is made between automatic Frequency Restoration Reserve[2] (aFRR) and manual Frequency Restoration Reserve directly activated[3] (mFRRda). These products are offered and delivered to TenneT by market parties in their role as balancing service providers (BSPs).

The - automatic - activation of aFRR is specifically targeted for system balancing and is done via delta-setpoints calculated by the Load Frequency Control (LFC) system. This document describes both, the operational process with regards to offering and activation of aFRR bids, as well as the requirements to be met for delivering aFRR and the data flows between BSP and TenneT.

This document is translated from the Dutch version. TenneT takes great care in translation of this document. It is however possible that this translation could be multiple interpretable or incorrect. In case of discrepancies due the translation of the Dutch Document, the Dutch document shall prevail.

Below you can find other relevant documents and data sources related to the provision of aFRR which might be of your interest.

General information on support services:
https://www.tennet.eu/electricity-market/ancillary-services/general-documents/

Electricity grid code
The codes were drawn up to give substance to existing legislation and regulations and describe the way in which network operators behave towards each other and towards other connected parties: https://www.acm.nl/nl/onderwerpen/energie/codes-energie/overzicht-codes-energie/ or via https://wetten.overheid.nl .

Implementation rules
Further detailing of the rules regarding the provision of aFRR by BSPs to TenneT by means of energy bids, as laid down in the Grid Code on Electricity.
This document is available at https://www.tennet.eu/electricity-market/ancillary-services/

Imbalance pricing system
Further specification of the roles, responsibilities and methods applied in relation to the imbalance pricing system.
This document is available on https://www.tennet.eu/electricity-market/ancillary-services/ .

Manual Bids Balancing and Transporting Capacity
This document contains instructions for the provision of aFRR and Reserve Power other Purposes.

[1] Since this document concerns the *Dutch* power balance, 'TenneT' refers to 'TenneT TSO B.V'.
[2] This product was previously known as " Regulating Power".
[3] This product was previously known as 'Emergency Power (incident reserve)'.

https://www.tennet.eu/electricity-market/ancillary-services/afrr-documents/

Implementation guides

Many IT-related documents relating to the various communication channels with TenneT can be found on MyTenneT. This is a web portal for BSPs which is made accessible after a request for prequalification.

Historical prices and volumes:

Entso-e transparency platform: https://transparency.entsoe.eu/
average prices and contracted volumes aFRR capacity bids

Imbalance Delta:
https://www.tennet.org/bedrijfsvoering/Systeemgegevens_uitvoering/Systeembalans_informatie/balansdelta2017.aspx

Version control

The document has several chapters that describe the specific elements of aFRR (delivery). In order to have a clear view of what has been changed in each chapter, the version control table describes the changes at chapter level.

Version	Date	
V 1.0 Final	1-4-2021	First issue Manual aFRR for BSP's
V 1.1	10-5-2021	Chapter 6.3 Clarification reference signal Chapter 7 change of term imbalance correction to imbalance adjustment Chapter 8.3.2.1 change of information transfer point to the TenneT data centre
V 1.2	9-7-2021	Chapter 6.1 and 6.2 clarification of requirements for aggregation and zero minute lead time
V 1.3	20-01-2022	Paragraph 4.1 Addition on contracted energy bids Chapter 5. Elaboration on responsibility of a BSP in case of a transport/distribution congestion takes place. Chapter 8.2 added possibility to send in energy bids via the MMC-hub with a temporary format and with exemption of RESIN bids.
V 1.4	07-02-2022	6.3 Addition on reference signal irt LER
V 1.5	25-02-2022	3 1MW capacity bids (instead of 5MW); added on product requirements ramp rate 20% as of 01-07-2022 6.3 More explicit text on LER
V 1.6	18-07-2022	8.5 CBP open for contracted aFRR energy bids.

1. Terms and abbreviations

This section describes important terms and abbreviations used throughout this document.

Term/abbreviation	Description
ACE	Area Control Error. The difference between the planned net position of the Netherlands and the actual net position, and corrected for the expected Dutch frequency support, i.e., FCR activation.
aFRR	Automatic Frequency Restoration Reserve/ regulating power. aFRR is a service that the TSO procures from the market for balancing the electricity system..
BRP	Balance Responsible Party, A market party, or the representative chosen by a market party, that is responsible for its imbalances(EB GL).
BSP	In EB-GBL: balancing service provider or 'BSP' means a market participant with reserve providing units or reserve providing groups that can provide balancing services to TSOs.
Capacity bid	A capacity bid contains the volume for which a BSP when awarded will be obliged to make energy bids, so-called contracted bids.
CBP	Crowd Balancing Platform - TenneT data connection option.
CE	Continental Europe, the synchronous electricity grid of continental Europe.
CPS	Central Postbox System.
DSO	Distribution System Operator (DSO).
EB-GL	Electricity Balancing Guideline, being the Regulation 2017/2195 establishing guidelines for electricity balancing.
EMS	Energy Management System.
Energy bid	Energy bid contains the price for which aFRR is offered. Energy bids are put on the merit order list, the LFC nominates the energy bids for activation of the BSP.
FCR	Frequency Containment Reserve.
FRR	Frequency Restoration Reserve.
IGCC	International Grid Control Cooperation.
ISP	Imbalance Settlement Period. The time unit over which the imbalance of BRPs is calculated (EB GL). Notes: In the past ISP was also referred to as Program Time Unit (PTU). The ISP is fixed at 15 minutes.
ITP	Information Transfer Point.
LER	Limited Energy Resources (e.g. batteries)
LFC	Load Frequency Control, the system used by TenneT to enforce the national balance.
mFRRda	Manual Frequency Restoration Reserve direct activated/ incident reserve. MFRRda is a service that the TSO procures from the market for balancing

	the electricity system. Detailed product information is available on the website www.tennet.eu.
MMChub	Market-to-market communication, the TenneT implementation of web services.
MyTenneT	Web portal for BSPs made accessible after application for prequalification.
Portfolio	The collection of RPGs and/or RPUs controlled by one BSP.
ROP	Reserve Power Other Purposes. TenneT uses this product to resolve transport problems.
RPG	Reserve Providing Group, defined as a group of electricity generation units, consumption units and/or reserve supply units connected to multiple connection points and providing the required supply of FCR or FRR.
RPU	Reserve Providing Unit, defined as a single electricity generation unit or composite group of electricity generation units and/or consumer units connected to a common connection point providing the required supply of FCR or FRR
RTU	Remote Terminal Unit.
SO-GL	System Operation Guide Line; Regulation (EU) 2017/1485.
TI	Technical Installation.
TSO	Transmission System Operator, Operator of the national electricity and/or gas grid. TenneT TSO B.V. is the designated TSO for electricity in the Netherlands.

Table 1: Terms and abbriviations

2. General description of balancing

The TenneT system for national power balancing is the so-called Load Frequency Control (LFC). The main purpose of the LFC to respond to significant imbalance in the Netherlands and restore this imbalance within 15 minutes [4]. In addition, the LFC acts in case of smaller imbalance situations in order to limit the unintended energy exchange with the electricity network in the synchronous area of Continental Europe (CE). Continuous monitoring of this energy exchange and adjustment by the LFC is necessary to provide a proper system balancing quality. The LFC activates aFRR energy bids by sending Balancing Service Providers (BSPs) aFRR activation signals.

The LFC continuously determines the area control error (ACE) of The Netherlands. The ACE is mostly dependent on so-called unintended international electricity exchange', or in other words the difference between the total cross-border electricity exchange as set in the E-programmes versus the total measured exchange on the interconnectors with the Continental European synchronous electricity system. This value is then corrected for the expected Dutch frequency support – which occurs by activation of Frequency Containment Reserve (FCR)[5]. The expected FCR-delivery is determined by multiplying the measured frequency deviation with the internationally agreed frequency constant for The Netherlands. Based on those calculations the LFC then determines the volume of aFRR to be activated in order to maintain the power balance.

Market parties often work with an own controller to adhere to their schedule obligations and to reduce imbalance in their role as Balancing Responsible Party (BRP). From a technical point of view the LFC operates separately from these local controllers, apart from the aFRR activations by the LFC determined aFRR activations. Nonetheless, In the balancing process the parallel controllers interact with each other: the LFC responds to a balance disturbance, to which (some of the) local controllers may also react. Furthermore, the LFC will respond correctively when a local controller introduces a national power imbalance that may have the positive but uncoordinated aim of achieving an individually desired level of energy production.

IGCC

Along with other Transmission System Operators (TSOs) in the CE region TenneT participates in the International Grid Control Cooperation (IGCC), that addresses the market imbalance of individual TSOs in a coordinated way. To this end, IGCC converts market imbalances (the ACE plus the current activated aFRR volumes) from different countries with opposite direction into mutual support; a dynamic adjustment of the exchange program. In this way, the market imbalances of the involved countries are decreased instantaneously resulting in lower imbalance prices and preserving FRR for potential following balance disruptions[6].

3. Specifications aFRR product

The aFRR product has the following characteristics and/or conditions:

[4] *Regulation (EU) 2017/1485 on electricity transmission system operation* prescribes in Article 127 and Annex III a frequency recovery time of 15 minutes in the synchronous zone Continental Europe (CE).
[5] More information about FCR can be found via https://www.tennet.eu/electricity-market/ancillary-services/
[6] For more information on IGCC see https://www.tennet.eu/electricity-market/ancillary-services/afrr-documents/

General

- aFRR can be delivered in two directions: power delivery *to* the network (upward regulation) and extracting power *from* the network (downward regulation). Note that upward regulation can be provided by producing more or consuming less electricity; vice versa for downward regulation this can be provided by producing less or consuming more electricity.
- The availability of the minimum required quantity of aFRR[7] is secured by TenneT through contracts with BSPs. By this, the BSPs commit themselves to offer at least the contracted volume in aFRR energy bids. Contracted aFRR power must be available in all time units of the contracted period, so that TenneT can reduce the ACE within 15 minutes.
- Prequalified BSPs may also bid their available aFRR volume on a voluntary basis (so-called "free bids"). Contracted aFRR energy bids has no priority over voluntarily offered aFRR energy bids; the merit order list is formed based on bid price only.
- After a documented warning, TenneT has the right to refuse capacity and/or energy bids of aFRR from a BSP for an unlimited period of time, by revoking the BSP prequalification status. This can for example happen when the power measurement shows that the BSP is structurally unable to follow the aFRR delta-setpoints, or when the power measurement is missing.
- aFRR can only be delivered on connections indicated as telemetric or with smart meter allocation, no profiled customers are allowed.
- The EAN and BRP of the allocation point must be known by the BSP in order to perform the prequalification and delivery of aFRR

Capacity bids

- Capacity bids must be asymmetrical .
- A capacity bid can be offered in multiples of 1 MW with a minimum of 1 MW.

Energy bids

- BSPs are responsible for sending their aFRR energy bids to TenneT.
- An individual aFRR energy bid has a minimum size of 1 MW and a maximum size of 999 MW.
- A BSP can offer at maximum three energy bids smaller than 4 MW per ISP. For smooth and efficient control of aFRR it is beneficial to have a mix of small and large energy bids.
- In an energy bid the BSP can create a 'regulating object' by specifying the same *regulating object name* for an upward and a downward energy bid. This prevents the simultaneous activation and deactivation of the upward and downward bid, and limits the requested regulating speed for the BSP.

More detailed information in how to construct an energy bid is to be found in the Manual Bidding of Balancing- and Transport Power on the website of TenneT

Product requirements

- The LFC activates aFRR energy bids by sending delta-setpoints with a minimum step of 1 MW.
- The LFC sends delta-setpoints since they refer to the aFRR power that needs to be delivered additional to

[7] The minimum quantity is determined in accordance with the ENTSO-E CE guideline.

the power profile of the aFRR pool in that moment in time.

- A real-time power measurement of the BSP must be communicated to TenneT in order to monitor the aFRR delivery.
- The ramp rate of the offered aFRR (up and/or down) volume should be at least 7% per minute of the energy bid volume (10% in case of an aFRR energy bid smaller than 4MW) and maximal 100%. As of 01-07-2022 the ramp rate of the offered aFRR (up and/or down) volume should be at least 20% per minute of the energy bid volume (also for bids < 4MW)
- An observable power change is expected within 30 seconds after a delta-setpoint change.

aFRR process components

The aFRR process consists of several components with different interfaces between the BSP and TenneT. The following 4 chapters deal with the different process steps, see table below. Chapter 8 explains the data connections.

Chapter in manual	***Interface BSP-TSO***		***TenneT backend system***
4. Contracted aFRR through capacity bidding	MMC-hub/Web portal	n/a	APFAS
5. aFRR energy bids and the merit order list	CPS/MMC-hub	Crowd balancing platform	Merit order list
6. Activation of aFRR energy bids and monitoring	RTU-CS		LFC
7. Settlement and imbalance adjustment	MMC-hub		PASAR

Table 2: overview aFRR process

4. Contracted aFRR through capacity bidding

TenneT must have a minimum amount of FRR and as part of this a minimum amount of aFRR available. The dimensioning of these minimum quantities is described in European regulations. Further explanation of the dimensioning can be found on the TenneT website[8].

To ensure that sufficient aFRR capacity is available at all times TenneT contracts a bidding obligation with BSPs. To this end, TenneT organizes capacity auctions via the Action Platform for Ancillary Services (APFAS).

When awarded the BSP has an obligation to send energy bids for the volume awarded and volume transferred from another BSP during the contract period. The volume of contracted aFRR must be offered to TenneT through energy bids[9]. In this way TenneT ensures that the minimum determined volume of aFRR energy bids required for balance maintenance is available.

FRR auctions are organized in APFAS where aFRR capacity bids and mFRRda capacity bids are selected simultaneously. The award algorithm takes into account the minimum required amount of aFRR and the minimum total FRR and then awards the cheapest total FRR package (aFRR and mFRRda). When awarded, the BSP receives the price of the capacity bid (pay-as-bid). The auction takes place daily on the day prior to the day of execution (d-1) at 9:00 am[10].

4.1 Conditions of energy offers resulting from contracts

To ensure the minimum required aFRR volume is available, specific conditions are defined for aFRR energy bids from a contract obligation:

- The BSP is obliged to send in aFRR energy bids for each ISP of the day on which the BSP has a contracted capacity for at least the volume of the contract for upward and/or downward adjustment, no later than 14:45 UTC+01:00, on the day prior to the day of execution.
- If BSP does not submit a correct bid message, TenneT has the right to submit energy bids on behalf of the BSP with a price of EUR 0,00 per MWh for the upward direction and the day ahead market price for the hour which the PTE belongs to plus EUR 35,00 per MWh for the volume specified in the contract for the day in question [11].
- Bid obligations can be transferred to other pre-qualified BSPs through APFAS secondary market.

[8] https://www.tennet.eu/electricity-market/ancillary-services/
[9] Via aFRR energy bids in accordance with chapter 5.
[10] UTC + 01:00, Amsterdam time.
[11] TenneT is currently not enforcing this.

5. aFRR energy bids and the merit order list

The BSP sends an aFRR energy bid message for the entire day, where different energy bids can be indicated per ISP, and an offered volume of 0 MW is allowed only if the offered price is 0 €/MWh. On the day of execution the period for submitting changed energy bids closes 2 entire ISPs before the start of each ISP. aFRR energy bids are sorted based on their price and placed on the so-called "merit order list". During the current ISP(s) the LFC activates the energy bids automatically based on the calculated ACE.

At the start of a new ISP the LFC determines the energy bids to be activated based on the new merit order list.

Delivery of balance services in case of transport/distribution restrictions.

When a connected party is imposed with transport/distribution restrictions, no FRR can be delivered at that location if it exceeds the restriction.
In that case, the BSP has an obligation to guarantee the product delivery. The BSP has several options for this:

- Move FRR delivery to other units in his portfolio
- In case of a capacity contract, transfer the obligation to another BSP (before d-1 23:00)
- Do not offer FRR on restricted connections via capacity (before d-1 9:00) and energy bids (before 30 minutes before ISP start)

If it is not possible to guarantee product delivery in the case of a capacity contract, the unavailability of the product must be reported to TenneT by means of the withdrawal of energy bids.
This notification will not result in a penalty if the BSP can demonstrate that it was indeed not possible to deliver the product in another way. The decision for this lies with TenneT.

6. Activation of aFRR energy bids and monitoring

This chapter describes the functionality of delta-setpoints, total net power and the reference signal. Based on this, TenneT assesses the control quality of the activated aFRR.

The LFC sends so-called 'delta-setpoints' to the BSPs of aFRR in order to active their energy bids. Delta-setpoints values are absolute and represent the amount of requested aFRR in MW. A delta-setpoint will never exceed the offered power value, nor will the rate of change of the delta-setpoints exceed the ramp rate specified in the energy bids. The ramp rate is at least 7% (at least 20% from 1-7-2022 on) of the energy bid volume per minute or 10 % in case of an 1, 2 or 3 MW energy bid (from 1-7-2022 the ramprate for bids smaller then 4MW will also be 20%). This minimum ramp rate is necessary to ensure that large(r) imbalances can be solved within 15 minutes.

An energy bid can be activated fully or partially during the timespan of the ISP to which the bid applies. Previously activated energy bids may no longer be available or would not have been activated due to their price, and therefore are deactivated and regulated to zero. This can possibly lead to deactivation of the power in the ISP following the ISP of activation, even when the power has not been offered for that ISP.

The total amount aFRR energy bids that is activated by the LFC depends on the balance situation.

- As long as the imbalance in the Netherlands does not show significant deviations, energy bids are activated based on the *"merit order"* approach", i.e., the desired correction is determined based on the measured system imbalance and then activated based on price.
- Only after significant balance disturbances, where the rate of change of the imbalance is larger than a (set by TenneT) incident threshold value, a *"pro-rata"* approach of activating energy bids is applied. This means that all energy bids are activated in parallel, such that the maximum possible ramping rate for aFRR is achieved.

The LFC constantly monitors the amount of aFRR energy that it activates per bid. The BSP is also expected to keep an own record of the activated power in order to be able to check this information afterwards if needed.

6.1 aFRR activation by the delta-setpoint

The delta-setpoint represent the aFRR power that needs to be delivered additional to the power profile of the aFRR pool in that moment in time.
Delta-setpoints consist of integeter values. The calculated volume of aFRR activation is rounded, and therefore aFRR is activated in steps of 1MW.
A delta-setpoint shall not be higher than the energy bid and the rate of change in delta-setpoint values shall not be higher than the specified control speed of the activated energy bids. In the case of several energy bids being activated for the same direction, the LFC will send an (rounded) aggregated delta-setpoint to the BSP.
The delta-setpoint value can change every 4 seconds, and only when the value of the delta-setpoint changes (according to the ramp rate), a new delta-setpoint is sent to the BSP.

The LFC sends separate delta-setpoints for aFRR upwards and downwards regulation, since the activations

come from different energy bids and the requested energy for those actions is settled at different activation prices. The BSP can combine the two delta-setpoints (upward and downward regulation) in its own control system for realization of the requested power adjustment. This can be relevant when the LFC is deactivating earlier requested power in one direction and there is a need to simultaneously activate aFRR in the opposite direction.[12]

The BSP is expected to respond to each delta-setpoint change within the agreed specifications for the response time, ramp rate and capacity.

6.2 Power measurement portfolio

The BSP must send the power measurement of its portfolio in real time to TenneT with a resolution of 4 seconds, (In the future, 1 second resolution should be possible). In the case it is not possible to perform power measurements per technical installation with this resolution, it is permitted to construct an aggregated power measurement using measurements with a lower resolution and in which inter/extrapolation[13] can take place. However, the BSP using this should demonstrate during the prequalification process why the aggregated power measurement is a good representation of the individual measurements. TenneT should be informed if a change in the aFRR portfolio occurs that causes a different calculation of the aggregate measurements . An example for this could be a different algorithm or aggregation method used for the calculation of the aggregate measurement. The prequalification report should be updated accordingly (only the relevant section).

The aggregated measurements must be stored by the BSP at a resolution of 4 seconds for at least 6 months. Measurements of the individual technical installations must also be stored at the resolution used for the aggregated measurement for a period of at least 6 months.

6.3 Reference signal

The reference signal is used to determine the quality of the delivered aFRR when an energy bid is activated by TenneT. The reference signal should represent the expected power exchange one minute later of the aFRR portfolio. The signal should include program steps at ISP-borders and other correcting actions, but *exclude* possible aFRR volume requested by TenneT. Furthermore, the reference signal should include all (prequalified) technical installations of the BSP that (are able to) participate in aFRR delivery and should consider the capabilities of those installations. Complete or partial inclusion of TenneT's delta-setpoints in the reference signal may prevent an objective evaluation of the realized regulating quality and is therefore prohibited. The way the reference signal is constructed should not vary if an activation is received by the BSP, entailing that the reference signal should be constructed the same with or without an aFRR activation.

In the case of LER, aFRR deliveries shall not be based on/dependent on load management. If load

[12] In case the BSP knows that he is not able to activate both upward and downward energy bids simultaneously (for instance because they will be delivered with the same installation), it is possible – as mentioned in Chapter 3 in the section regarding energy bids – to create a 'regulating object' that prevents the LFC from activating those energy bids at the same time.
[13] An easy and transparent method for this is to keep the measurements of the technical installations constant until a different value is measured. Also known as the zero-order-hold method.

management is applied and there is an aFRR call, the load management shall be correctly included in the reference signal. Moreover, the reference signal, and hence the charge management setpoint, is not allowed to be dependent on the aFRR setpoint, as this would not be considered an adequate aFRR delivery. In case the charge management is impacting on the actual aFRR delivery and therefore cannot be applied when delivering aFRR, it considered to be a responsibility of the BSP to take this into account in their bidding strategy. All the above implies that in case a single LER or RPGs that consist of only LER(s), unless the LER or RPG has the capacity to deliver for the whole contracted period it cannot enter the market for contracted aFRR. Similarly this applies to voluntary bids if the LER(s) does not have the capability to deliver aFRR for at least 15 minutes.

In case of problems regarding the definition or realisation of the reference signal, it can be agreed to deviate from the preferred method, for example a reference signal without lead-time or use multiple reference signals. Reasons for proposing a reference signal without a lead time may be, for example, that the variability of the power of a portfolio is such that a reference signal with a lead time of one minute is insufficiently accurate. A reference signal without lead-time can only be requested for that part of the aFRR portfolio that is deemed unpredictable. For the remainder of the aFRR portfolio, the preferred method (expected power exchange one minute later of the aFRR portfolio) applies. In this case, this may entail that the BSP should provide multiple reference signals to TenneT. These reference signals will be combined on TenneT side to perform the monitoring of the aFRR delivery at portfolio level.

The evaluation for approval by TenneT of a reference signal without lead time takes place during the prequalification process and will include the following:

- Explanation why a reference signal with a lead time of one minute is insufficiently accurate and why a reference signal without a lead time provides a more accurate estimate of the reference signal supported by a quantitative example (e.g. error analysis).
- The design of, and inputs used for, the reference signal are described in detail.
- The BSP can prove that the construction of the reference signal is completely independent of the TenneT aFRR delta-setpoint and of the portfolio output power.
- The reference signal is traceable to certain inputs.
- The visualization of simulated reference signal and aggregated measurement with or without a (simulated) activation

TenneT should be informed if a change in aFRR portfolio occurs that causes a different calculation of the reference signal. An example for this could be the addition of TIs that require a reference signal with a different lead time. In the case a zero minute lead time reference signal has been applied, this requirement is applicable when a different type of TI with respect to the rest of the portfolio is added to the aFRR pool. The prequalification report should be updated accordingly (only the relevant section).

6.4 Monitoring the control quality of the BSP

To evaluate the quality of delivered aFRR the power response of the BSP is compared with the expected

response. To do so, the difference between the reference signal and power measurement of the BSP is compared with the sent delta-setpoints (requested aFRR). Monitoring of the regulating quality is performed daily by TenneT.

In case the value of the BSP's realized power deviates from the requested value, TenneT makes an overview of the event(s) and sends this to the BSP – including a request for an explanation about the cause of the incorrect or insufficient response. Penalties for insufficient response for contracted BSPs are defined in the aFRR contract. For voluntary energy bids "free bids" no penalties exist. However, as stated in Chapter 3, TenneT may refuse free bids from a BSP by revoking the prequalification status, in the case activations are not followed on a structural basis, or in the case when a reliable power measurement is lacking.

TenneT has the right to check the data processing (including the reference signal) and relevant procedures of a BSP by means of an audit, carried out by an independent party.

6.5 Data exchange for activation and monitoring

Both for real-time operation of aFRR and monitoring of the quality afterwards, real-time data exchange between BSP and TenneT is necessary. TenneT stores this data every 4 seconds for analysis purposes. The BSP must also store this data, at least on a 10 second basis, and keep it available. This information may serve as backup for outages in TenneT systems or as a supplement when discussing TenneT incident reports. For a good comparison with the information collected by TenneT, the provider should record the relevant data at least every 10 seconds.

The following signals will be exchanged between TenneT and BSP:

From TenneT to BSP:

1) Upward regulating delta-setpoint.
2) Downward regulating delta-setpoint.
3) Heartbeat signal .

From BSP to TenneT:

4) Total net power.
5) Reference signal (or when agreed upon: reference signals).
6) Verification upward delta-setpoint.
7) Verification downward delta-setpoint.
8) Verification heartbeat signal.

NB. The BSP must store at least the first five signals above, as well as the measurements of the individual technical installations that form the basis for the total net power for the time horizon of at least 6 months.

Upward regulating delta-setpoint (TenneT >> BSP)
The requested volume to regulate up with respect to the BSP's power level (MW value without decimals). The LFC sends this data upon initialisation or when the value changes.

Downward regulating delta-setpoint (TenneT >> BSP)
The requested volume to regulate down with respect to the BSP's power level (MW value without decimals). The LFC sends this data upon initialisation or when the value changes.

Heartbeat signal (TenneT >> BSP)
In order to monitor the data connection with the BSP TenneT sends a continuously changing signal, a so-called 'sawtooth shape'.
NB. The verification signals of the delta-setpoints are not suited for this purpose since they might have the same value for a longer period.

Total net power (BSP >> TenneT)
The sum of generation and demand of technical installations which are used to realise the delta-setpoints sent out by TenneT (MW value without decimals). This information is used to check the aFRR quality of the BSP. The measurements of individual technical installations do not have to have a resolution of 4 seconds, but may be interpolated, provided that it is demonstrated during the prequalification process that the aggregated signal meets the aFRR requirements.

Reference signal (BSP >> TenneT)
The planned value of the net power of all active technical installations in the portfolio of the BSP excluding the requested aFRR power by TenneT. This information is used to check the quality of the aFRR delivery of the BSP.
When a single value is insufficient to judge the control quality, multiple reference signals may be used.

Verification upward delta-setpoint (BSP >> TenneT)
The upward delta-setpoint of TenneT returned (MW value without decimals).
A so-called ‘return signal’ to detect when problems with the (route of the) data exchange occur.

Verification downward delta-setpoint (BSP >> TenneT)
The downward delta-setpoint of TenneT returned (MW value without decimals).
A so-called ‘return signal’ to detect when problems with the (route of the) data exchange occur.

Verification heartbeat signal (BSP >> TenneT)
The heartbeat signal of TenneT is returned.
A so-called ‘return signal’ to detect when problems with the (route of the) data exchange occur.

7. Settlement and imbalance adjustment

A BSP is settled based on the balancing energy price and the total activation (kWh) per ISP.
The highest[14] or lowest[15] price of activated energy bids [16] determines the balancing energy price for upwards or downwards activations. In case of mFRRda activation the balancing energy price is equal to the price of mFRRda. The balancing energy price is the price at which the delivered aFRR energy is settled with the BSP and is the basis for determining the imbalance price[17].

When the deactivation of an energy bid takes place in the subsequent ISP for which the energy bid does not exist it is referred to as a dummy bid. The price of the dummy bids does not affect the activation price of the current ISP, but the delivered aFRR energy from the deactivated bid will be remunerated at the activation price of the ISP in which the energy is actually delivered. Balancing energy is remunerated for the balancing energy price of the ISP during which the aFRR was delivered. When in this following ISP no bids have been activated (only deactivated), such that no activation price for up- or downward regulation exists, the price of the previous ISP is used (so from the ISP in which the energy bid was initially activated).

After an aFRR activation the BSP needs to deliver the following data to TenneT:

- *Pool Configuration:* an overview of the allocation points in the BSP pool with corresponding BRP(s);
- *Activated Energy:* activated energy by the BSP for aFRR per allocation point per 5 minute period.

Additionally, the BSP should be able to receive:

- *Confirmation Market Document:* feedback document for the (above) messages that the BSP has sent, including an overview of the volumes that will be settled with the BSP.

The energy that the BSP activates (and sends to TenneT in the Activated Energy message) is used for settlement between TenneT and the BSP. The combination with the Pool Configuration determines the imbalance adjustment, that TenneT performs for the BRP(s) of the activated allocation points.

The BSP is responsible to divide the delta-setpoint that it receives from TenneT over the technical installations in its portfolio. The total volume of activated energy should add up to the requested volume by TenneT (based on the sent out delta-setpoints). In case the Activated Energy is less than the requested volume, i.e., the TenneT delta-setpoint, the activated energy is settled with the BSP and is the volume that is corrected at the BRP(s). In case the Activated Energy is more than the requested volume ,the requested volume by TenneT is leading for settlement with the BSP while the total activated energy from the BSP will be corrected at the BRP(s) [18].

[14] In case of upward regulation bids FRR (positive price: TenneT pays BSP; negative price: TenneT receives from BSP). NB. Negative upward regulation prices are practically non-existent.
[15] In case of downward regulation bids FRR (positive price: TenneT receives from BSP; negative price: TenneT pays BSP).
[16] This is based on aFRR bids activated by the LFC. After code change ACM/18/032994 for the Grid Code Electricity, activated mFRRda bids also determine the marginal price.
[17] See also description of imbalance system via tennet.eu
[18] Existing BSPs will also have to implement this information flow with the re-qualification

8. Data connections

There are different data flows between TenneT and the BSP per process step. The figure below shows the different ways of connecting to TenneT.
A detailed description of each data flow can be found in implementation guides that can be requested via MyTenneT. The Crowd Balancing Platform (CBP) facilitates multiple information flows simultaneously; this is further explained in section 8.5.

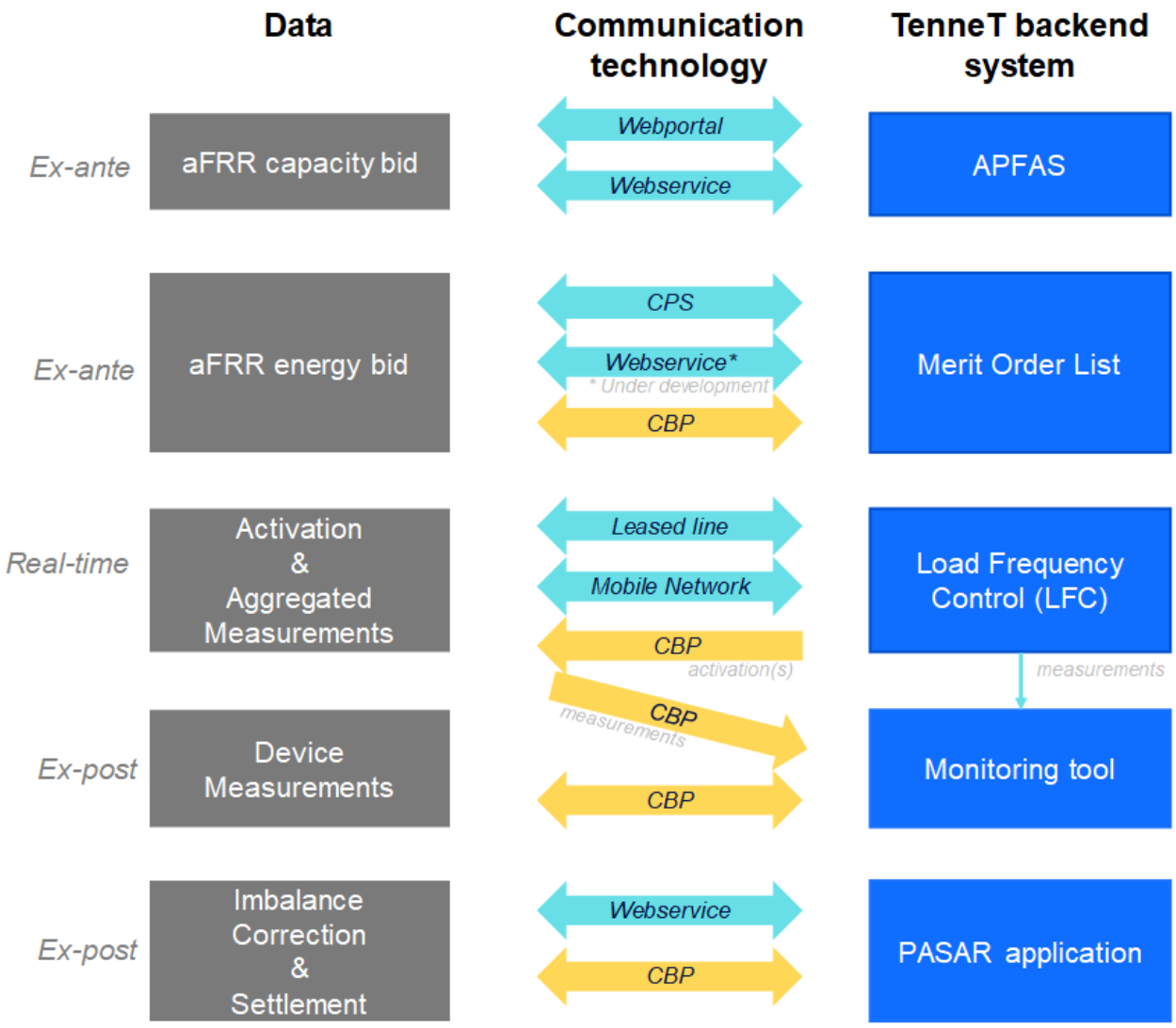

Figure 1: Overview options data connections

8.1 Capacity bid

The Auction Platform For Ancillary Services (APFAS) is used for contracting and transferring FRR capacity obligations. This platform has been developed as a multi-channel application, which means that the BSP can use both the APFAS online web portal and the MMChub, TenneT's implementation of web services.

After successful completion of the prequalification process (see also chapter 0 Prequalification and BSP approval) for contracted aFRR and/or mFRRda, an APFAS account is set up for the BSP. With access to APFAS the BSP gains insight into the auction calendar, open auctions, auction results and the secondary market.

For auctions with "Gate open" status, a BSP can place a capacity bid for the volume of RPUs/RPGs that are prequalified. When the gate closure time is reached, it is no longer possible to place capacity bids and TenneT will select the requested capacity on the basis of the best price for the total requested capacity. The auction results can be found in the APFAS web portal under "Auction Results".

As indicated, the Portal functionality mentioned above is also available via the MMC hub, more information about the APFAS B2B services can be found in the implementation guide, which can be found via MyTenneT.

For a detailed description of the APFAS platform, the "APFAS User Manual" can be requested by sending an e-mail to apfas@tennet.eu.

8.2 Energy bids

In order to offer aFRR (and ROP) to TenneT, a supplier must be certified for electronic data interchange (EDINE) with TenneT.
Information on EDINE related topics, such as Message Implementation Guides (MIG) of the UTILTS messages (for the purpose of the energy bid messages), are maintained by via EDSN. The MIG can be obtained by EDSN or via systemservices@tennet.eu

A project is underway at TenneT involving a transition in the near future from EDINE to XML messages. A definitive date for the message migration is not available at present.

Until the final date for the migration it is already possible to use the XML messages via the MMC-hub. However, this route cannot be used for RESIN bids and does not yet contain the final XML message. The required implementation guide(s) can be found via MyTenneT.

8.3 Activation and measurements

A real-time data connection between TenneT and the BSP is required for activation and measurements.

8.3.1 Information transfer point

- The BSP of aFRR is responsible for the data transfer between its own systems and the Information Transfer Point hereinafter "ITP" (being the place where the responsibility for the information exchanged between TenneT and BSP is transferred).
- TenneT is responsible for the data transfer between the ITP and the TenneT back-end system, or Energy Management System (EMS).
- Both TenneT and BSP cover their own expenses for the realisation and maintenance of the agreed

information exchange method until the ITP.

In the event of a failure in the data transfer between the ITP and TenneT, TenneT will not compensate for lost income. Hence, TenneT recommends to monitor the connection closely in case of an aFRR activation, and to deactivate when the connection is lost.

8.3.2 Communication links and RTUs

For data exchange with the EMS of TenneT, Remote Terminal Units (RTUs) are being used. Further communication between specialists of both parties must take place regarding the design and implementation of the RTUs and the corresponding communication method. In this way the system to be used as well as the specifications of the individual signals can be implemented unambiguously.

Existing connections with the EMS of TenneT have to fulfil the "IEC 870-5-101" protocol. New connections have to fulfil the 'IEC 870-5-104' protocol. The used RTU has to To implement those protocols TenneT developed a so-called Protocol Implementation Documents (PIDs); these are available via MyTenneT. The RTU used by the BSP has to be conformance tested according to the protocol implementation document, by a third party test lab.

There are two options for exchanging data for the benefit of aFRR: via a leased line or via the private mobile network. The private mobile network is recently added as an option for a real-time data connection with TenneT with the goal of reducing connection barriers. TenneT concluded after a period of monitoring that the private mobile network is reliable enough to meet the TenneT requirements. Nevertheless TenneT will continue monitoring the reliability and serves the right to freeze the connection of new BSPs when the reliability significantly reduces and no direct solution is available, to find if mitigation measures are possible.

The following paragraphs summarize the specifics of both options.

8.3.2.1 Leased line

The continuously active data transfer requires two communication connections to limit risks such as interruptions, due to failures or maintenance. One of the two connections functions as a backup, to which it is automatically switched over when the primary connection is interrupted. Both BSP and TenneT must be able to switch from the active connection to the backup connection, and vice versa.

When the 'IEC 870-5-101' protocol is applied, the two connections are used simultaneously: one is the active and one is the passive connection. The delta-setpoints are sent via the active connection. The passive connection is still scanned by the EMS to check whether the connection is working correctly.

When the 'IEC 870-5-104' protocol is applied, one connection is used at one given time. Once a day the connection is switched to the other RTU. The location of the ITP is the physical point where information is transferred from BSP to TenneT and is located at the TenneT datacentre.

8.3.2.2 Private mobile network

When using the private mobile network, TenneT takes care of the infrastructure up to and including the router that is delivered to the BSP. The location of the ITP is the physical point where information is transferred between BSP and TenneT and is the router at the BSP. This means the following:

- The BSP ensures that a good reception for the router is possible;
- The RTU has to be able to communicate with the by TenneT accounted IP-adress.

The BSP is responsible for the connection between the router and his RTU, as described in paragraph 8.3.1. More information about the implementation of the private mobile network is available via MyTenneT.

NB. The probability of disruption between TenneT and the ITP is bigger when using the private mobile network compared to the leased line. The BSP has to take this into account when choosing between the leased line or the private mobile network.

8.4 Settlement and imbalance adjustment

For the aFRR settlement and imbalance adjustment, two messages are sent from the BSP to TenneT, namely the pool configuration and activated energy, and one message is sent from TenneT to the BSP, namely the confirmation market document, as described in chapter 7. These messages are exchanged via web services and require a connection to TenneT's MMChub. The required implementation guide(s) can be found via MyTenneT.

8.5 Crowd Balancing Platform

As an alternative for the data flow exchange described in 8.2- 8.3 and -8.4, the Crowd Balancing Platform (CBP) has been developed with the aim of lowering the communication barriers for BSPs to enter the aFRR market. This is achieved through a single data communication method for all data flows (except contracted aFRR energy bids[19]), as shown in the figure above.

The CBP is characterised by private blockchain technology, which forms the basis of the platform and provides a unique source of truth for all participants. Note that due to the 'private' nature of this type of blockchain technology, all participants in the network are known and trusted and information is only accessible to those who have access (so that commercial information remains confidential).

Communication for BSPs with the Crowd Balancing Platform takes place via REST APIs. The interface between CBP (REST API) and TenneT (all other types of formats) is designed in such a way that all data flows can be exchanged with regular TenneT backend systems.

Via the Crowd Balancing Platform additional next to the delta-setpoint and the aggregated measurements also the measurements of technical installations can be exchanged. This additional data stream is optional

[19] The crowd balancing platform does not yet facilitate aFRR capacity bids. For the aFRR capacity bids the above mentioned webportal or webservice can be used. The Crowed Balancing Platform does facilitate the sending of aFRR energy bids based on awarded capacity.

and can be used by TenneT for audit purposes as explained in chapter 6. Because it concerns small-scale technical installations, the data resolution of the measurement may be lower than for the aggregated data. Currently, there are no requirements for the time resolution of the data. During the prequalification process TenneT will verify if the lower resolution measurements achieve a high-quality aggregated measurement signal.

Information about the technical implementation of the Crowd Balancing Platform can be found via MyTenneT.

9. Responsibilities independent BSP and portfolio participants

An independent BSP consist of a legal entity that does not fulfil the role of BRP of the allocation points used in his portfolio. The table below is intended to provide an overview of where which responsibilities lie in case of an independent BSP .

Topic	Portfolio participant	Independent BSP	TenneT
Portfolio formation	Binding to BSP by mutual agreement No profile connections allowed. Household connections must be fitted with a smart meter with corresponding allocation		
Balance responsibility	Align with BRP (in case household customers outsourced to the supplier). Administrative consequences and possible billing of supplied energy.	Assisting portfolio participant with agreements with BRP.	None, the balance responsibility lies with the BRP of the allocation point! Communicate to BRP about implemented imbalance adjustment after an activation.
Electricity supplier	Coordinating with electricity supplier. Consequences for energy supply on the connection and its settlement.	Assisting portfolio participant with agreements with supplier	
Exclusivity	May only enter into 1 contract with BSP for aFRR	Mutual contracts available for inspection on request to TenneT	TenneT can inspect mutual contracts on request in connection with exclusivity
Technical availability and other technical requirements	Coordinates with BSP so that BSP can guarantee the required availability	Arranges and ensures the fulfilment of all technical requirements; in particular, availability and call-off time	Uses the same technical requirements as solo providers
Administrative requirements		Arranges and ensures compliance with all administrative requirements, in particular the timely delivery of messages and metering data and coordination with BRPs and suppliers of portfolio participants	Uses the same administrative requirements as solo BSPs
Capacity bid		Bid to TenneT on behalf of all portfolio participants via APFAS	Award (if selected) to BSP

Topic	Portfolio participant	Independent BSP	TenneT
Energy bid		Bid to TenneT on behalf of all portfolio participants	
Accessibility		Available 24/7, in case of contracted power.	Has a full continuous service
Activation	Activated via BSP.	Distribution of the aFRR activation by TenneT to the portfolio participant	Activation to BSP
Total portfolio power measurement .	Send real time to the BSP, with an agreed resolution.	Send real time to TenneT with a resolution of 4 seconds	TenneT receives the total power measurement of the entire portfolio from the BSP. TenneT can request the measurement data of the individual portfolio member from the BSP.
Invoicing / payment	Must be arranged with BSP.	Must be arranged with portfolio participant s.	Exclusively via BSP
Imbalance adjustment	TenneT corrects the imbalance of the BRP of each portfolio participant on the basis of activated energy. called up quantities.	Sends activated energy per allocation point per 5 minutes.	TenneT corrects the activated energy at the BRP portfolio.

Table 3: Responsibilities independent BSP and portfolio participants

10. Prequalification process and BSP recognition

Before a BSP can supply aFRR, it must complete the prequalification process in accordance with the prequalification process published on TenneT's website. The prequalification process describes the general steps that are followed during the prequalification process. This chapter further elaborates on the specific prequalification tests that need to be performed for aFRR.

In the prequalification process for aFRR, a distinction is made between voluntary energy bids and contracted energy bids. A BSP approval for voluntary energy bids is a requirement for the prequalification for contracted energy bids.

10.1 Voluntary energy bids

To be eligible for voluntary aFRR energy bids, the applicant must, at its own discretion and in alignment with TenneT, perform a number of tests to demonstrate that it meets the requirements for the supply of voluntary aFRR energy bids.

The tests should at least demonstrate that:

- aFRR energy bids with an regulating speed of at least the percentage specified in chapter 3 of this document, can be regulated upwards or downwards.
- A power change is visible within 30 seconds after a set point change.

The applicant submits a report based on the tests to TenneT, in which the tests and the results are described. This report has a structure agreed with TenneT and describes at least the following:

- Date and time of the test.
- Time synchronous values of the sent set point, the measured power (per RPU and RPG) and the reference signal as data and in graph form.
- Analyses in which, based on the data, it is illustrated that:
  - The power change is visible within 30 seconds after a set point change.
  - The power change is in line with the power agreed in advance with TenneT.
  - The power agreed with TenneT can be activated within the automatic FRR activation time.
- Explanatory note to the structure/method of the total net power when the measurement of technical installations (TI's) ae used with a resolution lower than 4 seconds.
- Explanatory note to the structure/method of the reference signal, including charge management and bidding strategies if applicable.

The applicant must store the original measurement data (including underlying data per TI) of the test with a resolution of at least once every 4 seconds and keep it for 5 years, or until a repeat of the prequalification. TenneT can request these data for control purposes.

10.2 Contracted energy bids

The test described here supplements the test for voluntary aFRR energy bids.

The prequalification tests should be done with regular operational settings. When a BSP is only prequalifying for either upward or downward regulating it only needs to perform the parts in the direction being offered.

To show that the BSP is in a position to make bids and subsequently to deliver in conformity with specifications, the following applies:

a) the BSP is expected for at least one day to make energy bids for each ISP for upward and/or downward regulating, with a volume to be agreed with TenneT for each of the categories in which it intends to make a bid (upward or downward regulating power or both);
b) during this consecutive period the BSP is actually called; the activations in this period should furthermore at the very least meet the following requirements:
    - For the purpose of prequalification for downward regulating power: at least two activations for downward regulating power;
    - For the purpose of prequalification for upward regulating power: at least two activations for upward regulating power;
    - For the purpose of prequalification for and downward and upward regulating power: at least two activations for downward regulating power and two activations for upward regulating power.

It is up to the BSP to make bids such that sufficient activations occur to be able to meet the prequalification requirements.

In the event of an inadequate response[20] in the consecutive one-week period, the prequalification test will be rejected unless TenneT decides on the basis of additional information provided by the BSP that an inadequate response does not have to be taken into account because, for example, the cause is unlikely to reoccur.

The BSP submits a report based on the tests to TenneT in which the tests and the results are described. This report has a structure agreed with TenneT upfront and describes at least the following:

- Date and time of the test;
- An explanation of the bids (in particular how availability is guaranteed).

The BSP must store the original measurement data (including underlying TI) of the test with a resolution of at least once every 4 seconds and keep it for 5 years[21], or until re-qualification. TenneT can request these data for control purposes.

10.3 Framework agreement

In the case of contracted aFRR, the BSP qualification results in a framework agreement. A blank version of this document can be found on the TenneT website.

[20] Inadequate response by a BSP means that a BSP upon activation by TenneT does not act in accordance with the relevant regulating instruction or does not meet the specifications (Response time, regulating speed) as described in the product specification.
[21] 5 years since the prequalification is valid for 5 years.