End report FCR pilot

FCR delivery with aggregated assets

Just a matter of balance

Executive Summary

The energy market is changing. The push for sustainability and energy independence is driving large-scale adoption of (decentral) renewable energy supply. Also, consumers play a more active role in electricity management, with some consumers (partly) producing their own electricity, and hence becoming so-called prosumers. In this way the system is changing from a demand-driven, centralised production system towards a more supply-driven, decentralised grid system.

Having set market facilitation as one of its main goals, TenneT wants to explore how these developments can be facilitated. New market participants would like to enter the ancillary services market, for instance the Frequency Containment Reserves (FCR) market. However, the current specifications of this product pose a barrier for the new participants to enter the market. Mainly participants with little capacity or widely distributed Technical Entities (TEs) have difficulties to fulfil the FCR product requirements, e.g. required measurement instruments on each individual TE or deliver data via dedicated leased lines. Developing knowledge and experience on the supply of FCR by small scale decentral production, storage units and demand response, is helpful to enlarge supply in the FCR market and hence to enhance competition.

To this end, TenneT initiated the pilot project FCR. The main objectives of this pilot are:

- To investigate the barriers and technical feasibility for entering the FCR market with an aggregated pool of new technologies such as renewable energy sources and demand response;
- To create a level playing field for all technologies and therefore enlarge the number of market participants in the FCR market.

Five pilot participants were selected by TenneT to participate in this project. These were ENGIE, KPN, NewMotion, Peeeks and Senfal. The delivery of FCR in the pilot started in 2017 and lasted until March 2017. The pilot project allowed for some deviations compared to the regular market for FCR:

- The minimum bid size for pilot participants was reduced from 1 MW to 100 kW.
- Pilot participants were allowed to prequalify for the delivery of FCR during the delivery phase whereas for the regular market this is a prerequisite for delivering FCR.
- Each week the pilot participants needed to nominate and allocate the planned volume for the upcoming week. This is different compared to the regular market as these volumes were nominated and allocated by sending a weekly e-mail to TenneT.
- In the pilot nominations done by the pilot participants were always awarded while in the regular market this is done via an auction.
- Monitoring the FCR delivery was done using data sent by the pilot participants ex-post via e-mail.
- Non-conformities were not incentivised because the FCR delivered during the pilot was complimentary to Dutch obligation within the synchronous area. Instead, feedback was provided to allow participants to improve their FCR delivery.

TenneT had little insight in the actual aggregation of the individual assets measurement data. Therefore, an independent audit has been carried out to verify the reliability of the (aggregated) data provided by the pilot parties. The audits helped gaining insight in the FCR delivery with aggregated assets. All examined assets (except for wind turbines) proved to fit the product specifications.

Based on the monitoring results it was concluded that, although based on the data provided by the pilot participants, most of the time delivery of FCR was sufficient. Most of the inadequacies could be explained (with various explanations) by the suppliers.

The following main conclusions are drawn from the pilot:
Aggregated assets are able to deliver FCR;

- The main barriers to participate in the regular market proved to be a real time data communication with a leased line and the measurements requirements for a pool.
- These conclusions resulted in the development of a web service for FCR data delivery and changes in the product specifications for the regular market.

Supported by the findings, an FCR manual for BSPs has been prepared. The objective of this manual is to provide both new and existing suppliers of FCR with a complete overview of supplying FCR. The document provides in-depth information on among others the definition of reserve providing groups, product specifications including limited energy sources and operational data exchange including the option of using the webservice. With this TenneT expects to lower the barriers for Balance Service Providers (BSP) further in order to deliver FCR and enhances a technology neutral level playing field.

Table of contents

1. Nomenclature

Abbreviation	Description	Explanation	Reference
BSP	Balancing Service Provider	A market participant providing balancing services to its connecting TSO.	EB GL, Article 2
EB GL	Electricity Balancing Guidelines	Commission regulation 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.	
FCR	Frequency Containment Reserve	'Frequency containment reserves' or 'FCR' means the active power reserves available to contain system frequency after the occurrence of an imbalance	SO GL, Article 3, 6.
NDA	Non-disclosure agreement	A legal contract between at least two parties that outlines confidential material, knowledge, or information that the parties wish to share with one another for certain purposes, but wish to restrict access to or by third parties.	
SO GL	System Operation Guidelines	Commission regulation 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation	
SoC	State of Charge	Used to describe how full a battery is. When a battery is fully charged, we can say that the SoC of this battery is 100%	
TE	Technical Entity	A power generation module or demand unit	
TSO	Transmission System Operator	An party that is responsible for a stable power system operation (including the organisation of physical balance) through a transmission grid in a geographical area.	

2. Introduction

The energy market is changing. The push for sustainability and energy independence is driving large-scale adoption of (decentral) renewable energy supply. Also, consumers play a more active role in electricity management, with some consumers (partly) producing their own electricity, and hence becoming so-called prosumers. In this way the system is changing from a demand-driven, centralised production system towards a more supply-driven, decentralised grid system.

Having set market facilitation as one of its main goals, TenneT wants to explore how these developments can be facilitated. New market participants want to enter the ancillary services market, for instance the market for Frequency Containment Reserves (FCR). However, the current specifications of this product pose a barrier for the new participants to enter the market. Mainly participants with little capacity or widely distributed Technical Entities (TEs) have difficulties to fulfil the FCR product requirements. Developing knowledge and experience on the supply of FCR by small scale decentral production, storage units and demand response, is helpful to enlarge supply in the FCR market and hence to enhance competition.

To this end, TenneT initiated the pilot project FCR. The main objective of the pilot is to investigate the barriers and technical feasibility for entering the FCR market with an aggregated pool of new technologies such as renewable energy sources and demand response. Furthermore, the objective is to create a level playing field for all technologies and therefore enlarge the number of market participants in the FCR market. The pilot contributes to facilitating market entry which in turn contributes to both the creation of a level playing field and the enlargement of the FCR supply base. Therefore it contributes to article 18 (c) of the EB-GL: *"allow demand facility owners, third parties and owners of power generating facilities from conventional and renewable energy sources as well as owners of energy storage units to become balancing service providers".*

For this research TenneT has:
a) organised market consultations;
b) selected five balancing service providers for FCR and performed a proof of concept with them;
c) investigated the required modifications to FCR specifications, contracts, procurement procedures and internal processes and resources for allowing FCR supply by the deployment of small capacities.

The specifications for FCR used at the start of the pilot are described in the *"productspecificatie FCR"*, with reference "FCR V2 from 17th of February 2017" – attached as annex. New FCR product specifications as a result of the pilot are described in the *"FCR Manual for BSPs"*.
This report describes the objectives, setup, execution and conclusions of this pilot, all from TenneT's perspective. The pilot participants have been asked to reflect upon this report. Project details and general information on the pilot operation are depicted in Chapter 3. Chapters 0, 5 and 6 describe the development of data communication for monitoring data, the monitoring results and the audits, respectively. Chapter 7 reports the actions at TenneT side that followed up on the pilot. Finally, conclusions, lessons learned and possible next steps are described.

3. Project information

The main research objective is:

The investigation of barriers and technical feasibility to enter the FCR market with of technologies that are new to the FCR market, such as renewable energy sources and demand response by means of aggregation.

The pilot consisted of six different phases:

1. Selection of pilot participants
2. Setting up FCR delivery
3. Prequalification
4. FCR delivery and monitoring
5. Audits
6. Evaluation of results

This chapter describes how the different phases of the pilot were executed and what was experienced during these phases. The figure below shows the timeline of the execution of the different phases. It should be noted that some phases were executed in parallel.

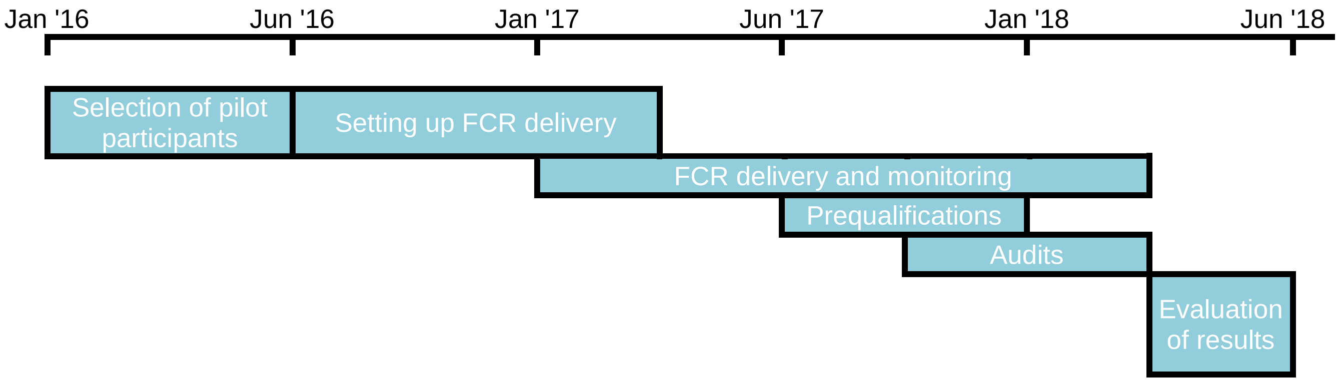

Figure 1: Phases in the pilot project

Due to unforeseen delays in setting up the data communication for FCR monitoring, prequalifications and audits it has not been possible to completely finalise the pilot as originally planned in December 2017. Therefore, it was decided to extend the FCR delivery by three months.

3.1 Selection of pilot participants

TenneT published an invitation for joining the pilot in February 2016. Seventeen different companies showed their interest and signed up. TenneT organized meetings with all applicants in which they could further explain their plans, which led to the selection of five pilot participants. TenneT aimed to learn as much as possible from the pilot and therefore chose different types of technologies and different types of companies. This resulted in the selections of the following pilot participants: Engie, KPN, NewMotion, Peeeks and Senfal.

ENGIE

ENGIE is a global energy and services group, focused on three core activities: low-carbon power generation, mainly based on natural gas and renewable energy; global networks and customer solutions. ENGIE has the ambition to contribute to a harmonious progress, taking up major global challenges such as the fight against global warming and access to energy for all.

In the FCR pilot, ENGIE proposes to aggregate a variety flexible assets that cannot comply to the FCR requirements individually due to size (<1 MW), flexibility characteristics (mainly speed and precision) and/or reliability. The main assets to be used are: new and second life Li-Ion batteries, industrial processes such as heat pumps and residential water boilers. Next to the technical aggregation, ENGIE also proposed to work out a financial model in which each of the assets receives a fair share of the revenues taking into account its characteristics and limitation. ENGIE has also set the goal to directly introduce this flexibility pool into the common market directly after the pilot.

KPN

KPN is a telecom operator in The Netherlands offering fixed and mobile services like internet, interactive TV and voice, operating on the consumer and business market. One of the key goals is to contribute to society and to minimize the environmental impact KPN has by being energy neutral. At the moment KPN uses 100% green energy and is the number one telecom operator in the Dow Jones Sustainability Index (DJSI).

During the FCR pilot the fundamental thought was to re-use KPN’s existing assets to provide the service to TenneT. These assets mainly consist of rectifiers (48Vdc) and batteries (lead acid, OPzS). It was a challenge using stationary batteries to deliver a symmetrical service looking at the characteristics of these lead acid batteries. At the end of the pilot delivering the full service to TenneT was not met due to a combination of the current type of batteries and other specifications the existing assets could not fully provide.

NewMotion

NewMotion - founded in 2009 - is Europe’s biggest provider of smart charging solutions for electric driving. The organization wants to make electric driving simple and convenient for as many people as possible. NewMotion offers smart charge points, a mobile app and a charge card. There are 1,500 companies with their own NewMotion charge point(s) and thousands of individual drivers can charge their electric car at home by using NewMotion technology. Customers can use NewMotion’s public charge network of 64,000 charge points in twenty-five countries, the biggest and fastest growing network in Europe.

For the FCR pilot, NewMotion installed special V2G chargers capable of charging and discharging electric vehicle (EV) batteries to investigate whether EV’s combined with special hardware can provide FCR effectively. The V2G chargers used in the pilot are 10 kW bi-directional AC to DC converters connecting directly to the high voltage DC bus in the EV, hence offering direct control of the energy flow. Vehicles used were Mitsubishi Outlanders predominantly, at both office as residential locations. Aggregation software and services were provided by Nuvve running their software in the cloud as well as on the V2G chargers.

Peeeks

Peeeks develops smart control solutions for demand-side management of electric devices.

During the course of the TenneT Pilot, Peeeks facilitated FCR delivery for a number of its agricultural customers. Peeeks provided a group of farmers with the opportunity to monetize on the flexibility of their CHPs by connecting them to our cloud platform. The CHPs adapted their rate of generation based on real-time frequency variations in a fully automated fashion, 24/7.

Senfal

Senfal is a tech-company that uses artificial intelligence to match energy demand- and production- with continuously evolving market conditions, and where possible, control assets for further optimization.

During the pilot project Senfal developed aggregation technology that can pool charging stations of electric vehicles, residential energy storage and wind turbines to deliver primary reserves. Senfal successfully delivered FCR with batteries and charging stations of electric vehicles and are now scaling up their activities.

3.2 Setting up FCR delivery

While the pilot officially started January 1st 2017, the actual FCR-delivery of most of the pilot participants started somewhat later in Q1 of 2017.

Building an asset portfolio proved to be more challenging than expected

Four of the five pilot participants were selected in the summer of 2016, which allowed them half a year to set up and/or extend their pool of assets. This appeared to be a very short timeframe due to the many interdependencies, and the pilot participants had to do concessions on the (by them ideally desired) pool configuration. Nevertheless they succeeded in configuring a pool of assets and setting up FCR-delivery within a foreseeable timeframe.

Dependency on third parties

The used assets were not always owned by the pilot participants, meaning that they were dependent on third parties (e.g. asset owners, service partners). Issues at those third parties (both relational, hardware and/or software related) caused delays for the pilot participants, and hence for FCR-delivery in the pilot. Dependency on third parties created some uncertainty on possible timelines in the pilot, for instance with respect to the planning of the audit.

It is important to realise that aggregators are, almost without exception, dependent on third parties. That is inherent to their type of role and their business model. The pilot provided the pilot participants with an environment to gain experience on those (typically aggregator-related) aspects.

The iterative processes and learnings in an innovative project

Even though the concepts were well thought through by the pilot participants, often things turned out differently than expected. Either due to software bugs or due to hardware constraints that were not considered, issues arose during the start-up phase of the FCR-delivery. The pilot participants' effort and implemented system improvements, combined with the product-specific knowledge of the TenneT pilot team, ensured that significant improvements were made. The given space for iterative improvements and learning from issues proved to be crucial for the success of this pilot project. In addition, openness on things that go well and things that go 'wrong', is of major importance.

Data communication for monitoring data

At the start of the pilot it was unclear whether the pilot participants would have to set up a real time connection to TenneT via a leased line. But after many (internal) discussions it became clear that this data communication method would have a large negative impact on the business case of future FCR providers. In addition, it seemed not fit for scaling to a large number of FCR providers. Therefore another method had to be developed. TenneT and the pilot participants agreed in the meantime to send in the measurement data via e-mail according to a format developed by TenneT.

3.3 Prequalification

In the regular FCR market, suppliers need to prequalify their installations before being able to participate in the market i.e. deliver FCR. However, within the pilot participants were allowed to prequalify their installations after FCR delivery started. Prequalification consists of a sequence of tests which need to be carried out to verify correct FCR-response of the assets. The following tests are defined in TenneT's document product specification FCR, February 17, 2017, which is attached as annex.

During the tests a) to f) the adjusted power achieved during the test must be delivered for at least 15 minutes:

- *a) For a power setting established in consultation with TenneT between minimum net power and maximum net power, the full power decrease must be realised within 30 seconds at a simulated frequency deviation of +200 mHz.*
- *b) For the power setting stated under a), the full power increase must be realised within 30 seconds at a simulated frequency deviation of -200 mHz.*
- *c) For the power setting stated under a), half of the power decrease must be realised within 15 seconds at a simulated frequency deviation of +100 mHz.*
- *d) For the power setting stated under a), half of the power increase must be realised within 15 seconds at a simulated frequency deviation of -100 mHz.*
- *e) For the power setting stated under a), an evenly progressing power decrease of the full power must be realised in 2 minutes at a simulated evenly increasing frequency deviation of 0 mHz to +200 mHz. The power decrease must have an even course and be fully realised within 2.5 minutes (max. 30 seconds lag on simulated frequency change).*
- *f) For the power setting stated under a), an evenly progressing power increase to the full power must be realised in 2 minutes at a simulated evenly decreasing frequency deviation of 0 mHz to -200 mHz. The power increase must have a linear course and be fully realised within 2.5 minutes (max. 30 seconds lag on simulated frequency change).*

Once the above tests have been satisfactorily completed, the technical unit should track the frequency for 8 hours and submit the corresponding measurement strips. These last test results are needed to be able to pass judgment on the quality that the unit supplies to the frequency support.

In order to fulfil the prequalification requirement, Supplier must provide the results of the tests. This concerns at least:
- *Measurement protocol including the relevant measurement results*
- *Test structure, precise specification of the measurement points*
- *Test time, list of tests performed*
- *Description of the way the tests have been done*
- *Persons involved in the test (including the contact person for the test)*

Pilot participants were requested to schedule a prequalification test. In some cases TenneT was present during (part of) the test sequence. Results from the prequalification test (a report and the original measurement data) were sent to TenneT for review. In some cases updates in the report or specific further explanations (leading to a more detailed report) were required.

The prequalification process as applied during the FCR-pilot is illustrated in Figure 2: Prequalification process as applied during the FCR-pilot. The prequalification process assumes that the data originating from the tests and written in the report is reliable. This assumption was verified in the auditing process (see chapter 6).

After TenneT received the report and the corresponding data, both the report and the data were reviewed and feedback was given to the supplier. This feedback consists of a prequalification approval, rejection, or request for further information and update of the report. Other than in the regular market, prequalification was not a prerequisite before FCR could be delivered, however, it was a prerequisite before the end of the pilot.

During the FCR-pilot, the following issues within the prequalification process appeared:
- Insufficient delivery of FCR during one or more subtests;
- Non-complete or non-synchronous execution of prequalification tests;
- Unclear or incomplete (figures not readable, lacking information) reporting;
- Different data-formats. Data is required from the pilot participants for analysis by TenneT. Multiple data-formats made the data-analysis a rather time-consuming process.

TenneT concluded that a more detailed and clearer prequalification process will further facilitate suppliers. As a result the following aspects are integrated in the FCR product specification document:
- Test requirements, such as the time period that output power should be maintained;
- Measurement requirements, such as sampling rate for power and frequency measurements;

- State Of Charge (SoC) requirements, such as identical SoC at the start of each subtest.

Acquired insights in the prequalification process are used for updating the FCR product specifications and for the documentation of the FCR prequalification process.

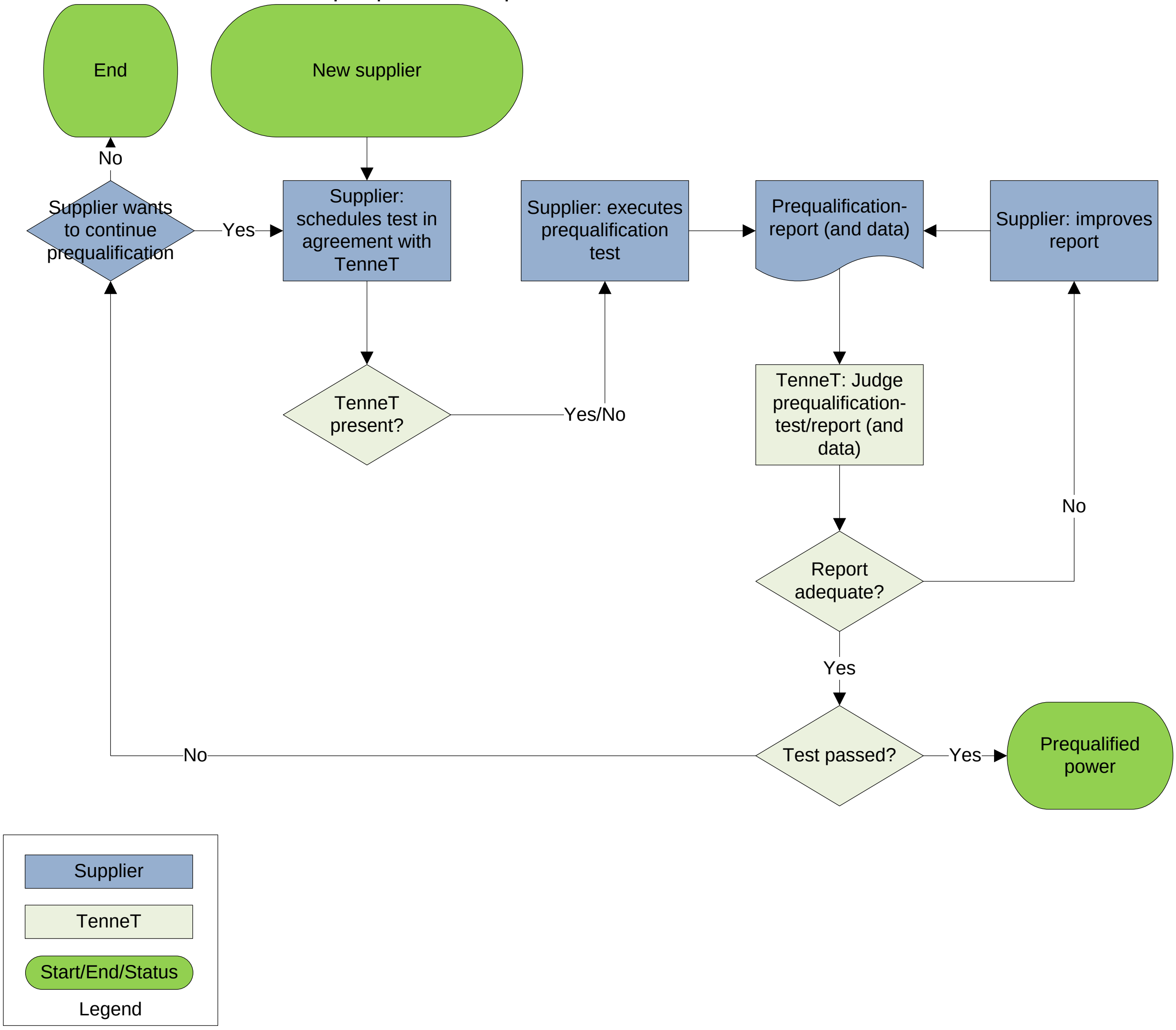

Figure 2: Prequalification process as applied during the FCR-pilot

3.4 FCR delivery and monitoring

Most of the current product specifications were effective for the FCR delivery. Figure 3: FCR pilot operation shows how daily operation of the pilot took place.

The pilot participants needed to nominate the volume they planned to deliver for the upcoming week. The difference to the regular market, however, was that these volumes were nominated by sending a weekly e-mail to TenneT and which were also always awarded. By nominating the allocation was implicitly provided.

The minimal required volume and bid size was different from the regular market, since 100 kW bids with increases of 100 kW were allowed.

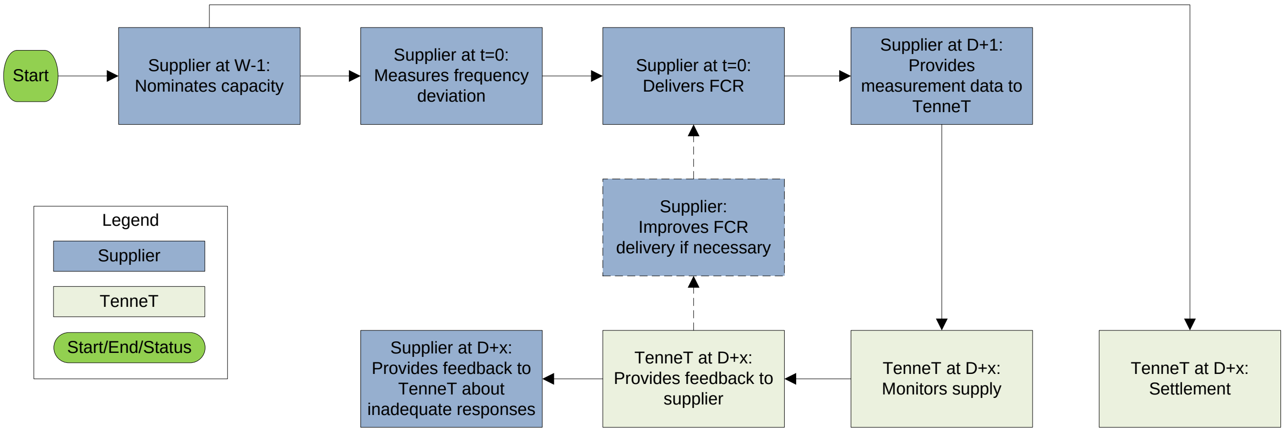

Figure 3: FCR pilot operation

Different from the regular operation was also the settlement and incentives in case non-conformities were determined. Instead of an auction with bids, the remuneration for the pilot participants was based on the average price of the Dutch auction. Non-conformities were not incentivised because the FCR delivered during the pilot, was complementarily to Dutch obligation within the synchronous area.

Monitoring the FCR delivery was done ex-post using data sent by the pilot participants via e-mail, which is another difference to the regular market. The ex-post data was analysed to determine if the allocated FCR was delivered correctly. When an issue occurred, it was reported to the pilot participant for further analysis and explanation. The pilot participants used this information also as input to improve the quality of the FCR delivery.

3.5 Audits

During the pilot two external independent parties performed an audit to check the integrity of the submitted data. The auditors investigated the performance of individual assets, the software and control system, and the FCR assurance during the bid period (one week). The main reason to execute an audit was to gain more insights in the ability of aggregated assets to deliver FCR.

The audits were initially planned in Q3 and Q4 in 2017, but most of the audits took place in Q1 2018. This had two main reasons. The first reason was delays in the prequalification process. The audits could only take place after the prequalification process had a positive outcome. Secondly, delays emerged due to issues with Non-Disclosure Agreements (NDA's) and information sharing. TenneT chose external auditors for an independent judgement, but this resulted in more privacy concerns and complicated the set up off and agreement upon NDA's.

Due to the delay of the execution of the audits, the pilot operation was extended to Q1 2018. Unfortunately, TenneT communicated this rather late to the pilot participants. At that time, it was clear that some of the contracts between pilot participants and asset owners expired after Q4 2017. Therefore not all pilot participants could fully continue the pilot during Q1 2018, with a non-exhaustive audit as a result. In those cases the asset owners were available for the audit, but no FCR nomination was done during the audit period.

3.6 Evaluation and conclusions

After the pilot, conclusions were formed and new documents were set-up such as a FCR Manual for BSPs. As these changes are applicable for all market participants at the same time, TenneT decided to publish the new product specifications and framework agreement together with this project end report and the final presentations. Therefore the pilot participants were not able to join the regular FCR market directly after the end of the pilot operation in Q1 2018 because the new specifications were not yet valid.

4. Data connection

In the regular FCR market, it is currently only possible to connect to TenneT via a dedicated 'lease line' in order to transfer the measurements required for the monitoring of the FCR delivery. For those lines only the IEC 60870-5-101 protocol is accepted by TenneT. This protocol cannot be provided for new connections in the Netherlands any longer, such that providers entering the FCR market cannot connect to TenneT. While the successor protocol (IEC 60870-5-104) is likely to be accepted by TenneT soon, it still requires a hardwired dedicated line that comes with significant costs and installation time.

Due to these developments a new data communication method has been set up during the pilot: a web service. This does not only enable new providers to enter the FCR market, but it also comes with lower costs. Using a web service for transferring measurement data for FCR monitoring, TenneT accepts that the data is not delivered in real time, but only a couple of times per day. The main reason for accepting ex-post data is that the delivered (aggregated) signal could also be manipulated with new advanced IT systems even on a 1 second basis, and hence real time data does not guarantee the integrity of data any longer.

The SO GL specifies that the time resolution of FCR signals sent to TSOs should be least on a 10 second basis; this is however under discussion and is probably going to be secondly-based. To avoid data files that are too large to process, data can be sent to TenneT via the web service multiple times per day.

Even though the web service solution is chosen because it is a simple data communication solution, it proved to be a difficult process implementing it at TenneT. Web services are new to TenneT and policies and processes for it are still being set-up. Data security is of high priority to TenneT and therefore the web service should be implemented without increasing the possibility of a security breach. Furthermore, the web service should guarantee a high availability and confidentiality. During the implementation a lot of discussions arose on the exact requirements of the web service. Therefore it took much more effort and time as initially anticipated.

The web service is being implemented in two phases. In phase one the web service is already functioning and data can be processed by it but does not meet all requirements. In phase two the web service is upgraded to a mature version. At first phase one was only meant for pilot participants, but because of the delay in the implementation of the web service, TenneT decided that every new FCR provider can connect to the web service before the end of phase two. This however implies that these FCR providers accept the risk that errors will not be detected when the data is received by the web service but only during the monitoring afterwards.

5. Monitoring results

The FCR delivery has been monitored based on the data that pilot participants sent ex-post to TenneT via e-mail. Monitoring was done as in the regular market by an ex-post analysis. For this a baseline is used, which is a reference as if no FCR would have been activated. The provided monitoring data was in some cases the aggregation of the power output of the individual assets and in other the power output compensated by the baseline itself. The formation of a baseline is currently subject of further investigation by TenneT.

In case the FCR delivery was deemed inadequate, it was reported to the pilot participant for further analysis and explanation. The pilot participants used this as input to improve the quality of the FCR delivery.

Over the pilot period from January 2017 until March 2018[1], the results from monitoring are as shown in Figure 4.

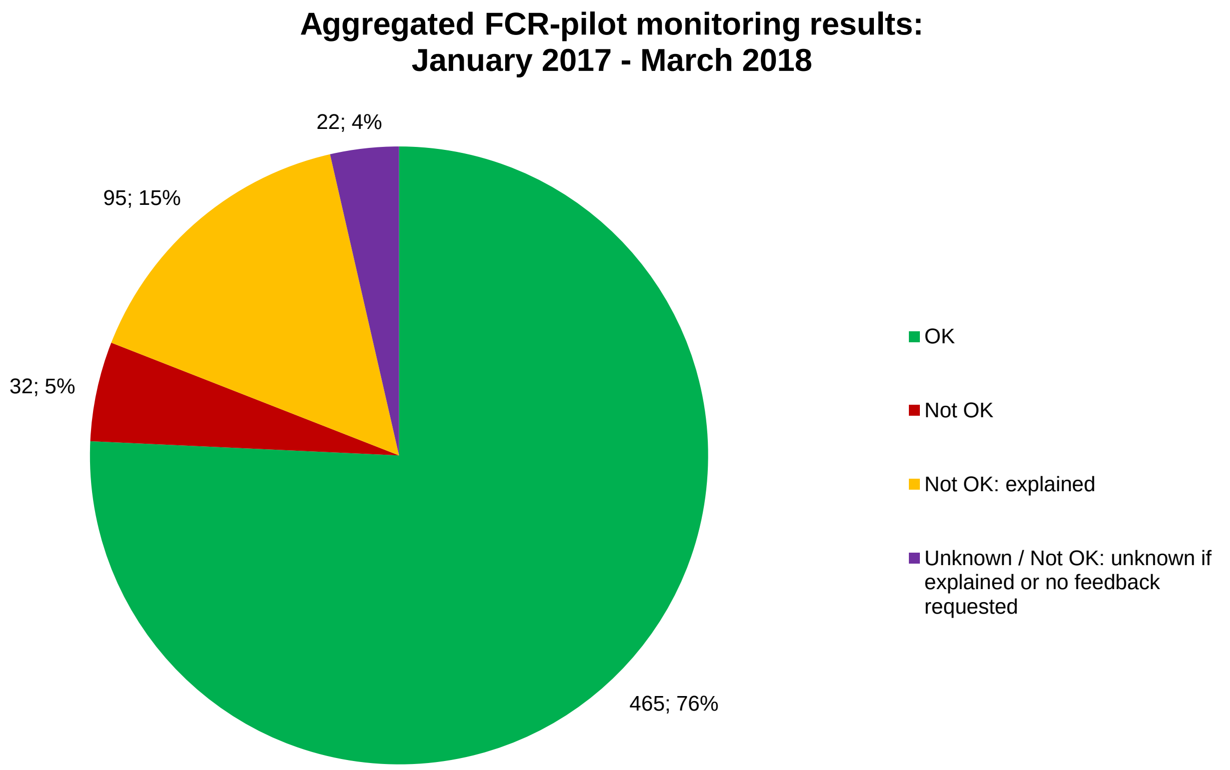

Figure 4: Aggregated monitoring results based on samples selected (number of samples: 614).

[1] Although monitoring also occurred after 25 Feb 2018, no feedback was requested from pilot participants in this period in case of inadequate response.

The list below is a (non-exhaustive) list of causes which were declared by pilot participants for non-adequate FCR-delivery:

- Start-up problems of components ;
- Failure or malfunction of components (assets);
- Summertime-wintertime transition;
- Server issues;
- Error(s) in frequency measurement;
- Power failure of the (local) grid;
- Software (algorithm) or aggregation errors;
- Nomination was not correctly processed;
- Not known (not recoverable).

Fout! Verwijzingsbron niet gevonden. shows the allocated FCR capacity during the pilot. It indicates that during the start-up phase of the pilot less FCR is nominated and during the pilot the volume increased.

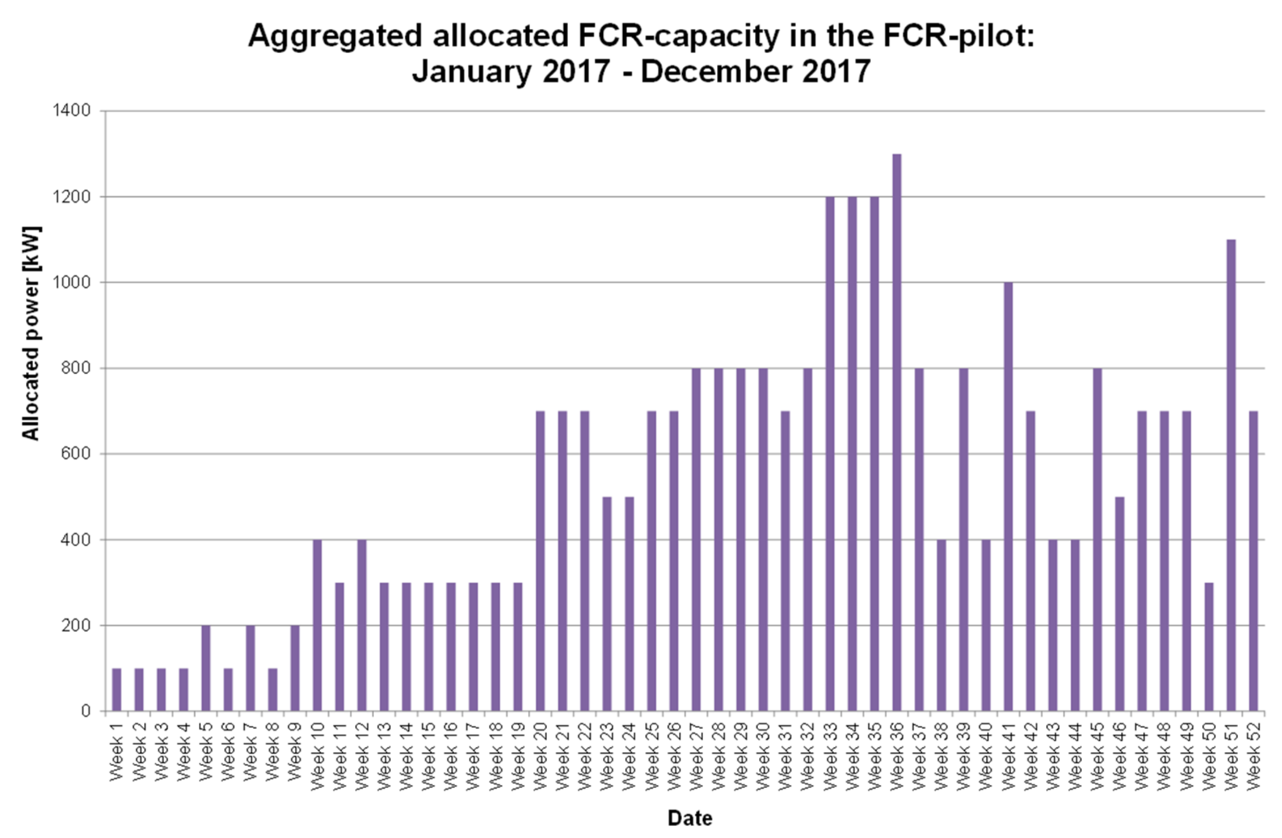

Figure 5: Aggregated allocated FCR-capacity in the pilot: 2 January 2017 - 31 December 2017[2].

[2] The pilot was extended until the end of March 2018.

Observations and conclusions

- Most of the time the delivery of FCR was sufficient, nevertheless this is based on the data provided by the pilot participants.
- Converting the data, submitted by e-mail by the pilot-participants to the correct format proved to be a time-consuming process for TenneT.
- Monitoring done by TenneT was also useful for the pilot participants.
- In most monitoring samples FCR delivery was considered to be adequate.
- If FCR delivery was deemed inadequate, the inadequacy could be explained by the supplier.
- Reasons provided for inadequate FCR delivery proved to be various.
- When the power output of the aggregated assets is influenced by more factors than only FCR delivery, a baseline is necessary for monitoring FCR delivery.

6. Audit

The prequalification and monitoring of FCR delivery was fully based on data provided by the pilot participants. The pilot participants sent this data to TenneT via e-mail, ex-post only once a day. Consequently, the reliability of the data, which is usually sent in real time, is in this case not guaranteed. Also, TenneT had little insight in the actual aggregation of the individual assets measurement data. Therefore, an independent audit has been carried out to verify the reliability of the (aggregated) data provided by the pilot parties.

Since the importance of the audit and the newly developed data delivery, TenneT decided to execute the audit with two separate parties who had to investigate the following topics:

- Response of the assets on frequency deviations/set points;
- Aggregation of the pool, including aggregation of the individual asset measurements;
- Assurance of FCR delivery during the entire period.

The focus of the audit was to assess the technical ability of the assets and aggregation for FCR delivery. During the audit, tests were done at the assets in the field and with the centralised IT-system for steering the assets.

6.1 Process

During the audit process a lot of challenges occurred because of shared responsibilities of different parties. The relation between asset owners, IT partners, BSP, audit party and TenneT was complex in most cases.

The pilot participants were mostly not the owners of the assets. To measure the assets in a safe and secure way, the owners of the assets and someone with adequate technical knowledge of the assets had to be present. In some cases the owner of the assets did not have adequate technical knowledge about the hardware to arrange safe and secure measurements. Because safety should never be compromised, not all measurements could take place. It is important that the BSP ensures a safe working environment for the auditing party.

Not all pilot participants had access to all needed information for the auditors. They were dependent on other parties for algorithms, which had to be shared with the audit parties for the verification of the integrity. This resulted in issues on intellectual property rights and non-disclosure agreements. Because of this, some aspects were not auditable and had no positive outcome as result. Nevertheless it is a responsibility of the BSP that an audit on the FCR delivery can be done as is described in the framework agreement. After all, (according to the SO-GL) TenneT has to be able to verify the delivery of FCR.

During the audit not all assets were working correctly, therefore it was not possible to randomly select the assets for the audit. This demonstrates that the pilot participants were not completely ready for the audit when it was executed.

6.2 Individual assets

The audit results indicated that in principle all assets were technically capable to deliver FCR. Measurements showed that the frequency was followed, the response time of the assets met the product specification and all assets proved to deliver FCR for a sufficient period of time.

Verification FCR delivery with wind turbines was proven to be challenging because wind variations are much larger than FCR delivery. In order to determine the provided FCR the power measurements of the wind turbines and a reference signal was used. This validation mechanism was not able to filter out severe variations in wind speed and therefore was unable to show that the FCR was adequately delivered. Because of this, wind turbines do not fit within the current FCR specifications.

Another finding from the audit is that FCR delivery with batteries and EVs showed to be largely dependent on the battery management system of the battery itself. Different kinds of batteries have different discrete charging steps. For example: one battery had charging rates with steps of 250 W while another one had steps of 80 W. It depends on the type of battery and has to be taken into account in the control software of the pool.

Some batteries were not able to react with very small steps on frequency deviations around the power set point of 0 kW. When all the batteries in a pool have the exact same behaviour at a frequency change around 50 Hz, it results in a large discrete step at the initial response. This should be taken into account in the steering algorithm so that aggregated (sum of the) FCR delivery is in line with the frequency deviation.

6.3 Control and software

Some audits showed differences between the reaction of the assets and the steering signal of the pilot participant. The steering signal was mostly based on assumptions, such as a stable voltage and the calculated reactive power. Fluctuations in the voltage and reactive power were immediately reflected in fluctuations in power consumption and/or generation, which does not benefit the quality of FCR delivery.

Some measurements of the audit showed differences between measured data of the audit party and the data sent to TenneT. Therefore it has additional value to be present in the field during prequalification or sample-wise during normal delivery ensuring the data integrity. The audits with simultaneous measurements proved to have much added value for the determination of data integrity. The integrity is easily proven when simultaneously someone is available at the asset and someone else at the central system to check if something that happens in the field, is also recorded in the central system and vice versa. The whole data chain can be checked as one with these simultaneous measurements and therefore integrity can be determined. When simultaneous measurements are not possible, the algorithm of the IT-system has to be investigated. This can be difficult with intellectual property rights and subsequent required NDA's.

Quality of aggregation and hence quality of FCR delivery is improved when making use of time synchronisation of local power meters and local frequency meters. This assumption was confirmed in some audits.

Redundant data connections have to be used when many assets are steered via that connection. This is the case when, for example, one connection is used for a large wind farm. But when the impact of one asset failing is low, the redundant connections are of less importance. Furthermore, it was found very valuable to have a clear process of how the system deals with moments when the connection is completely broken.

6.4 Organisational aspects

The audits showed that some organisational improvements can be made. Note that the organisational improvements are not TenneT requirements but just recommendations. The BSP is responsible for how the pool of assets reacts on frequency changes.

Most of the audits concluded that the assurance of FCR delivery was insufficient. In most of the cases there were not enough assets in the pool and when one asset failed the other assets did not take over. Furthermore, uniform behaviour of assets will cause issues when a pool only consists of the same kind of assets. For example, FCR delivery cannot be assured during rush hour when the pool only consists of electrical vehicles or during periods with low wind when the pool only consists of wind turbines. In addition, adequate FCR delivery should be guaranteed at the moment when an asset is taken from the 'FCR pool'. This could, for example, be the case when a battery has a SoC that is too low, or in case asset owners stop FCR delivery deliberately. In those cases, the ramp-down and ramp-up of the replacement asset should be taken into account, otherwise insufficient FCR is supplied for a number of seconds.

In case of an incident, the time to repair can be high when the asset owner has no expert with adequate knowledge on the spot. In some situations there was a complex relation between TenneT, the asset owner, the aggregator, and a party that delivers the software. In these cases it is recommended to agree upon clear responsibilities about who does what to repair the incident.

Another important organisational aspect is the process on continuous improvement for efficient forecasting. Forecasting is essential to determine the capacity that can be made available with the pool of assets for the FCR bids period of one week. In this period, both the economic deployment of assets and a certain delivery of FCR are optimized.

6.5 Conclusion audit

The audits helped gaining insight in the FCR delivery with aggregated assets. All assets (except for wind turbines) proved to fit the product specifications. But some points were raised by the audits for improvement, such as:

- Quality of the reference signal (baseline) for FCR delivery with wind turbines. Without this, wind turbines do not fit the product specifications;
- Taking into account that different kind of batteries have different kind of discrete charging steps;
- Taking into account the effect of changes in voltage and reactive power on active power;
- Time synchronisation of local power and frequency meters;

- Clear process and responsibilities during an incident with the data connection or the asset;
- Assurance of FCR delivery;
- Continuous improvement for efficient forecasting.

The audits proved to be very valuable for assessing the ability of a pool to deliver FCR. Therefore TenneT would like to create a standard audit protocol, which will result in a smoother audit process.

7. Subsequent actions following from the pilot

During the course of the pilot TenneT, pilot participants and auditors encountered impediments and faced challenges. These led to insights on desired changes in order to facilitate market entrance of new FCR providers or assets without compromising the system security. As a result changes were made in the framework agreement, the 'type approval' was added and both were merged with other FCR documentation in the new FCR Manual for BSPs. These and other considered developments are described in this chapter. It should be noted that these pilot driven developments may be subject to changes due to decisions or legislative developments on a European or a national level.

7.1 Minimum bid size

The main adjustment within the pilot was to lower the minimum bid size from 1 MW to 100 kW, with the possibility to raise the volume – with multiples of 100 kW – to a maximum of 1,5 MW. Because of this, all pilot participants could deliver FCR, which would not have been the case with the regular minimum bid size of 1 MW.

Even though delivering FCR in the regular market (after the pilot) is a challenge for most pilot participants due to the minimum bid size of 1 MW, TenneT and the European TSO's concluded to keep this requirement[3].

This has the following reasons:

- It is very hard for aggregators to have a positive business case with volumes below 1 MW ;
- Costs will increase significantly for TenneT when accepting smaller FCR bids. For example, more prequalification tests are needed, more data has to be monitored and more audits have to take place;
- Other changes of product requirements will have a bigger impact on facilitating new FCR providers, such as lowering the bid period (from week to 4-hour products) and measurement requirements. Therefore these product requirements are prioritised over a change of the minimum bid size, and will be implemented first. After that, the option of changing the bid size will be addressed again by the TSOs of the Regelleistung platform.

7.2 Requirements on aggregation

The pilot showed that a pool can deliver FCR. Based on discussions between the participating TSO's in the common auction some new requirements are set out. For instance:

- The maximum volume of a pool with which aggregated FCR delivery is provided, must not exceed 150 MW;
- Each decentral asset that is included in this pool must not exceed 1,5 MW FCR providing capacity.

[3] *"Consultation Report "FCR Cooperation"*, available at: https://www.entsoe.eu/Documents/Consultations/20170601_FCR_Consultation_Report.pdf .

The FCR pilot has shown that these limiting requirements do not pose a problem for the FCR providers that took part in the pilot. All the details on requirements on aggregation can be found in the FCR Manual for BSPs.

7.3 Guidelines on type approval

A pool with a lot of small decentral assets will change more regularly than the current FCR portfolio's. A new prequalification tests for every new asset entering a pool (for example: a new electrical vehicle) will be too time consuming. Because of this, TenneT wants to allow type approval and developed guidelines that are based on the experiences from the FCR pilot. The complete set of requirements is published in the FCR Manual for BSPs.

7.4 Prequalification

The pilot showed that the prequalification process is a very time consuming process with new FCR providers. The pilot participants showed different interpretations of the tests and used different formats sending in the data and different formats of the report. Therefore TenneT would like to standardize the prequalification process further. This will help new FCR providers to prequalify more smoothly and will make the prequalification process less time consuming for both TenneT and the FCR providers.

7.5 Ex-post data delivery

The pilot concluded that leased lines and the requirement of a real time connection has a negative impact on the business case of a new FCR provider.

The data that is sent via the leased line is used for the sole purpose of the verification of FCR delivery, which is an ex-post process. From a historical perspective FCR providers were the same companies/production plants as the aFRR providers. For aFRR, the production plants needed to have a real time connection with the TenneT system, a leased line. This was also used in case a supplier delivered FCR, and hence another data communication option solely for FCR was not necessary. With the arrival of new parties that only aim to offer FCR, however, there is a need for a new data communication method.

Next to that, the fact that the data was send in real time, ensured that the data could not be manipulated. But with new advanced IT systems data could be manipulated within a second, and hence real time data is not a certain guarantee for credible data anymore. Therefore, TenneT concluded that ex-post data delivery could be accepted and data communication via a web service seems to be an efficient option. It needs to be emphasised that the web service is an option to send in FCR monitoring data but also already existing leased lines can be used.

The web service is thus added as an option for sending in measurement data in the FCR Manual for BSPs. Furthermore, documents are set-up, which explain how the measurement data has to be sent to TenneT. These documents are:

- Document Implementation Guide, which describes how the send-in data should be structured;

- TenneT web service guide, which describes how web services within TenneT are used;
- Technical guide, which describes how a connection with the web service should be established.

7.6 Central/decentral frequency measurement

During the pilot, discussions of central/decentral frequency measurements in Europe took place. The pilot gave input for this discussion. It is concluded within the TSOs in Europe that central frequency measurements are allowed. The exact requirements for this are added in the FCR Manual for BSPs.

8. Conclusions

The main conclusion which can be drawn from this pilot is that aggregated assets are able to deliver FCR but there are some barriers. The main barriers to participate in the regular market proved to be a real time data communication with a leased line and the measurements requirements for a pool of assets. This resulted in the development of a web service for FCR data delivery and changes in the product specifications.

Also the complete FCR description and FCR prequalification process were revised in order to provide to needed information for the expanding market. Therefore the newly written FCR Manual for BSPs explains how FCR can be delivered and includes all the requirements for FCR delivery. This manual provides more details on:

- The definition of a reserve providing group;
- Product specifications including limited energy sources;
- Operational data exchange including the option of using the web service;
- The prequalification process for FCR including the test protocol;
- The FCR auction.

Lessons learned with respect to the pilot are:

- Prequalification tests proved to require considerable effort from both TenneT and supplier;
- Audits are more time consuming than anticipated and involve NDA's to protect the intellectual property;
- Setting up a new data connection proved to be more comprehensive than anticipated.

Possible future research:

- Standardisation of the prequalification process, report and data structure could streamline the prequalification for both suppliers and TenneT.
- Standardisation of the audit protocol could result in a smoother auditing process.
- For monitoring the FCR response, adequate baselining proves to be necessary. It should be investigated further how this could best be implemented.

Chosen not to investigate (yet):

- At this stage the minimum bid size for participating in the FCR auction is not subject for further investigation.

Annex 1: Product specification FCR

MEMORANDUM

TO	Potential suppliers of FCR	DATE	February 17, 2017
		REFERENCE	FCR V2
		FROM	SON-SY

SUBJECT Productspecification FCR

This document, a translation of the 'product specificatie FCR', is provided for information purposes only and is expressly not legally binding. The only legally binding agreement is the Dutch 'product specificatie FCR'. Although great care has been taken in drafting this document TenneT is in no way liable for any damage whatsoever as a result for the use of this document nor for any omission, incorrect, incomplete and/or improper translation.

Version history

November 2016	Detailed the 15 minute criterion
Januari 2017	requirements for metering and typo's in testprotocol corrected

1. General

The purpose of primary reserve is to limit and stabilise frequency disruptions in the entire (internationally) synchronously connected high-voltage grid, irrespective of the cause and location of the imbalance that has caused the frequency disruption. Without adequate intervention, frequency disruptions may lead to automatic load shedding and even cause a black-out in the worst case scenario.

The minimum size required for primary contributions from each control area is agreed annually within ENTSO-E Regional Group Continental Europe. The individual values are determined in proportion to the total electricity production in the control area of each connected TSO.

2. Requirements

In order to offer primary reserve, a technical unit must be prequalified in accordance with the prequalification requirements set out in the annexes of the framework agreement that is concluded following the successful prequalification of the unit. The framework agreement along with the annexes is on the TenneT website. Part of the prequalification is a test of whether the technical unit is in a position to supply primary reserve in accordance with the specifications. A test protocol is included for this in annex 1 of these product specifications.
Following prequalification and the signing of the framework agreement, the signatory party gains access to the auction platform. The requirements for the auction are also shown in the annexes to the framework agreement.

Ensuing from the European Codes, and in particular the 'System operations Guideline' (SO GL) and the Dutch System Code, specifications that the primary reserve product must meet have been drawn up:

TenneT TSO B.V.
DATE February 17, 2017
REFERENCE FCR V2
PAGE 2 of 9

Minimum Bidsize	1 MW (upward and downward)
Accuracy of the frequency measurement	10 mHz or better
Insensitivity range of the frequency control	Max 10 mHz
FCR Full Activation Time	30 s for the complete bid
Full Activation Frequency Deviation.	+200 mHz / - 200 mHz
Real-time operating measurement of power	In MW with a resolution of no more than 4-10 seconds

A technical unit or pool where must supply primary reserve for as long as the deviation in frequency persists. For supply from limited resources additional requirements are set out in chapter 4.

A supplier has the right to combine the measurement data of units with Pnom lower than 1.5 MW to a maximum aggregation of 30 MW and an objective check on the activation of the primary reaction is possible.

3. Target frequency

A supplier with a contract/permit for primary reserve must, for a 24-hour period with a different target frequency, determine a setpoint correction on the basis of the contractual commitment. A correction is preferably applied to each unit with an allocation. If a correction to the unit is not possible in practice, the supplier must include the correction in his central energy/power regulation in order to support the frequency correctly and to limit his imbalance.
Example: a contractual commitment of 30 MW (at 200 mHz) requires a correction to the setpoints of -1.5 MW at 49.99 Hz or +1.5 MW at 50.01 Hz target frequency.

4. Limited sources

The requirements for supplying the primary reserve for limited[1] and unlimited[2] sources are the same with a some exceptions. Specific requirements for limited sources are discussed below. The specific requirements are based on the SO GL.

[1] Units with limited energy reservoirs like: Batteries, Flywheels, Water reservoirs etc.
[2] Conventional units

4.1 15-minute requirement[3]

Technical units or pool units with limited energy must able to provide constant support to the frequency within the "standard frequency range"[4].

If, in the event of a larger deviation in frequency, the "alert state"[5] is reached, a unit must be able to continuously supply the full quantity of primary reserve awarded/contracted for a period of not less than 15 minutes at a deviation of 200 mHz or more, or to supply partial delivery for a proportionately longer period in the event of frequency deviations lower than 200 mHz.

After these 15 minutes (or proportionately longer period), the limited unit must have the energy fully available again as soon as possible, but at the most within 2 hours after reaching "standard frequency range".

4.2 Battery

A battery or a pool of batteries has specific characteristics (charging limits, self-discharge, ageing, unacceptable operating conditions etc.). These must be documented and submitted with the other prequalification documents.

4.2.1 Charging management

The frequency within the synchronous system of continental Europe has a nominal setpoint of 50 Hz. Periods with with an average frequency deviation in one direction will however occur.

For a battery that supplies primary reserve, this means that, despite the fact that the frequency is in the normal state, it will have an impact on the state of charge (SoC). For a battery that supplies primary reserve, this means that active charging management is necessary to facilitate constant support for the frequency within the "standard frequency range".

The charging management must be designed in such a way that, with a transition from "normal" to "alert state", full activation of the contracted primary reserve for 30 minutes is possible or for as much longer as the deviation is lower than 200 mHz. The charging management must be documented in the prequalification documents.

4.2.2 Power

The dimensioned power is related to the offered power desired | (in MW). No further requirements are set here.

4.2.3 Charging and discharging capacity

The charging and/or discharging capacity of the battery is related to the charging management and the energy content of the battery. No further requirements are set here.

4.2.4 Energy content

[3] Explanation on 15 minutes described in annex 3
[4] Is the "normal state" (49.95-50.05 Hz)
[5] Alert state: Δf > +/-100 mHz for 5 min or Δf > +/- 50 mHz for 15 min

The energy content of the battery is related to the power and the charging management. No further requirements are set here.

5. Exchange of proces information on FCR

5.1 Meter

- Refresh rate 4 sec or smaller
- Max measurement error 1% (of nominal value, class 0.5s)

5.2 Data exchange

For exchange of measurement data specific means are necessary. In addition a number of general aspects are important. The means and general aspects are state below.

5.2.1 Basic Principles

- Location of the Information Exchange Point (IEP).
- The physical location/point where the information is exchanges between supplier and TenneT. This is at TenneT in Arnhem, the Netherlands, or in one of the TenneT high voltage stations..
- The supplier is responsible for the data transfer between its own systems and the agreed IEP.
- TenneT is responsible for the exchange of information between the agreed IEP and the TenneT EMS (Energy Management System)
- Each party bears its own expenses for the realisation and maintenance of the agreed information exchange. The demarcation point for the costs is the IEP.

5.2.2 Communication connections and RTU's

Detailed specialist consultation will have to take place about the design and implementation of the Remote Terminal Units (RTUs) in order to set out the coordination of the systems used and the specifications of the individual signals unambiguously.

- RTUs with the 'IEC 870-5-101' protocol are used for the communication with the EMS of TenneT. Some existing connections still use the "IEC 870-5-104" protocol. TenneT has made so-called Protocol Implementation Documents (PID) for these protocols.

- The continuously active data transfer requires two communication connections to limit the risk of interruptions to the signal transfer due to failures or maintenance. One of the two connections functions as a backup, with functionality to switch over automatically if the primary connection is interrupted. Both the supplier and TenneT must be able to switch from the active connection to the backup connection.

- When the 'IEC 870-5-101' protocol is applied, the two connections are scanned simultaneously. In that case there is one active and one passive connection. The set points are sent via the active connection. The passive connection is scanned by the EMS to check whether the connection is still working correctly.

- When the 'IEC 870-5-104' protocol is applied, one connection is called on at any time. Once a day there is a switch to the other connection on the RTU.

5.3 Optional

If a technical unit is connected to regional grid which is connected to the TenneT grid. It might be possible the real-time metering of the unit is already part of the regional grid operator's scada system. If this is the case it could be investigated if the real time metered data is of sufficient quality and can be forwarded to TenneT.

ANNEX 1

1. Testing protocol

1.1 Introduction

For a Technical unit to prequalify for the supply of Primary Reserve, it must be tested on technical requirements as described below. The prequalification tests must take place under normal operational settings of the Technical unit.

1.2 Simulation of frequency deviations

Frequency deviations are simulated during the tests. A stepwise frequency increase and decrease of 100 mHz and 200 mHz is simulated and also an even frequency increase and decrease of 200 mHz.

1.3 Requirements

Accuracy of measurement of the writers: < 1% (of the nominal value, Class 0.5s)
Accuracy of the desired frequency value: < 10 mHz
The different measurements must have an unambiguous time stamp and be synchronous.

1.4 Recommendations

The tests are performed under the responsibility of Supplier by qualified technicians.
The measurement results are the basis of the prequalification. The Technical unit must remain connected to the grid during the tests.

1.5 Description of tests to be performed

The tests to be performed test the power to be prequalified; the droop is set such that the expected power changes are realised. The tests described below must be performed. In the description of the tests, 'power' means that power that is to be prequalified. It is noted that with batteries a charging state can be agreed instead of a power setting. Apart from frequency and power, batteries should also include the charging state as a measurement. During the tests a) to f) the adjusted power achieved during the test must be delivered for at least 15 minutes:

a) For a power setting established in consultation with TenneT[6] between minimum net power and maximum net power, the full power decrease must be realised within 30 seconds at a simulated frequency deviation of +200 mHz.
b) For the power setting stated under a), the full power increase must be realised within 30 seconds at a simulated frequency deviation of -200 mHz.
c) For the power setting stated under a), half of the power decrease must be realised within 15 seconds at

[6] For batteries a certain charging state can be agreed on

a simulated frequency deviation of +100 mHz.

d) For the power setting stated under a), half of the power increase must be realised within 15 seconds at a simulated frequency deviation of -100 mHz.
e) For the power setting stated under a), an evenly progressing power decrease of the full power must be realised in 2 minutes at a simulated evenly increasing frequency deviation of 0 mHz to +200 mHz. The power decrease must have an even course and be fully realised within 2.5 minutes (max. 30 seconds lag on simulated frequency change).
f) For the power setting stated under a), an evenly progressing power increase to the full power must be realised in 2 minutes at a simulated evenly decreasing frequency deviation of 0 mHz to -200 mHz. The power increase must have a linear course and be fully realised within 2.5 minutes (max. 30 seconds lag on simulated frequency change).
g) Once the above tests have been satisfactorily completed, the technical unit should track the frequency for 8 hours and submit the corresponding measurement strips. These last test results are needed to be able to pass judgment on the quality that the unit supplies to the frequency support.

1.6 Reporting and evaluation

In order to fulfil the prequalification requirement, Supplier must provide the results of the tests. This concerns at least:

- Measurement protocol including the relevant measurement results
- Test structure, precise specification of the measurement points
- Test time, list of tests performed
- Description of the way the tests have been done
- Persons involved in the test (including the contact person for the test)

The results are checked by TenneT, or by an independent third party appointed by TenneT.

ANNEX 2

Explanation Droop

The droop is related to the volume that is to be prequalified. The droop is defined as follows:

$$\frac{\Delta P}{P_{nom}} = \frac{100}{x} \frac{|\Delta f|}{f_{nom}}$$

Where:

Δf = frequency change in Hz
f_{nom} = nominal frequency (= 50 Hz)
ΔP = difference in power in MW
P_{nom} = nominal power in MW
x = droop in %

The full primary reserve must be activated if the (quasi-stationary) frequency deviation is 200 mHz. This forms the basis, together with Pnom and the offered bid size, for calculating the droop for the Technical unit concerned. The table below gives an example:

	Value
Δf = frequency change in Hz	-0.2
f_{nom} = nominal frequency in Hz	50
Bid (ΔP = difference in power in MW) bv	20
Unit (P_{nom} = nominal power in MW) bv	500
x = droop in %	$x=100*\Delta f* P_{nom}/\Delta P/ f_{nom}$ x=100 *0.2*500/20/50 x=10

ANNEX 3

The Guideline System Operations (GL-SO) describe activation time for "limited resources", i.e. Energy Storage (ES) units. The articles 156 sub 9 to 13 do not describe a final value on the exact activation time for "limited resources"..

In those articles, the European TSO's are requested to develop a cost benefit analysis resulting in a proposal for a time period which shall not be greater than 30 or smaller than 15 minutes.

The process of developing a methodology by TSO's for conducting a cost benefit analyses, the analyzing itself up to the final decision by all regulatory authorities of the concerned region will last up to max. 30 months. During this period, each individual TSO will define an activation time which shall not be greater than 30 or smaller than 15 minutes.

In our current System code the general activation time is 15 minutes (art 2.1.5c) but is only applicable on production units (art 2.1.2a) there are no specific rules concerning limited resources like storage.

At this moment, there are several initiatives to install ES units (e.g. batteries) on different locations in the Netherlands. A major obstacle in the development of these initiatives is the lack of clarity on activation time.

At this moment the quality of the frequency containment process is stable on a normal level. For the Netherlands there is no need to enlarge the activation time to 30 minutes. TenneT TSO B.V. will maintain an activation time of 15 minutes (also for limited resources) for the time being. If in the future the activation time may change as a result of the mentioned analyses we will implement this new activation time with a implementation period of 6 months after the decision is made public.

In the end, it is up to the market party to decide if, at this moment, he wants to invest in 15 or 30 minutes capacity on ES units without the knowledge what in the future will be decided on activation duration.