1. Current IGCC settlement [February 2016]

The current IGCC settlement description can be found in the Stakeholder document for the principles of IGCC on the ENTSO-E webpage for IGCC.

2. Opportunity prices description

In this section the determination of the opportunity prices is presented. The opportunity prices reflect the value of netted imbalances, i.e. avoided aFRR energy costs due to the avoidance of aFRR activation and are usually based on national aFRR energy prices, , which are therefore more accurately described per country.

2.1. Austria

The IGCC Opportunity Prices are determined by the activated aFRR energy. The IGCC Opportunity Prices for both IGCC import and IGCC export are determined as the quantity-weighted average of aFRR energy costs billed for the respected direction within the settlement period in Austria. The IGCC Opportunity Prices are determined separately for IGCC import and IGCC export deliveries.

If there was no aFRR energy activation neither for negative nor positive direction, the aFRR energy price that would have been paid for the first activated bid in the Austrian merit order list in the respectiveed direction (respectively in case of aFRR cooperation the first activated bid in the common merit order list of the cooperation) is taken as the IGCC Opportunity Price.

$$C_{i,IMP} = \frac{M_{aFRR\_pos,i}}{aFRR_{pos,i}}$$

$$C_{i,EXP} = \frac{M_{aFRR\_neg,i}}{aFRR_{neg,i}}$$

Variable	Description	Unit	Sign
$aFRR_{pos,\,i}$	Amount of activated positive aFRR energy for the IGCC settlement period$_i$.	[MWh]	Always positive.
$aFRR_{neg,\,i}$	Amount of activated negative aFRR energy for the IGCC settlement period$_i$.	[MWh]	Always positive.
$C_{i,Imp}$	Resulting IGCC Opportunity Price of APG for IGCC import for the IGCC settlement period$_i$.	[€/MWh]	Positive values means APG pays for activation of positive aFRR energy. Negative value means APG is paid for activation of positive aFRR energy.
$C_{i,Exp}$	Resulting IGCC Opportunity Price of APG for IGCC export for the IGCC settlement period$_i$.	[€/MWh]	Positive value means APG is paid for activation of negative aFRR energy. Negative value means APG pays for activation of negative aFRR energy.
$M_{aFRR\_pos,\,i}$	Total costs for positive aFRR energy deliveries of APG for the IGCC settlement period$_i$.	[€]	Positive value means APG has costs. Negative value means APG receives payment.
$M_{aFRR\_neg,\,i}$	Total costs for negative aFRR energy deliveries of APG for the IGCC settlement period$_i$.	[€]	Positive value means APG receives payment. Negative value means APG has costs.

Examples for Calculation of IGCC Opportunity Prices

Example for one IGCC settlement period of a day:

Example for IGCC Opportunity Price for import			
	aFRR energy amount in MWh	Price in €/MWh	Costs in €
Bid 1	30	80	2400
Bid 2	200	100	20000
Bid 3	5	110	550
Sum ($aFRR_{pos}$ and M_{aFRR_pos})	235		22950

IGCC Opportunity Price €/MWh	97,660

Example for IGCC Opportunity Price for export			
	aFRR energy amount in MWh	Price in €/MWh	Revenues[1] in €
Bid 1	30	15	450
Bid 2	200	-8	-1600
Bid 3	5	-50	-250
Sum ($aFRR_{neg}$ and M_{aFRR_neg})	235		-1400

IGCC Opportunity Price €/MWh	-5,957

2.2. Belgium

Calculation of IGCC Opportunity Prices

The IGCC Opportunity Prices are determined by the activated aFRR energy. Remunerations for positive aFRR energy and negative aFRR energy are paid separately at their respective price during one settlement period (quarter of an hour). All resources which are part of the activated aFRR are activated at the same time. The quantity of aFRR to be activated per resource is calculated as a pro rata, with the selected aFRR as weighting factor.

The IGCC Opportunity Prices for both export and import direction are determined as the quantity-weighted average of the activated aFRR energy bids. The weighting factor corresponds with the share of the quantity of selected aFRR per supplier.

The aFRR energy bids are subject to price caps based on fuel cost and a markup. The maximum price for positive aFRR energy is the fuel cost of a standard Combined Cycle Gas Turbine with an efficiency of 50% plus 40€/MWh. The minimum price for negative aFRR energy is 0 €/MWh.

Variable	Description	Unit	Sign/ source
$aFRR_{pos;i;k}$	Positive activated aFRR energy from $supplier_k$ for the aFRR energy accounting $period_i$.	[MWh]	Always positive.
$aFRR_{neg;i;k}$	Negative activated aFRR energy from $supplier_k$ for the aFRR energy accounting $period_i$.	[MWh]	Always positive.

[1] Negative revenues are costs.

$P_{pos;i;k}$	aFRR energy price for the positive activated aFRR energy from supplier$_k$ for the aFRR energy accounting period$_i$.	[€/MWh]	Always positive (Elia pays for activation of positive aFRR energy).
$P_{neg;i;k}$	aFRR energy price for the negative activated aFRR energy from supplier$_k$ for the aFRR energy accounting period$_i$.	[€/MWh]	Always positive (Elia is paid for activation of negative aFRR energy).
$C_{i;Imp}$	Resulting IGCC Opportunity Price of Elia for IGCC import for the IGCC settlement period$_i$.	[€/MWh]	Positive (Elia pays for activation of positive aFRR energy).
$C_{i;Exp}$	Resulting IGCC Opportunity Price of Elia for IGCC export for the IGCC settlement period$_i$.	[€/MWh]	Positive (Elia is paid for activation of negative aFRR energy).

$$C_{i;Imp} = \frac{\sum_{k}^{all\ suppliers}\left[P_{pos;i;k} * aFRR_{pos;i;k}\right]}{\sum_{k=1}^{all\ suppliers}\left[aFRR_{pos;i;k}\right]}$$

$$C_{i;Exp} = \frac{\sum_{k=1}^{all\ suppliers}\left[P_{neg;i;k} * aFRR_{neg;i;k}\right]}{\sum_{k}^{all\ suppliers}\left[aFRR_{neg;i;k}\right]}$$

Examples for Calculation of IGCC Opportunity Prices

Examples for Elia IGCC Opportunity Price determination for one IGCC settlement period:

Example for IGCC Opportunity Price for import			
	aFRR energy amount in MWh	Price in €/MWh	Costs in €
Bid 1	30	40	1200
Bid 2	100	60	6000
Bid 3	20	70	1400
Sum	150		8600
IGCC Opportunity Price €/MWh	57,33		

Example for IGCC Opportunity Price for export			
	aFRR energy amount in MWh	Price in €/MWh	Costs in €
Bid 1	60	25	1500
Bid 2	60	10	600
Bid 3	30	0	0
Sum	150		2100
IGCC Opportunity Price €/MWh	14		

2.3. Czech Republic

The aFRR energy price is fixed by the Czech energy regulator for a year per direction of delivery. Delivered positive and negative aFRR energy is netted per aFRR provider over 60 minutes. If aFRR energy balance is positive, aFRR provider receives regulated price for positive aFRR energy times final balance and vice versa for negative aFRR energy final balance.

The IGCC opportunity prices are based on cost reduction of aFRR energy payments in the Czech Republic. The cost reduction is based on the value of netted imbalances and is determined as a difference between payments for aFRR energy with ČEPS not participating in IGCC and payments for aFRR energy with ČEPS participating in IGCC. Czech Republic has 60 minutes imbalance settlement period (accounting period), therefore, the IGCC opportunity prices are same for four (4) consecutive quarters of an hour constituting 60min imbalance settlement period. Further, due to use of the aFRR energy fixed price and netting of positive and negative aFRR energy deliveries over 60 minutes, the IGCC opportunity prices are same for IGCC import and IGCC export.

Determination of the Czech opportunity prices is as follows:

$$C_{i,Imp} = C_{i,Exp} = \frac{aFRR_{costs\_without\_IGCC;i} - aFRR_{costs\_with\_IGCC;i}}{IGCC_{Import;\,i} - IGCC_{Export;\,i}}$$

Variable	Description	Unit	Sign
$C_{i,Imp}$	IGCC Opportunity Price for import in the aFRR energy accounting period.	[€/MWh]	Positive: ČEPS pays for activation of positive aFRR energy to aFRR providers; Negative: ČEPS avoids to pay for activation of positive aFRR energy to aFRR providers due to aFRR netting.
$C_{i,Exp}$	IGCC Opportunity Price for export in the aFRR energy accounting period.	[€/MWh]	Positive: ČEPS avoids to pay for activation of positive aFRR energy to aFRR providers due to aFRR netting. Negative; ČEPS pays for activation of positive aFRR energy to aFRR providers.
index i	aFRR energy accounting period in the Czech Republic	-	-
$aFRR_{costs\_without\_IGCC;i}$	Costs of aFRR energy deliveries that would be payed to aFRR energy providers if ČEPS would not be participating in IGCC in the aFRR energy accounting period.	[€]	Positive value means payment to aFRR energy providers.
$aFRR_{costs\_with\_IGCC;i}$	Costs of aFRR energy deliveries payed to aFRR energy providers due to IGCC in the aFRR energy accounting period.	[€]	Positive value means payment to aFRR energy providers.
$IGCC_{Import;i}$	IGCC energy import in the aFRR energy accounting period.	[MWh]	Always positive.
$IGCC_{Export;i}$	IGCC energy export in the aFRR energy accounting period.	[MWh]	Always positive.

2.4. Denmark

The Danish IGCC Opportunity Prices are calculated separately for IGCC import and export. For import the IGCC Opportunity Price is derived from a price of positive aFRR energy and is determined as the hightest of the Nord Pool Spot Price for DK1 plus 100 DKK/MWh and the mFRR energy price for DK1.

For export the IGCC Opportunity Price is derived from a price of negative aFRR energy and is determined as the lowest of the Nord Pool Spot Price for DK1 minus 100 DKK/MWh and the mFRR energy price for DK1.

Examples for Calcualtion of IGCC Opportunity Prices

Example for an IGCC settlement period of a respective day:

Example for IGCC Opportunity Price for import	
Price for positive mFRR energy	244.70 DKK/MWh
Nord Pool Spot DK1 Price	208.88 DKK/MWh
Maximum	Max [244.70 ; 208.88 + 100 DKK]
IGCC Opportunity Price	308.88 DKK/MWh

Example for IGCC Opportunity Price for export	
Price for negative mFRR energy	190.58 DKK/MWh
Nord Pool Spot DK1 Price	208.88 DKK/MWh
Minimum	Min [190.58; 208.88 - 100 DKK]
IGCC Opportunity Price	108.88 DKK/MWh

2.5. France

The French aFRR energy price is regulated and equal to the French hourly Day-Ahead EPEX spot price of the corresponding settlement period. There is one single price for both positive and negative aFRR energy.

RTE opportunity prices are exactly equal to the prices for activated aFRR energy in the corresponding settlement period; which means the French hourly Day-Ahead EPEX spot price of the settlement period. IGCC imports and exports are valuated with the same IGCC Opportunity Prices. There is one RTE Opportunity price for both IGCC import and export in each IGCC settlement period (quarter of an hour), equal to the French hourly Day-Ahead EPEX spot price of the quarter of hour.

2.6. Germany

In Germany, calls for secondary control energy are made based on a common merit order list. This merit order list includes all aFRR-bids of the four German TSOs and from the beginning of the German-Austrian-Cooperation (11th Juli 2016) also the aFRR-bids from APG. The offers taken up are then settled on a "pay-as-bid" basis.

The opportunity prices for Germany are determined separately for positive and negative secondary control energy per each quarter of an hour. For the calculation of the opportunity price, the average price of secondary control energy exchanged in each balancing direction during a 15-minute interval is used. Only bids which were activated for Germany are considered.

In case positive secondary balancing is needed by the German TSOs, the opportunity price corresponds with the quotient of the positive secondary control energy costs per 15 minutes and the positive secondary control energy volume per 15 minutes.

In case negative secondary control energy is needed by the German TSOs, the opportunity price corresponds with the quotient of the negative secondary control energy costs or proceeds per 15 minutes and the negative secondary control energy volume per 15 minutes.

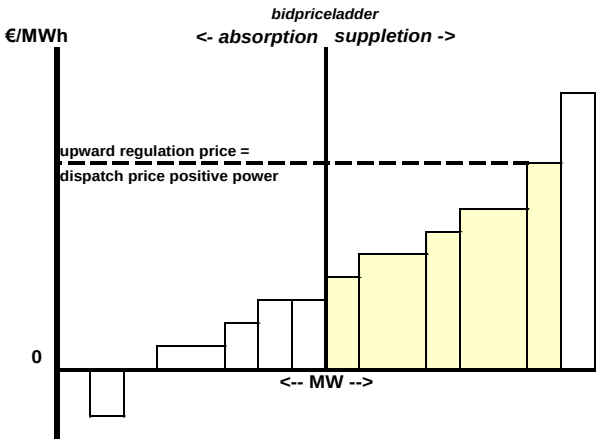
If there was no demand in a certain direction, the lowest energy price of the merit order for that direction will be used as the opportunity price.

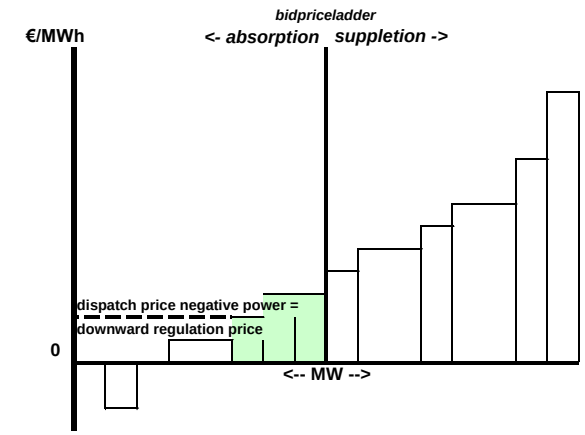
Detailed Information about the settlement within the cooperation can be found on https://www.regelleistung.net.

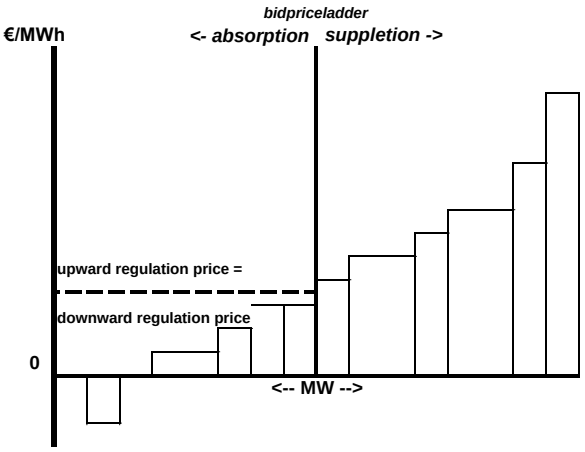
2.7. Netherlands

The Dutch IGCC Opportunity Prices are derived from the price of activated aFRR bids. This means that the last activated FRR bid determines the FRR price for all suppliers (marginal pricing). These FRR prices are published the following business day. There is only either a positive or a negative price for suppliers of FRR energy. If, however, activation in a ¼ hour occurs in both directions, prices are therefore also calculated, published and invoiced in both directions. These prices then constitute the opportunity prices. When no activation of FRR has occurred in a ¼ h period, then the midprice will be the opportunity price: the average of the lowest upward regulation bid and the highest downward regulation bid.

See below three examples of the constitution of the imbalance prices, respectively upward regulation, downward regulation and no regulation:

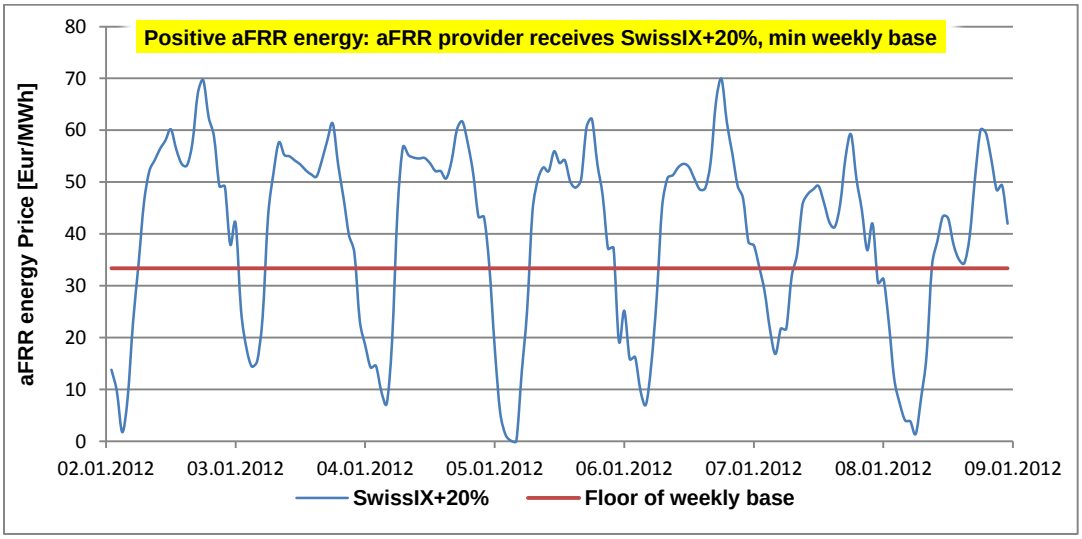


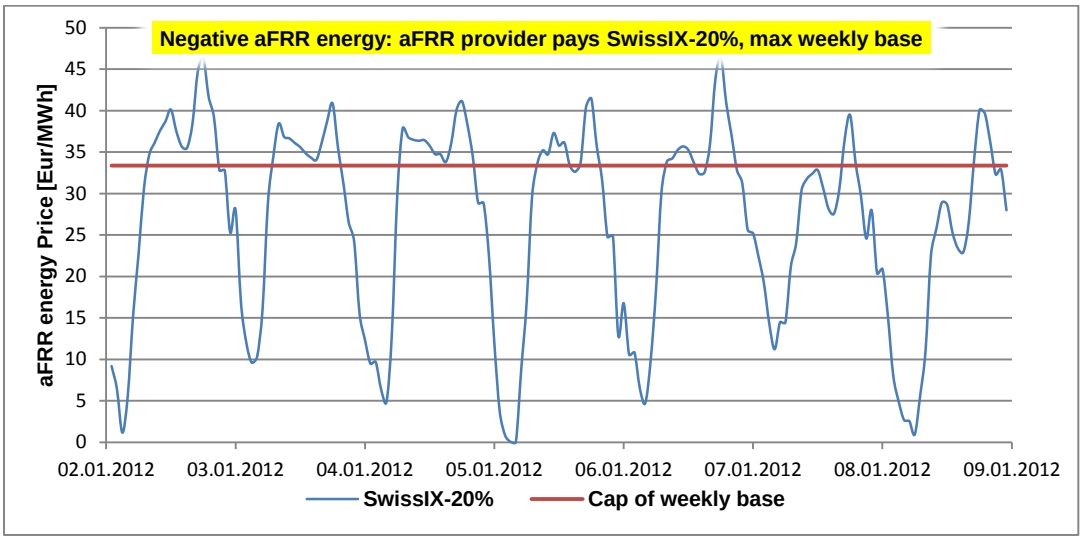




2.8. Switzerland

The Swiss Opportunity Prices are linked with Swiss aFRR energy price that is derived from EPEX hourly spot electricity price, so called Swissix. Below you can find an example for the , the Swiss aFRR energy price (and opportunity price) determination respectively:





The IGCC import and export are evaluated with different IGCC IGCC Opportunity Prices. There is one opportunity price for IGCC import and another opportunity price for IGCC exports in each IGCC settlement period (quarter of an hour).

In Switzerland the provision of aFRR energy is netted for each 15 minutes before the remuneration is calculated. Swissgrid remunerates the netted activation within one time interval with the respective aFRR energy price, thus there are no seperate payments for positive and negative delivery in the same time interval. The netting of aFRR energy deliveries over 15 minutes affects the opportunity costs and will be therefore taken into account when calculating the opportunity costs as follows:

- The balance of aFRR energy delivery without IGCC energy exchange within the aFRR energy accounting period is calculated. Its sign determines the opportunity cost.
- In case of positive balanced demand for aFRR energy (energy shortage) the opportunity cost for deliveries to and from IGCC are set to the cost of aFRR energy positive (+). In case of negative balanced demand for aFRR energy (energy surplus) the opportunity costs deliveries to and from IGCC are set to the cost of aFRR energy negative (-), respectively.
- In the very unlikely case of completely netted demand the opportunity costs are set to an average of aFRR energy + and aFRR energy - costs.

Example for Swiss IGCC Opportunity Price				
15-min intervals	Netted aFRR energy amount without IGCC energy exchange in MWh	aFRR negative energy price (Swissix - 20%, max weekly base) €/MWh	aFRR positive energy price (Swissix +20%, min weekly base) €/MWh	Swiss IGCC Opportunity Price €/MWh
00-15	30	22.64	33.96	33.96
15-30	-20	30.55	45.83	30.55
30-45	0	33.37	52.06	42.72