Public

Swissgrid Ltd
Bleichemattstrasse 31
P.O. Box
5001 Aarau
Switzerland

T +41 58 580 21 11
info@swissgrid.ch
www.swissgrid.ch

TSO report on balancing

Energy balancing guideline article 60

Version 1.0 of 25th October 2020

List of figures

List of tables

1 Introduction

The annual TSO report on balancing in Switzerland was prepared according to Article 60 of Commission Regulation (EU) 2017/2195 establishing a guideline on electricity balancing, referred to in short as energy balancing guideline (“EB GL”).

The annual report aggregates data of the balancing market in Switzerland for 2019 and provides detailed information on the mechanisms applied to maintain a well-functioning and economical balancing market in Switzerland. In the beginning of the report the specific regulatory framework of Switzerland governing the procurement and activation of balancing capacity is described. The report includes information concerning the volumes of available, procured and used products (local, specific as well as standard products). It discusses the dimensioning of reserve capacity including the explanation for the calculated reserve capacity requirements. Additionally, it shows the exchange and sharing agreements Swissgrid developed with neighbouring TSOs and analyses their economic impact. Furthermore, the report presents the imbalance settlement mechanism and the imbalance settlement prices, deriving conclusions for future developments especially with regard to European balancing platforms. As soon as the European balancing platforms like TERRE are in operation, further analysis will be done to assess the costs, benefits, inefficiencies of specific and standard products and to evaluate the efficiency of the activation optimization functions for the balancing energy from frequency restoration reserves and replacement reserves.

According to Article 59 of the balancing guideline, ENTSO-E publishes a European report on integration of balancing markets. This report shall also contain, pursuant to paragraph 2(a) of Article 59, an executive summary in English of each TSO’s report on balancing pursuant to Article 60. This executive summary can be found at the end of this report.

2 Regulatory framework

The regulatory framework of Switzerland consists of different hierarchical levels. On the federal law level, electricity supply is mainly regulated by the Law on Electricity Supply (Stromversorgungsgesetz, «StromVG»). Its purpose is to define the conditions for a secure energy supply as well as for a competitive electricity market.

The StromVG currently in force is accessible in the online compilation of Swiss federal law: https://www.admin.ch/opc/de/classified-compilation/20042411/index.html

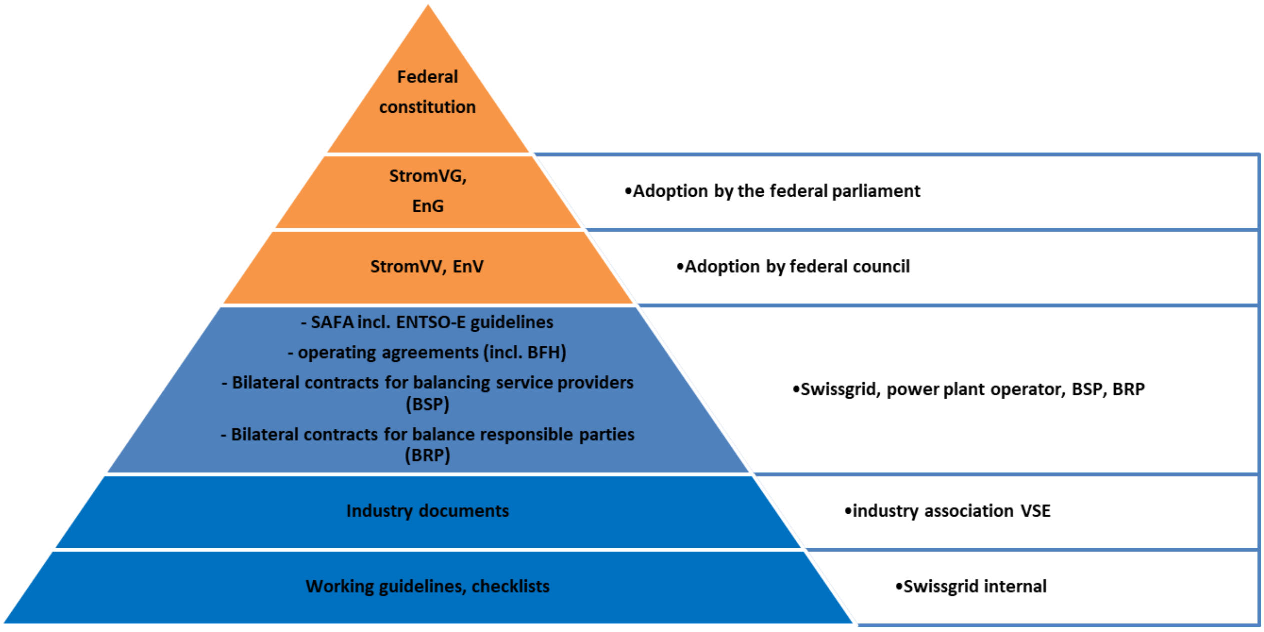

Figure 1: Regulatory hierarchy regarding electricity supply and electricity market in Switzerland (most important regulations)

The implementing provision to the StromVG is regulated in the Regulation on Energy Supply (Stromversorgungsverordnung, «StromVV»). The StromVV specifies the technical and economic rules for the participants in the Swiss energy markets. Thus, the StromVG and the StromVV form the basis for the market contracts which Swissgrid, as transmission system operator (TSO), concludes with other parties.

The StromVV currently in force is also accessible in the online compilation of Swiss federal law: https://www.admin.ch/opc/de/classified-compilation/20071266/index.html

Security of supply and the application of StromVG and StromVV are ensured through the interaction of several links in a chain, in which different players are involved. Producers of electricity, electricity traders, transmission system and distributions system operators as well as customers are all involved in this process. Each player must exercise due care in the performance of its assigned role in accordance with market and system rules. The assignment of roles, tasks and responsibilities to the players must be governed by clear and binding legal relationships so that the players can engage in a market-oriented activity that ultimately ensure the security of supply.

For this purpose, Swissgrid concludes bilateral contracts with balancing service providers ("BSP") in which the standardized conditions for ancillary services are set out to assure frequency control of the balancing area of Swissgrid. Furthermore, each balance responsible party ("BRP") taking part in the Swiss electricity market needs to sign a standardized bilateral balance group agreement with Swissgrid. The contracts related to balancing are described in further detail in the next section.

The Swiss regulatory authority in the electricity sector is called ElCom (Federal Electricity Commission). ElCom monitors compliance with the StromVG as well as StromVV, takes the decisions and issues the decrees necessary for the enforcement of the StromVG and StromVV. Its supervisory role with respect to balancing markets comprises the monitoring of costs, market activities and tariffs.

2.1 Contracts related to balancing

The federal law is implemented on a contractual basis between Swissgrid and the BSP. The contracts regulate the mechanisms for each type of balancing energy (FCR, aFRR and mFRR) to ensure the availability of balancing capacity and energy. After an examination of the technical and operational requirements of a supplier (prequalification), standard contracts can be concluded for the respective product (ancillary services). After conclusion of the contract, BSPs can submit bids in response to Swissgrid's invitations to tender. The respective contracts and conditions are listed below and published on Swissgrid's website under the following link.
https://www.swissgrid.ch/en/home/customers/topics/legal-system.html#ancillary-services

Frequency containment reserves (FCR):

- Framework Agreement for the supply of primary control power
- Conditions of tender – primary control power
- Technical regulations and procedural rules governing the prequalification of ASP[1] for the supply of primary control power

Automatic frequency restoration reserves (aFRR):

- Framework agreement for the supply of secondary control power
- Conditions of tender – Secondary Control Power
- Technical regulations and procedural rules for prequalification of an ASP for the supply of secondary control power

Manual frequency restoration reserves (mFRR) and replacement reserves (RR):

- Framework agreement for the delivery of tertiary control power
- Conditions of tender – Tertiary Control Power
- Technical regulations and procedural rules for prequalification of an ASP for the supply of tertiary control power

The contract with the BRP and its appendices are also published on Swissgrid's website:
https://www.swissgrid.ch/en/home/customers/topics/legal-system.html#balance-groups.
They contain the necessary provisions for the establishment of European platforms for the exchange of balancing energy from replacement reserves and for the imbalance netting process.

The following documents are available on the above-mentioned website:

- Balance group contract
- Appendix 1: General balance responsible party regulations
- Appendix 2: Technical Balance group regulations

[1] ASP stands for Ancillary Service Provider and can be also understood as Balancing Service Provider (BSP)

- Appendix 3: Registration form
- Appendix 4: Balancing Pooling

Regarding rules for suspension and restoration of market activities pursuant to Article 36 of Regulation (EU) 2017/2196 and rules for settlement in case of market suspension pursuant to Article 39 of Regulation (EU) 2017/2196 approved in accordance with Article 4 of Regulation (EU) 2017/2196, Swissgrid announced a derogation. Swissgrid has started the design of these rules and expects the implementation to be completed by the end of 2023.

3 Load frequency control

The load frequency control (LFC) process is presented in Figure 2 and comprises three sub-processes:

1. The Frequency Containment Reserve (FCR) process,
2. the Frequency Restoration Reserve (FRR) process and
3. the Replacement Reserve (RR) process.

The FCR, also known as primary frequency control reserve, restores the balance between power generation and consumption within seconds of the disturbance occurring. During this operation, the frequency is stabilised within the permissible limit values. Activation takes place directly at local level, for example directly in the power stations, by means of turbine regulators. In this phase, the system frequency is monitored and, in the event of deviations, the FCR needed is activated. All transmission system operators in the synchronous area Continental Europe must fulfil the requirements in their country in accordance with the rules of the Synchronous Area Framework Agreement for Regional Group Continental Europe (“SAFA”).

The FRR process comprises the activation of automatic frequency restoration reserves (aFRR - also known as secondary frequency control reserve) and the manual frequency restoration reserves (mFRR - also known as fast tertiary frequency control reserve). It is used to maintain the desired energy exchange of a control area with the rest of the synchronous area, using simultaneous, integral support to maintain the frequency at 50 Hz. In the event of an imbalance between production and consumption, aFRR in the connected power providing units is automatically activated by the central grid controller operated by the TSO. In order to meet the requirements of the central load frequency controller at all times, these power providing units must usually be in operation, but must not be generating the maximum or minimum possible nominal capacity.

Switzerland consists of one scheduling area equal to scheduling block and LFC area. The exchange program is, besides the daily setpoint frequency, the main setpoint input for the load frequency controller of Swissgrid. mFRR are used to support the aFRR to maintain the nominal value or to maintain the desired energy exchange particularly after production outages or unexpected long-lasting load changes.

The RR process (also known as slow tertiary frequency control reserve) is used to replace the FRR. The RR is primarily necessary for adjusting major, longer-lasting control deviations, particularly after production outages or unexpected long-lasting load changes.

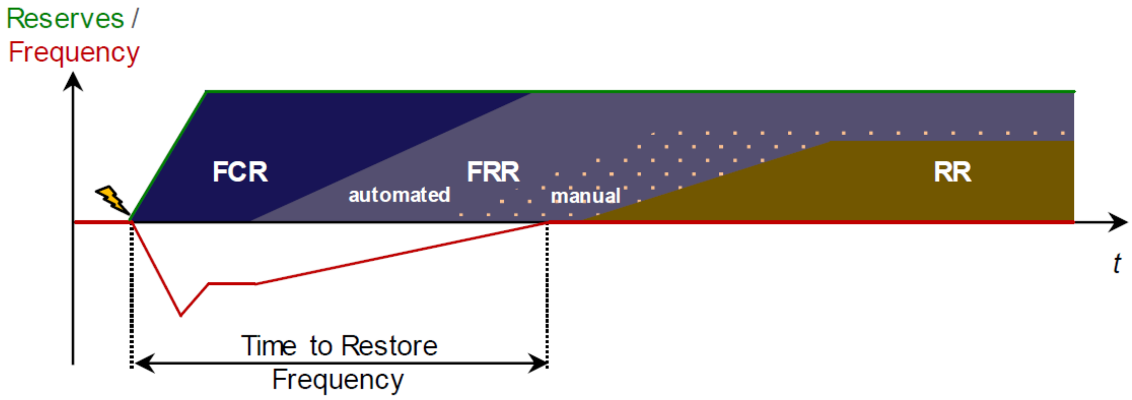

Figure 2: Load frequency control process[2]

4 Procurement and activation of balancing capacity and balancing energy

4.1 Prequalification

As a first step, any entity that applies for participation in the ancillary services market is required to create a standard balance group and subsequently be prequalified as a BSP (or also known as an Ancillary Services Provider - ASP). The process of prequalification of a BSP checks the administrative and organizational requirements that the entity must satisfy as well as the operational availability and the capability to fulfil the specified obligations. Examples of the above requirements are the establishment of a monitoring system and connection to online communications channels, the registration in online platforms, the implementation of scheduling, etc. A successful prequalification as an BSP is followed by the prequalification of a generating unit for a specific product. A generating unit can be conventional or virtual. A conventional generating unit refers to bigger power plants connected to the transmission grid found in one location and comprising different generators or groups of generators. A virtual generating unit refers to groups of smaller power plants of usually different technology types that can also be in different geographical locations. Each sub-unit or generator is prequalified separately through a series of technical tests in order to determine their capability in providing balancing energy. In the case of conventional units, groups of identical generators can be prequalified together but non-identical generators are prequalified separately. In virtual generating units each sub-unit is prequalified separately. Each prequalification is valid for a maximum of 5 years.

Testing of each sub-unit or generators' group differs depending on the balancing service product (primary control, secondary control or tertiary control) and the product's specifications. In addition to the necessary tests, units of new technology types, such as cogeneration plants, waste incineration plants, power-to-heat units, are required to submit a concept describing the operational principles of the unit and how it can provide the necessary balancing energy. In case of limited energy sources, such as batteries, additional tests have to be performed in order to prove that the unit can provide the prequalified power for the specified time range of each product.

A BSP can create a virtual unit with not only power plants that belong to the same balancing group but also with power plants that are part of other balancing groups. This is called pooling. In case of virtual generating units consisting of pooled sub-units more information is necessary in order to make sure that the balancing energy is provided and billed correctly. During the prequalification process, the BSP is required to

[2] 2020 ENTSO-E Balancing report, 30 June 2020,1000 Brussels

provide proof that the unit operator/owner, the respective distribution grid operator and the energy supplier are informed of the use of the sub-unit for balancing energy. During operation, the BSP is obliged to send additional schedules that declare how much energy was activated in each of the pooling sub-units.

Online monitoring is implemented to monitor the balancing reserves for each product in the entire portfolio of each BSP, but also in each generating unit. This data is used subsequently to check the reserve availability for each BSP. In case of violations of the contractual agreement regarding the availability, penalties are imposed.

Detailed technical requirements are described in the published legal and technical documentation referred to in chapter 2.1.

4.2 Dimensioning of balancing capacity

4.2.1 Process of dimensioning

Dimensioning of balancing capacity for FRR is done in two steps:

- Yearly process: Based on the observed imbalance data in LFC area Switzerland of the previous year (January to December) the probability of experiencing a deficit is calculated. The deficit probability assesses how likely it is that the reserve capacity is not sufficient to cover the imbalance as a function of the procured amount of mFRR and aFRR capacity.
- Weekly/daily process: The auctions for the procurement of FRR reserves are performed weekly and daily. In each auction the quantities are determined such that the procurement costs are minimized while the deficit probability is below the defined threshold and additional deterministic criteria are fulfilled. The additional deterministic criteria account for reference incidents and obligations from mutual emergency agreements with other TSOs. Thus, the weekly and daily processes perform a joint dimensioning and procurement and allow the procurement of variable amounts of mFRR and aFRR considering the respective prices. To that end the most economically efficient combination of weekly and daily mFRR and weekly aFRR is selected that satisfies the probabilistic and deterministic criteria for every given market time unit.

The dimensioning of FCR is performed in accordance with Article 153 Commission Regulation (EU) 2017/1485 establishing a guideline on electricity transmission system operation by the dedicated Group within ENTSO-E for the Synchronous Area Continental Europe.

4.2.2 Evaluation of benefits from reserve sharing and exchange

Swissgrid exchanges FCR reserves within the FCR Cooperation with the following countries in 2019: Austria, Belgium, Germany, France and the Netherlands.

The priority in 2019 and 2020 is the establishment of common activation processes for FRR through the developments of the European Platforms for the exchange of balancing energy from aFRR (PICASSO) and mFRR (MARI). A common activation of balancing energy enables the easier exchange of balancing capacity since there is an existing process to activate the reserved balancing capacity in another country on behalf of another TSO through the common activation and exchange of balancing energy. Swissgrid is also open to establish further cooperations with other TSOs with the aim to exchange FRR, while giving priority to the establishment of the European platforms over such bilateral contracts.

4.3 Markets for balancing capacity and energy

4.3.1 Balancing capacity

In 2019 there were no standard and specific balancing capacity products on the Swiss balancing capacity market, since the proposal for standard balancing capacity products was in development in 2019 in accordance with EBGL. Thus, all FRR balancing capacity products in the Swiss energy market are currently national local products.

These three products are:

- Automatic frequency restoration reserves (aFRR) as positive and negative secondary control power
- Manual frequency restoration reserves (mFRR) as positive and negative fast tertiary control power
- Replacement Reserves (RR) as negative slow tertiary control power

The aFRR is activated automatically by the load frequency controller (LFC). Awarded offers in the balancing capacity must make available in real time the amount of balancing energy upon activation corresponding to the awarded capacity. The LFC is a system to maintain the frequency reasonably steady by bringing it back to the nominal value of 50 Hz and to keep the exchange of each control block as close to the scheduled values as possible. The aFRR at the LFC of Swissgrid is activated on a pro rata basis. That means that each balancing service provider receives its percentage share of the total demand of the control block corresponding to his specific share of the total awarded and available aFRR.

Tertiary control power in the negative direction, meaning a reduction of power injection in the grid, exists with two different lead times. Mainly in order to be feasible for nuclear power plants a negative RR product with a lead time (Full Activation Time) of 20 minutes to the activation period has been implemented. In addition, mFRR products in positive as well as negative direction have a lead time of 15 minutes. Balancing service providers that are awarded for offers of balancing capacity for mFRR or RR must subsequently provide bids for balancing energy products corresponding to the awarded balancing capacity in a different bidding process. In 2019, there was no ramping for the activation of mFRR or RR in Switzerland. The balancing service provider must activate the requested balancing energy as fast as possible on the specific time requested by Swissgrid. Due to the planned ramping of 10 minutes for the European balancing products like TERRE, Swissgrid will change the activation time of all products introducing ramps in the mFRR and RR balancing energy products in 2020.

Finally, FCR as primary control power, are procured in the FCR cooperation with the following countries in 2019: Austria, Belgium, Germany, France, and the Netherlands.

4.3.1.1. Standard product for balancing capacity

As explained in section 4.3.1, not yet applicable in 2019.

4.3.1.2. Specific products for balancing capacity

As explained in section 4.3.1, not yet applicable in 2019.

4.3.2 Balancing energy

In 2019 there were no standard and specific balancing energy products on the Swiss balancing energy market, since none of the TERRE, MARI and PICASSO projects that implement the European balancing energy platforms for the exchange of standard products for balancing energy were operational. The implementation of the balancing energy platforms is ongoing and Swissgrid aims to join the TERRE platform in Q3 2020 as the first balancing platform for replacement reserves. TERRE stands for Trans European Replacement Reserves Exchange and serves the EU target for the integration of the European balancing market.

The TERRE platform enables the exchange of balancing energy based on an optimized activation of replacement reserves (RR).

As the implementation is not completed yet, the next TSO balancing report will analyse the suitability of standard products with respect to the latest development, the evolution of different balancing resources and propose possible improvements of standard products.

4.3.2.1. Standard product for balancing energy
As explained in section 4.3.2, not yet applicable in 2019.

4.3.2.2. Specific products for balancing energy
As explained in section 4.3.2, not yet applicable in 2019.

4.4 Tender results on balancing markets

4.4.1 Procured balancing services and bid excess

Swissgrid procures balancing capacity in an auction mechanism. Additionally, BSPs that have not been awarded a bid for mFRR can offer, on a voluntary basis, further balancing energy which is compensated at the offered price (pay-as-bid). These mechanisms provide incentives to BSPs to offer and deliver balancing services to the connecting TSO and support competition among market participants.

On average, Swissgrid procured 1,083 MW of upward balancing energy bid volume[3] in 2019, of which 0.34 MW were not available due to unavailability of the BSP. In the downward direction 856 MW of balancing energy bid volume were available on average in the control block of Swissgrid and 0.49 MW had not been available due to unavailability of the BSP. Details are provided in Table 6.

Table 1: Available balancing energy bid volume; Annual average in MW

	total volume of available bids (average)	Unavailable bids (average)	Unavailable bids (max)
FCR	61	0	0
aFRR upward	394	0	0
aFRR downward	383	0	0
mFRR upward	628	0.34	30
mFRR downward	412	0.49	66
Total upward	**1,083**	**0.34**	**33**
Total downward	**856**	**0.49**	**66**

The weekly average over the course of 2019 is similar to the yearly average (see Figure 11). Therefore, there were no weeks with significantly reduced availability of balancing reserves in 2019.

[3] Balancing energy bid volume stands for all energy bids including awarded bids of the capacity auction and bids on a voluntary basis. The value is in MW due to the averaging of the energy values on a yearly basis.

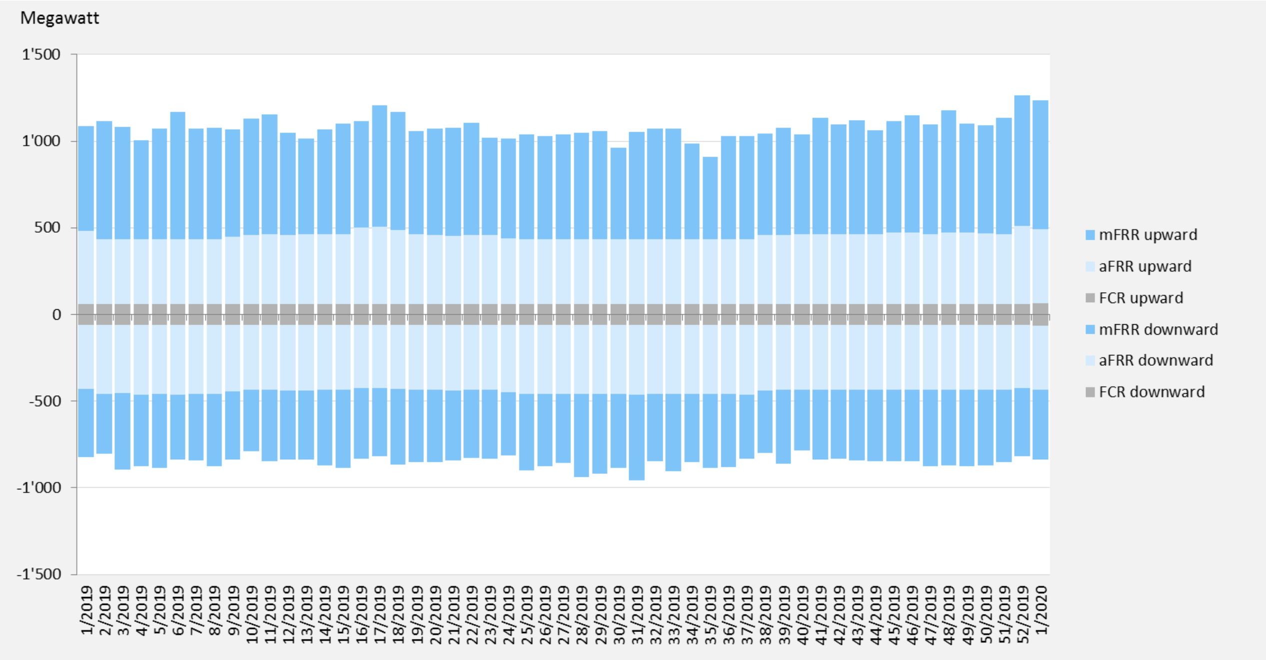

Figure 3: Availability of balancing energy bid volume, including the additional voluntary bids compensated as pay-as-bid

4.5 Activation of balancing energy

4.5.1 Activated balancing energy

Another indicator of a well-functioning balancing mechanism is its utilization. In exceptional cases, e.g. loss of a power plant, the total available balancing energy may be used to reduce the impact of the incident. But also during the general operation of the grid balancing energy is used to compensate imbalances of the balancing groups.

Figure 4 shows the average activated balancing energy bid volume compared to the available balancing energy bid volume in 2019 broken down according to:

- per direction (upward and downward)
- per type of product
  - standard
  - specific, if applicable
- per reserve type (aFRR, mFRR and RR if used by a TSO)

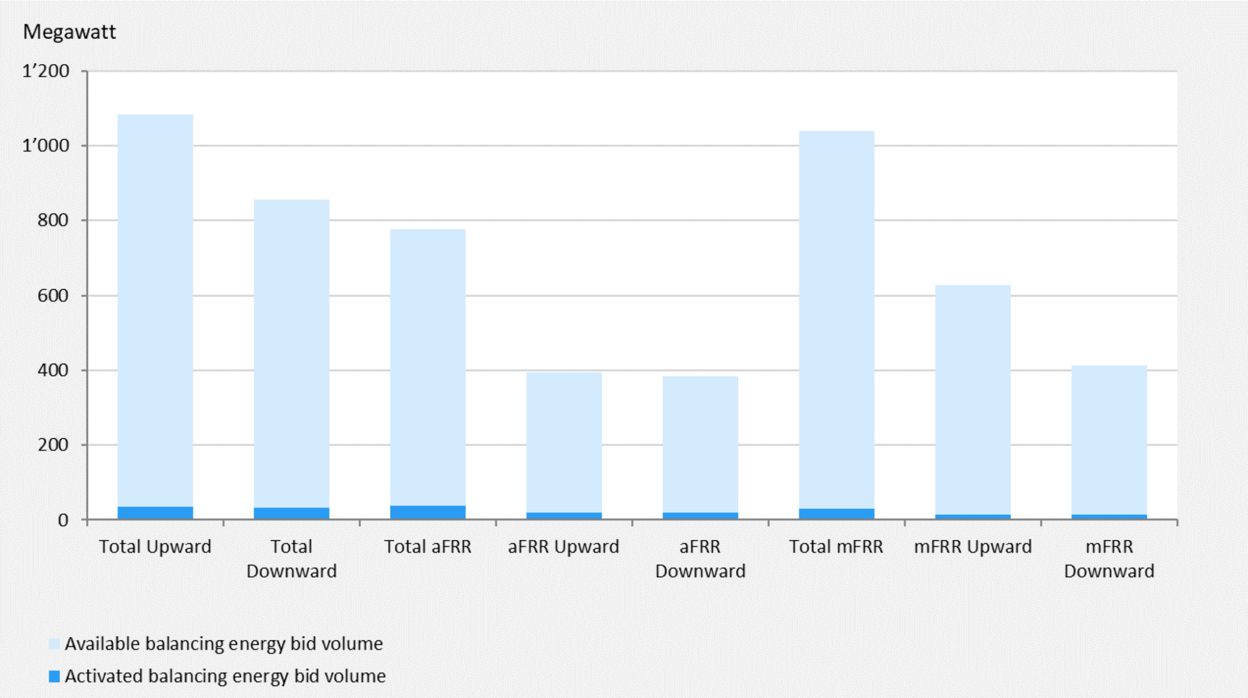

Figure 4: Average available balancing energy bid volume versus average activated balancing energy bid volume

Based on these average values of activated and available balancing energy per year the KPI 3.8 defined by ENTSO-E based on Art. 59(4) EB GL can be calculated (see Table 2). With 52.4% of the total activated balancing energy, slightly more balancing energy was used in the upward direction. Comparing the use of aFRR versus mFRR, there is a higher utilisation of aFRR with 57.1%, whereas mFRR was utilised in 42.9% of the total activated balancing energy. Here, we note that in the Swiss product design applied in 2019, downward mFRR indicated in the figure 4 includes also downward RR balancing capacity. The BSPs always have the possibility to submit bids for downward mFRR balancing energy instead of downward RR balancing energy that correspond to the total awarded downward RR balancing capacity.

In 2019 Swissgrid had a total demand of balancing energy about 596'054 MWh.

Table 2: Activated balancing energy compared to the total TSO demand

Type of balancing energy	Activated balancing energy [MWh]	Activated balancing energy [MWh] divided by total TSO demand [KPI 3.8]
Upward	312,062[4]	52.4%
Downward	283,992[5]	47.6%
aFRR	340,473	57.1%
mFRR	255'581	42.9%

In the following the utilization of the available balancing energy is discussed. The utilization factor describes the average use of each kind of balancing energy types compared to the average available balancing energy.

[4] Sum of aFRR upward and mFRR upward

[5] Sum of aFRR downward, mFRR downward and RR

$$\text{utilization factor} = \frac{\text{activated balacing energy bid volume}}{\text{available balacing energy bid volume}}$$

In Table 3 the utilization factors are calculated separately for each direction for the total activation. This shows that Swissgrid activates in average 3-4 % of the available balancing energy. Separated by type of product the average activated energy bid volume is divided by the available balancing energy bid volume range. aFRR has a flexibility range of 777 MW and mFRR of 1,040 MW.

Table 3: Activated balancing energy bid volume compared to the available balancing energy bid volume

Type of balancing energy	Activated balancing energy bid volume on average [MW]	Available balancing energy bid volume on average [MW]	Utilization factor [%]
Total Upward	35.6	1,083	3.3 %
Total Downward	32.4	856	3.8 %
aFRR	38.9	777	5.0 %
mFRR	29.2	1,040	2.8 %

4.5.2 Ex-post plausibility check for procured capacities

In order to provide the summary analysis of the optimal provision of reserve capacity including the justification of the volume of balancing capacity (EB GL Art. 60.2.c) the balancing quality in the control block of Swissgrid is discussed.

Besides the average utilisation of balancing energy and capacity the time, periods of maximal activation are important for the provision of reserve capacity. In this respect, aFRR is the most important type of balancing reserves. The degree of utilisation of the aFRR may be considered as an indicator of the quality of the balancing process.

Swissgrid has defined as a target that the total available amount of aFRR is to be fully used only 0.1 % of the time. Regarding the accumulated data of 2019, Figure 5 shows that the effective aFRR use is constantly below the Swissgrid target values throughout 2019. Maximal 0.0288 % of the time the LFR controller of the Swiss balancing block had to activate the total available aFRR of approximately 380 MW (depending on the tender results). The upper part of figure 5 provides the 12-month moving average of the percentage of the time when aFRR is fully utilised. The lower part of figure 5 counts the seconds per months during which aFRR is fully used.

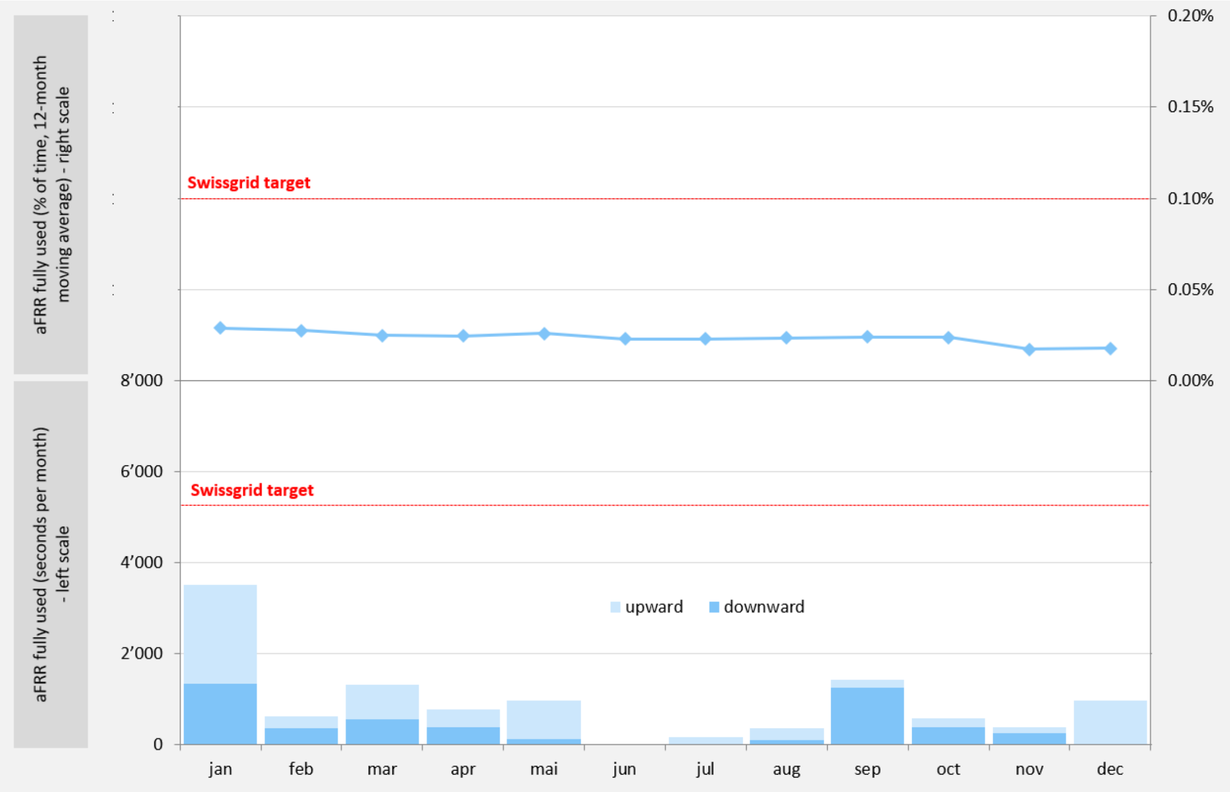

Figure 5: aFRR fully utilized and Swissgrid target (seconds per month and in % of time as 12 months moving average)

Apart from the amount of time with full aFRR utilization, the Area Control Error (ACE) is a key indicator of the balancing quality of a control block. The sum of the monthly ACE in upward and downward direction is shown in Figure 6. The ACE in upward direction is between 900 MWh and 1,600 MWh. It is evident that the ACE is nearly symmetric. Therefore, no clear deflection in the upward or downward direction can be noted, which indicates a well-functioning load frequency control process. Also, the average grid frequency is not significantly influenced because the ACE is nearly symmetric. Regarding the average deviation in MW, the Swiss control block has an ACE of 1.3 to 2.2 MW, which is associated with a high quality of balancing.

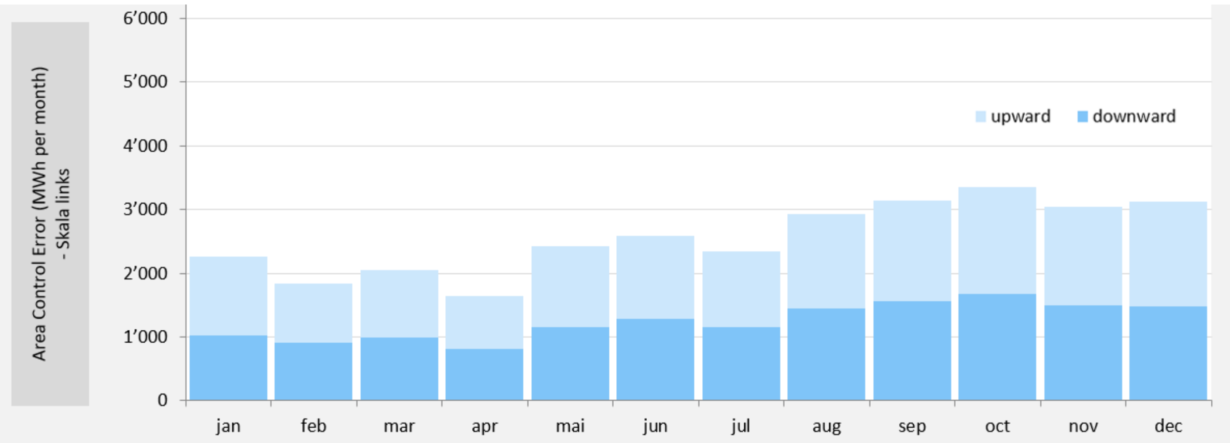

Figure 6: Area Control Error in MWh per month[6]

[6] The data in the resolution of 1 second is averaged in 15 minutes; afterwards the sum of each 15 minutes is calculated

4.6 Costs of balancing energy and capacity

4.6.1 Statistic values

In 2019 Swissgrid incurred annual total net costs for balancing energy activations of 22 Mio. Euro. For the products aFRR and mFRR in positive direction Swissgrid spent about 28 Mio EUR. On the other hand, negative balancing energy of aFRR and mFRR generated incomes of 5.4 Mio EUR. By contrast, imbalance net revenue amounts to 43 Mio. Euro. Figure 7 shows the total annual cost or income and the average prices for each balancing product, as well as the total annual cost or income and the average price of imbalance energy for the balance responsible parties in EUR/MWh.

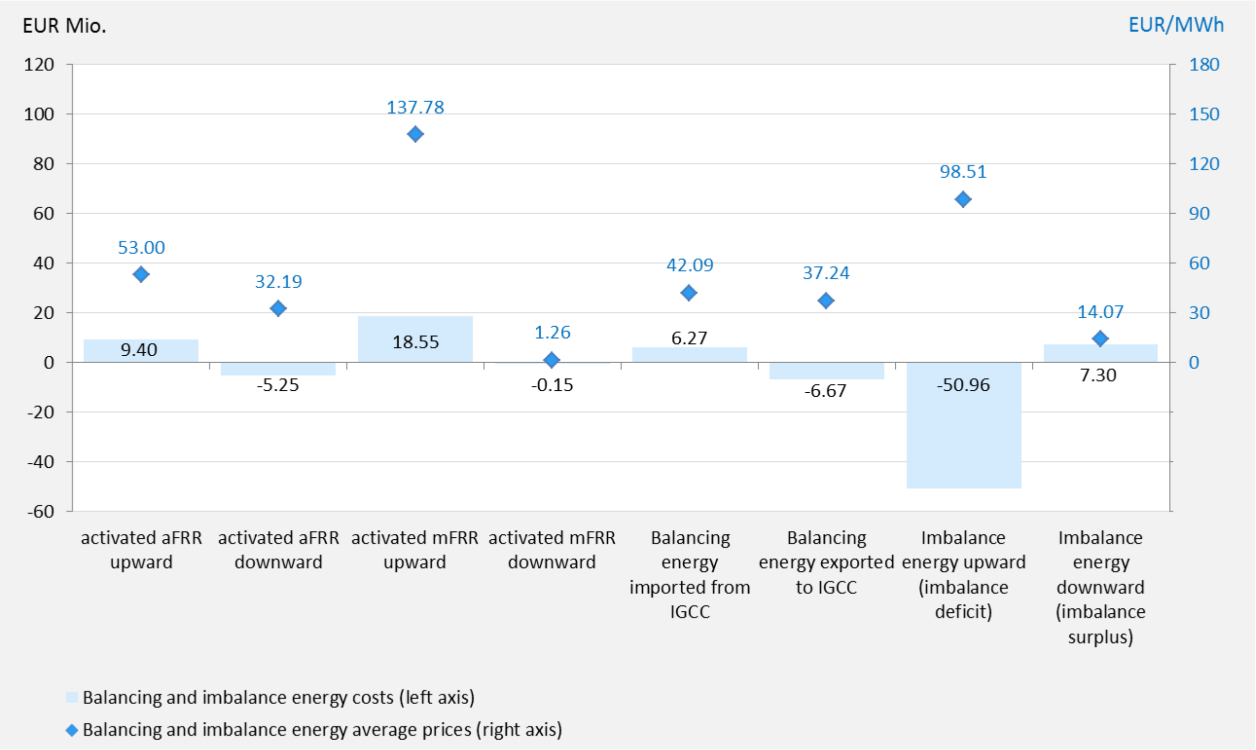

Figure 7: Balancing product costs and imbalance energy prices

Separate statistics for specific und standard products will be provided in future reports once the standard products have been implemented.

In future reports the price of balancing energy:

- for activated energy from standard products, the clearing price reported by the common platform
- for activated energy from specific products, the volume-weighted average price reported by TSOs

will be discussed.

The balancing capacity procurement costs (equivalent to KPI 3.4 defined by ENTSO-E based on Art. 59 (4) EB GL) are shown in Table 4.

Table 4: Balancing capacity procurement costs

Type of balancing capacity	Balancing capacity procurement costs [EUR Mio.]	Share [%]
FCR	4.4	8.0 %
aFRR upward	16.8	30.8 %
aFRR downward	29.4	53.9 %
mFRR upward	2.5	4.6 %
mFRR downward	1.5	2.8 %
Total 2019	**54.5**	

4.6.2 Efficiency of the activation optimisation functions

In future reports, after the implementation of European balancing platforms, the efficiency of the activation optimisation functions for the balancing energy from frequency restoration reserves and, if applicable, for the balancing energy from replacement reserves (EB GL Art. 60.2.g) will be analysed.

Similarly, the costs and benefits, and the possible inefficiencies and distortions of having specific products in terms of competition and market fragmentation, participation of demand response and renewable energy sources, integration of balancing markets and side-effects on other electricity markets (EB GL Art. 60.2.d) will be analysed in future reports.

4.7 TSO-TSO settlement

4.7.1 Imbalance netting process IGCC

The guideline on electricity balancing (EB GL Art. 22) defines the imbalance netting process which is implemented by the International Grid Control Cooperation (IGCC) and which is to become the future European Platform for the IN-process. Swissgrid is a member of the IGCC since March 2012.

According to ENTSO-E[7], «Imbalance netting is the process agreed between TSOs of two or more LFC areas that allows avoiding the simultaneous activation of frequency restoration reserves (FRR) in opposite directions by taking into account the respective frequency restoration control errors as well as the activated FRR, and by correcting the input of the involved frequency restoration processes accordingly. IGCC performs imbalance netting of automatic frequency restoration reserves (aFRR)». Further details can be found on the official ENTSO-E website on IN (link). Thus, the TSOs participating in the IGCC can reduce the amount of activated aFRR by avoiding the simultaneous activation of aFRR in opposite direction within different LFC areas.

Figure 8 displays the weekly imported and exported energy from and to the IGCC in 2019. In 2019 Swissgrid imported 148.8 GWh of balancing energy from IGCC and exported 179.0 GWh of balancing energy to IGCC. That shows that the import and export from and to the IGCC is evenly spread. Also, no significant seasonal patterns are identified.

Based on the average prices in 2019 of aFRR positive (53.00 EUR/MWh) and negative (32.19 EUR/MWh) (shown in Figure 7 above), an estimated financial benefit for Swissgrid due to the IGCC of approximately 2.5 Mio EUR results.

[7] https://www.entsoe.eu/network_codes/eb/imbalance-netting/ on the 12th of May 2020

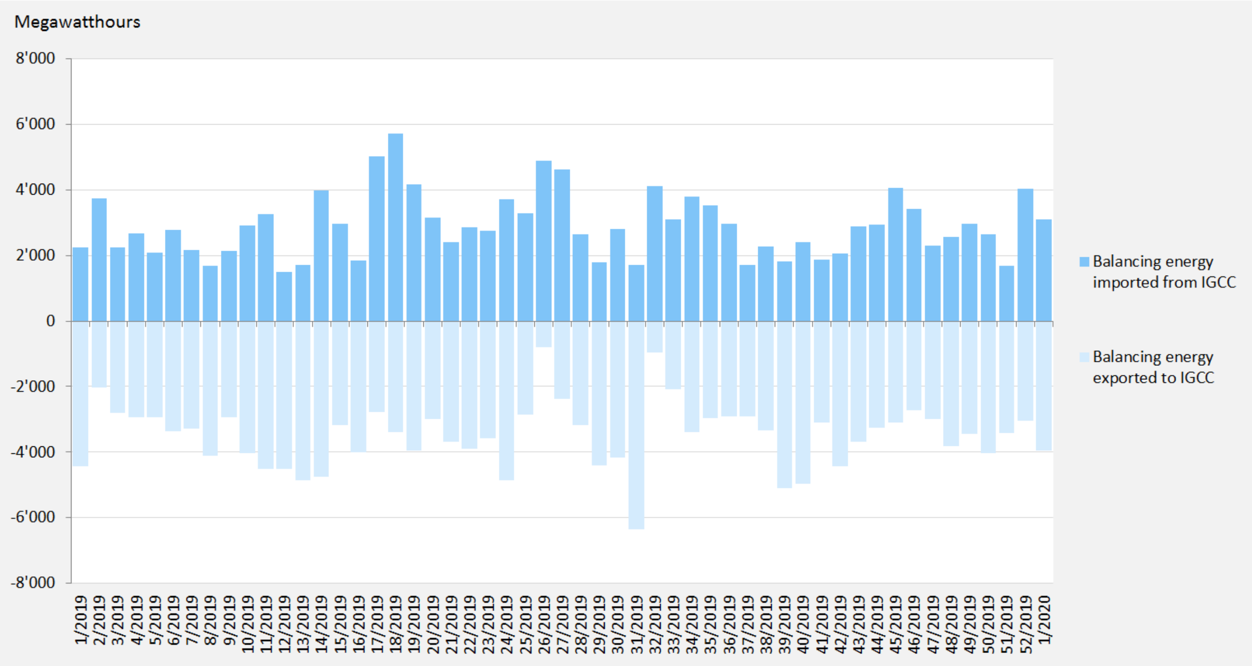

Figure 8: Weekly imported and exported energy from and to the IGCC

4.7.2 FCR cooperation

Swissgrid takes part in the FCR cooperation. This is a centralized mechanism implemented to procure nearly half of Continental Europe's synchronous area's frequency containment reserve (FCR) capacities. The FCR Cooperation consists of 50Hertz, Amprion, APG, Elia, Energinet (not operational member), RTE, Swissgrid, TransnetBW, TenneT Netherlands and Tennet Germany. In July 2019 a new FCR market design has been launched. Besides shortening the product length from one week to one day, the FCR Cooperation introduced a marginal pricing scheme. Therefore, a complex allocation algorithm with constraint dependent optimization was developed to handle different price areas. The aim is to reduce procurement costs and foster entry of new Balancing Service Providers and new balancing service technologies.

This is the first regional cooperation which realizes market harmonization under the methodology of the EB GL. The roadmap for developing and evolving this market was discussed with inclusion of stakeholders and NRAs of the regional cooperation. Next steps, in July 2020, are the change to 4-hour products and bringing gate closure time closer to delivery time.

The FCR cooperation has decided that analyses of monetary gains and savings due to exchange of balancing services within the FCR cooperation (Article 59(4)(b) KPI 3.2) will be discussed in future reports.

4.7.3 Mutual Emergency Assistance Service

For additional reserve power, Swissgrid has two contracts of Mutual Emergency Assistance Service (MEAS), one with RTE and one with Terna. The contract between Swissgrid and RTE assures a maximum of four hundred Megawatt (400 MW) for the Emergency Assistance Service. On the other hand, the MEAS-contract between Swissgrid and Terna assures a maximum of three hundred Megawatt (300 MW). Nevertheless, it may be possible in exceptional conditions to request higher demands up to five hundred Megawatt (500 MW) with RTE or 400 MW with Terna. When the Mutual Emergency Assistance Service becomes totally or partially unavailable, each party has to inform the other party promptly about the unavailability and the expected duration of this unavailability.

5 Imbalance settlement

5.1 Calculation and settlement of imbalance energy

All energy trades in Switzerland as well as electrical injections and withdrawals to and from the transmission system must be assigned to a balance group. Consequently, each feed-in and feed-out point (e.g. power plant, connection point to the distribution grid, end consumer) is precisely assigned to one balance group. The balance group serves as a kind of energy account. The transmission system operators have the task of keeping their control area balanced at all times. For this reason, the total of all trading transactions of the balance groups, their energy injections and withdrawals must also be balanced every quarter of an hour. The sum of the energy fed in by production units and the energy import from trading transactions in a defined unit of time is therefore equal to the sum of withdrawn energy and the schedules for energy export from trading transactions.

The balance groups provide the schedules that reflect their planned and already implemented international and national trading transactions, for the first time one day before real-time operation (D-1), to Swissgrid. Swissgrid matches the commercial transactions and verifies them with neighboring TSOs. The balance groups can update their schedules as often as they want during the intraday period, for trades within Switzerland, until 15 minutes before real time.

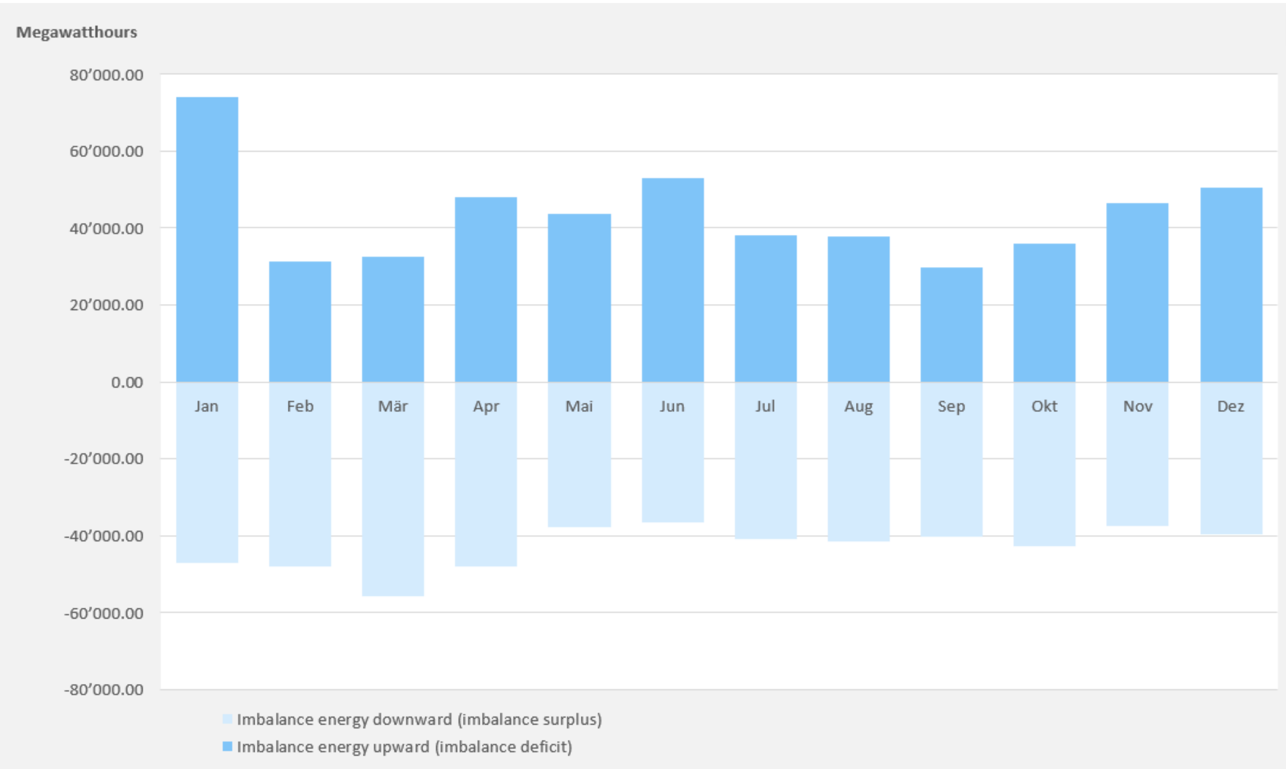

Figure 9: Total monthly imbalance energy of the balancing block Switzerland

If the energy injection and withdrawal across all balance groups in Switzerland is not balanced in real-time, Swissgrid must use balancing energy in real time to assure the system balance. If the majority of the balance groups have too much energy in their balance (i.e. are «long»), Swissgrid uses negative control energy, so that power plants reduce the injections. If the majority of the balance groups have insufficient energy (i.e. are "short"), Swissgrid uses positive balancing energy such that power plants increase production. The deviation of the balance groups between their target schedule for energy exchange and their actual (measured) energy exchange determines the so-called imbalance balancing energy.

The average imbalance of all balance groups in Switzerland of each months are shown in Figure 9. For the balance energy corresponding to their deviation, the balance groups have to pay the imbalance energy price.

5.2 Calculation of imbalance price

The imbalance energy price mechanism in the control block of Swissgrid is a two-price system in which the 15-minute prices for imbalance energy are calculated in function of the direction of the 15-minute deviation of a balance responsible party. The calculation can be inferred from the following Table 5.

Table 5: Calculation of imbalance energy prices

Balancing responsible party	short (deficit)	BRP pays $(A + P_1) * \alpha_1$	$A = \max (P_{spot}; P_{sek+}; P_{ter+})$
	long (surplus)	BRP receives $(B – P_2) * \alpha_2$	$B = \min (P_{spot}; P_{sek-}; P_{ter-})$

With alpha factors as following:	α_1	1.1
	α_2	0.9
With base price as following:	P_1	1 ct/kWh
	P_2	0.5 ct/kWh

Notes on the calculation:

1. Within the calculation of the prices A and B, the prices of P_{sek} and P_{ter} will only be used if a use of secondary control or tertiary control occurred in the relevant direction.
2. P_{spot} is the Swissix day-ahead spot price for the given 15-minute period.
3. P_{sek} is the price for aFRR(in Swiss terminology secondary control energy) in the given 15-minute period.
4. $P_{ter-/+}$ is defined as the weighted average price of the mFRR (in Swiss terminology tertiary control energy) which is procured for the given 15-minute period.
5. If the price $(A+P_1)$ results in a negative price, the alpha factor α_1 will be replaced by the alpha factor α_2. If the price $(B-P_2)$ results in a negative price, the alpha factor α_2 will be replaced by the alpha factor α_1.

The settlement process aims to provide incentives to balance responsible parties to be in balance. It avoids distorting incentives for balance responsible parties and balancing service providers. The price at which imbalances are settled reflects the market prices as it is calculated based on the minimum/maximum of the actual market prices of the spot market, aFRR and mFRR (in Swiss terminology secondary or tertiary balancing) prices. Furthermore, the imbalance prices establish adequate economic signals which reflect the imbalance situation of Swissgrid's control block.

swissgrid

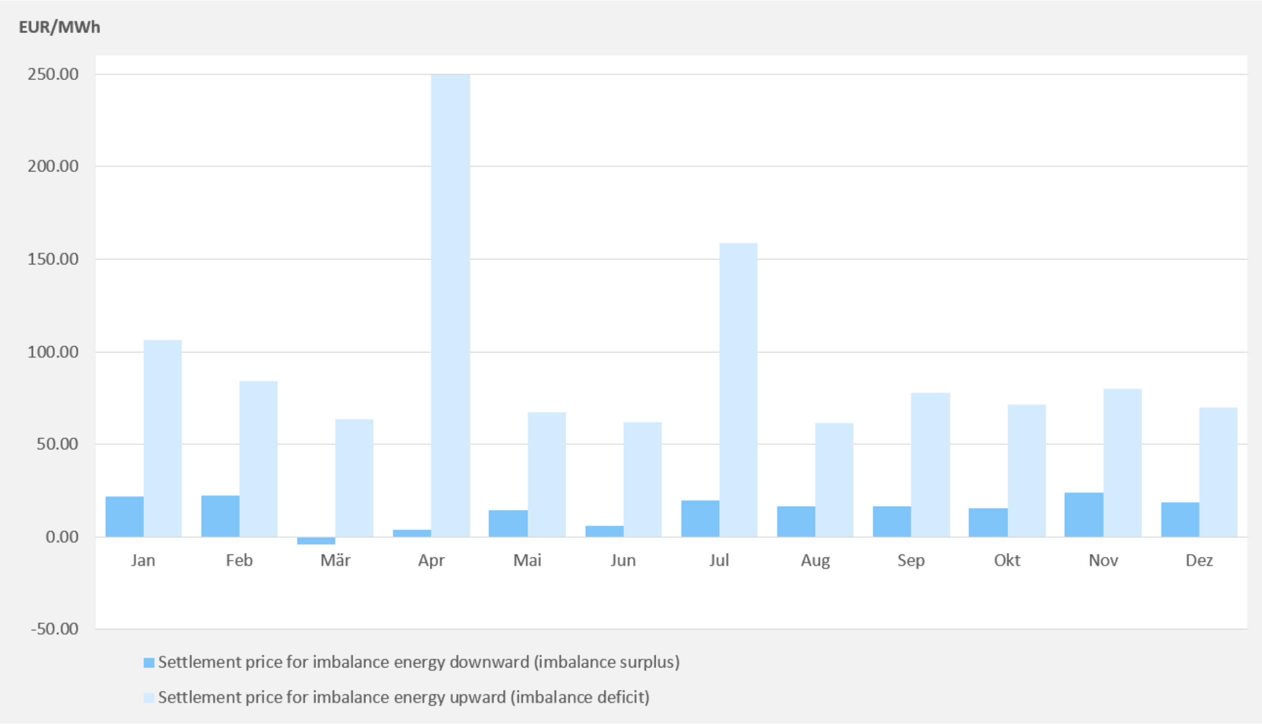

Figure 10: Monthly imbalance energy settlement prices

The current imbalance energy prices are published for each 15 minute period on Swissgrid's website in the subsection on balance energy (see here) for each month by the 15th working day of the following month.

6 Future developments of balancing markets in the harmonisation and integration process

Swissgrid will continue to participate as an active partner in the development of the following projects to improve the provisioning of balancing energy and balancing capacity in the synchronous area Continental Europe:

FCR Cooperation: A voluntary cooperation for the common procurement of frequency containment reserves (FCR – primary control reserves). The co-operation was originally initiated in 2013 by Swissgrid and APG. Meanwhile roughly half of the FCR demand of continental Europe is procured through the cooperation. It is still a voluntary cooperation but is being in accordance with the objectives of the EBGL.

IGCC is the implementation project to become the European Platform for the imbalance netting process according to EB GL. Formerly it was founded in 2010 by German TSOs as NRV (Netzregelverbund). Swissgrid joined in 2012. IGCC avoids counteractivations of aFRR by performing a netting of opposing aFRR demands in different countries. This of course is only possible if the available cross-border capacity allows for it. The project is expanding to cover the TSOs of Synchronous Area Continental Europe

PICASSO is the implementation project to establish the European platform for the exchange of balancing energy from the automatic frequency restoration reserves (aFRR – secondary control energy) according to EB GL. It is planned that Picasso becomes operational in 2022. It will be built up on the basis of IGCC. In addition to IGCC (where only a common netting is performed), in Picasso also the activation of the remaining demand after netting will be performed commonly in the country where the most economically efficient activation is possible.

MARI is the implementation project to establish the European platform for the exchange of balancing energy from manual frequency restoration reserves (mFRR – fast tertiary control energy) according to EBGL. It is planned that the platform becomes operational in 2022.

TERRE is the implementation project to build the European Platform for the exchange of Replacement Reserves (RR – slow tertiary control energy) according to EB GL. TERRE was initially initiated by a small number of TSOs including Swissgrid in 2015 more than two years before entry into force of the EB GL. The platform went live on 1 January 2020, and the GoLive of Swissgrid will take place in Q3 2020.

7 Conclusion

For the 2019 TSO report on balancing, Swissgrid analysed the procured balancing capacities, usage of the available balancing capacity and energy, its cost and future developments in balancing within the synchronous area Continental Europe and the control block of Switzerland. On average 1,083 MW balancing energy bid volume in upward direction and 856 MW balancing energy bid volume in downward direction across FCR, aFRR, mFRR and RR were available in 2019. Of those, the average utilisation was 3.3 % in upward direction and 3.8 % in downward direction. Regarding the total usage of aFRR Swissgrid did use the total available aFRR in less than 0.029 % of the time. The usage of the balancing products is nearly symmetric and does not show a significant skew in one direction. All the discussed values in the control block of Swissgrid indicate a high quality of load frequency control. Swissgrid strives to optimise the balancing processes in the future by participating in the development of further collaborations in the European balancing mechanisms.

In 2019 Swissgrid incurred annual total net costs for balancing energy activations of 22 Mio. Euro. By contrast, the imbalance net revenue amounts to 43 Mio. Euro. The participation in imbalance netting mechanism IGCC and the MEAS contracts have proven the utility of these collaborations in the last year.

8 Executive summary

8.1 Contracts related to balancing

The contracts with balancing service providers (BSP) and their appendices are listed below and published on Swissgrid's website under the following link. The contracts regulate the mechanisms for each type of balancing energy (FCR, aFRR and mFRR) to ensure the availability of balancing capacity and energy.

https://www.swissgrid.ch/en/home/customers/topics/legal-system.html#ancillary-services

Frequency containment reserves (FCR):

- Framework Agreement for the Supply of Primary Control Power
- Conditions of tender – primary control power
- Technical regulations and procedural rules governing the prequalification of ASP[8] for the supply of primary control power

Automatic frequency restoration reserves (aFRR):

- Framework agreement for the supply of secondary control power
- Conditions of tender – Secondary Control Power
- Technical regulations and procedural rules for prequalification of an ASP for the supply of secondary control power

Manual frequency restoration reserves (mFRR):

- Framework agreement for the delivery of tertiary control power (valid in 2019)
- Conditions of tender – Tertiary Control Power
- Technical regulations and procedural rules for prequalification of an ASP for the supply of tertiary control power

The contracts with balance responsible parties (BRP) and their appendices are also published on Swissgrid's website under the category legal system with the following link. They contain the necessary provisions for the establishment of European platforms for the exchange of balancing energy from replacement reserves and for the imbalance netting process.

https://www.swissgrid.ch/en/home/customers/topics/legal-system.html#balance-groups

The website contains the following documents.

- Balance responsible party contract
- Appendix 1: General balance responsible party regulations
- Appendix 2: Technical balance responsible party regulations
- Appendix 3: Registration form
- Appendix 4: Balancing Pooling

Regarding rules for suspension and restoration of market activities pursuant to Article 36 of Regulation (EU) 2017/2196 and rules for settlement in case of market suspension pursuant to Article 39 of Regulation (EU) 2017/2196 approved in accordance with Article 4 of Regulation (EU) 2017/2196, Swissgrid announced a derogation. Swissgrid has started the design of these rules and expects the implementation to be completed by the end of 2021.

[8] ASP stands for Ancillary Service Provider and can be also understood as Balancing Service Provider (BSP)

8.2 Balancing products and key performance of balancing market in Switzerland

8.2.1 Available balancing services

Swissgrid procures balancing services to assure the equilibrium of its control block and to maintain the frequency in the synchronous area CE. Swissgrid determines the required reserve capacity on aFRR and mFRR based on historical records and dimensioning incidents and procures balancing capacity in an auction mechanism. Additionally, BSP can provide further energy which is compensated at the offered price (pay-as-bid). These mechanisms provide incentives to balancing service providers to offer and deliver balancing services to the connecting TSO and supports competition among market participants.

On average, Swissgrid procured 1083 MW of upward balancing energy bid volume in 2019, of which 0.34 MW were not available due to unavailability of the BSP. In the downward direction 856 MW of balancing capacity were available on average in the control block of Swissgrid and 0.49 MW had not been available due to unavailability of the BSP. Details are provided in Table 6.

Table 6: Available balancing energy bid volume; Annual average in MW

	total volume of available bids (average)	Unavailable bids (average)	Unavailable bids (max)
FCR	61	0	0
aFRR upward	394	0	0
aFRR downward	383	0	0
mFRR upward	628	0.34	30
mFRR downward	412	0.49	66
Total upward	**1083**	**0.34**	**33**
Total downward	**856**	**0.49**	**66**

Regarding the weekly average over the course of 2019, one can see that the weekly average is similar to the yearly average (Figure 11). Therefore, there were no weeks with significantly reduced availability of balancing reserves in 2019.

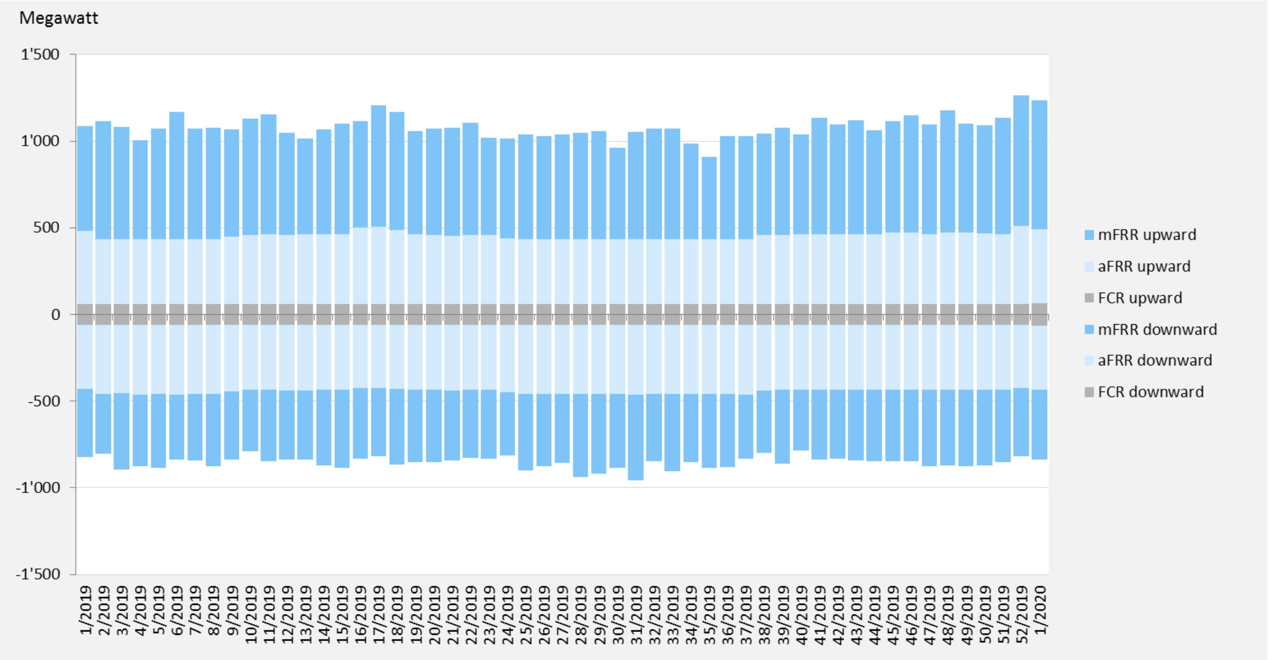

Figure 11: Availability of balancing energy bid volume, including the additional voluntary bids compensated as pay-as-bid

8.2.2 Imbalance netting and IGCC

The guideline on electricity balancing (EB GL Art. 22) defines the imbalance netting process (IN-Platform) which is implemented by the International Grid Control Cooperation (IGCC). Swissgrid is a member of the IGCC, which is to become the future European Platform for the IN-process, since March 2012.

According to ENTSO-E[9], «Imbalance netting is the process agreed between TSOs of two or more LFC areas that allows avoiding the simultaneous activation of frequency restoration reserves (FRR) in opposite directions by taking into account the respective frequency restoration control errors as well as the activated FRR, and by correcting the input of the involved frequency restoration processes accordingly. IGCC performs imbalance netting of automatic frequency restoration reserves (aFRR).» Further details can be found on the official ENTSO-E website on IN (link).

In 2019 Swissgrid imported 148.8 GWh of balancing energy from IGCC and exported 179.0 GWh of balancing energy to IGCC. Figure 12 displays the weekly imported and exported energy from and to the IGCC for 2019.

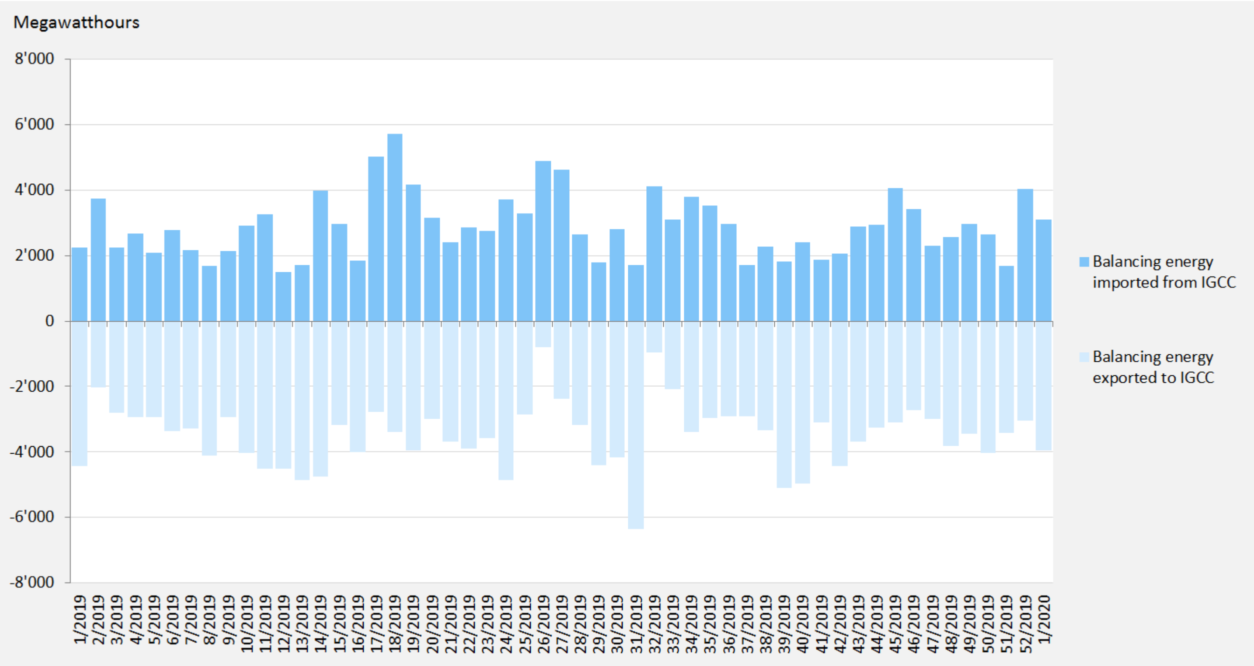

Figure 12: Weekly imported and exported energy from and to the IGCC

8.2.3 Activated balancing energy

A further indicator of well-functioning balancing mechanism is its utilization. In exceptional cases, e.g. loss of a power plant, the total available balancing energy bids may be used to reduce the impact of the incident. Figure 13 shows the activated balancing energy bid volume compared to the available balancing energy bid volume.

The highest utilization occurs for positive aFRR (secondary balancing energy in Swiss terminology) which is used with an annual average 5.2 % of the available positive aFRR capacity. Separated by direction 3.3 % of the available positive energy bid volume (of all products) had been used. In the opposite direction 3.8 % of the available downward energy bid volume (of all products) had been used.

---

[9] See https://www.entsoe.eu/network_codes/eb/imbalance-netting/

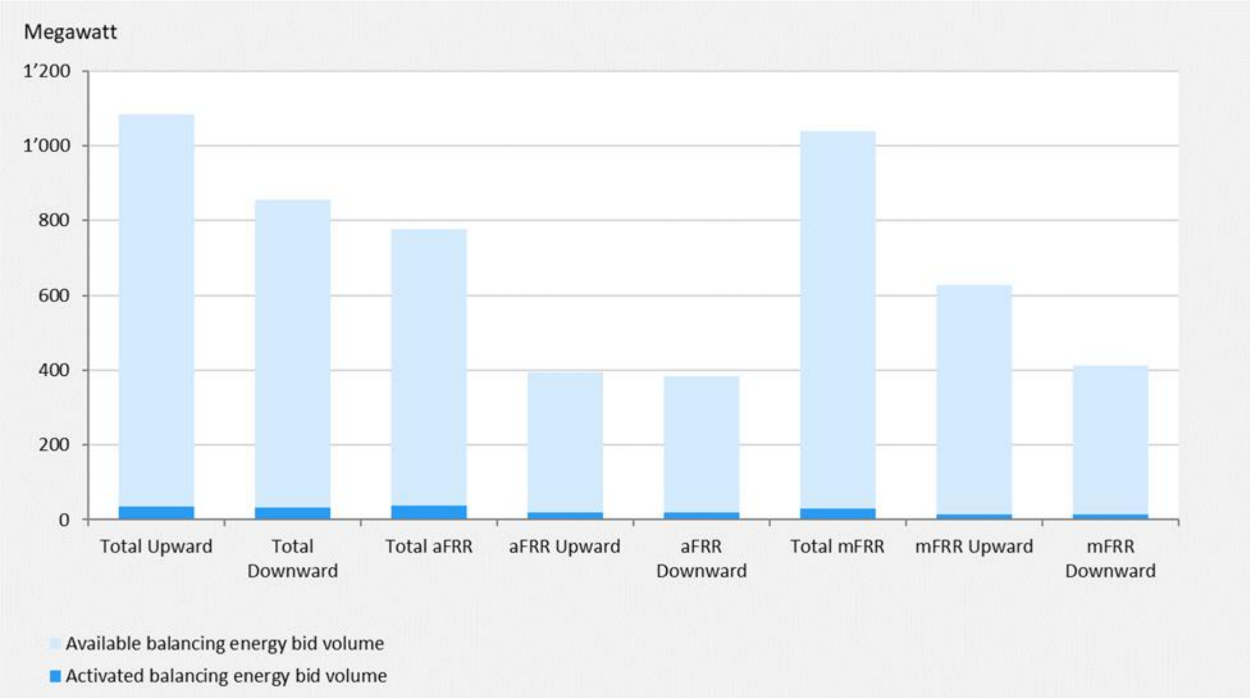

Figure 13: Average available balancing energy bid volume versus activated balancing energy bid volume

8.2.4 Balancing energy costs

In 2019 Swissgrid incurred annual total net costs for balancing energy activations of 22 Mio. Euro. By contrast, the imbalance net revenue amounts to 43 Mio. Euro. Figure 14 shows for each balancing product the total annual cost or income and the average prices, as well as the total annual cost or income and the average price of imbalance energy for the balance responsible parties in EUR/MWh.

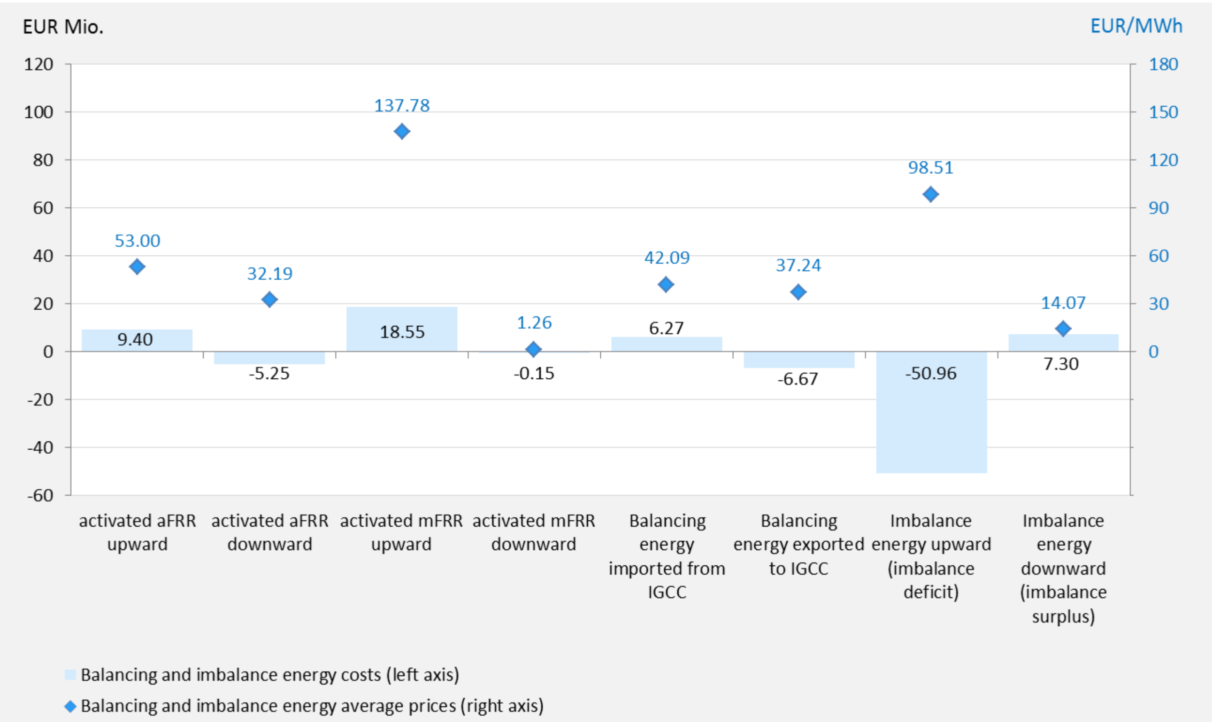

Figure 14: Balancing product costs and imbalance energy prices

Separate statistics for specific und standard products will be provided in future reports once the standard products have been implemented.

8.3 Settlement principles and imbalance energy price mechanism

The imbalance energy price mechanism in the control block of Swissgrid is a two-price system in which the 15-minute prices for imbalance energy are calculated in function of the direction of the 15-minute deviation of a balance responsible party. The calculation can be inferred from the following Table 7.

Table 7: Calculation of imbalance energy prices

Balancing responsible party	short (deficit)	BRP pays $(A + P_1) * \alpha_1$	$A = \max(P_{spot}; P_{sek+}; P_{ter+})$
	long (surplus)	BRP receives $(B - P_2) * \alpha_2$	$B = \min(P_{spot}; P_{sek-}; P_{ter-})$

With alpha factors as following:	α_1	1.1
	α_2	0.9
With base price as following:	P_1	1 ct/kWh
	P_2	0.5 ct/kWh

Note:

1. Within the calculation of the prices A and B, the prices of P_{sek} and P_{ter} will only be used if a use of secondary control or tertiary control occurred in the relevant direction.
2. P_{spot} is the Swissix day-ahead spot price for the given 15-minute period.
3. P_{sek} is the price for aFRR (in Swiss terminology secondary control energy) in the given 15-minute period.
4. $P_{ter-/+}$ is defined as the weighted average price of the mFRR (in Swiss terminology tertiary control energy) which is procured for the given 15-minute period.
5. If the price $(A+P_1)$ results in a negative price, the alpha factor α_1 will be replaced by the alpha factor α_2. If the price $(B-P_2)$ results in a negative price, the alpha factor α_2 will be replaced by the alpha factor α_1.

The settlement process at Swissgrid aims to provide incentives to balance responsible parties to be in balance. It avoids distorting incentives for balance responsible parties and balancing service providers. The price at which imbalances are settled reflects the market prices as it is calculated based on the minimum/maximum of the actual market prices of the spot market, aFRR and mFRR (in Swiss terminology secondary or tertiary balancing) prices. Furthermore, the imbalance prices establish adequate economic signals which reflect the imbalance situation of Swissgrid's control block.

The current balance energy prices are published for each 15minute period on Swissgrid's website in the subsection on balance energy (see here) for each month by the 15th working day of the following month.