Case no: Svk 2022/215 **Date:** 202310-21

Reporting of measurements for units and groups participating with variable production and consumption

SVENSKA KRAFTNÄT

Svenska kraftnät

Svenska kraftnät is a state owned enterprise with the task of maintaining Sweden's electricity transmission grid, which consists of about 16,000 kilometres of 400 kV and 220 kV transmission lines with substations and interconnectors. Svenska kraftnät is also the system operator for electricity in Sweden.

Svenska kraftnät is developing the transmission grid and the electricity market to meet society's need for a secure, sustainable and cost-effective supply of electricity. In this, Svenska kraftnät plays an important role in implementing national climate policies.

Version 1.0
Org. No 202 100-4284

Svenska kraftnät
Box 1200
172 24 Sundbyberg
Sturegatan 1

Phone: +46 10-475 80 00
Fax: +46 10-475 89 50
www.svk.se

Content

Introduction

Providers with variable resources shall continuously log data during at least 2 month and submit logged data to Svenska kraftnät for evaluation in the prequalification. Data should include at least 300 hours of bids for FCR and FFR and 150 hours for mFRR and aFRR. This document describes the requirements on the format and sampling time of the submitted data. The provider may choose in which format the data is logged during operation, but when it is submitted to Svenska kraftnät, it must be in the units and format specified in this document.

Measurements to be logged

The provider shall, for each unit or group, log and save the data listed below with the specified resolution or better for the whole time period. The data most be logged for the whole time period regardless of whether the unit or the group has been procured or not. The file that contains the data must be compressed (zipped) before uploading. The data is divided into two main areas: operational data and forecasted data. Operational data is data that is measured/calculated in real time and corresponds to the actual operating hour as it is measured/calculated, while forecasted data is forecasted values before the operating hours. Forecasted data for an operating hour must be calculated in advance, latest at the time of procurement.

The provider might choose whether these two categories of data should be logged in the same file or divided into two separate files. Below is a list of the data to be logged for each category.

Operational data

> Date and time (preferably UTC, otherwise clearly marked)

> Measured active power [MW]

> Reference value (baseline) active power [MW], excluding regulation.
For each unit and/or group, the provider must provide a baseline. The baseline shall correspond to the power that would have been delivered if no ancillary service had been activated. The baseline can be equal to the plan for production/consumption if the instantaneous deviations from the plan during normal operation are insignificant.

> Max power [MW]
Maximum power refers to the unit's or group's maximum power, above which regulation should not or cannot take place. This could possibly be used to calculate the current headroom.

> Min power [MW]
Minimum power refers to the unit's or group's minimum power, below which regulation should not or cannot take place. This could possibly be used to calculate the current headroom.

> Regarding LER: Available energy for upward regulation [MWh]
Current available amount of energy in the unit or group that can be used for upward regulation.

> Regarding LER: Available energy for downward regulation [MWh]
Current available amount of energy in the unit or group that can be used for downward regulation.

Forecasted data

> Date and time (preferably UTC, otherwise clearly marked).
Time indicates the moment for which the forecast tries to predict. If forecasted data is in the same file as operational data, only one column is used for date and time that refers to both operational data and forecasted data.

> Forecasted bid capacity [MW]
Forecasted bid capacity refers to the minimum capacity that the provider has calculated and guaranteed to be available for delivery during the entire actual operating hour. This constitutes the ceiling for how much the actor estimates might be sold, based on the forecast and uncertainty margin. This corresponds to procured capacity if all the bid capacity is procured. Forecasted bid capacity must be calculated in advance, latest at the time of bidding. If the resource are not participating in the market yet the forcasted bid capacity corresponds to what would have been bided is it was participating. The provider must describe their bidding strategy so that Svenska kraftnät could understand why they bided certain hours and others not.

> Procured capacity [MW]
Procured capacity refers to the capacity the actor has been cleared during the actual operating hour. It can be all or parts of the forecasted bid capacity.

> Forecasted power [MW]
Forecasted power refers to relevant data linked to the actor's expected power (produced or consumed) during the operating hour. Forecasted power can consist of several values and should, in addition to the expected power, also include uncertainty intervals, such as percentiles. Forecasted power must be calculated in advance, latest at the time of bidding.

In addition to the general signals specified above, ancillary service specific signals must be logged in accordance with following sections.

Other information

In the event of deviating or unexpected behavior of the resource, Svenska kraftnät may need to ask control questions about the response. In addition to

the mandatory values stated above, it may therefore be appropriate to log other measured values, in order to facilitate the assessment and enable a less restrictive interpretation of the exhibited behavior. This type of information can for example include:

> Wind speed [m/s]

> Pitch angle [°]

> Solar irradiance [W/m²]

> State-of-charge [%]

> Guide vane opening [%]

> Hydraulic head [m]

> Description of the operating condition

Ancillary service specific information

This section specifies information that applies specifically to each respective ancillary service. This includes data to be logged (in addition to the general data specified above) and sampling time.

FFR

Data

Additional measurements to be logged for FFR, supplementary to the general ones:

> Measured grid frequency [Hz] (resolution ≤ 10 mHz)

> Available capacity FFR [MW] (resolution ≤ 0.01 MW)
This refers to the actual delivery of FFR that will take place in the event of an activation.

> Status regulator on/off [1/0]
This value indicates whether the FFR regulator is on or off. The value is 0 or 1, where 1 indicates the regulator is switched on.

> Activated FFR-capacity on/off [1/0]
This value indicates whether FFR is activated or not. The value is 0 or 1, where 1 indicates ongoing FFR activation.

Sampling time

Registration intervals of logged data for FFR are described under point 1 below. If this is not possible for the actor to fulfill, the actor can log data according to point 2, after agreement with Svenska kraftnät.

1. Keep the sampling time constant at maximum 100 ms throughout the measurement series.

2. Use a sampling time of 1 s during normal operation and 100 ms in the event of a disturbance. The time interval to be logged and saved in the event of a disturbance is from 10 seconds before the activation of FFR up until 15 minutes from the time of activation. Since this results in two different sampling times, the measurement data must be separated into two files before they are sent to Svenska kraftnät. One file must contain logged data for normal operation (sampling time 1 s), while the other file contains logged data during disturbance (sampling time 100 ms).

FCR

Data

Additional measurements to be logged for FCR, supplementary to the general ones:

> Measured grid frequency [Hz] (resolution ≤ 10 mHz)

> Available capacity FCR-N [MW] (resolution ≤ 0.01 MW)
This refers to the actual delivery of FCR-N that will take place in the event of a full activation. Should FCR-N capacity for upward and downward regulation differ, the reported value shall consist of the capacity in the limited direction. Available capacity FCR-N is always stated as a positive value.

> Available capacity FCR-D upward [MW] (resolution ≤ 0.01 MW)
This refers to the actual delivery of FCR-D upward regulation that will take place in the event of a full activation.

> Available capacity FCR-D downward [MW] (resolution ≤ 0.01 MW)
This refers to the actual delivery of FCR-D downward regulation that will take place in the event of a full activation. Available capacity for FCR-D downward regulation is stated as a positive value.

> Status regulator FCR-N on/off [1/0]
This value indicates whether the FCR-N regulator is on or off. The value is 0 or 1, where 1 indicates the regulator is switched on.

> Status regulator FCR-D upward on/off [1/0]
This value indicates whether the FCR-D upward regulator is on or off. The value is 0 or 1, where 1 indicates the regulator is switched on.

> Status regulator FCR-D downward on/off [1/0]
This value indicates whether the FCR-D downward regulator is on or off. The value is 0 or 1, where 1 indicates the regulator is switched on.

Sampling time

Registration interval of logged data for FCR is described under point 1 below. If this is not possible for the actor to fulfill, the actor can log data according to point 2, after agreement with Svenska kraftnät.

1. Keep the sampling time constant at maximum of 1 s throughout the measurement series.
2. Logging with 1 s sampling time applies when a change in the measured value has taken place in excess of a threshold value[1], otherwise logging must take place at least once per minute when the change in the measured value does not exceed the threshold value.

aFRR

Data

Additional measurements to be logged for aFRR, supplementary to the general ones:

> aFRR-Setpoint per unit or group [MW] (resolution ≤ 1 MW)

> Activated aFRR per unit or group [MW] (resolution ≤ 0.1 MW)

> Available capacity aFRR upward regulation [MW] (resolution ≤ 0.1 MW)
This refers to the actual delivery of the aFRR upward regulation that will take place in the event of a full activation.

[1] According to agreement with Svenska kraftnät.

> Available capacity aFRR downward regulation [MW] (resolution ≤ 0.1 MW)
This refers to the actual delivery of the aFRR downward regulation that will take place in the event of a full activation. Available capacity for aFRR downward regulation is stated with a positive value.

> Status aFRR control on/off [1/0]
This value indicates whether the unit or group is available for delivery of aFRR (responsive to aFRR control signal). The value is 0 or 1, where 1 indicates that the unit or group is responsive to the aFRR control signal.

Sampling time

Registration interval of logged data for aFRR is described under point 1 below. If this is not possible for the actor to fulfill, the actor can log data according to point 2, after agreement with Svenska kraftnät.

1. Keep the sampling time constant at maximum of 5 s throughout the measurement series.

2. Logging with 5 s sampling time applies when a change in the measured value has taken place in excess of a threshold value, otherwise logging must take place at least once per minute when the change in the measured value does not exceed the threshold value. The threshold value for the change is 0.1 MW, alternatively X %[2] of the unit's/group's maximum capacity. The measurements must be logged in a common data file where it is clearly shown with which time intervals logging has been done.

It is recommended to log with 1 second sampling time if possible, especially during response test at prequalification.

mFRR

Data

> mFRR-Setpoint per unit or group [MW] (resolution ≤ 1 MW)

> Activated mFRR per unit or group [MW] (resolution≤ 0.1 MW)

> Available capacity mFRR upward regulation [MW] (resolution ≤ 0.1 MW)
This refers to the actual delivery of mFRR upward regulation that will take place in the event of a full activation.

[2] According to agreement with Svenska kraftnät.

> Available capacity mFRR downward regulation [MW] (resolution≤ 0.1 MW)
This refers to the actual delivery of mFRR downward regulation that will take place in the event of a full activation. Available capacity for mFRR downward regulation is stated as a positive value.

> Status mFRR control on/off [1/0]
This value indicates whether the unit or group is available for delivery of mFRR. The value is 0 or 1, where 1 indicates available mFRR capacity.

Sampling time

Registration interval of logged data for mFRR is described under point 1 below. If this is not possible for the actor to fulfill, the actor can log data according to point 2, after agreement with Svenska kraftnät.

1. Keep the sampling time constant at maximum of 10 s throughout the measurement series.

2. Logging with 10 s sampling time applies when a change in the measured value has taken place in excess of a threshold value, otherwise logging must take place at least once per minute when the change in the measured value does not exceed the threshold value. The threshold value for the change is 0.1 MW, alternatively X %[3] of the unit's/group's maximum capacity. The measurements must be logged in a common data file where it is clearly shown with which time intervals logging has been done.

Format

In order for Svenska kraftnät to be able to review submitted data as smoothly and objectively as possible, the process for this is partially automated. Formatting and file names should therefore follow the specifications below.

Data must be delivered in csv-format (character encoding UTF-8), values separated by commas (,) and decimals specified with decimal point (.).

Rows are separated by line breaks (↵ ASCII/CRLF=0x0D 0x0A).

File names must be specified on the format [Resource]_[Service]_[Area]_[Interval]_[Sampling_rate]_[Date].csv, where the sub-elements are specified as follows:

[3] According to agreement with Svenska kraftnät.

> Resource = Identifier for the resource in accordance with an agreement with Svenska kraftnät.

> Service = Ancillary service that the log file includes. One of FFR, FCR-D Upward, FCR-D Downward, FCR-N, aFRR or mFRR.

> Area = Bid area for the unit/group. The bidding area can be either SE1, SE2, SE3 or SE4.

> Interval = Time intervals that the log file includes, are specified on the format YYYYMMDDThhmm-YYYYMMDDThhmm.

> Sampling rate = Nominal time difference between samples specified in milliseconds.

> Date = The date when the log file was compiled to be sent to Svenska kraftnät, on the format YYYYMMDD.

Example of file name:

```
UnitG1_FFR_SE3_20200515T0000-20200601T2359_100ms_20200602.csv
```

Data points in the csv-file are formatted as follows:

```
DateTime,Cap,InsAcPow, …
[DateTime1],[record1_1],[record1_2], … ,[record1_X]
[DateTime2],[record2_1],[record2_2], … ,[record2_X]
etc.
```

Data columns to be included in general

Columns to be included are specified below, including title row and data type. Columns that are not applicable must be left blank.

> DateTime = Date and time on the format YYYYMMDDThhmmss.nnn, where n is decimals of a second
Example: 20200601T093702.012

> InsAcPow = Instantaneous measured active power in [MW], specified as a double with at least two decimals (for aFRR and mFRR with at least one decimal)
Example: 120.53

> RefAcPow = Reference value (baseline) active power in [MW], specified as a double with at least three decimal
Example: 120.5820

> ForecAcPow = Forecasted power in [MW], specified as a double with at least one decimal
Example: 120.5

> Pmax = Maximum active power in [MW], specified as a double with at least three decimals
Example: 100.520

> Pmin = Minimum active power in [MW], specified as a double with at least three decimals
Example: 100.520

> LERUp = Available energy for upward regulation in [MWh], specified as a double with at least two decimals
Example: 10.57

> LERDown = Available energy for downward regulation in [MWh], specified as a double with at least two decimals
Example: 10.57

Data columns to be included for respective ancillary service and for FFR

Below is a list of data columns that are to be included specifically for each respective ancillary service and for FFR (in addition to the general ones above).

FFR

> GridFreq = Measured grid frequency in [Hz], specified as a double with at least two decimals
Example: 49.32

> ContStatusFfr = Control signal if the FFR regulator is set to allow delivery, Boolean indicator [1/0] with activated (= 1) or not activated (= 0)
Example: 1

> FfrCap = Available capacity FFR in [MW], specified as a double with at least two decimals
Example: 20.10

> ForecCapFfr = Forecasted bid capacity FFR for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ProcuCapFfr = Procured capacity FFR for the hour in [MW], specified as a double with at least one decimal
Exempel:120.5

> ContOutSig = Control signal for activation (i.e. trigger conditions met and delivery profile in progress), Boolean indicator [1/0] with activated (= 1) or not activated (= 0)
Example: 1

FCR

> GridFreq = Measured grid frequency in [Hz], specified as a double with at least two decimals
Example: 49.32

> ContStatusFcrn= Control signal for if the FCR-N regulator is set to allow delivery, Boolean indicator [1/0] with activated (= 1) or not activated (= 0)
Example: 1

> ContStatusFcrdUp = Control signal for if the FCR-D upward regulator is set to allow delivery, Boolean indicator [1/0] with activated (= 1) or not activated (= 0)
Example: 1

> ContStatusFcrdDown = Control signal for if the FCR-D down regulator is set to allow delivery, Boolean indicator [1/0] with activated (= 1) or not activated (= 0)
Example: 1

> Cap_Fcrn = Available capacity FCR-N in [MW], specified as a double with at least two decimals
Example: 20.10

> Cap_FcrdUp= Available capacity FCR-D upward regulation in [MW], specified as a double with at least two decimals
Example: 20.10

> Cap_FcrdDown = Available capacity FCR-D downward regulation in [MW], specified as a double with at least two decimals
Example: 20.10

> ForecCapFcrn = Forecasted bid capacity FCR-N for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ProcuCapFcrn = Procured capacity FCR-N for the hour in [MW], specified as a double with at least one decimal
Exempel: 120.5

> ForecCapFcrdUp = Forecasted bid capacity FCR-D upward regulation for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ProcuCapFcrdUp = Procured capacity FCR-D upward regulation for the hour in [MW], specified as a double with at least one decimal
Exempel:120.5

> ForecCapFcrdDown = Forecasted bid capacity FCR-D downward regulation for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ProcuCapFcrdDown = Procured capacity FCR-D downward regulation for the hour in [MW], specified as a double with at least one decimal
Exempel: 120.5

aFRR

> AfrrSetP = aFRR-setpoint in [MW], specified as a double
Exempel: 20

> AfrrAct = Activated aFRR in [MW], specified as a double with at least one decimal
Example: 20.1

> Cap_AfrrUp = Available capacity for aFRR upward regulation in [MW], specified as a double with at least one decimal
Example: 20.1

> Cap_AfrrDown = Available capacity for aFRR downward regulation in [MW], specified as a double with at least one decimal
Example: 20.1

> ForecCapAfrrUp = Forecasted bid capacity aFRR upward regulation for the hour in [MW], specified as a double
Example: 120

> ProcuCapAfrrUp = Procured capacity aFRR upward regulation for the hour in [MW], specified as a double
Example: 120

> ForecCapAfrrDown = Forecasted bid capacity aFRR downward regulation for the hour in [MW], specified as a double
Example: 120

> ProcuCapAfrrDown = Procured capacity aFRR downward regulation for the hour in [MW], specified as a double
Example: 120

> ContStatusAfrr = Control signal for whether the unit or group is available for control of aFRR, Boolean indicator [1/0] with available (= 1) or not available (= 0)
Example: 1

mFRR

> MfrrSetP = mFRR-setpoint per unit in [MW], specified as a double

> MfrrAct = Activated mFRR in [MW], specified as a double with at least one decimal
Example: 20.1

> Cap_MfrrUp = Available capacity for mFRR upward regulation in [MW], specified as a double with at least one decimal
Example: 20.1

> Cap_MfrrDown = Available capacity for mFRR downward regulation in [MW], specified as a double with at least one decimal
Example: 20.1

> ForecCapMfrrUp = Forecasted bid capacity mFRR upward regulation for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ProcuCapMfrrUp = Procured capacity mFRR upward regulation for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ForecCapMfrrDown = Forecasted bid capacity mFRR downward regulation for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ProcuCapMfrrDown = Procured capacity mFRR downward regulation for the hour in [MW], specified as a double with at least one decimal
Example: 120.5

> ContStatusMfrr = Control signal for whether the unit or group is available for control of mFRR, Boolean indicator [1/0] with available (= 1) or not available (= 0)
> Example: 1

Other data that is relevant to the specific resource and thus must be logged, may be freely named by the actor. Svenska kraftnät shall be informed of what each abbreviation stands for and in which unit they are specified.

An example of how a csv-file should be structured (without forecast data or resource-specific data) is shown in Figure 1. If the forecast data is logged in a separate file, it should be structured according to the same principle as in Figure 1 below, but with different column names and data.

```
DateTime, InsAcPow, RefAcPow, Pmax, Pmin, GridFreq,
ContStatusFcrdDown, FcrdDownCap

20200601T093702.000, 120.53, 120.2, 180.00, 20.00, 50.00, 1, 30.33
20200601T093703.000, 120.53, 120.2, 180.00, 20.00, 50.10, 1, 30.33
20200601T093704.000, 112.67, 120.3, 180.00, 20.00, 50.20, 1, 30.53
20200601T093705.000, 105.28, 120.5, 180.00, 20.00, 50.30, 1, 30.44
```

Figure 1: Example of how the logged operational data is to be reported, in this case for a unit that delivers FCR-D downward. This example does not include forecast data or resource-specific data.

Svenska kraftnät is a state owned enterprise with the task of maintaining Sweden's electricity transmission grid, which consists of about 16,000 kilometres of 400 kV and 220 kV transmission lines with substations and interconnectors. Svenska kraftnät is also the system operator for electricity in Sweden. Svenska kraftnät is developing the transmission grid and the electricity market to meet society's need for a secure, sustainable and cost-effective supply of electricity. In this, Svenska kraftnät plays an important role in implementing national climate policies.

Svenska kraftnät
Box 1200
172 24 Sundbyberg
Sturegatan 1

Phone: 010-475 80 00
Fax: 010-475 89 50
www.svk.se

SVENSKA KRAFTNÄT