

Balancing Roadmap Switzerland





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Swissgrid is leading the balancing markets into the future

Dear Reader,

How are Europe's energy systems and balancing markets¹ developing? Where could synergies be exploited, and where are potential uses emerging?

This publication is intended for Ancillary Service Providers (ASPs) and other interested readers. Its purpose is to provide a transparent overview of product developments in the area of balancing.

Swissgrid guarantees secure grid operation, thereby making a decisive contribution to Switzerland's security of supply. Sound, far-sighted planning is essential to ensuring that this continues in the future.

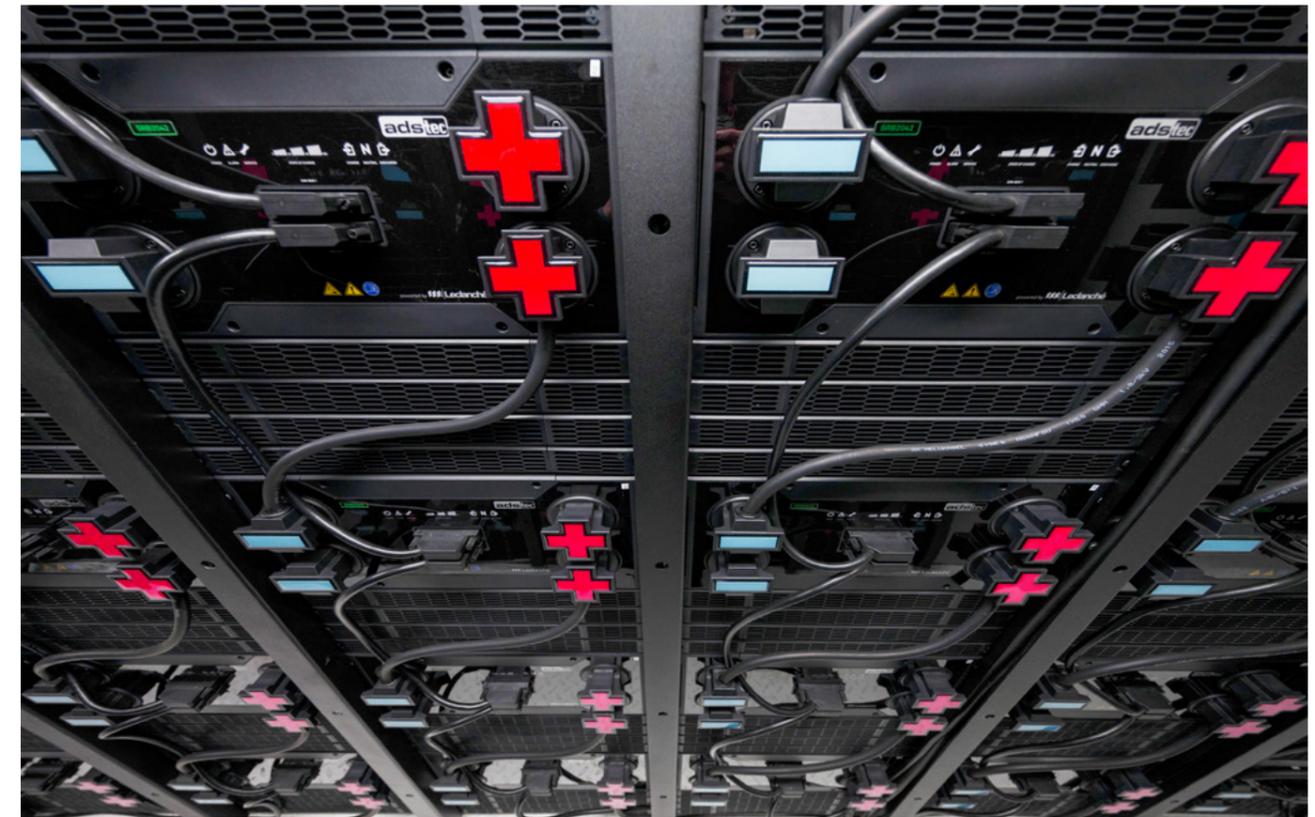
Secure grid operation requires, among other things, management of congestion, voltage stability and grid frequency regulation. The latter is accomplished by balancing load and production. The control reserves required for this are part of the Ancillary Services. Swissgrid procures these control reserves in a market-based and cost-efficient manner.

Three frequency control products are used in the Swiss control area. They are employed in a consecutive cascade: the **primary control reserves (PCR)** are typically available within seconds of an event, such as an unplanned outage of a power plant. PCR are distributed throughout continental Europe and serve to stabilise the frequency.

Within minutes, the **secondary control reserves (SCR)** in the control area where the event occurred replace the PCR and restore a frequency of 50 Hertz. If the imbalance lasts longer than 15 minutes, **tertiary control reserves (TCR)** can be manually activated and deployed to replace the SCR.

The year 2009 marked an important milestone in the liberalisation of the Ancillary Service (AS) market. Swissgrid undertook ground-breaking work at an international level in the procurement of control power. It played an important role in the development of both the PCR cooperation and the grid control cooperation and continues to promote their further development to this day.

¹ Because the European interconnected grid is so large, frequency fluctuations are typically relatively small (traditional frequency control). The products described here are primarily used to maintain the zero balance position in the control areas. For that reason, frequency control products are also referred to as "balancing products", which are procured on the corresponding "balancing markets."



The balancing markets have matured in recent years but are constantly being further developed in response to new ideas. Because of its central location, Switzerland is especially affected by the energy transformation, the coupling of energy markets and the harmonisation of balancing markets. To meet these new challenges, Swissgrid has identified the following strategic priorities:

1. **International partnerships** ensure that balancing and frequency-maintenance products remain seasonally available to grid operators. They enable Ancillary Service Providers to access large sales markets.
2. **Additional flexibility** is achieved by developing products further and making use of synergies.
3. **Simplification of pricing mechanisms across products** improves market incentives.

We hope you enjoy reading this report.

Thomas Reinthaler
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1. The transformation of energy systems is driving adaptations in balancing markets

The further development of balancing markets is based on three main drivers:

Transformation of the energy systems in Europe
 This is leading to increased volatility on the market and to regional congestion in the grid. While the percentage of flexible, conventional power plants is shrinking, the percentage of new, renewable energy sources is on the rise.

Development of European and national regulations
 These include the implementation of the Energy Strategy 2050 in Switzerland and the introduction of the Clean Energy Package at a European level.

Efficiency and digitalisation
 Technical innovations and digitalisation enable the system to undergo continuous optimisation. Digitalisation also makes it possible to coordinate more complex markets.

Environment

The **growing supply of renewable energy sources (wind, solar)** increasingly results in energy being generated far from where it is used. But the grid is expanding too slowly. The generation of energy from conventional power plants is declining. The problem of congestion in Europe is becoming ever more acute. The temporary non-availability of nuclear power plants in Europe and mounting **seasonal congestion** are leading to widely varying prices. Swiss production is characterised by predominately flexible hydroelectric power with seasonal availability.

The **Energy Strategy 2050** is being implemented across Switzerland. The international harmonisation of balancing products and processes and the **development of pan-European balancing markets** are based on the Electricity Balancing Guideline (EB GL). These activities are increasingly being coordinated via regional security initiatives (for example, TSCNet).

Digitalisation is allowing us to control markets and grids more efficiently, at lower cost and at shorter notice. In addition, increased standardisation is reducing transaction costs in commercial markets.

Drivers of further development of balancing markets

- Growing volatility in the market, feed-ins and cross-border load flows
- Risk of ancillary services experiencing short-term regional and seasonal congestion. To be balanced out by, among other things, more flexible procurement and the integration of new technologies.
- Commercial markets are moving closer to real time. Increased interaction between balancing, congestion management and power markets.

- Implementation of the **Energy Strategy 2050**, including integration of new, renewable technologies
- Participation/involvement in shaping international partnerships for ASPs and Swissgrid

- Facilitates the organisation of extremely short-term and international commercial and balancing markets
- Enables the development of complex new products
- New options for incorporating decentralised flexibility (for example, controllable loads, storages)

2. Forward-looking products and more efficient balancing markets

To ensure the constant availability of control reserves (market liquidity), both now and in the future, Swissgrid has developed a set of suitable measures in accordance with the following principles:

1

Swissgrid promotes the **market-based** procurement and **centrally coordinated** deployment of balancing products.

2

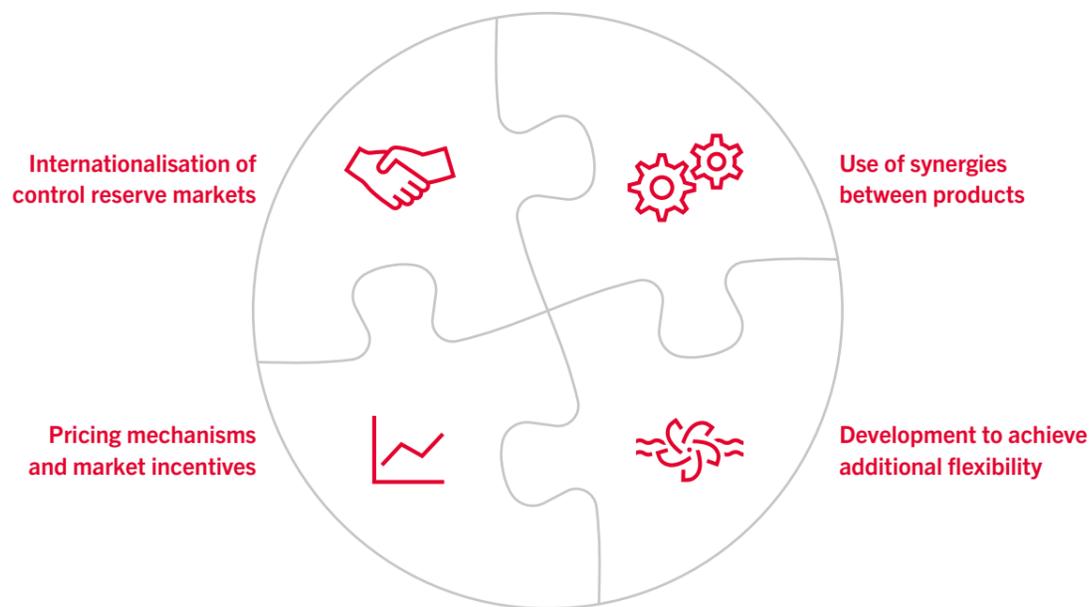
Swissgrid develops and **improves balancing products** to ensure that grid security can be maintained and costs kept low even in an altered environment. Swissgrid is open to forward-looking approaches and supports **the integration of suitable technologies** in the balancing market.

3

Swissgrid is committed to **cooperation with national and international stakeholders** and represents **Swiss interests in Europe**.

Shaping the balancing market

Based on these principles, Swissgrid promotes further developments along four strategic lines. The resulting products are described in section 4.



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Internationalisation of control reserve markets

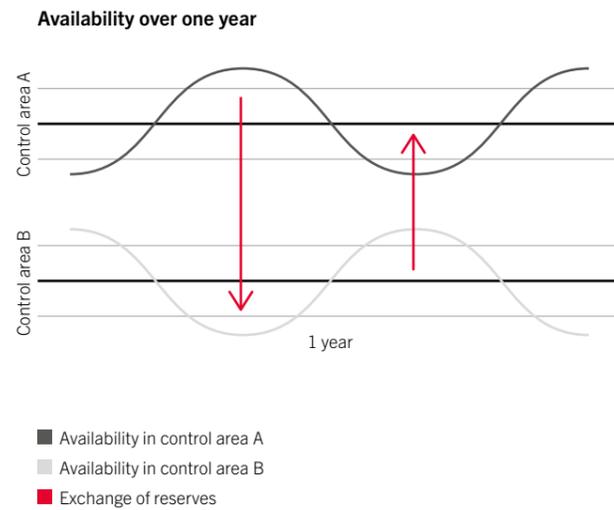
In cooperation with foreign transmission system operators, Swissgrid develops harmonised, standardised products for frequency control.

The advantages of standardised products include:

- Improved grid security
- Creation of centralised markets
- Utilisation of netting effects

Grid security

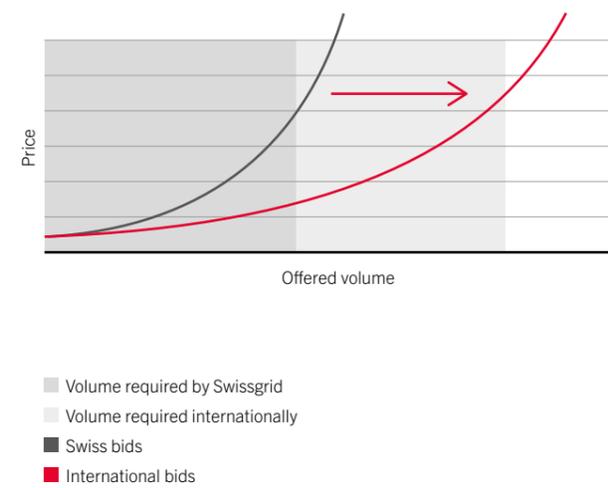
Improved grid security thanks to mutual securing with available power. Seasonal fluctuations in the availability of power plants can be balanced out between the different control areas.



Centralised markets

Coordinated procurement via centralised markets. Transmission system operators act as buyers, ASPs as sellers. For transmission system operators, this results in higher liquidity and security of supply. For ASPs, it offers greater marketing potential due to increased demand for flexible power plant output.

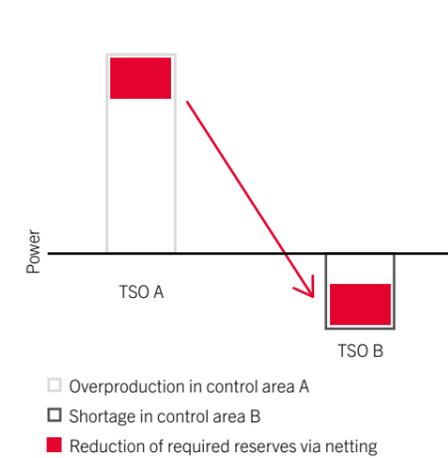
Balancing market



Netting effects

The coordination of requests makes it possible to exploit netting effects. Power imbalances from control areas are utilised to reduce the use of reserves.

Netting effect



The standardised European products are:

- **Frequency Containment Reserves (FCR)** correspond to present-day primary control reserves.
- **Automatic Frequency Restoration Reserves (aFRR)** correspond to present-day secondary control reserves.
- **Manual Frequency Restoration Reserves (mFRR)** and **Replacement Reserves (RR)** correspond to present-day fast and slow tertiary control reserves.

The Grid Control Cooperation that exists at present is to be expanded into a pan-European platform. This will serve to avoid simultaneous activation of reserves in opposite directions.

More information: www.entsoe.eu



Swissgrid is involved in the following international partnerships*:

Primary control

International PCR Cooperation

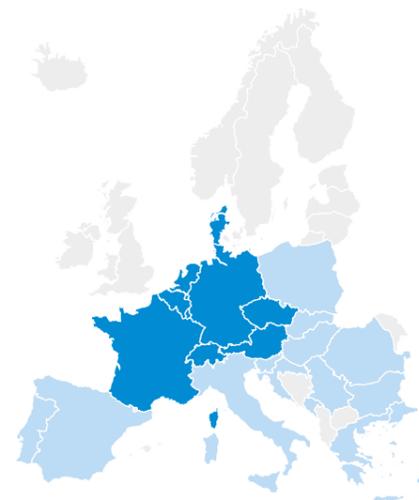


■ Member

The PCR Cooperation coordinates the procurement of PCR (provision) on the Central Clearing System platform (CCS). It began in 2015 with the merging of partnerships between Swissgrid and German transmission system operators (initiated in 2011) and between Swissgrid and the Austrian APG (initiated in 2012). The PCR Cooperation currently comprises ten transmission system operators. As of the end of 2018, weekly products will be replaced by daily products.

Secondary control

International Grid Control Cooperation (IGCC)



Procurement or provision of the required power is conducted at a national level. The IGCC is to become a European platform for imbalance netting and will eventually merge with the aFRR platform.

Since 2012, requests for secondary control energy have been coordinated internationally through the International Grid Control Cooperation (IGCC). The goal is to avoid simultaneous activation of reserves in opposite directions (imbalance netting). Requests are not reallocated, but only reduced as a result. Furthermore, an international control signal is used as a feed-forward signal for national load frequency controllers.

Automatic Frequency Restoration Reserves (aFRR): PICASSO-Project



■ Member
■ Observer

The PICASSO project provides for the creation of a platform for requesting automatic Frequency Restoration Reserves (aFRR). The platform is likely not only to supersede the Grid Control Cooperation, but also to minimise costs by optimising requests. The go-live for this ambitious project is expected to take place by the end of 2021.

Tertiary control

Manual Frequency Restoration Reserves (mFRR): MARI-Project

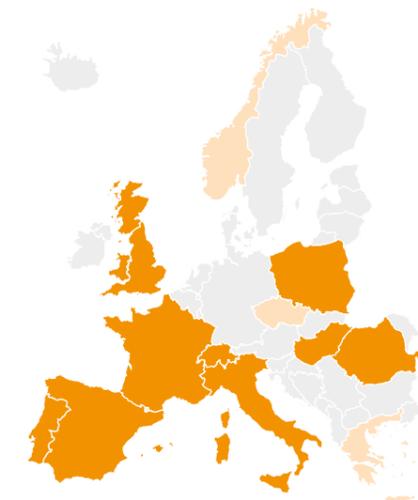


■ Member
■ Observer

The MARI project aims to develop a platform for internationally coordinated requests for manual Frequency Restoration Reserves (mFRR: activation time of 12.5 minutes and delivery time of 15 minutes). mFRR will replace Switzerland's current tertiary control reserve product. Procurement of power is still regulated nationally.

A memorandum of understanding has been signed by 19 transmission system operators. Market and product details are formulated in working groups. The mFRR platform is expected to be launched by the end of 2021.

Replacement Reserves (RR): TERRE-Project



■ Member
■ Observer

Requests for Replacement Reserves (RR: activation time of 30 minutes and delivery time of up to 1 hour) are coordinated within the framework of TERRE. Transmission system operators report their requirements and the proposals on a central clearing platform. Activated ASPs are remunerated as pay-as-cleared in the process. Provision and procurement take place at a national level. The TERRE project is expected to be launched by the end of 2019.

* Data valid as of the editorial deadline.



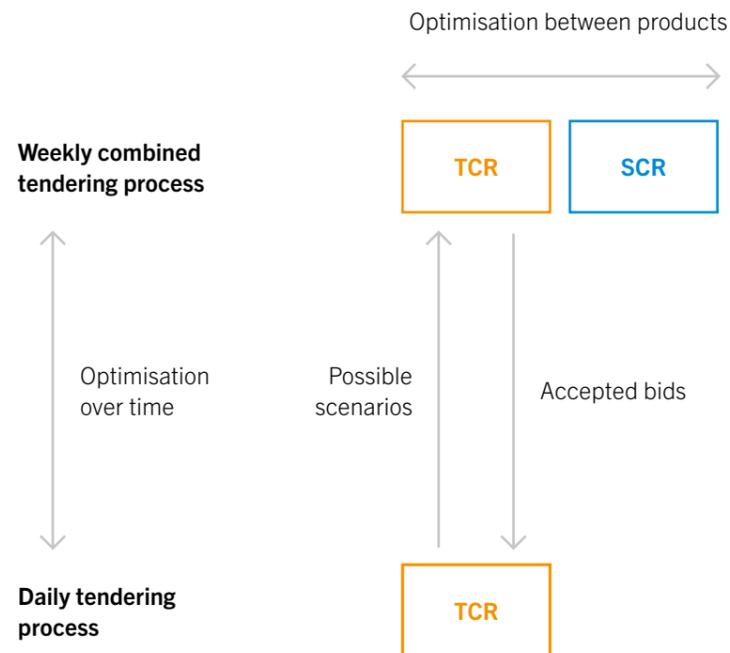
Use of synergies between products

Swissgrid uses synergies involving both requests and procurement for efficient grid operation.

Use of synergies regarding procurement²

SCR and TCR are currently procured on a weekly basis in a combined call for tenders. For TCR, supplementary tenders for four-hour blocks are held the day before delivery. In the **combined weekly tender process**, bids for SCR and TCR are selected in light of the anticipated costs for daily tenders. For this purpose stochastic optimisation is employed.

This makes it possible, on the one hand, to **distribute procurement volumes between SCR and TCR** (in view of the deficit criteria)³ and, on the other, to optimise distribution between weekly and daily tenders. For example, if lower prices are expected in daily tenders, less power will be contracted in the weekly tendering process. Swissgrid will continue to exploit these procurement synergies in the future, such as when introducing daily SCR tenders.



² An in-depth explanation of the stochastic optimisation method can be found in the following article: F. Abbaspourtorbati, M. Zima, "The Swiss Reserve Market: Stochastic Programming in Practice", IEEE Transactions on Power Systems, March 2016.

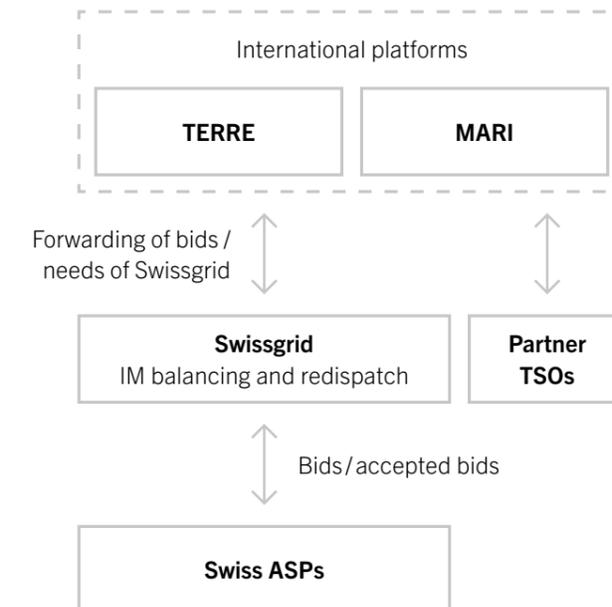
³ According to the operational handbook "Policy 1: Load Frequency Control" multiple procedures can be used to determine the provision volume. In general, Swissgrid refers to the probabilistic approach ("Probabilistic Risk Management Sizing Approach"), which statistically calculates how many hours it would take for the load frequency controller to reach its limit in a given year. The handbook recommends a threshold of 0.2%.

Use of synergies regarding requests

Redispatch energy and manually requested control energy (TCR or mFRR and RR) differ with regard to the factoring in of the feed-in points (at the node level) for the respective energy and consideration of the corresponding request characteristics. The products are procured separately for historical reasons and compensated differently.⁴ This leads to fragmented markets with correspondingly lower liquidity. For that reason, manually requested products for frequency control and redispatch will be consolidated into an Integrated Market (IM) in the future. The IM will enable ASPs to correctly assess the price of existing opportunity costs and allow Swissgrid to access a more liquid market.

A suitable, bid-based market product (see section 4) will ensure that it can be used for both redispatch and frequency stability. The integrated market will initially be available only for pool-based requests. The platform is to be expanded subsequently to include the node-level market.

mFRR and RR are comparable products. In the future, ASPs will therefore be able to participate in international platforms for mFRR (MARI platform) and RR (TERRE platform) via this interface as well.



⁴ Redispatch is remunerated in the form of indexed compensation, whereas the activated tertiary control reserve is compensated based on the proposals (pay-as-bid).



Development to achieve additional flexibility

Various aspects and effects are taken into account when developing the products further. In addition to ensuring compatibility with standardised international products, relevant regulations and the subsequent development of the energy market, the products should also be as flexible and non-discriminatory as possible.

The products are being developed along the following lines.

- A Shorter lead times for manual requests and provision**
Enables the closure of open positions on short-term intraday markets (short-term fluctuations in load and production) and the reduction of interactions between balancing and energy markets (balancing after the closure of energy markets). Procurement occurs closer to the start of the power provisioning period.
- B Shorter (manual) requests**
To achieve additional market liquidity (offering previously unused flexibility), to facilitate more precise use of reserves, and to make entry easier for market players with energy limits (for example, batteries).
- C Shorter provisioning times**
Greater flexibility in reacting to market signals and shorter immobilization of power.
- D More flexibility in the bid structure**
Simplification of the product structure, with the goal of putting additional flexibility to use, for example, cancellation of symmetrical⁵ power provision for SCR.
- E Creation of integration possibilities**
For small generating units and controllable loads.
- F Compatibility with standard products**
Enables netting and internationally coordinated requests.

⁵ Symmetrical means that a bidder must offer the same volume of increaseable as of reducible power.

Sample products:

Pooling concept

The pool concept was introduced in Switzerland in 2013. It enables prequalification and participation in the balancing market by consolidating small generating units and flexible loads that would not meet the requirements individually.



Direction-specific daily products for SCR

The cancellation of symmetrical power provision for secondary control power reduces market barriers and creates additional flexibility for bidders who cannot offer symmetrical power. The planned introduction of SCR daily products and their integration into the combined tendering process also makes it possible to offer flexibility that is only available for a short time.



PCR daily auctions

As the PCR product (FCR) undergoes further development, there are plans to replace the current weekly product with four-hour blocks, to be procured the day prior to delivery. This will result in shorter lead times for provisioning and shorter provisioning periods, which will have a positive impact on market liquidity.



Products of the integrated market

Energy proposals will be adjusted more frequently (24 rather than 6 gate closures per day) and closer to delivery (gate closure 30 minutes before delivery rather than 1 hour prior) and the maximum request time will be shorter (1 hour maximum rather than 4 hours).





Pricing mechanisms and market incentives

Swissgrid plans to carry out a sweeping reform of the pricing mechanisms for determining the prices of control energy and balance energy.

A variety of pricing mechanisms are used today to calculate remuneration for control energy, even though some of the energy is fed into the grid from the same power plants.⁶ For this reason, Swissgrid plans to carry out a sweeping reform of the pricing mechanisms for determining the prices of control energy and balance energy. The plan will be implemented in 2020 at the earliest.

The purpose of this pricing reform is to improve market liquidity and price signals by harmonising prices for control energy and balance energy and to create incentives for an efficient balancing mechanism.

The following **key elements** contribute to an efficient balancing mechanism:

One-price systems and cross-product harmonisation of pricing

Today's two-price systems (remuneration for secondary control energy and balance energy) will be replaced by a single price. This price represents the value of the control energy. Energy products for secondary and tertiary control reserves will be remunerated at the same price, regardless of the supply direction. Balance energy, too, will be remunerated at this price, thereby laying the foundation for an efficient balancing market. This will enable a state of balance to develop with a single, straightforward price for balance and control energy. Transmission system operators will be unaffected financially by a one-price system. Revenues/expenditures from balance energy billing will therefore cover income/expenses from control energy billing. These modifications are in conformity with the Electricity Balancing Guideline (EB GL).⁷

⁶ For example, secondary control energy is compensated based on the Swiss market price (SwissIX), while tertiary control energy is remunerated based on an energy price specified by the bidder.

⁷ The Electricity Balancing Guideline (EB GL) regulates the EU-wide introduction of standardised products for balancing and the creation of the corresponding markets.

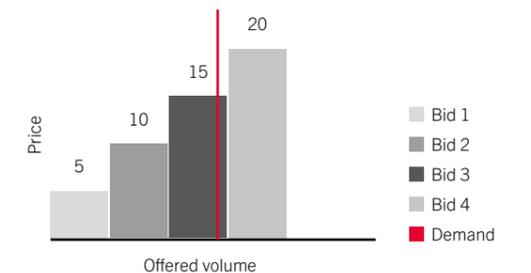
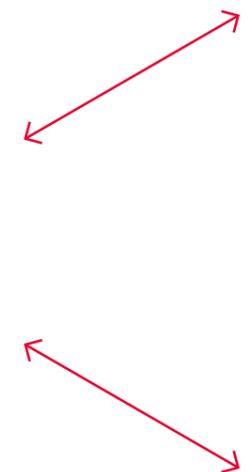
The purpose of this pricing reform is to improve market liquidity and price signals by harmonising prices for control energy and balance energy.

Signals on the market shortly behind real time

Prices for both control energy and balance energy are currently determined with a large time lag. As a result, they are unable to reflect the value of the energy at the corresponding time. In order to send signals to the market that BGMs and ASPs can react to, prices for control and balance energy should be published shortly behind real time.

Pay-as-cleared instead of pay-as-bid

To promote market liquidity, pay-as-cleared rather than pay-as-bid should be examined as a means of determining the price of control energy. The concept calls for all proposed offers to be paid at the price of the most expensive proposed offer. This will simplify bidder behaviour (true-cost bidding) as compared to pay-as-bid, while also helping smaller market players.

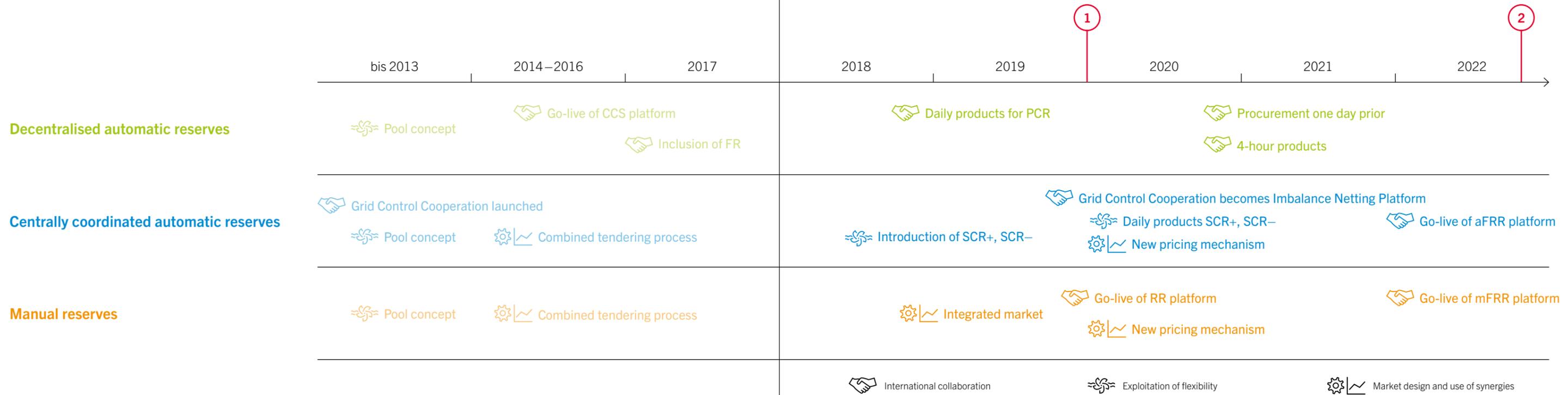


Payment				
5	10	15	0	Pay-as-bid
15	15	15	0	Pay-as-cleared

In order to safeguard Switzerland's security of supply now and in the future, planning that is both sound and, above all, far-sighted is required.



3. Roadmap to 2022



1 Product interaction in 2019, following implementation of TERRE and IM.

Category	Component	Switzerland	Cross-border
Frequency control	Primary control	Power provision	International PCR tendering process
	Secondary control	Power provision	National SCR tendering process
		Energy request	SCE request in Switzerland
	Tertiary control	Power provision	National TCR tendering process
Congestion management	Redispatch	Energy request	European RR energy market via IM, international energy support
		Energy request	Integrated market for products that can be requested manually
Congestion management	Redispatch	Energy request	International redispatch procedures with DE, FR, AT, IT, SL or MRA via TSC

2 Product interaction in 2022, following implementation of MARI and PICASSO.

Category	Component	Switzerland	Cross-border
Frequency control	Primary control	FCR power provision	International PCR tendering process
	Secondary control	aFRR power provision	National SCR tendering process
		aFRR energy request	Request via European aFRR platform
Frequency control	Tertiary control	mFRR/RR power provision	National mFRR/RR tendering process
		RR energy request	European RR energy market via IM
	mFRR energy request	Integrated market for products that can be requested manually	European mFRR energy market via IM, international energy support
Congestion management	Redispatch	Energy request	International redispatch procedures with DE, FR, AT, IT, SL or MRA via TSC

4. Product overview

Decentralised automatic reserves (PCR)

		PCR (FCR) today	PCR (FCR) in future		
Period	Available from/to	By the end of 2018	As of the end of 2018	Mid-2019	End of 2020
Procurement	Timing	In the preceding week, always for 1 week	Daily product, with at least two days in each case Lead time procured (D-2)	Introduction of indivisible offers and pay-as-cleared Pay-as-cleared	Introduction of 4-hour products and procurement one day prior (D-1)
	Bid structure	Symmetrical power band, 1 to 25 MW per bid			
	Clearing	Clearing in framework of PCR cooperation			
Product	Request	Continuous, decentralised requests via droop set for conventional power plants or via coordinated requests through aggregator of units in pool.			
	Activation time	Full activation after 30 seconds			
	Min/max. time of operation	15 minutes	In discussion: 15 to 30 minutes		
Remuneration	Provision	Pay-as-bid	Pay-as-bid	Pay-as-cleared	Pay-as-cleared
	Request	No remuneration			

Centralised, automatic reserves (SCR)

		SCR at present	SCR+, SCR-	Daily products SCR+, SCR-	aFRR (PICASSO)
Period	Available from/to	By the end of May 2018	As of June 2018	As of approx. 2019–2020	As of 2022
Procurement	Timing	In the preceding week, in each case for 1 week	In the preceding week, in each case for 1 week	Weekly product: in the preceding week, in each case for 1 week Daily product: one day prior, provisioning duration still undetermined.	Weekly product: in the preceding week, in each case for 1 week Daily product: one day prior, provisioning duration still undetermined.
	Bid structure	Symmetrical power band, 5 to 50 MW, possibility of multi-level bids	Direction-specific products (SCR+, SCR-), 5 to 100 MW per proposal, possibility of multi-level bids over both products	Analogous in principle to SCR+, SCR-	Analogous in principle to SCR+, SCR- with potential adjustments for compatibility with aFRR platform
	Clearing	National clearing together with TCR by means of stochastic, combined auction (minimisation of provisioning costs in consideration of deficit level based on historical data)			
Product	Request	Continuous, centrally coordinated pro rata requests for proposed offers. International coordination via Grid Control Cooperation.			Requested based on proposed energy price. Coordination via PICASSO platform pursuant to international merit-order list with proposed energy prices.
	Activation time	Dictated implicitly by ramp gradient, typically 2 to 3 minutes			5 minutes
	Time of operation	No limit	No limit	No limit	
Remuneration	Provision	Pay-as-bid	Pay-as-bid	Pay-as-bid	Pay-as-cleared or pay-as-bid
	Request	Indexed prices based on SwissIX. Net requested volume is billed.	Indexed prices based on SwissIX. Energy volumes are billed based on direction of supply.	Energy volumes are billed based on direction of supply.	Pay-as-cleared

Manually activated reserves (TCR)

		TCR at present	IM	RR (TERRE)	mFRR (MARI)
Period	Available from/to	Until introduction of IM	As of the end of 2018	As of 2019 (expansion of IM platform)	As of 2022 (expansion of IM platform)
Procurement	Timing	In the preceding week, in each case for 1 week. The day before, for 4-hour blocks.	In the preceding week, in each case for 1 week. The day before, for 4-hour blocks.	In the preceding week, for 1 week each. One day prior, provisioning duration still undetermined.	In the preceding week, in each case for 1 week. One day prior, provisioning duration still undetermined.
	Bid structure	Direction-specific products, 5 to 100 MW per proposal, possibility of multi-level bids	Direction-specific products, 5 to 100 MW per proposal, possibility of multi-level bids	Still unknown	Still unknown
	Clearing	National clearing. Weekly tender together with SCR by means of stochastic, combined auction (minimisation of provisioning costs in consideration of deficit level based on historical data). Daily tendering processes until introduction of "Daily products SCR+, SCR-" independently of SCR.			
Product	Request	Requested based on proposed energy price. Gate closure 1 hour prior to the start of each 4-hour block.	Requested (together with request for redispatch) in accordance with proposed energy price. 24 gate closures, each 30 minutes prior to a 1-hour delivery interval.	Requested in accordance with proposed energy price (joint merit-order list on TERRE platform). 24 gate closures, each 1 hour prior to the delivery interval.	Requested in accordance with proposed energy price (joint merit-order list on MARI platform). 96 gate closures, each 30 minutes prior to delivery interval (22.5 minutes prior to request).
	Activation time	15 minutes (20 minutes for "TCR slow")	15 minutes (20 minutes for "TCR slow")	30 minutes until full activation	12.5 minutes until full activation ⁸
	Time of operation	15 minutes to 4 hours	15 minutes to 1 hour	1 hour	15 minutes (ramp starts 5 minutes prior to beginning or end and ends 5 minutes after beginning or end of delivery period)
Remuneration	Provision	Pay-as-bid	Pay-as-bid	Pay-as-bid	Pay-as-bid
	Request	Pay-as-bid	Pay-as-bid	Pay-as-cleared	Pay-as-cleared

Detailed overview of present-day and future products. Data in accordance with the planning status as of the editorial deadline.

⁸ 2.5 minutes are scheduled for preparation and 10 minutes for the ramp.

Glossary

aFRR	Automatic Frequency Restoration Reserves
AS	Ancillary Services
ASP	Ancillary Service Provider
BGM	Balance Group Manager
CCS	Central Clearing System
EB GL	Electricity Balancing Guideline
FCR	Frequency Containment Reserves
IGCC	International Grid Control Cooperation
IM	Integrated Market
MARI	Manually Activated Reserves Initiative
mFRR	Manual Frequency Restoration Reserves
MRA	Multilateral Remedial Actions
Pay-as-bid	Remuneration based on individually proposed price
Pay-as-cleared	Remuneration based on the last proposed offer
PCR	Primary Control Power (provision)
PICASSO	Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation
PPO	Power Plant Operator
RR	Replacement Reserves
SCE	Secondary Control Energy (request)
SCR	Secondary Control Power (provision)
TCE	Tertiary Control Energy (request)
TCR	Tertiary Control Power (provision)
TERRE	Trans European Replacement Reserves Exchange
True-cost bidding	When a bid effectively corresponds to the resulting costs
TSC	TSO Security Cooperation
TSO	Transmission System Operator (CH: Swissgrid)



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