IGCC workshop

3.11.2014, Brussels

Agenda

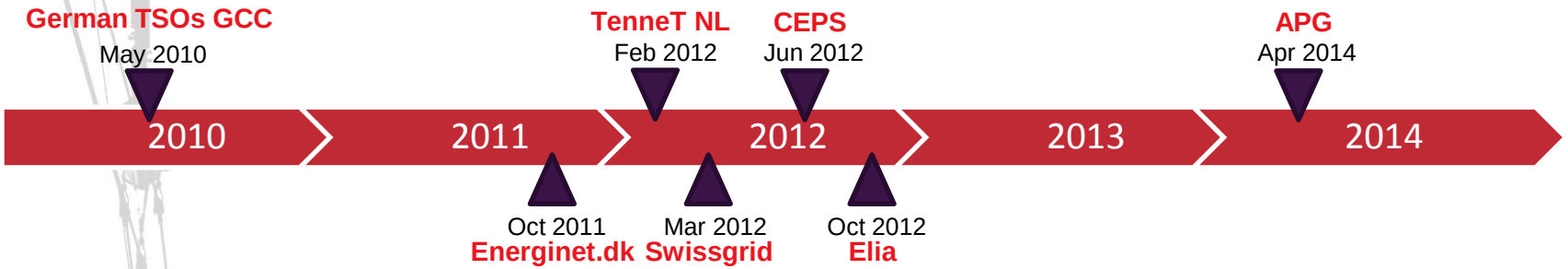
10:00 – 10:15	General introduction
10:15 – 11:00	Imbalance netting in IGCC
	Coffee break
11:20 – 11:40	Governance structure
11:40 – 12:30	Implementation in national markets, part I
	Lunch
13:15 – 14:45	Implementation in national markets, part II
	Coffee break
15:00 – 15:30	Future development
15:30 – 16:00	Closing remarks

General introduction

IGCC Introduction

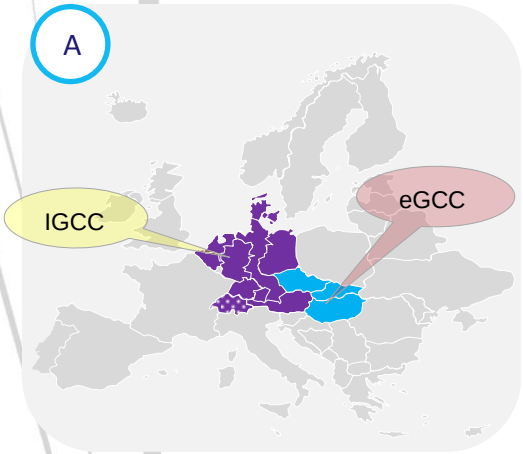
- Since May 2010, all four German TSOs have launched the so called **Grid Control Cooperation (GCC)** to optimize secondary control procurement and activation

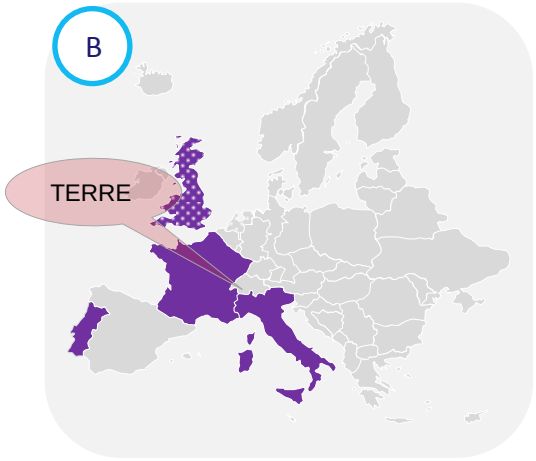
- Many aspects of the GCC system are open for a contribution of TSO's from neighboring countries, so called **International Grid Control Cooperation (IGCC)**

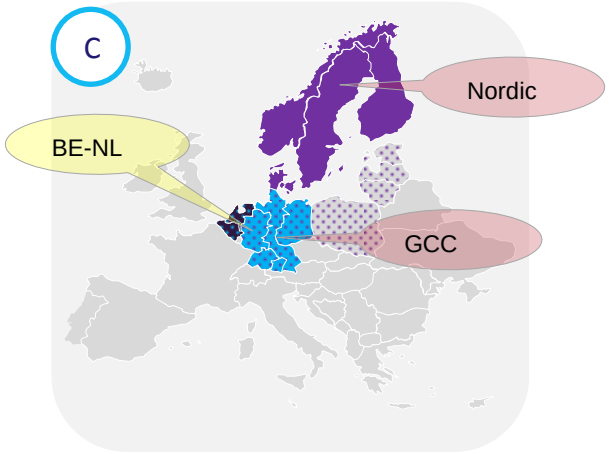


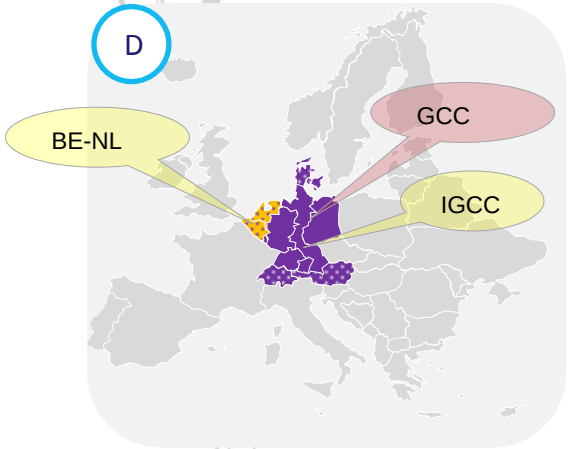
Pilot projects – EU context

8 EU pilot projects in total

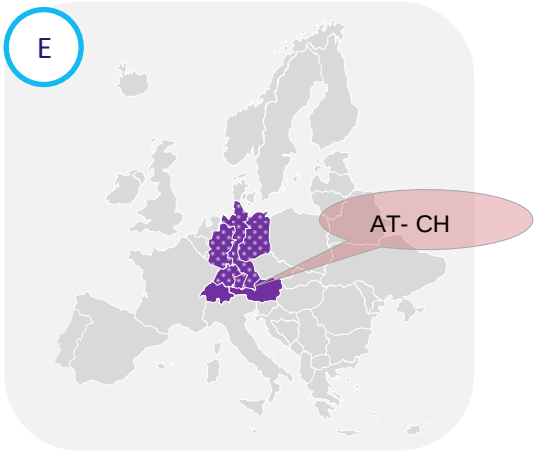








A. Imbalance Netting (IN)
B. Replacement Reserve (RR)
C. Manual Frequency Restoration (mFRR)
D. Automatic Frequency Restoration (aFRR)
E. Frequency Containment Reserve (FCR)



Imbalance Netting in IGCC

1. Introduction

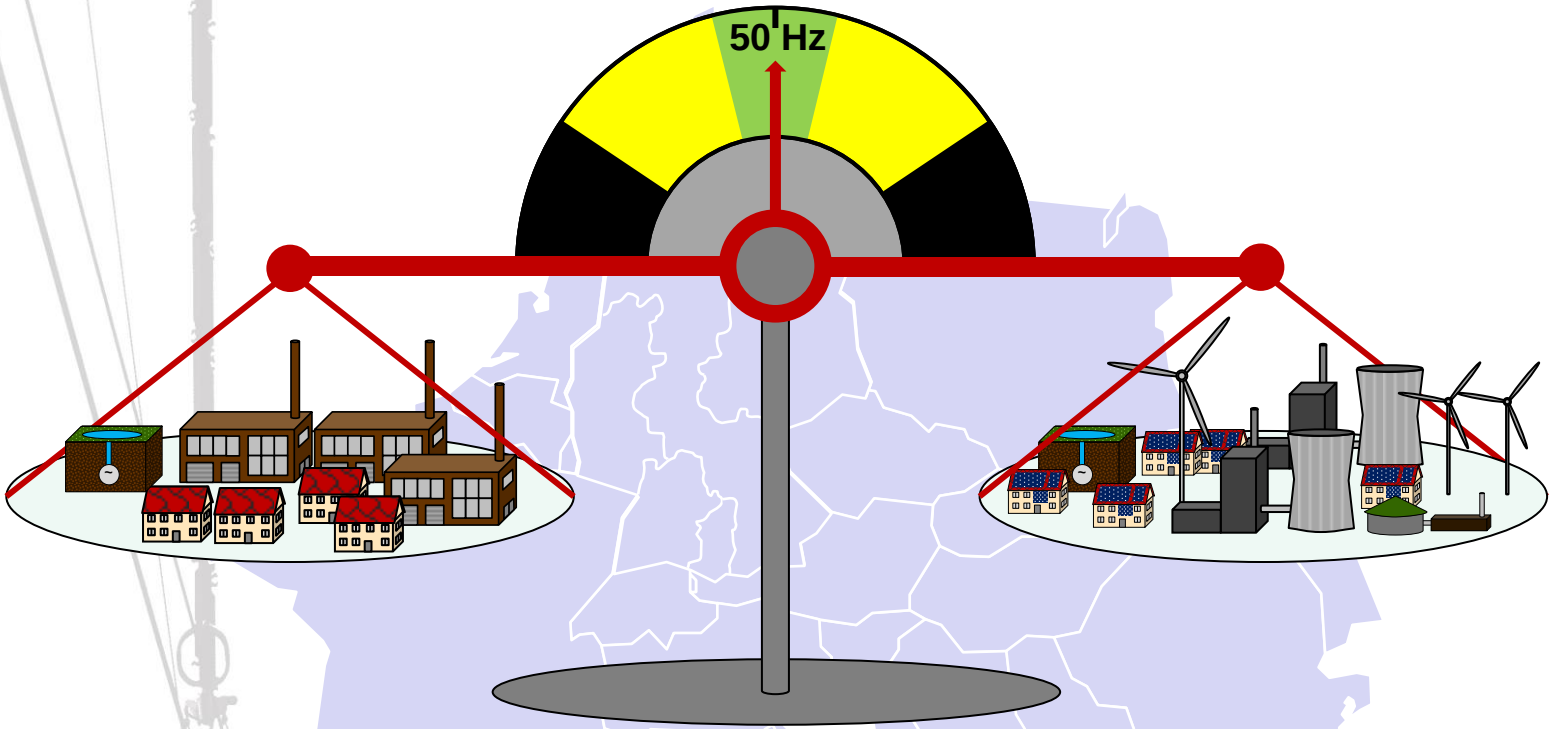
2. IGCC - Technical Overview

3. Experience

Frequency and Active Power

Production = Consumption

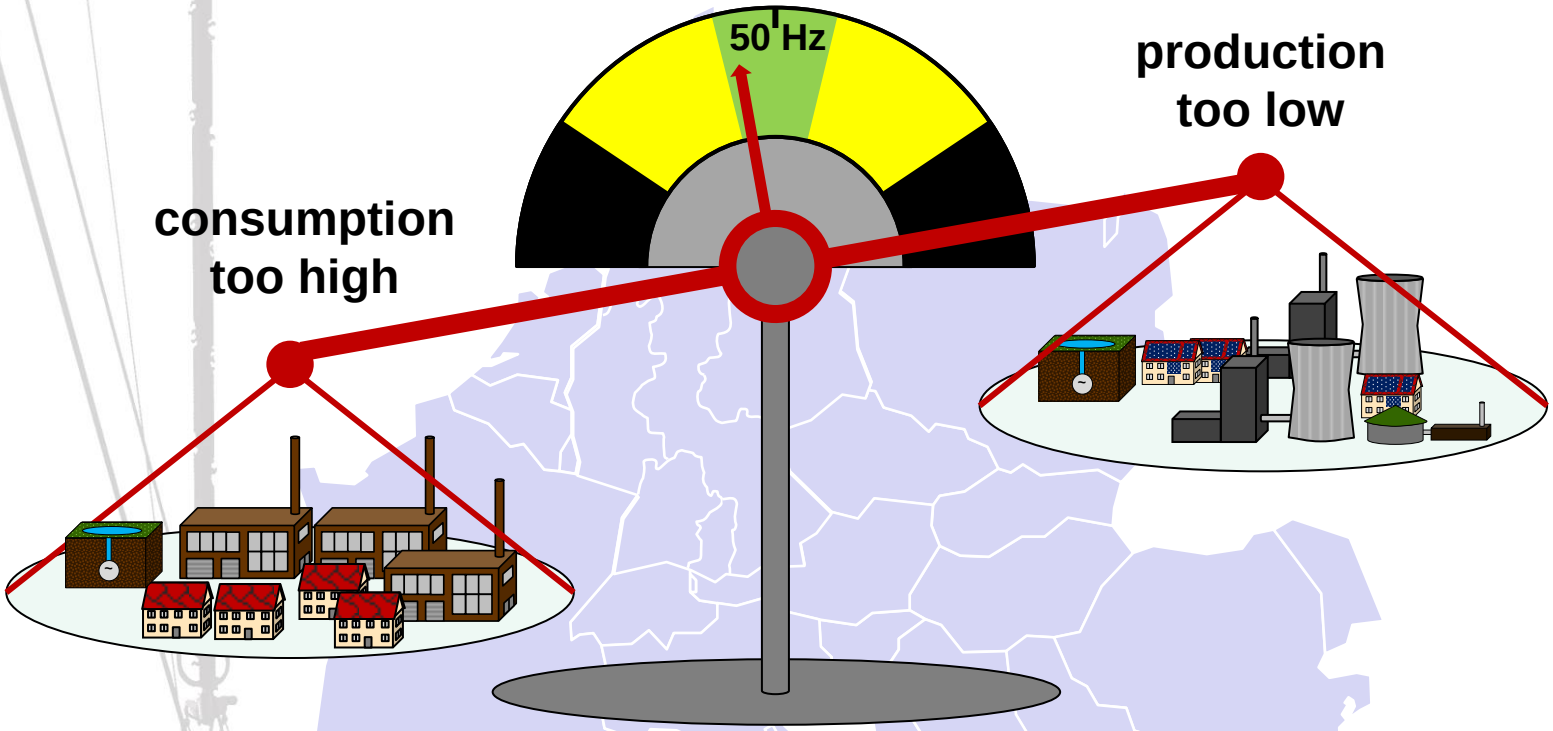
Frequency = 50 Hz



Frequency and Active Power

Production < Consumption

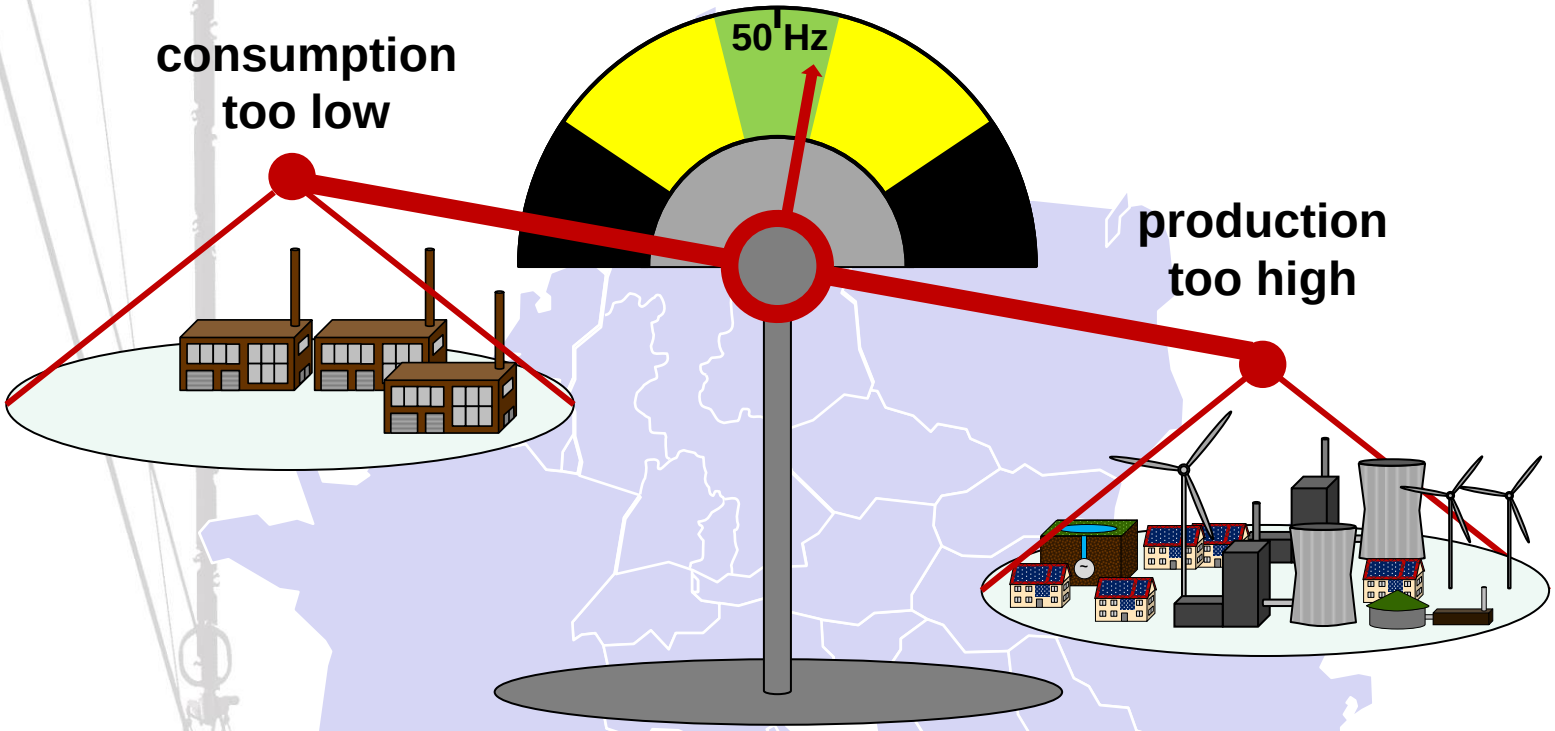
Frequency decreases



Frequency and Active Power

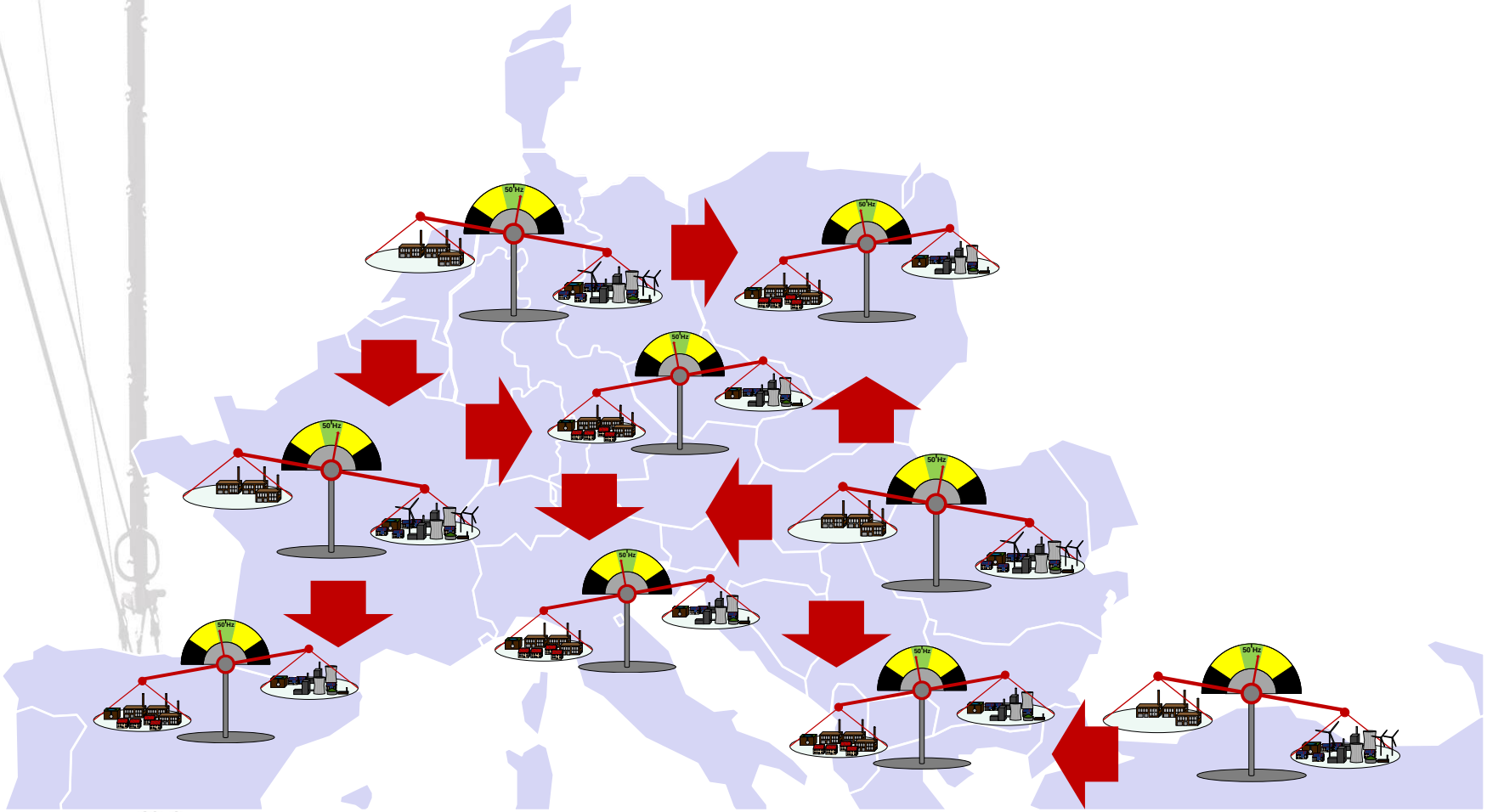
Production > Consumption

Frequency increases



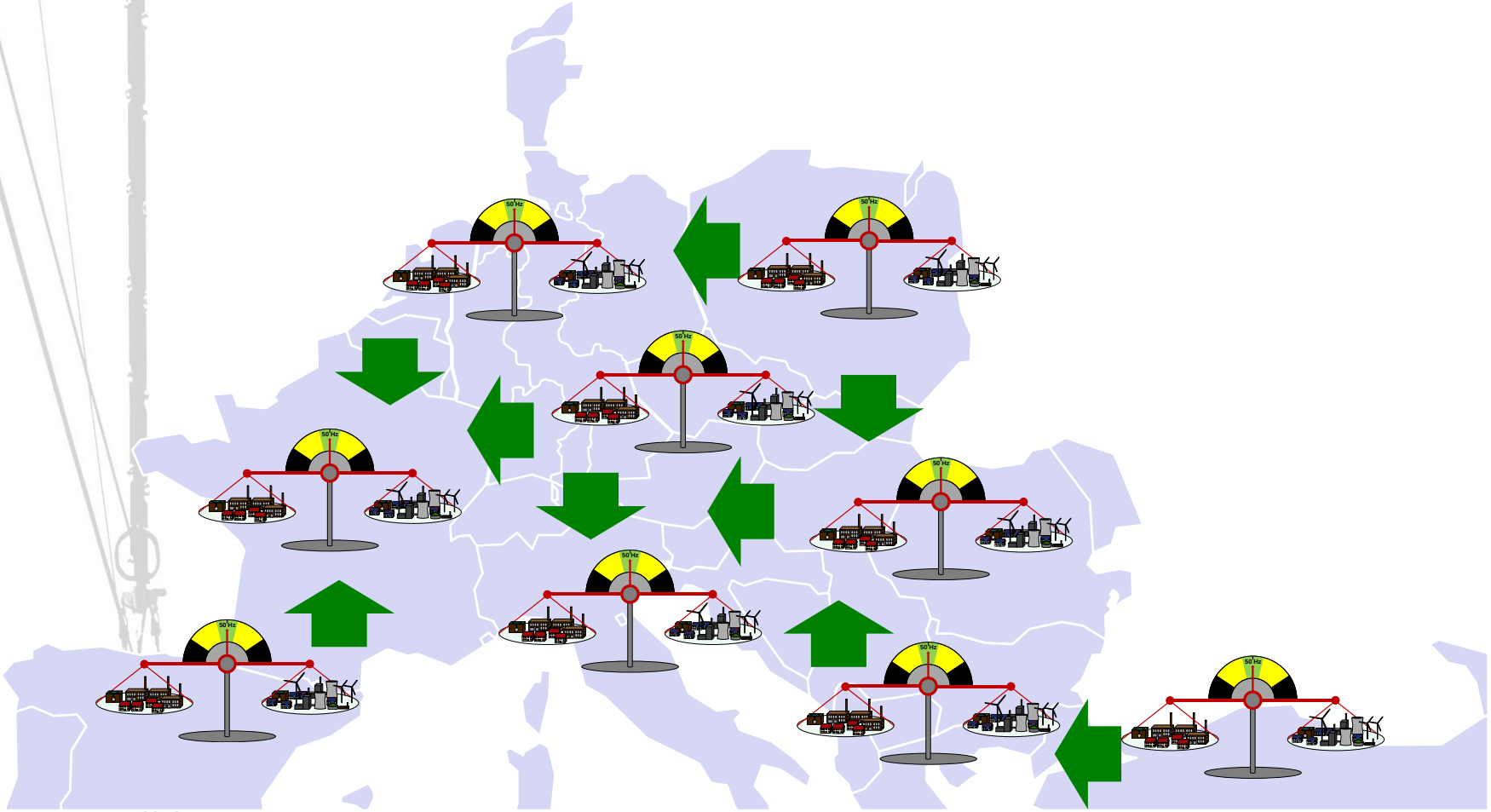
Imbalances and Flows

One frequency, but control of local imbalances is necessary …



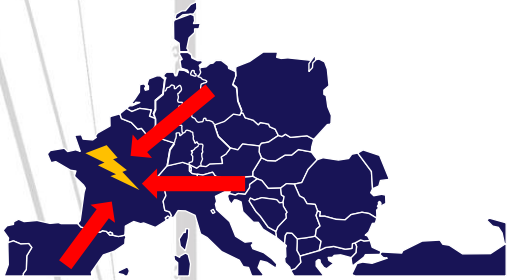
Imbalances and Flows

One frequency, but control of local imbalances is necessary in order to prevent uncontrolled flows



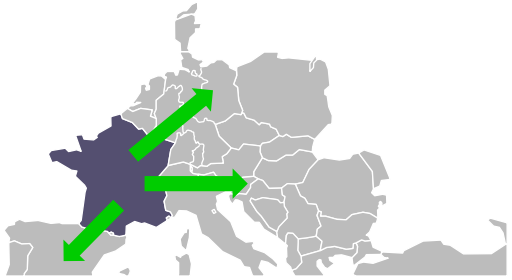
Load-Frequency-Control

Frequency Containment Reserves



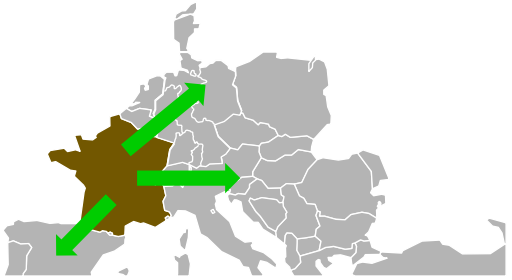
Stabilization

Frequency Restoration Reserves

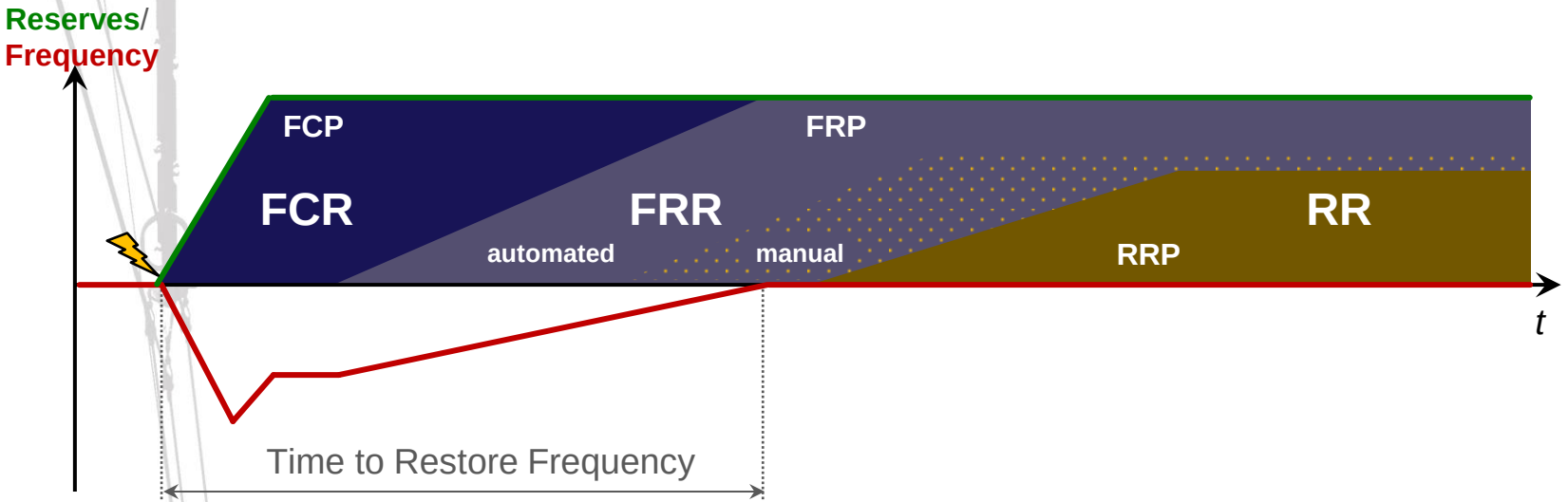


Control to Set-Point

Replacement Reserves

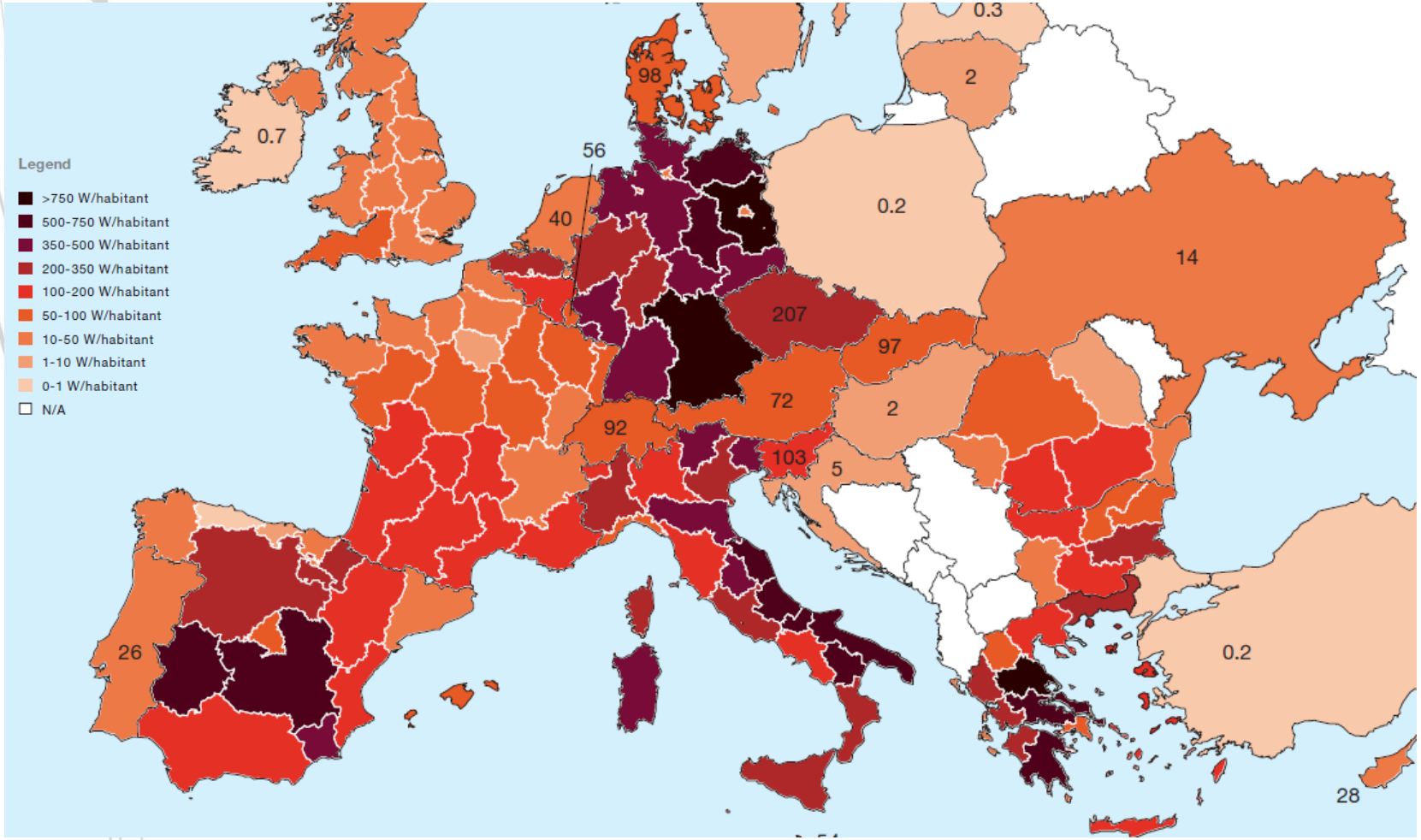


Release Used FRR

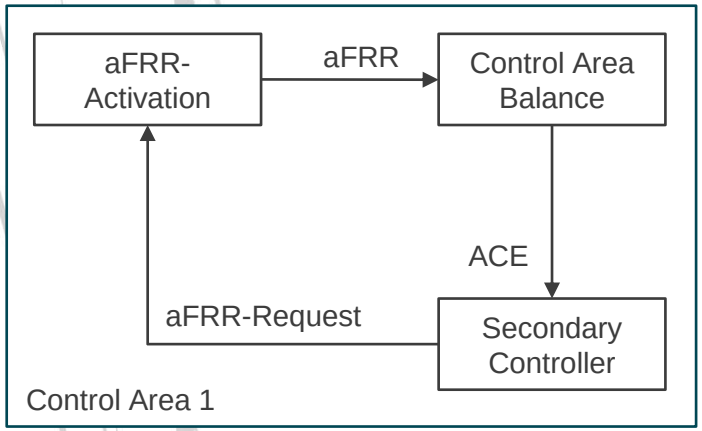


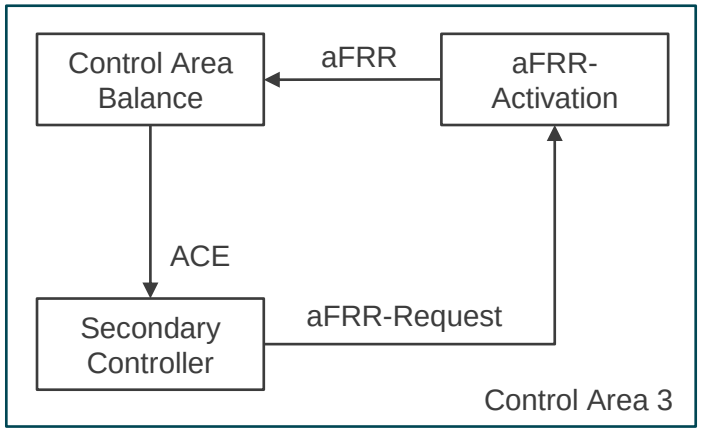
Need for Coordination - Example

Installed PV per Capita in 2013 (Source: EPIA)

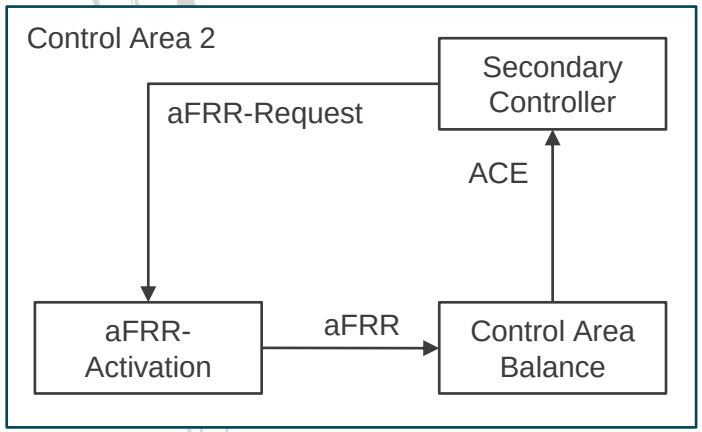


Imbalance Netting





Optimisation Potential!

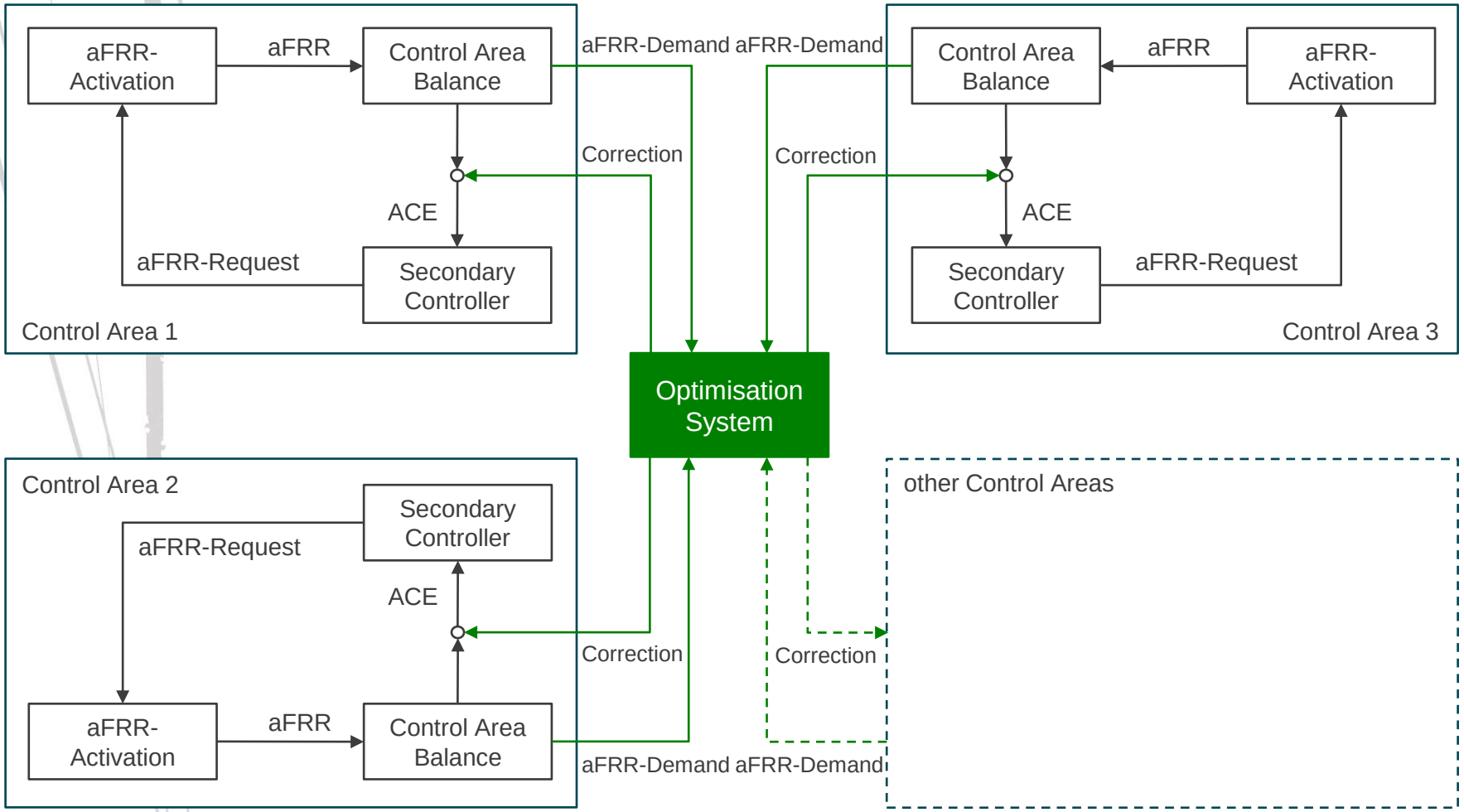


1. Introduction

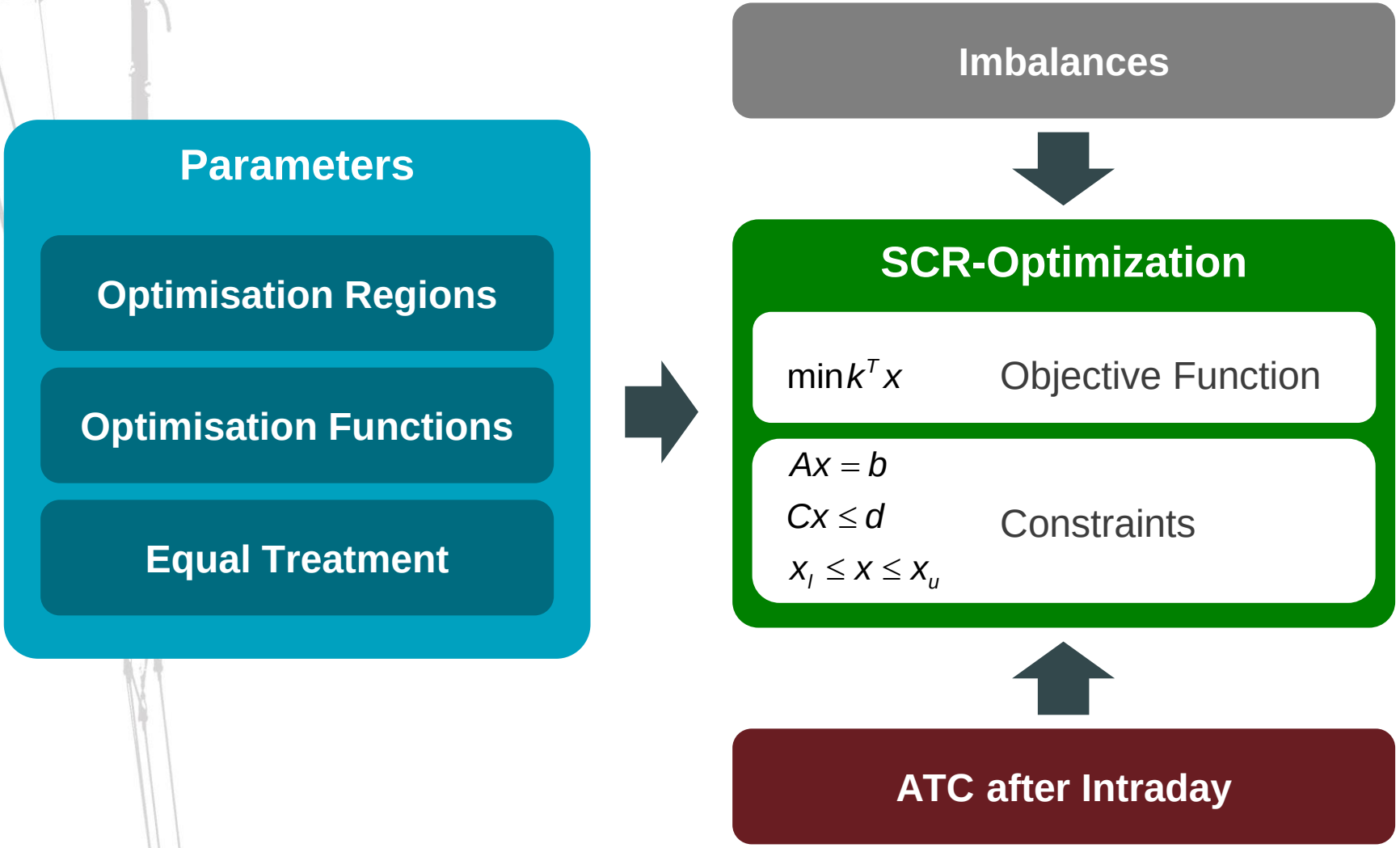
2. IGCC - Technical Overview

3. Experience

Imbalance Netting

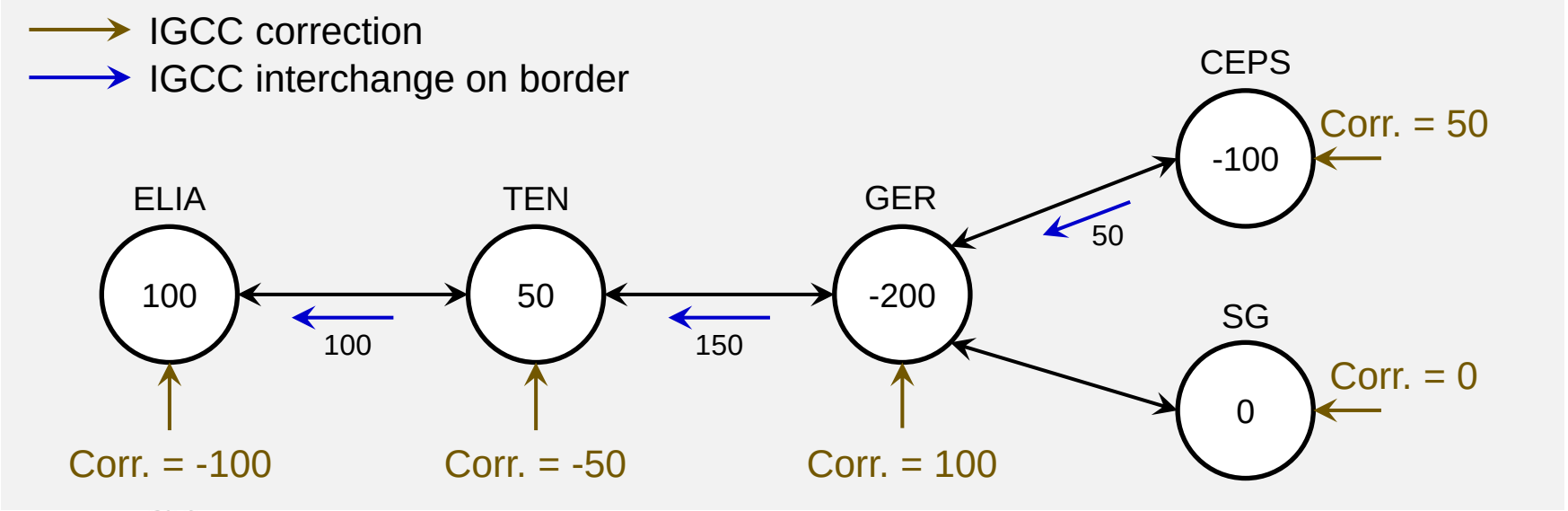


Algorithm Structure



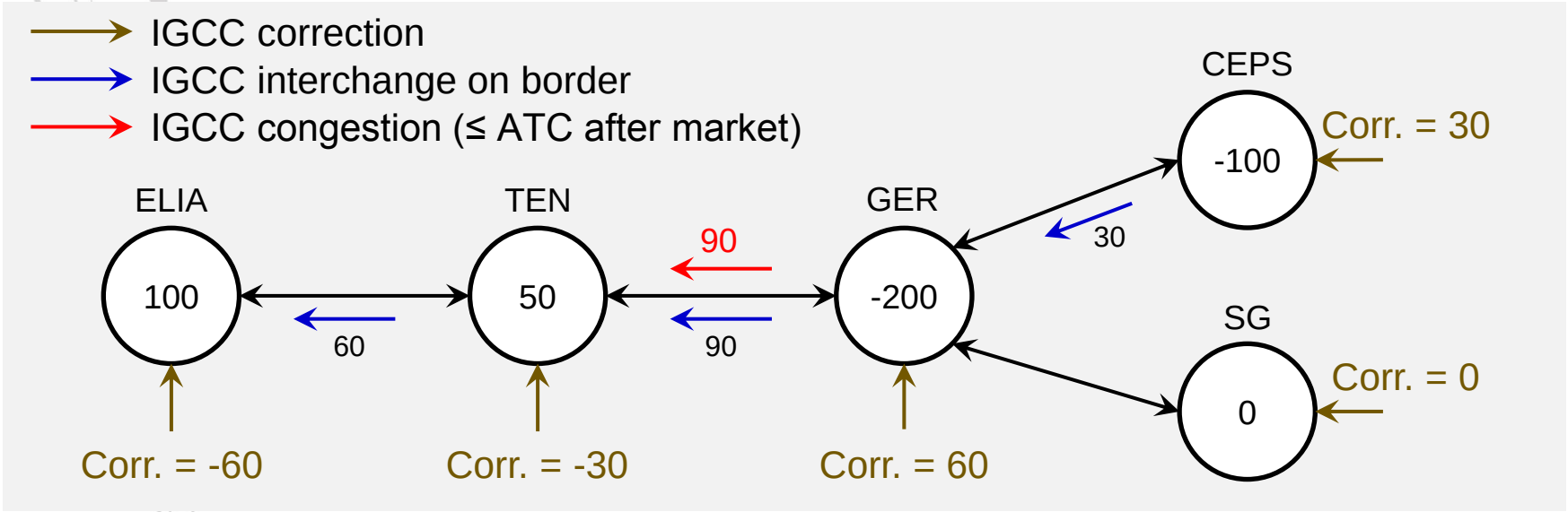
IGCC: Pro-Rata Distribution of Netting Potential (Example 1)

Control Block	ELIA	TEN	GER	CEPS	SG
Imbalance (SCR demand) [MW]	100	50	-200	-100	0
Correction without congestions [MW]	-100	-50	100	50	0



IGCC: Pro-Rata Distribution of Netting Potential (Example 2)

Control Block	ELIA	TEN	GER	CEPS	SG
Imbalance (SCR demand) [MW]	100	50	-200	-100	0
Correction without congestions [MW]	-100	-50	100	50	0
Correction with congestions [MW]	100	-100	0	0	0

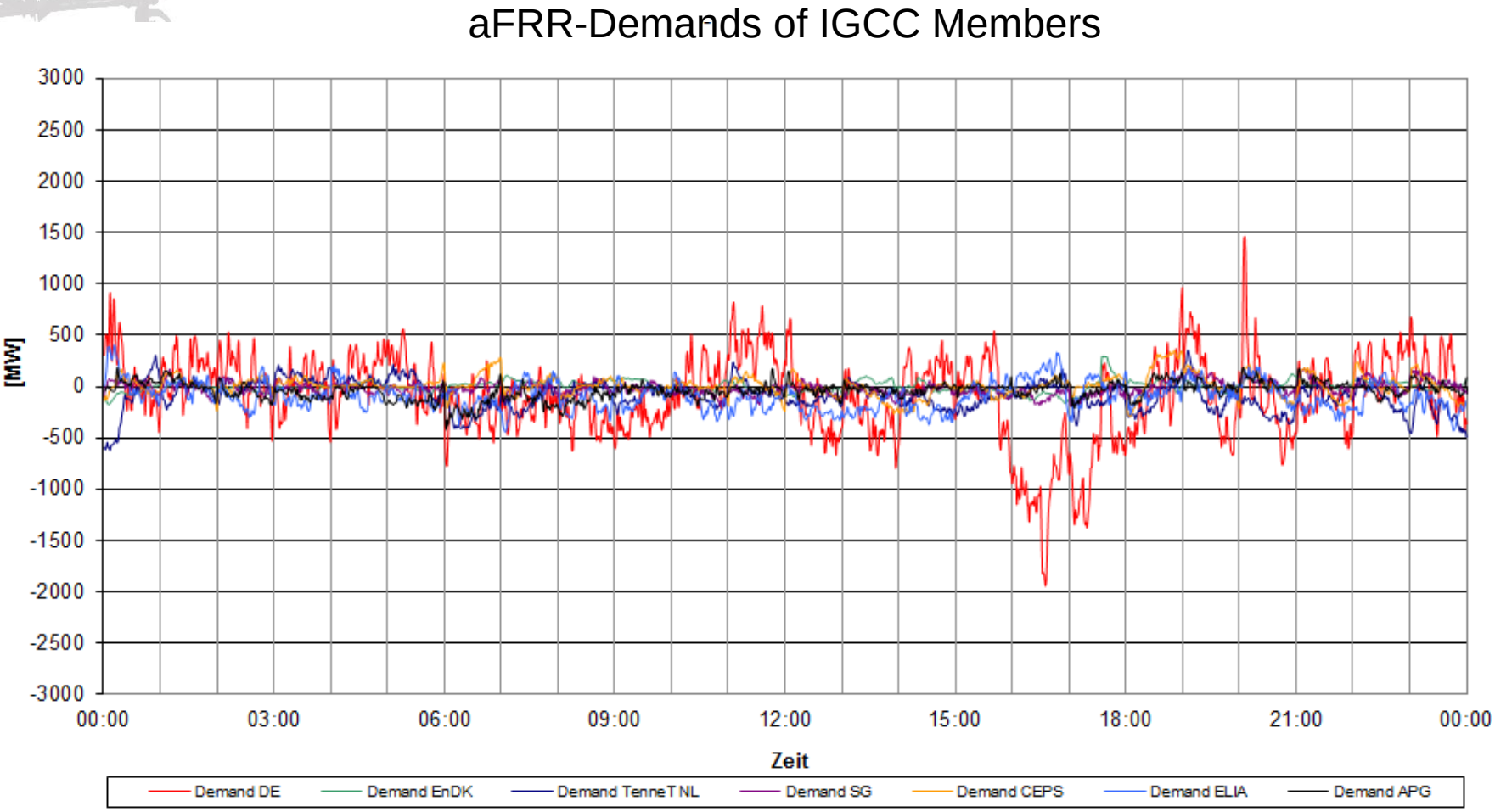


1. Introduction

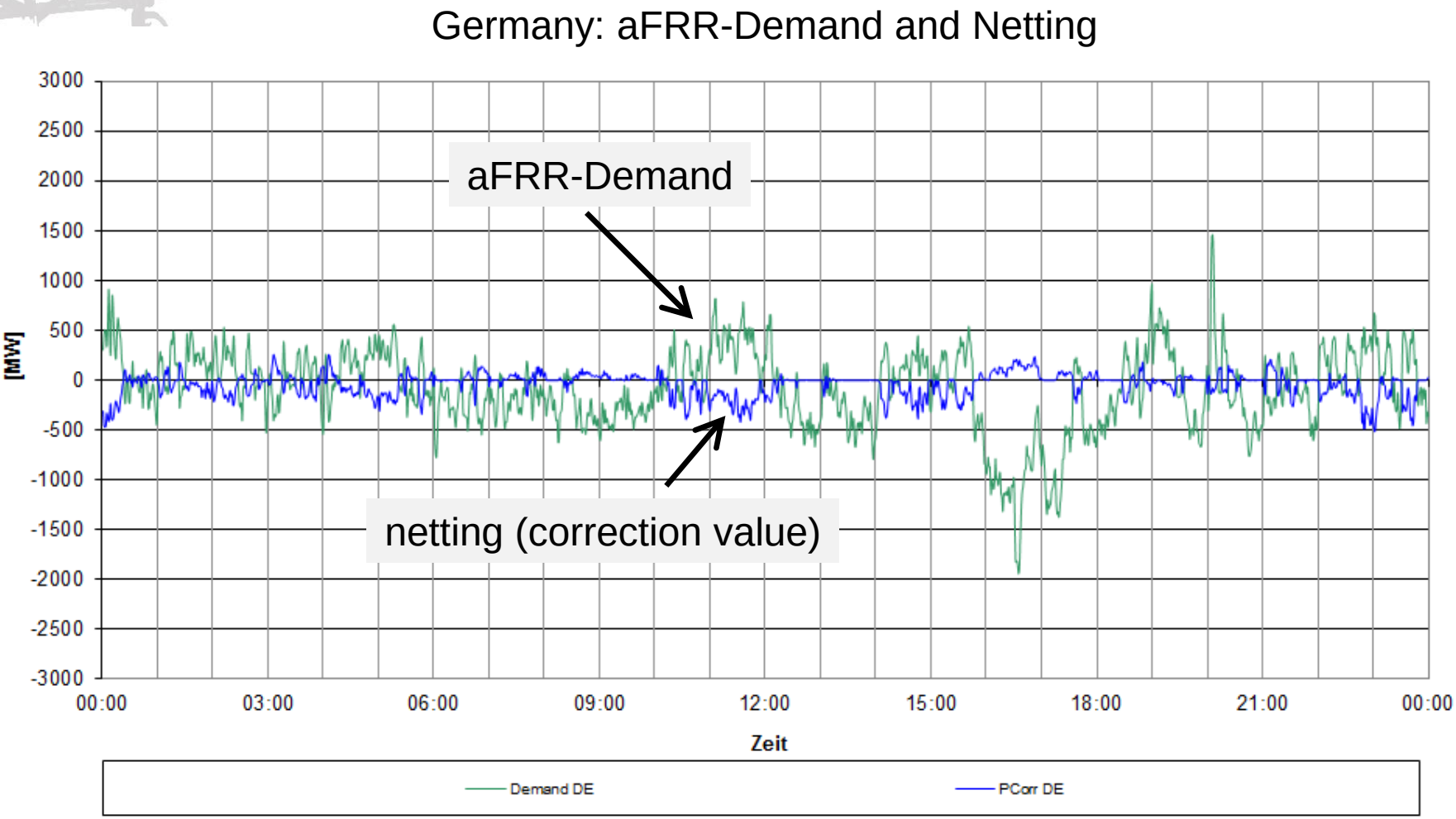
2. IGCC - Technical Overview

3. Experience

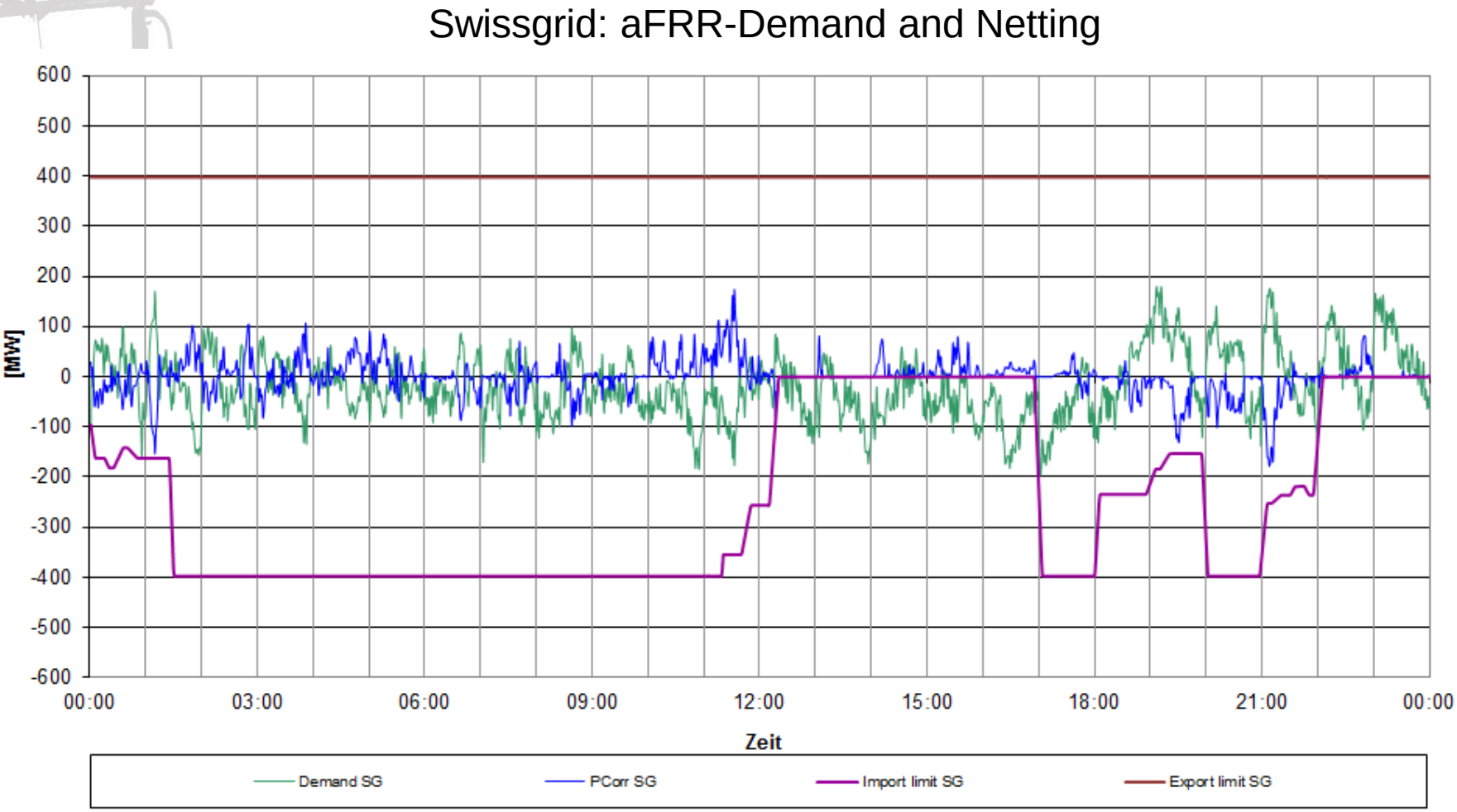
Operation Example (Random Pick)



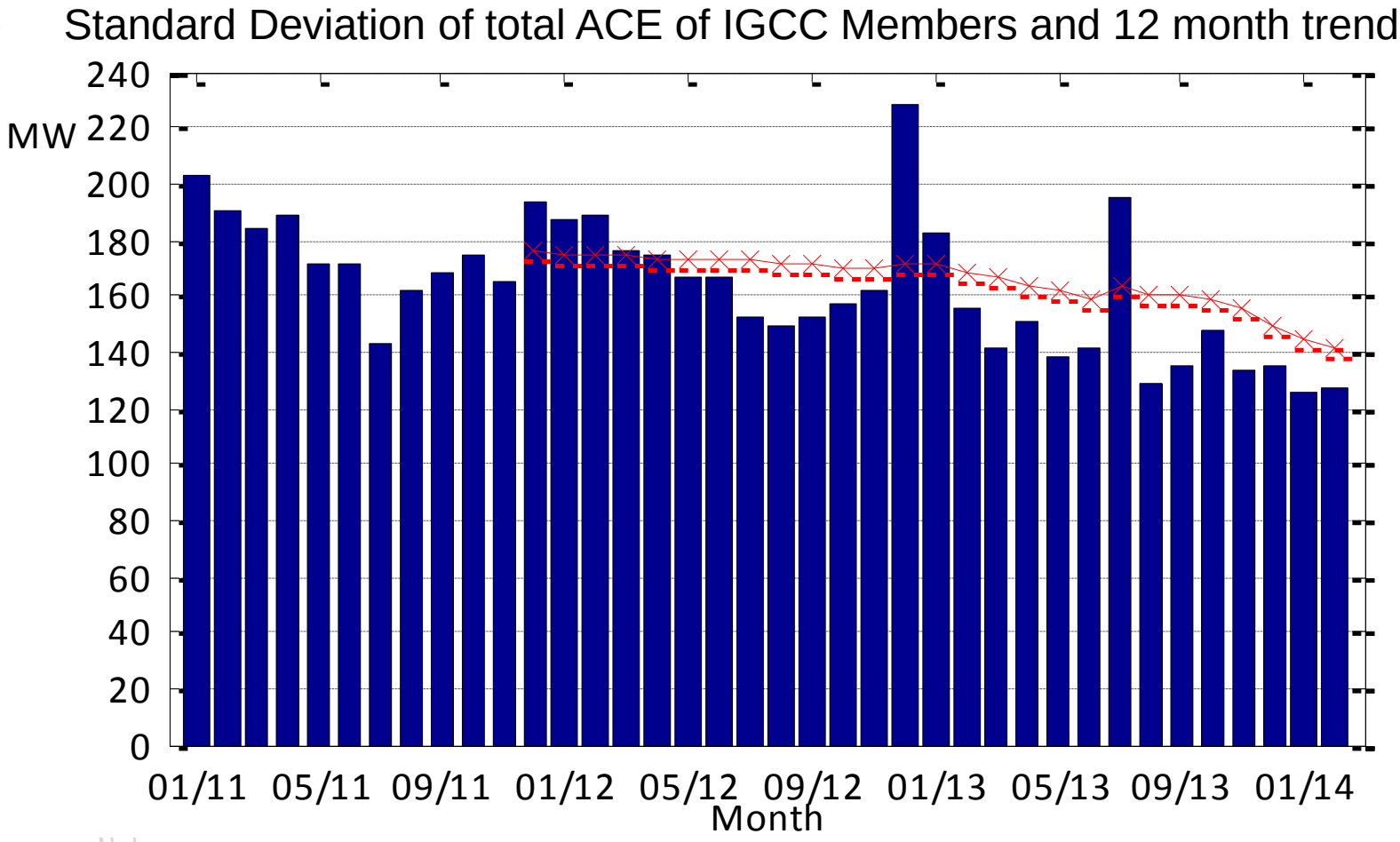
Operation Example (Random Pick)



Operation Example (Random Pick)



ACE Quality – Historical Development



Settlement

Opportunity Price as Input for Settlement in IGCC

without IGCC	with IGCC	Opportunity Price = Opportunity Value/IGCC Volume
$SCE_{before\ IGCC}$ [MWh] x $SCE\ price_{before\ IGCC}$ [€/MWh]	IGCC exchange: $SCE_{after\ IGCC}$ [MWh] x $SCE\ price_{after\ IGCC}$ [€/MWh]	[($SCE_{before\ IGCC}$ * $SCE\ price_{before\ IGCC}$) - ($SCE_{after\ IGCC}$ * $SCE\ price_{after\ IGCC}$)] / IGCC exchange

Calculation of IGCC Settlement Price

- IGCC Settlement Price (C_{IGCC}): **Energy weighted** ($E_{\mathrm{Imp},i}$ and $E_{\mathrm{Exp},i}$) **average** of the **opportunity prices** ($C_{\mathrm{Imp},i}$ and $C_{\mathrm{Exp},i}$)
- Single price for all IGCC exchanges

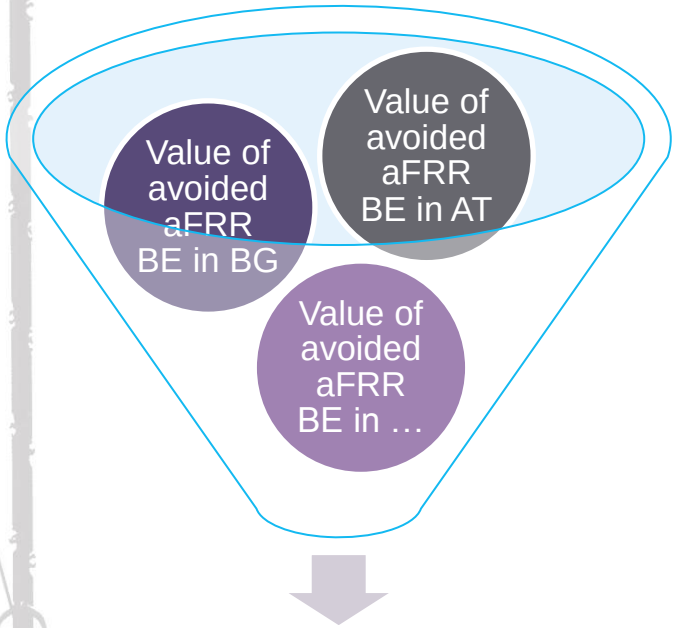
$$C_{\mathrm{IGCC}} = \sum_{i=1}^{n} \left(C_{\mathrm{Imp},i} E_{\mathrm{Imp},i} + C_{\mathrm{Exp},i}\, E_{\mathrm{Exp},i}\right) \Big/ \sum_{i=0}^{n} \left(E_{\mathrm{Imp},i} + E_{\mathrm{Exp},i}\right)$$

Value of Netted Imbalances

- Value of avoided activations for a participant is driven by the spread between the opportunity price and the IGCC settlement price

$$R_{\mathrm{IGCC}} = \sum_{i=1}^{n} \left(C_{\mathrm{Imp},i} - C_{\mathrm{IGCC}}\right) \cdot E_{\mathrm{Imp},i} + \sum_{i=1}^{n} \left(C_{\mathrm{IGCC}} - C_{\mathrm{Exp},i}\right) \cdot E_{\mathrm{Exp},i}$$

Compliance with NC EB Draft

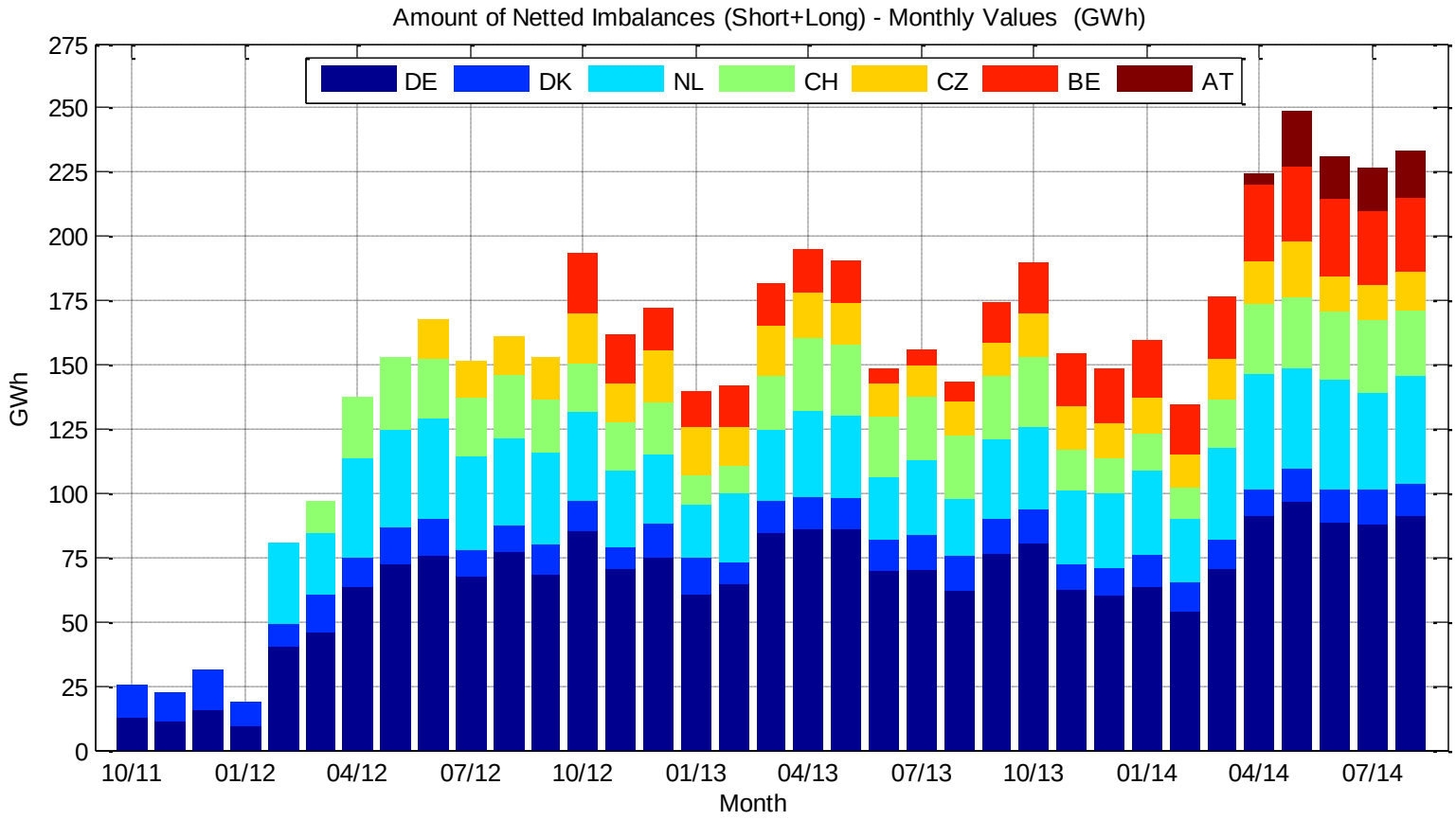


IGCC Settlement Price

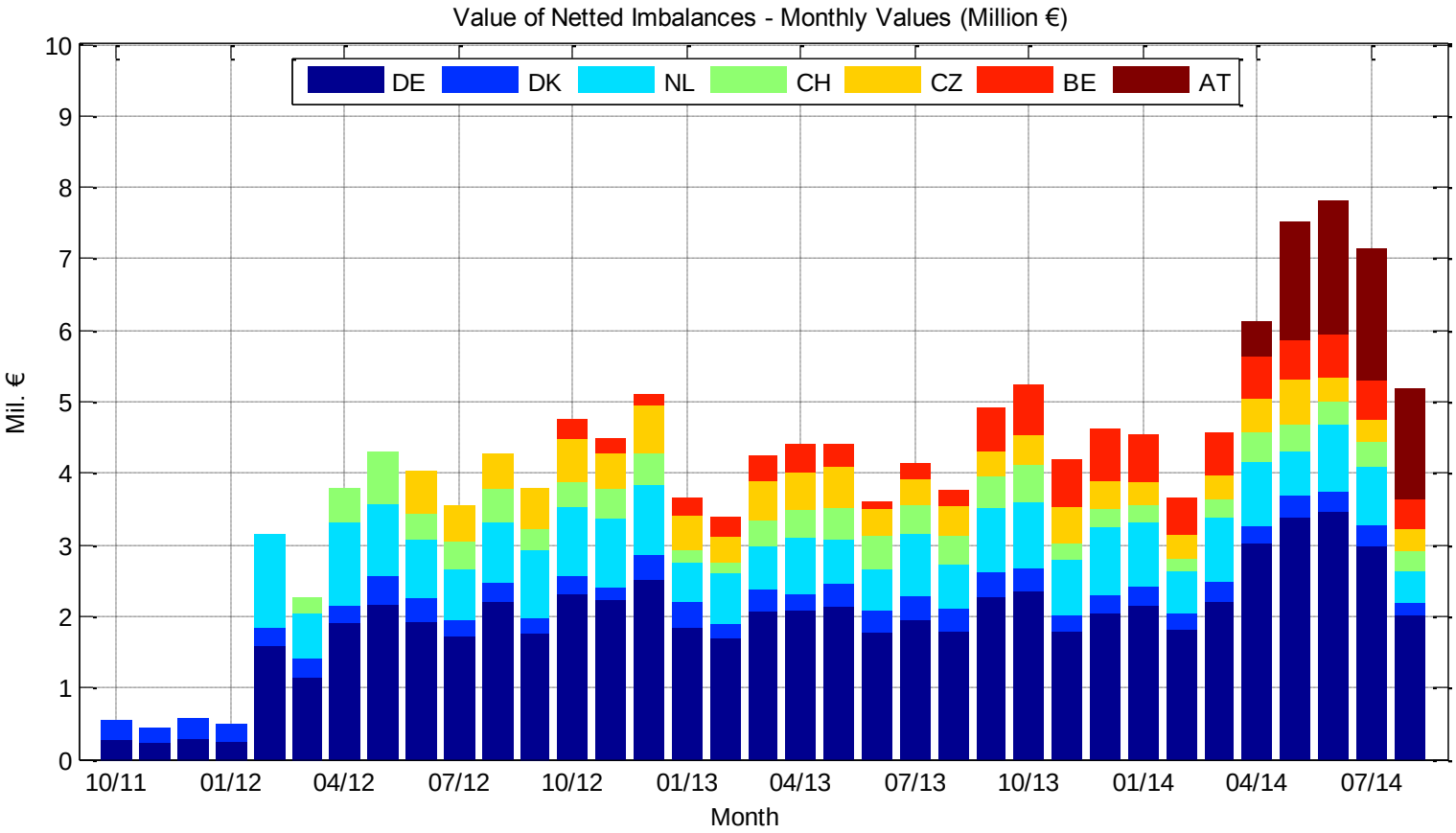
- ✓ Calculated for a 15min settlement interval
- ✓ Same for export and import
- ✓ Same for every participant
- ✓ Integral of power exchanges matched before
- ✓ Based on avoided aFRR BE costs

BE - Balancing Energy

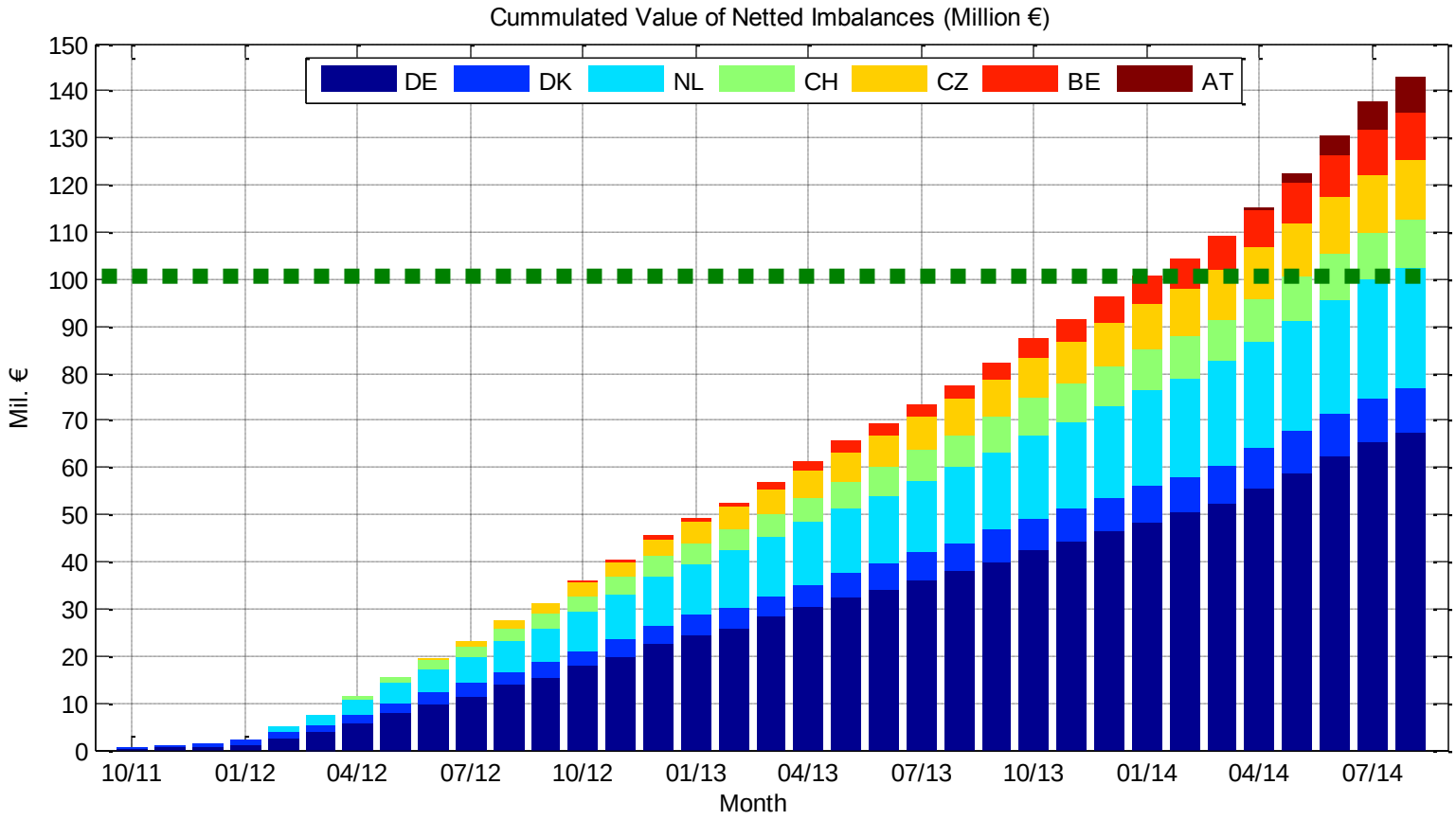
Netted Amounts



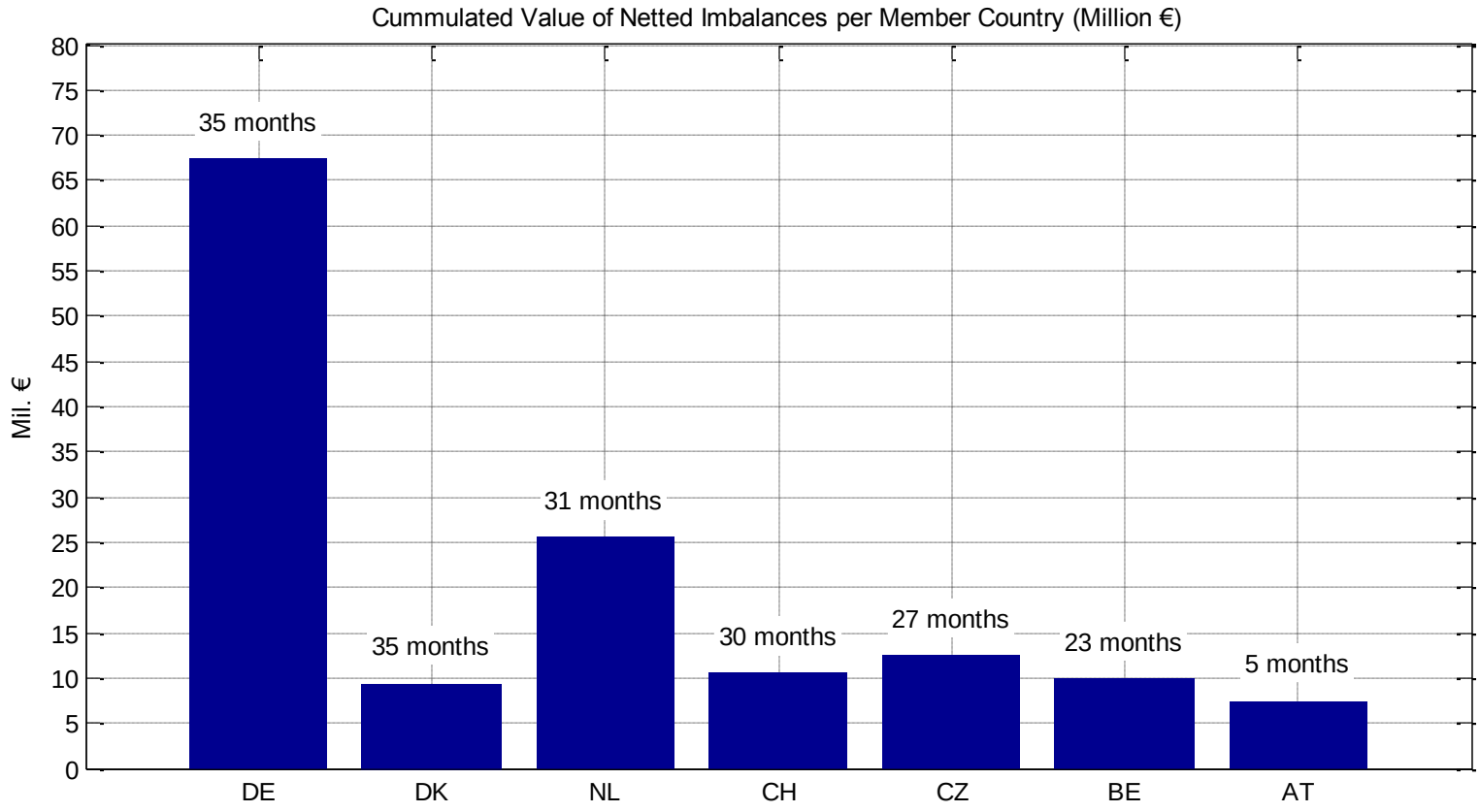
Monetary Value of Netting



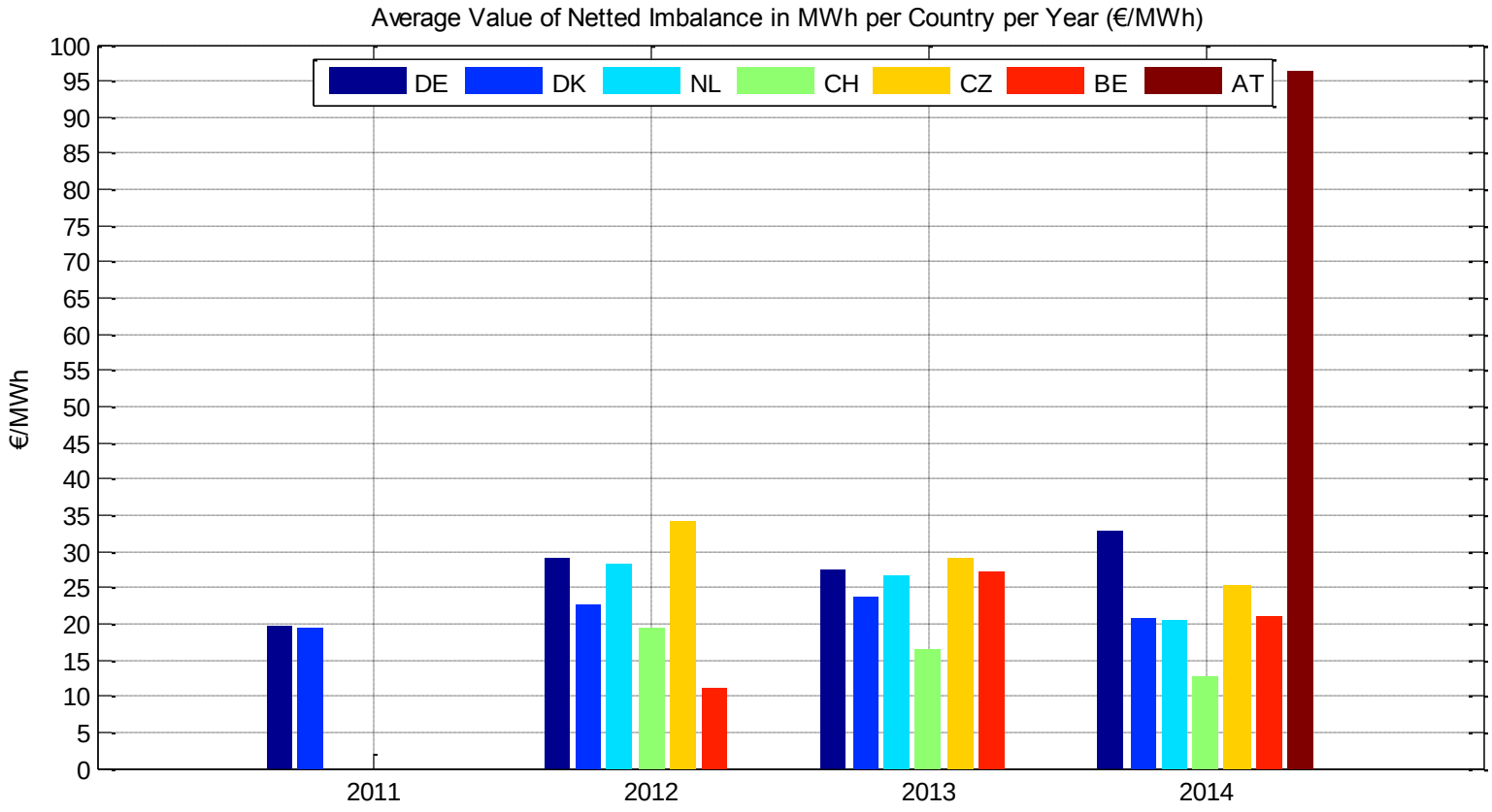
Cumulated Monetary Value



Cumulated Monetary Value per Member Country



Average Monetary Value of Netting per Member Country



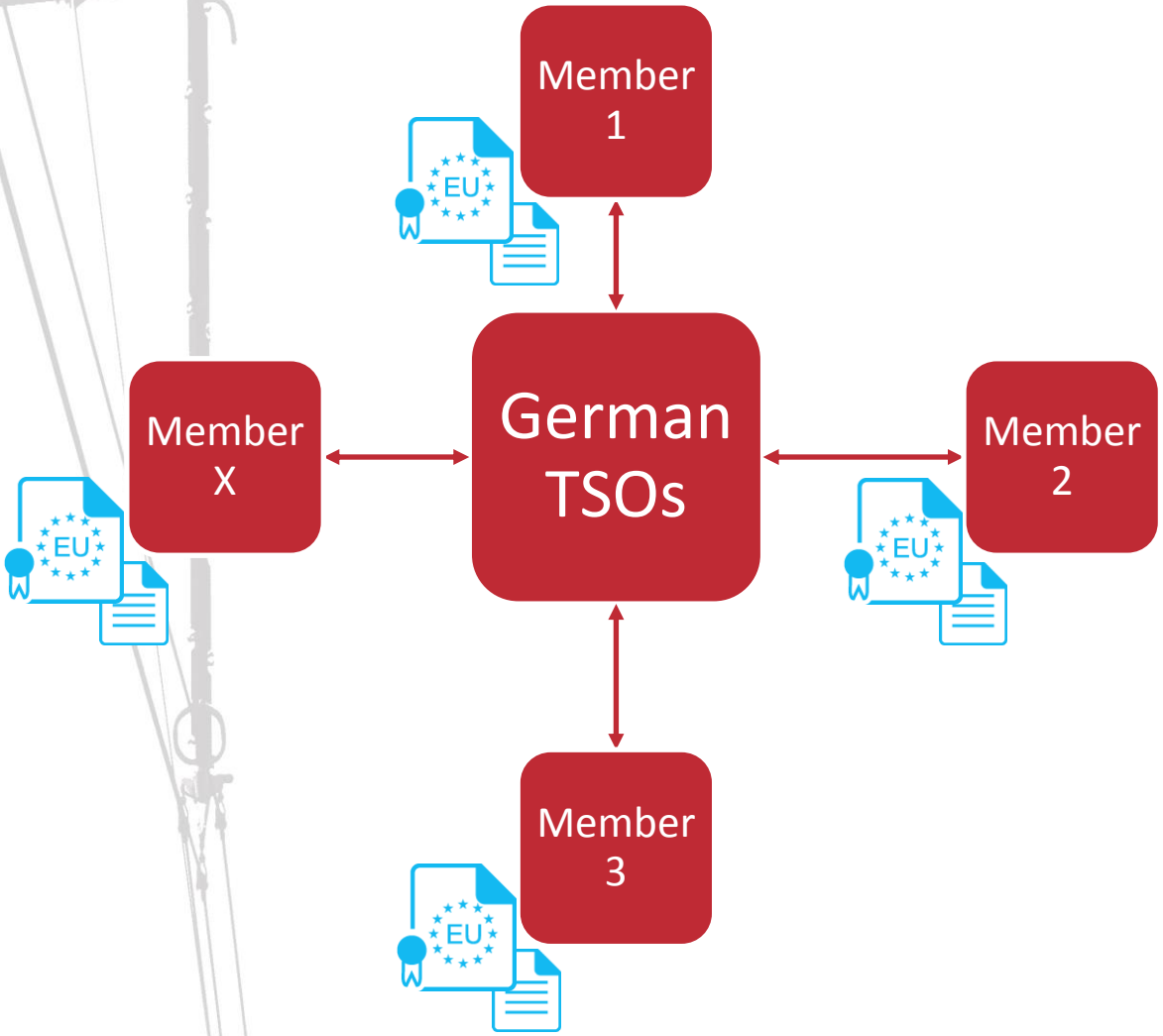
Differences are driven by different aFRR energy prices!

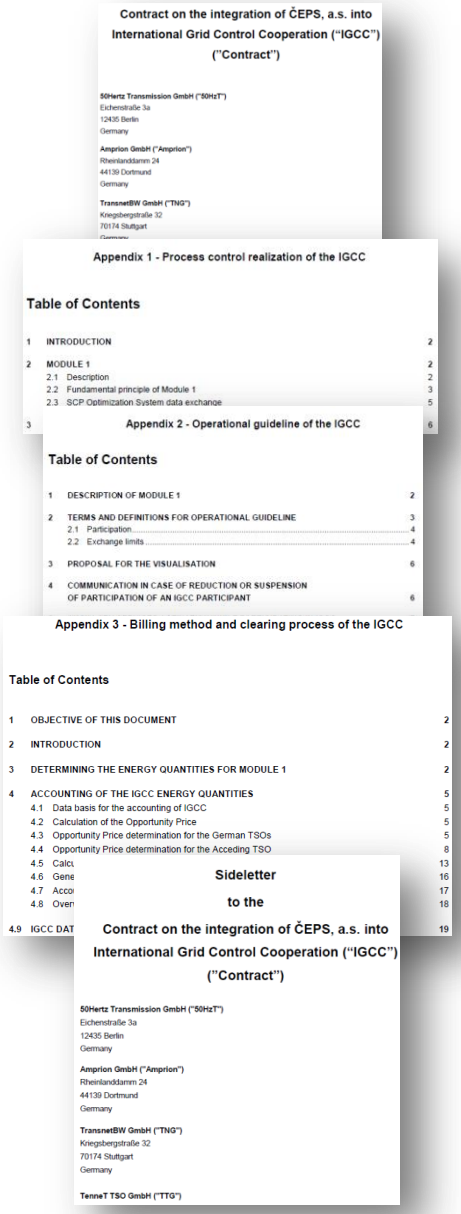
IGCC - Summary

- ✓ **Robust technical framework**
- ✓ **Increase of ACE quality**
- ✓ **Current monetary value of netted imbalances > €140 million**

Governance structure

Status quo – Bilateral agreements





Contract on the integration of ČEPS, a.s. into International Grid Control Cooperation ("IGCC") ("Contract")

50Hertz Transmission GmbH ("50HzT")
Eichenstraße 3a
12435 Berlin
Germany

Amprion GmbH ("Amprion")
Rheinlanddamm 24
44139 Dortmund
Germany

TransnetBW GmbH ("TNG")
Kriegsbergstraße 32
70174 Stuttgart
Germany

Appendix 1 - Process control realization of the IGCC

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Appendix 2 - Operational guideline of the IGCC

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4 COMMUNICATION IN CASE OF REDUCTION OR SUSPENSION OF PARTICIPATION OF AN IGCC PARTICIPANT 6

Appendix 3 - Billing method and clearing process of the IGCC

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Sideletter to the Contract on the integration of ČEPS, a.s. into International Grid Control Cooperation ("IGCC") ("Contract")

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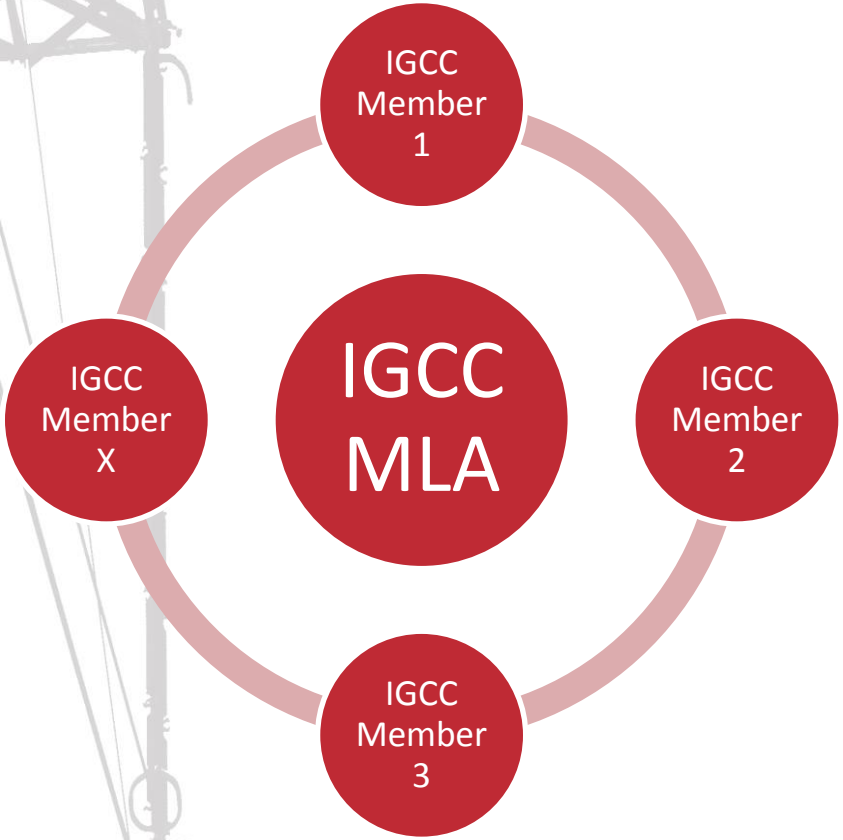
Kriegsbergstraße 32
70174 Stuttgart
Germany

TenneT TSO GmbH ("TTG")

Near future – The IGCC MLA



All IGCC Members will become parties to one agreement

Each IGCC Member is solely responsible for operation of its system and for correct determination of IGCC operation values

A two level working structure

Strengthen decision making

10/2013 — Agreement on the IGCC MLA development

2014 — Development of the IGCC MLA

H1/2015 — Signature of the IGCC MLA

The IGCC MLA – Working structure

Decision making

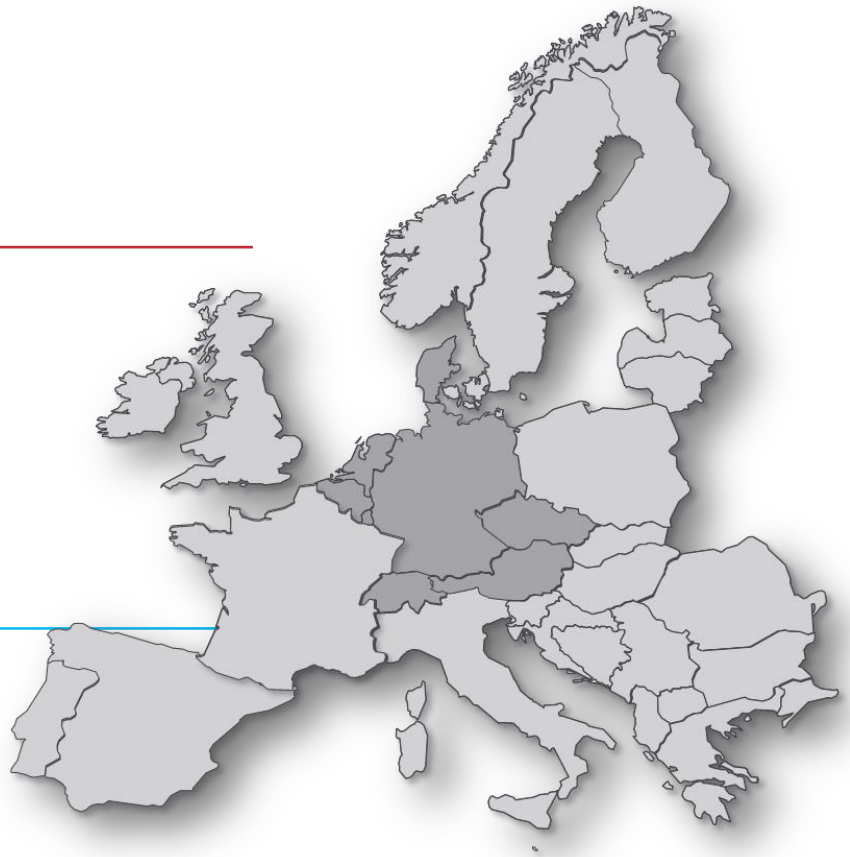
IGCC Steering Committee

- The decision making body
- Superior body to the IGCC EG
- Meets at least once per year

Expert - working level

IGCC Expert Group

- The expert body
- Proposes and evaluates concepts
- Meets regularly



IGCC Expert Group Convener

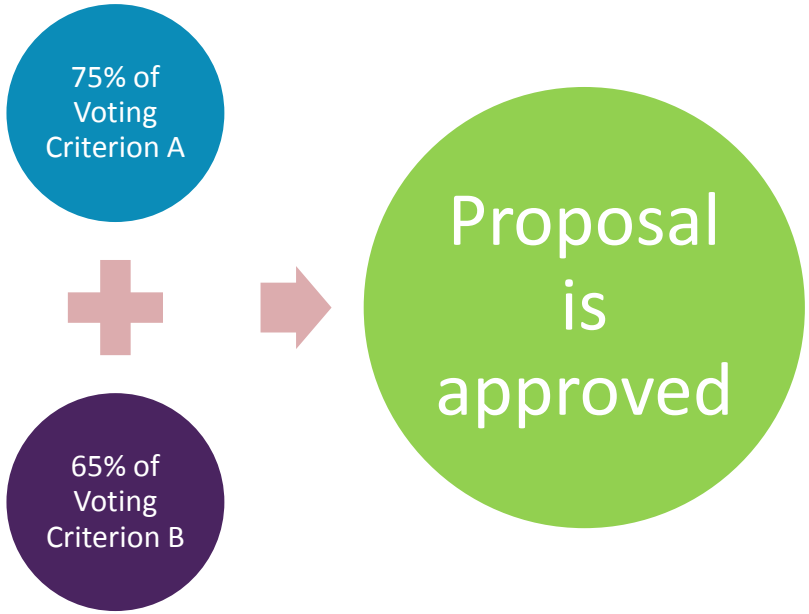
- Organization of the IGCC EG work
- Single point of contact between IGCC SC and IGCC EG

Facilitating Party

- Supports work of the IGCC

The IGCC MLA – Decision making

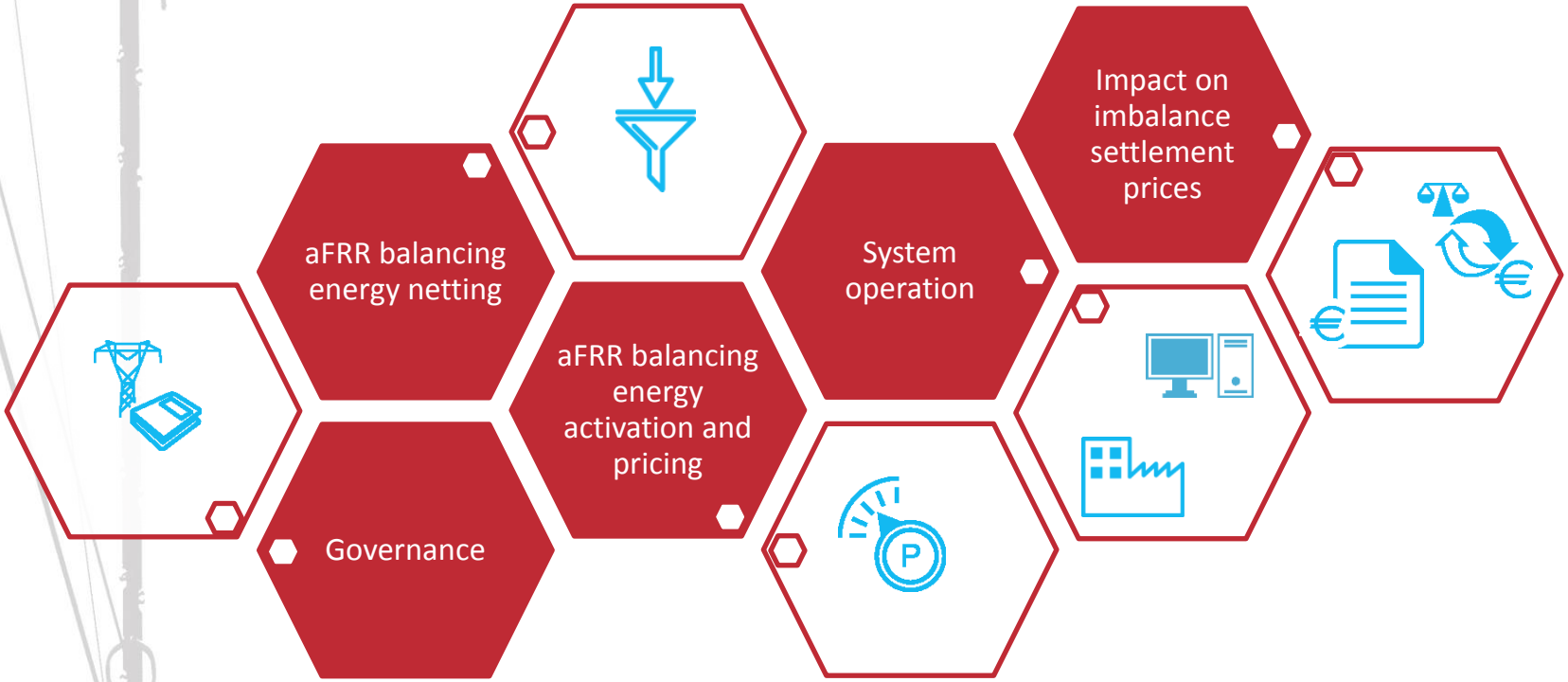
The IGCC Members strive for unanimous decision in a first place. Voting procedure is understood as a last resort measure…



Voting Criterion A = 1 country one vote Voting Criterion B = Population share

Implementation in national markets, part I.

Many countries but one „IGCC rules“



Austria

Riegler Markus - Markus.Riegler@apg.at

Interaction with other Balancing Services

Governance

Approval by NRA

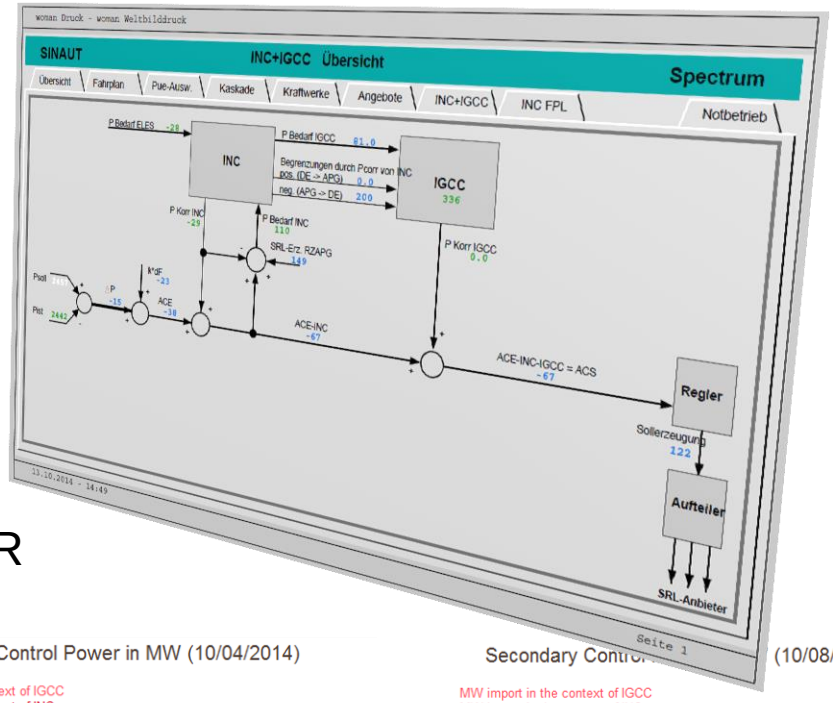
Mode of activation

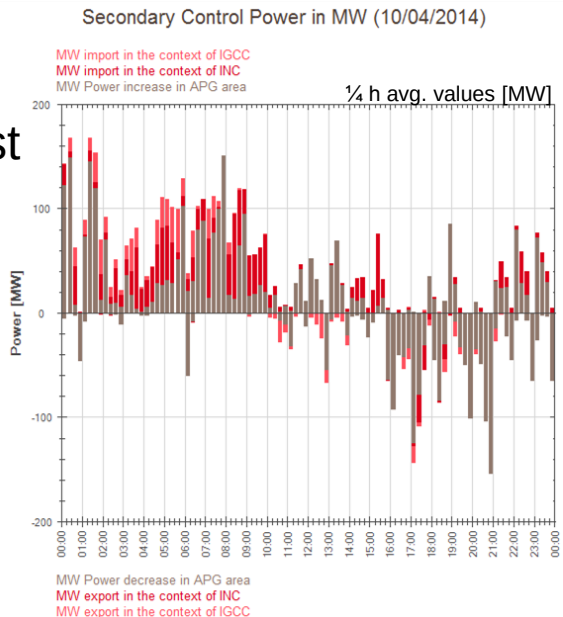
Automatic, aFRR

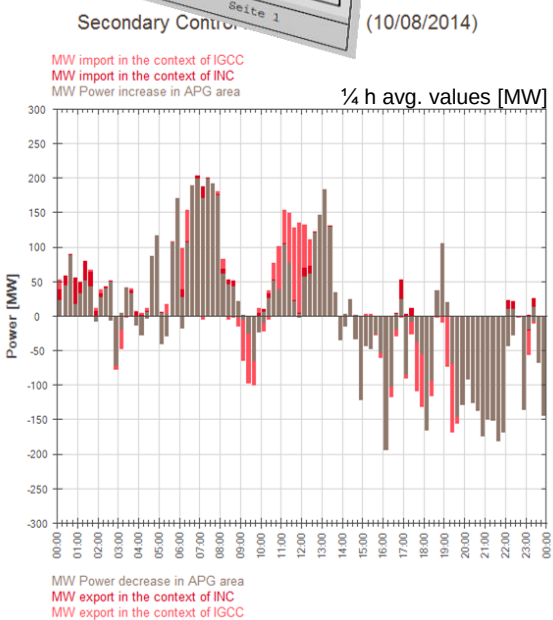
Influence on sizing of aFRR or mFRR

NO

*Activation of aFRR is based on a Merit Order List







Incorporation into the national imbalance settlement system

Type of balancing energy delivery

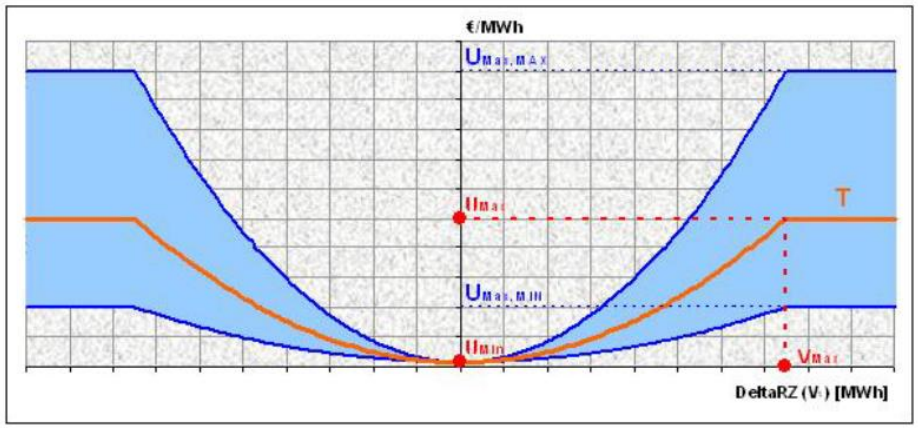
The Cooperations (INC & IGCC) are considered equally to BSPs, providing aFRR BE to the Austrian power system.

Energy price in national imbalance settlement system

The exchanged energy is valuated with the settlement price to ensure a 100 % cost related pricing towards the BRPs.

Netting of energy in national imbalance settlement system

The exchanged energy and related cots are treated as a part of aFRR activation.



The determination of the imbalance prices is governed by the AB-BKO*, agreed upon between the Austrian clearing authority (APCS) and the NRA (E-Control).
(No English version available)

It is based on a curve function, based on the costs for reserves, activations and exchanges, as well the total imbalance of the LFC-Area.

*General conditions of the Austrian Clearing Authority

The Austrian IGCC opportunity price(s)

The Austrian Opportunity Price for IGCC is equal to the average price for aFRR activation in the respective time frame (¼ h).

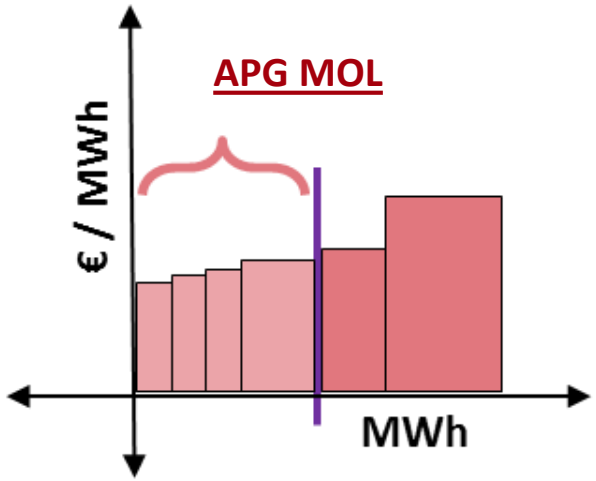
As the prices for aFRR activation are determined on a pay as bid basis, based on a Merit Order List, the determination is as shown below.

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

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

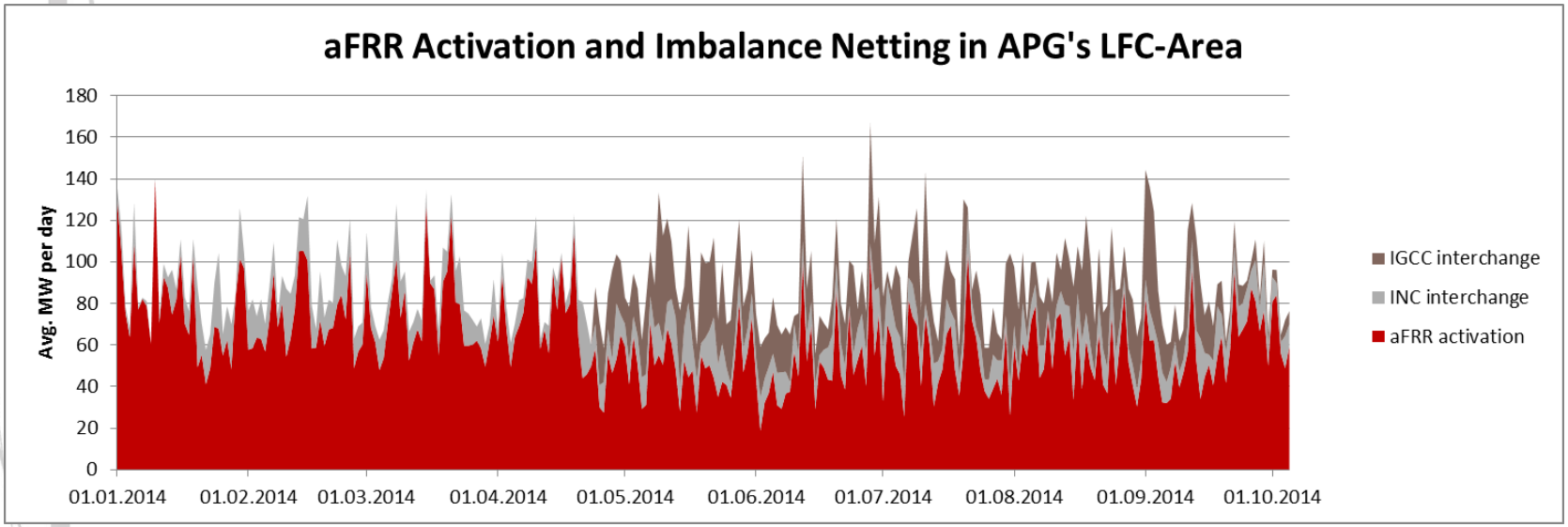
Variable	DeaFRRiption	Unit	Sign
$aFRR_{pos,\,i}$	Amount of activated positive aFRR Energy for the IGCC settlement period$_i$.	[MWh]	Always positive.
$aFRR_{neg,\,i}$	Amount of activated negative aFRR Energy for the IGCC settlement period$_i$.	[MWh]	Always positive.
$C_{i,Imp}$	Resulting IGCC Opportunity 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.

The Austrian IGCC opportunity price(s)



Activated aFRR_+ in the ¼ h: + 100 MWh
Costs for activated aFRR in the ¼ h: 12.000 EUR
= Opportunity Price for IGCC Import: 120 EUR/MWh

Share on balance of the power system



	aFRR acitation +	INC Import	IGCC Import
2014_01	84%	16%	0%
2014_02	74%	26%	0%
2014_03	74%	26%	0%
2014_04	68%	27%	5%
2014_05	52%	23%	26%
2014_06	50%	27%	23%
2014_07	59%	24%	17%
2014_08	46%	24%	30%
2014_09	65%	19%	16%

	aFRR activation -	INC Export	IGCC Export
2014_01	89%	11%	0%
2014_02	84%	16%	0%
2014_03	91%	9%	0%
2014_04	86%	6%	8%
2014_05	55%	10%	35%
2014_06	65%	7%	28%
2014_07	60%	3%	37%
2014_08	70%	6%	24%
2014_09	63%	11%	26%

Belgium

Sophie Van Caloen - Sophie.VanCaloen@elia.be

Interaction with other Balancing Services

Governance

Balancing Rules

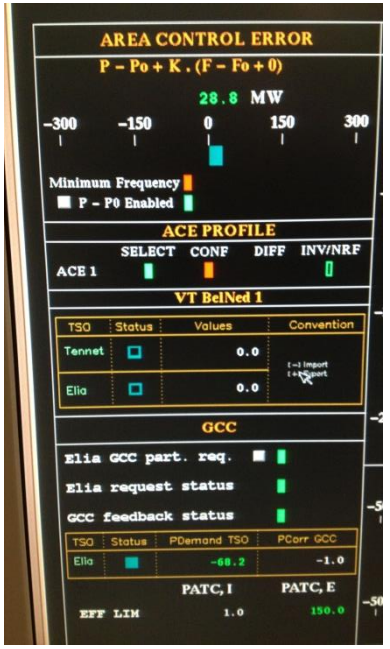
Mode of activation

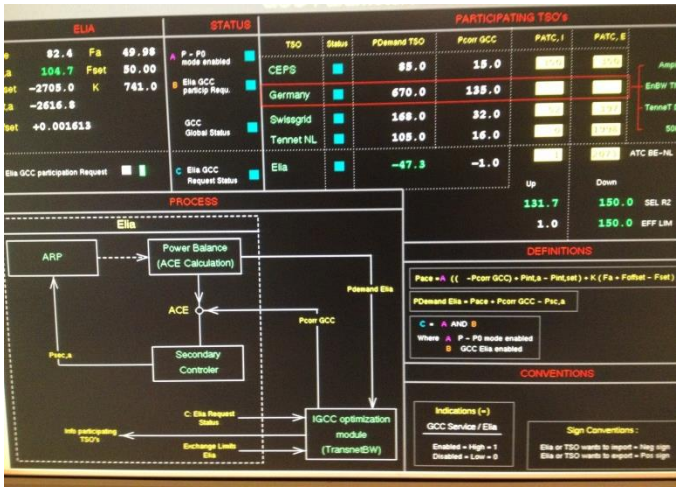
Automatic, preceeding aFRR

Influence on sizing of aFRR or mFRR

No

*Activation of aFRR is based on a pro-rata system





Incorporation into the national imbalance settlement system

Type of balancing energy delivery

The energy imported or exported between TSOs is part of the NRV (net regulation volume)

Energy price in national imbalance settlement system

The price will be equal to aFRR price

- Import will be valued at the weighted average price of positive aFRR
- Export will be valued at the weighted average price of negative aFRR

Netting of energy in national imbalance settlement system

IGCC balancing energy is netted similarly to aFRR

The Country IGCC opportunity price(s)

#1 Determination of aFRR price after selection of aFRR offers for each quarter-hour ~ Weighted Average of the price of each offer (pro-rata system)

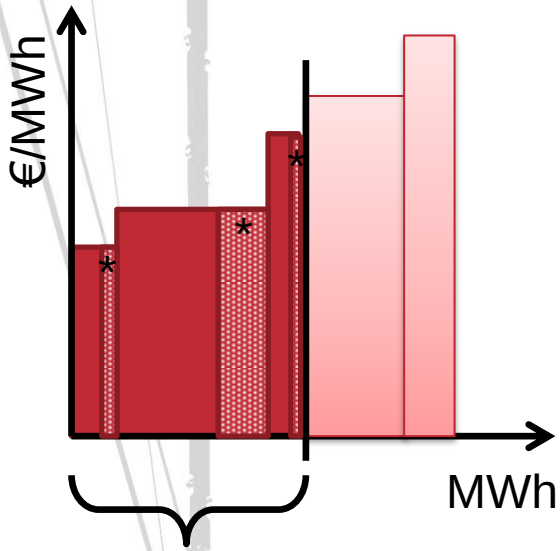
#2 The opportunity price for IGCC import/export is the aFRR price for aFRR positive/negative activated energy

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

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

*Due to 15min imbalance settlement period is the IGCC opportunity price calculated for each 15min IGCC settlement intervals

The Country IGCC opportunity price(s)

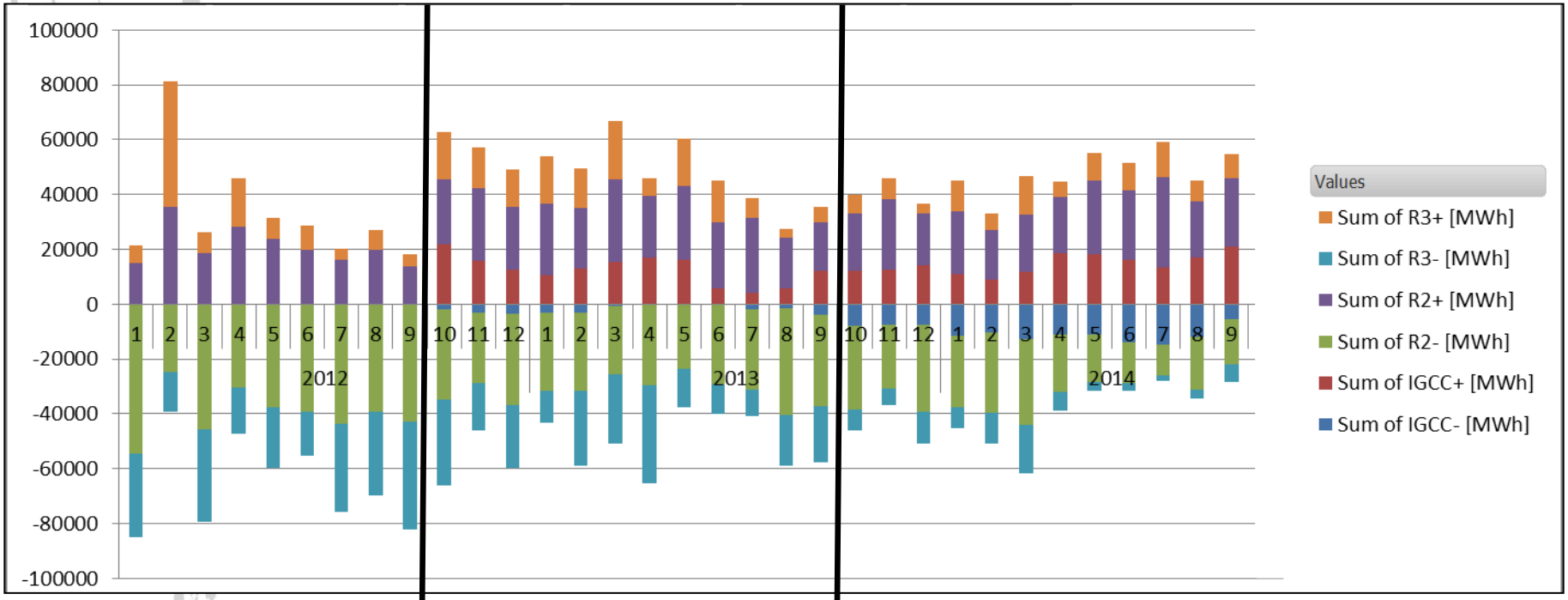


Selection of aFRR offers

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
IGCC Opportunity Price €/MWh	$\frac{30*40+100*60+20*70}{30+100+20} = 57,33$		

* Pro-rata activation of aFRR

Share on balance of the power system



IGCC 10/2012

Improvement optimisation software 10/2013

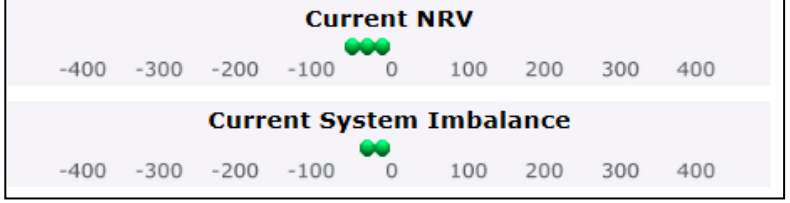
Publications

- Current NRV (IGCC included)

Situation at **14/10/2014 15:11** Quarter 15:00 -> 15:15

NRV = -56,2 MW
NRV Cumulated = -120,8 MW

System Imbalance = -26,8 MW
System Imbalance Cumulated = 86,9 MW



- Used regulation capacity

	Upward regulation Volume							Downward regulation Volume			
Quarter	NRV (MW)	GUV (MW)	IGCC+ (MW)	R2+ (MW)	Bids+ (MW)	R3+ (MW)	R3DP+ (MW)	GDV (MW)	IGCC- (MW)	R2- (MW)	Bids- (MW)
00:00 > 00:15	8,201	43,870		43,870				35,669	5,989	29,680	
00:15 > 00:30	24,410	41,560		41,560				17,150	0,367	16,783	
00:30 > 00:45	-103,276							103,276	0,278	102,998	
00:45 > 01:00	-125,398							125,398		125,398	
01:00 > 01:15	-9,378	31,377		31,377				40,755	0,044	40,711	
01:15 > 01:30	-98,088	0,341		0,341				98,429	13,233	85,196	
01:30 > 01:45	-125,320							125,320	0,078	125,242	
01:45 > 02:00	-85,897							85,897	0,200	85,697	

	Decremental Prices				
R3+ (€/MWh)	MDP (€/MWh)	IGCC- (€/MWh)	R2- (€/MWh)	Bids- (€/MWh)
	4,28	4,28	4,28	
	4,28	4,28	4,28	
	4,28	4,28	4,28	
	4,28		4,28	
	4,48	4,48	4,48	
	4,57	4,57	4,57	
	4,74	4,74	4,74	
	4,74	4,74	4,74	

The Czech Republic

Tomáš Bednář – bednar@ceps.cz

Interaction with other Balancing Services

Governance

The Grid Code, part II. 3.5.3

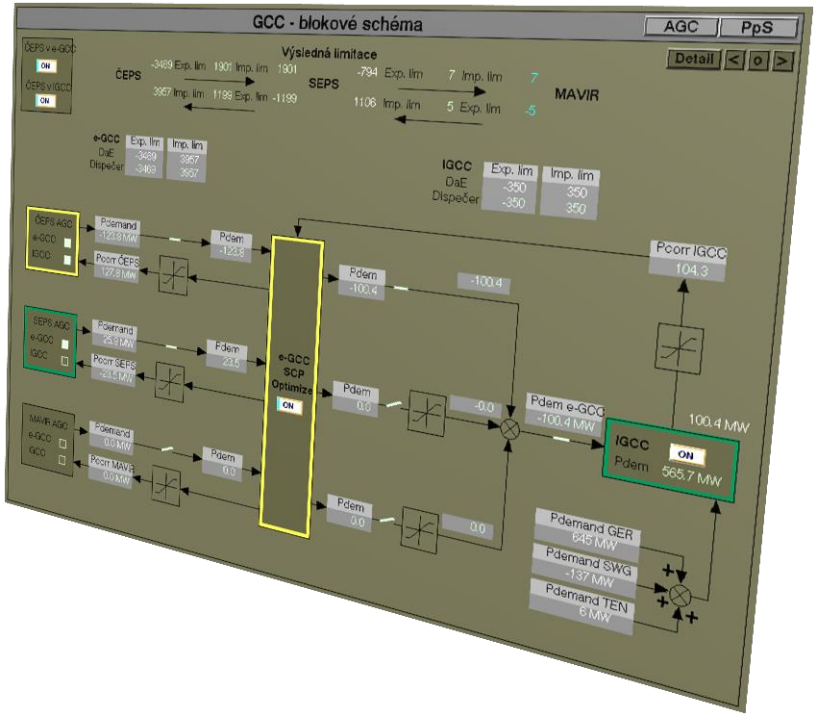
Mode of activation

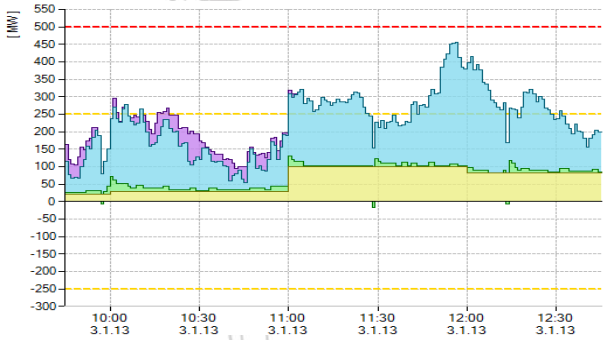
Automatic, preceeding aFRR

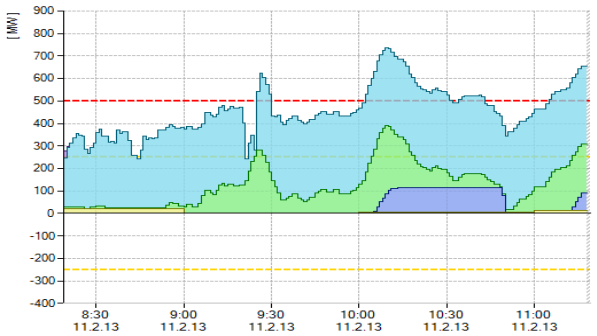
Influence on sizing of aFRR or mFRR

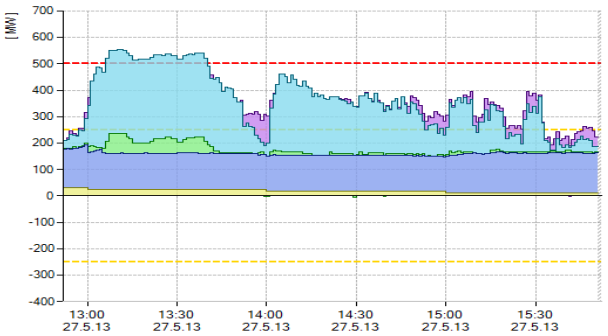
No

*Activation of aFRR is based on a pro-rata system









IGCC

Incorporation into the national imbalance settlement system

Type of balancing energy delivery

CEPS acts as another BSP providing aFRR BE to the Czech power system

Energy price in national imbalance settlement system

Set in NRA‘s price decision, equal to prices of aFRR BE

*IGCC balancing energy is netted similarly to aFRR

3.5.3 Electricity operative supplies from/to abroad, in context of co-operation on TSO level [EregZGCC]

It concerns a mutual exchange of electricity among co-operating TSOs, used as the control (regulating) energy maintaining the power balance in context of the secondary control. A control power supply (positive or negative) is effected operatively, on a basis of an evaluation of needs of the system status, by an automatically interconnected control system. In case ČEPS make use of this service, the electricity supplied to the CR ES, or received from the CR ES, is considered the control energy supplied by ČEPS. For settlement purposes, this control energy is provided by ČEPS; additionally, ČEPS sets the price of such electricity, in compliance with Price Decision of Energy Regulatory Office.

(11) Fixed prices for regulating [balancing] energy supply and fixed price for imbalance clearing:

(11.1) The fixed price for positive balancing energy supplied by units that had secondary control activated in the respective trading hour, and/or for *ad hoc* supply of positive balancing energy as part of co-operation in secondary control at the level of transmission system operators, shall be, under the public notice laying down the Electricity Market Rules[11]),

CZK 2,350/MWh.

The provider of balancing energy shall bill this price to the market operator.

(11.2) The fixed price for negative balancing energy supplied by units that had secondary control activated in the respective trading hour, and/or for ad hoc supply of positive balancing energy as part of co-operation in secondary control at the level of transmission system operators, shall be, under the public notice laying down the Electricity Market Rules [4]),

CZK 1/MWh;

The provider of the balancing energy shall bill this price to the market operator.

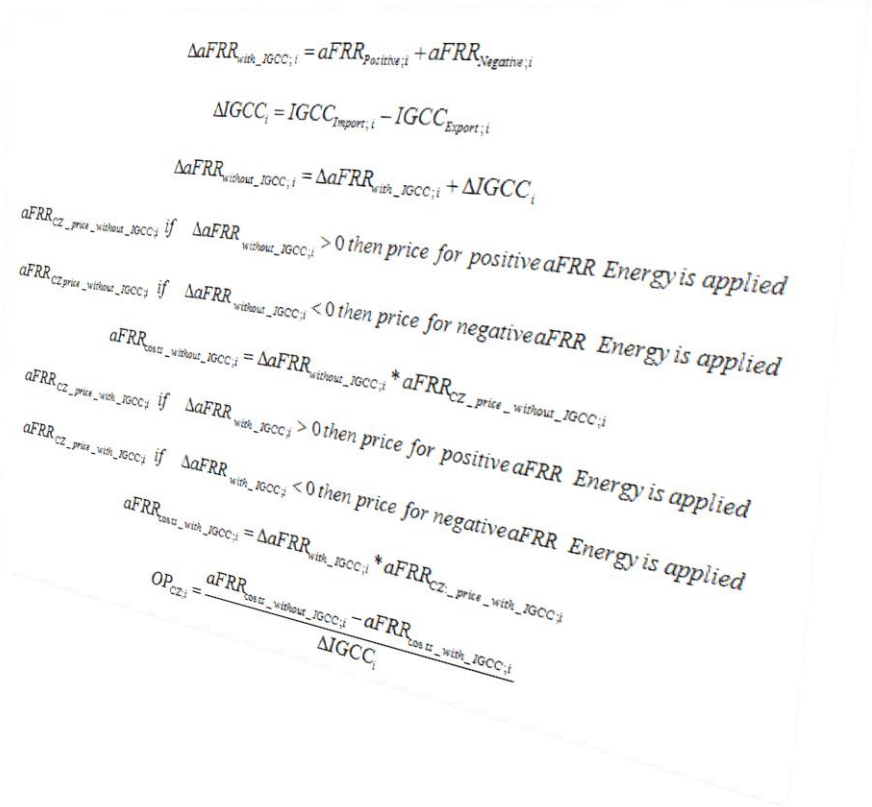
The Czech IGCC opportunity price(s)

#1 Determination of costs for aFRR BE without IGCC ~ Sum of all payments to aFRR suppliers if no IGCC exchange happens (derived settlement value)

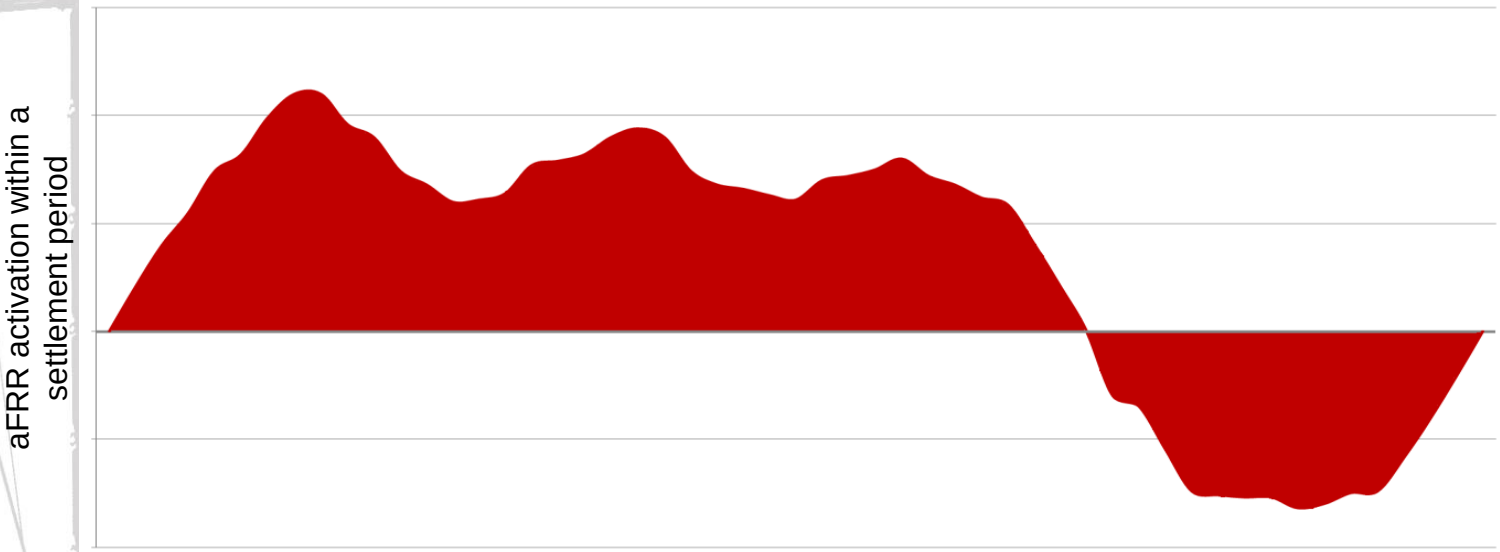
#2 Determination of costs for aFRR BE with IGCC ~ Sum of all payments to aFRR suppliers (real settlement value)

#3 The difference between costs weighted by netted IGCC exchange

*Due to 60min imbalance settlement period is the IGCC opportunity price same for four consequtive 15min IGCC settlement intervals



The Czech IGCC opportunity price – step # 1



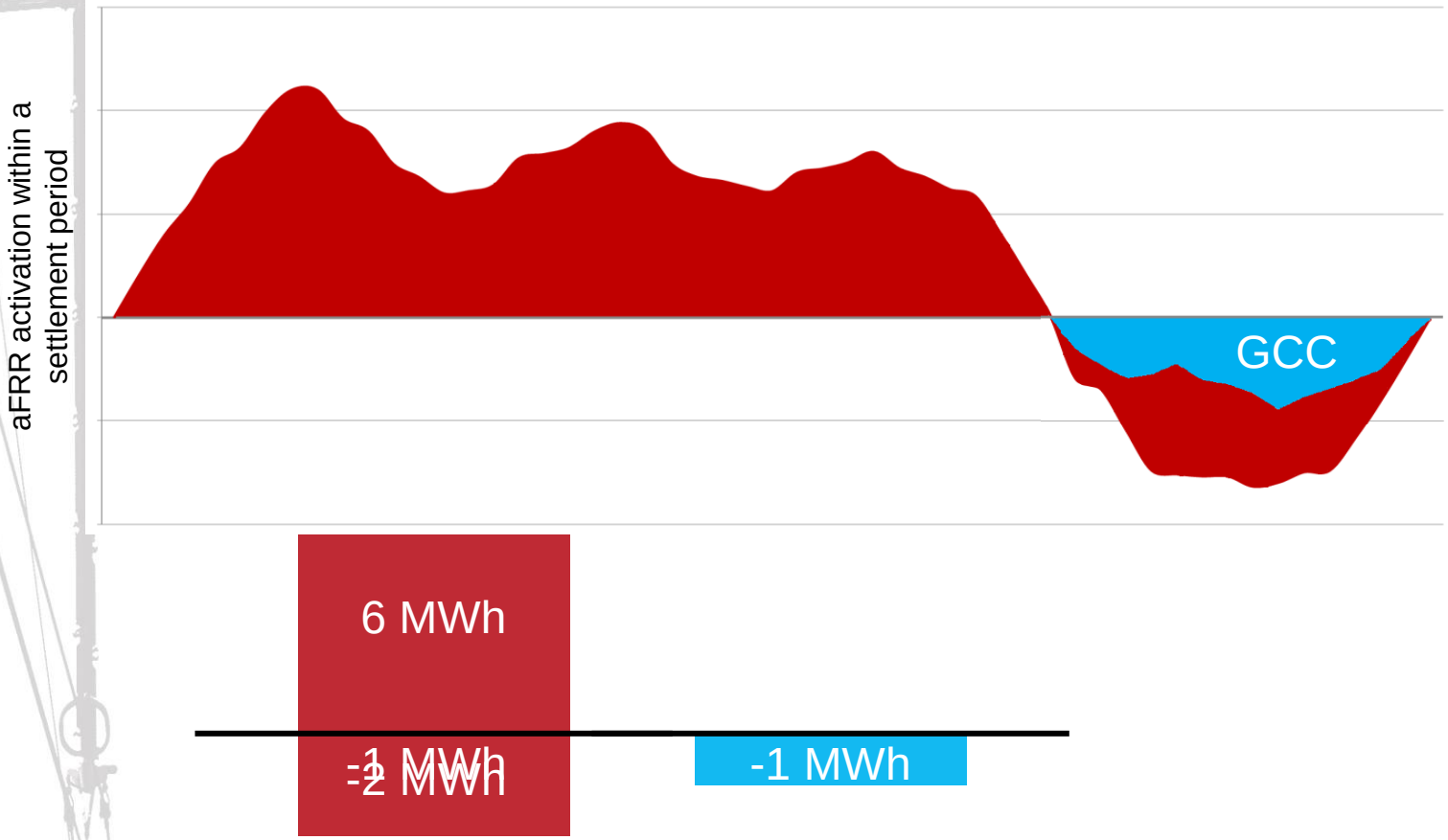
6 MWh

4 MWh

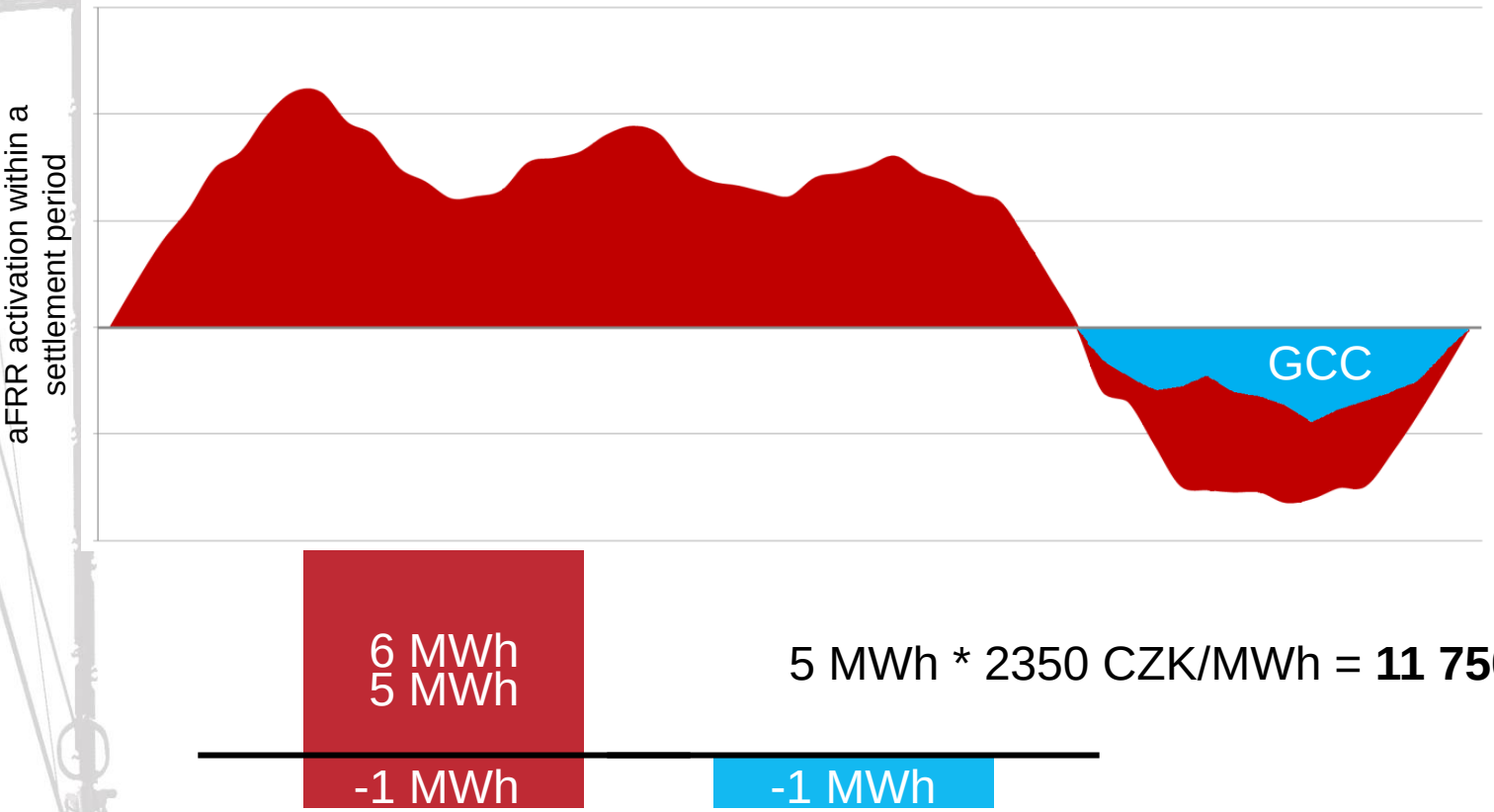
-2 MWh

4 MWh * 2350 CZK/MWh = **9 400 CZK**

The Czech IGCC opportunity price – step # 2



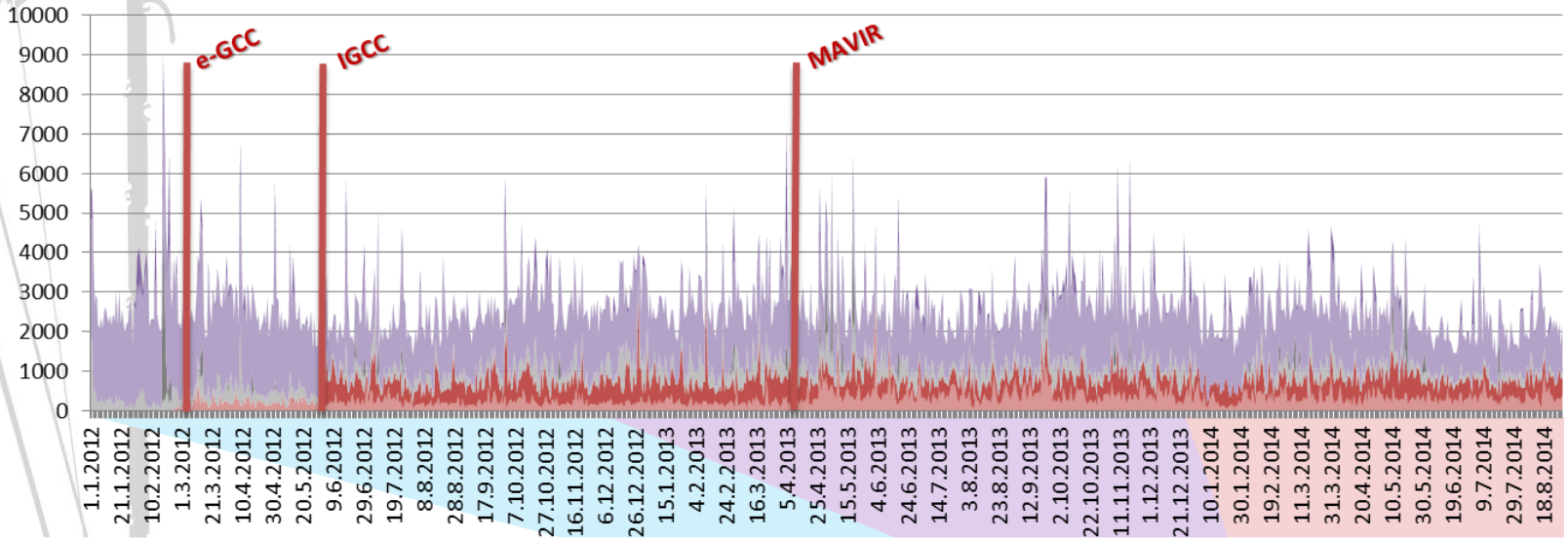
The Czech IGCC opportunity price – step # 2



5 MWh * 2350 CZK/MWh = **11 750 CZK**

But it was 9400 CZK without IGCC -> The difference 2350 CZK is weighted by IGCC exchange. CEPS‘ IGCC opportunity price is -2350 CZK/ MWh with minus indicating increased cost due to increased payment to aFRR suppliers.

Share on balance of the power system



	2012	2013	2014 (1. - 8. 2014)
Share of non-guaranteed BE on total BE	**31%**	**44%**	**42%**
GCC (IGCC + e-GCC) share on total BE	**18%**	**30%**	**33%**
BE exchange total [GWh]	**185**	**315**	**195**
- of which IGCC [GWh, %]	**115** (62%)	**186** (59%)	**118** (60%)
- of which e-GCC [GWh, %]	**70** (38%)	**129** (41%)	**77** (40%)
Positive / negative BE_{GCC} [%]	**57% / 43%**	**59% / 41%**	**52% / 48%**
Average BE_{GCC} in one hour [MWh]	**21**	**36**	**33**

Implementation in national markets, part II.

Denmark

Peter Bruhn – pbu@energinet.dk

Interaction with other Balancing Services

Governance

Danish Energy Regulatory Authority

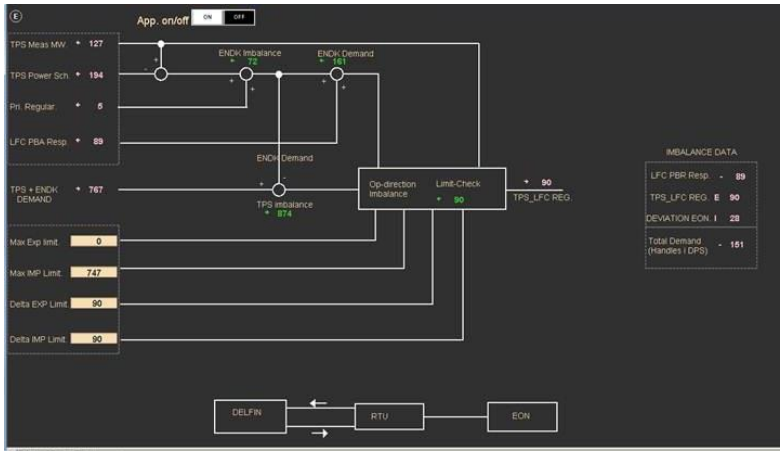
Mode of activation

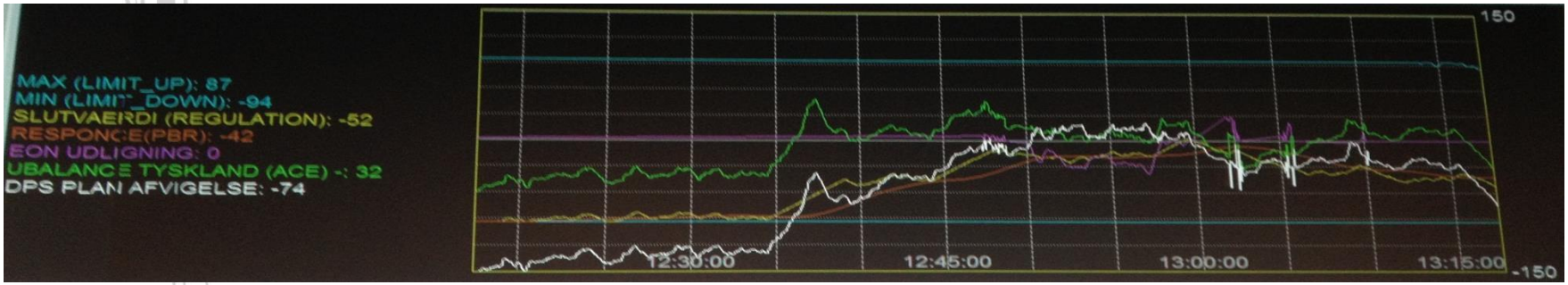
Automatic, preceeding aFRR

Influence on sizing of aFRR or mFRR

No

Activation of aFRR is based on a pro-rata system





Incorporation into the national imbalance settlement system

Type of balancing energy delivery

IGCC acts as another BSP providing aFRR BE to/from the Danish power system

Energy price in national imbalance settlement system

Set in Energinet.dk's price decision, equal to prices of aFRR BE

IGCC balancing energy is netted similarly to aFRR

1.2.3.1 Payment for energy

Delivery of energy from secondary up reserve is settled per MWh with the DK1-NordPoolSpot Price + DKK 100 / MWh or at least the price for tertiary up reserve energy.

The delivery of energy from from secondary down reserve is settled per MWh with the Danish DK1-NordPoolSpot Price – DKK 100 / MWh or maximum the price for activation of tertiary down reserve energy.

The delivery of energy is settled based on the log in Energinet.dk's SCADA-system as an integrated value of expected activaed power per 15 minutes.

The Danish IGCC opportunity price(s)

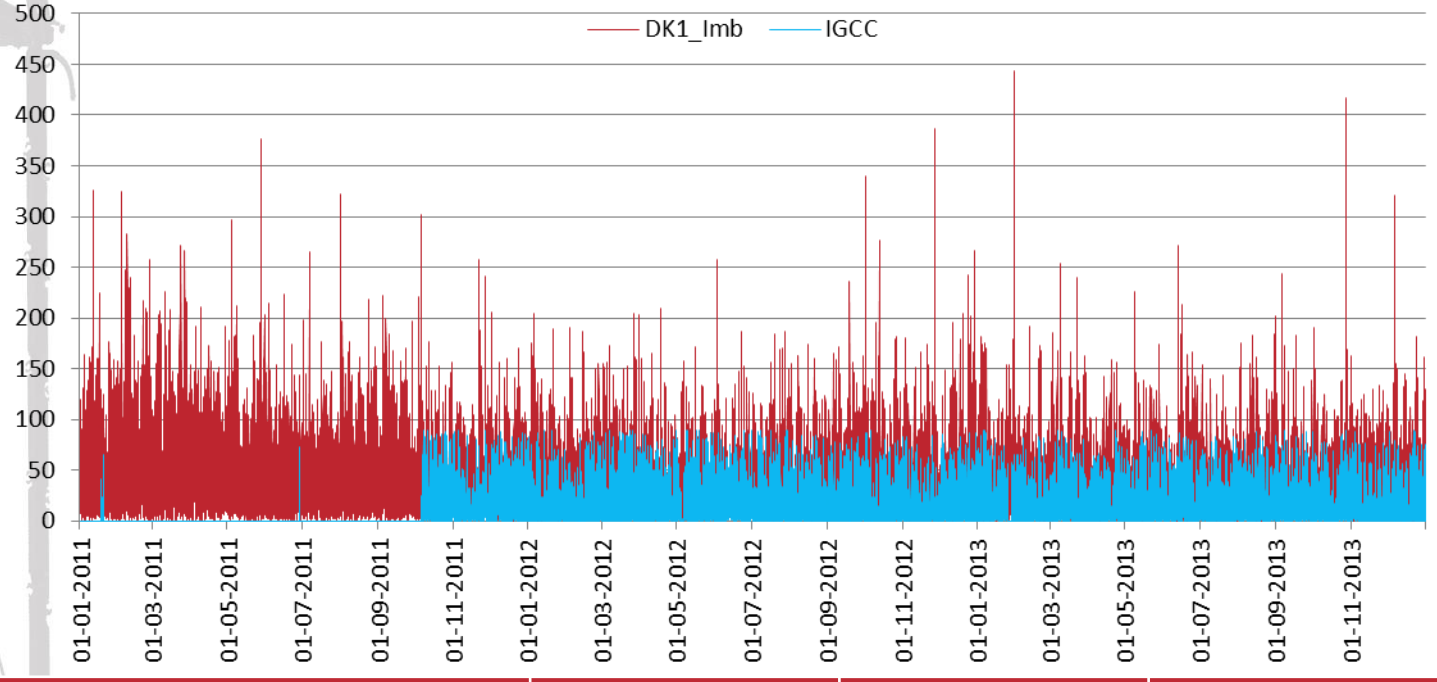
The Danish IGCC opportunity price is equal to the Danish energy price for aFRR BE in DK1

*Due to 60min imbalance settlement period the IGCC opportunity price is the same for four consequtive 15min IGCC settlement intervals

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]
Danish 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]
Danish IGCC Opportunity Price	108.88 DKK/MWh

Share on balance of the power system



	2011	2012	2013
IGCC share on total BE	10%	39%	42%
BE exchange total [GWh]	39	131	132
Positive / negative BE_{IGCC} [%]	2% / 15%	29% / 44%	53% / 34%
Average BE_{IGCC} in one hour [MWh]	4	15	15
Socio-economical savings [EUR]	0.8 mio.	3.2 mio.	3.6 mio.

Germany

Interaction with other Balancing Services

Governance

Balancing rules, approval by NRA

Mode of activation

Automatic, preceeding aFRR

Influence on sizing of aFRR or mFRR

No

Activation of aFRR is based on a Merit Order List

Incorporation into the national imbalance settlement system

Type of balancing energy delivery

The cooperation is considered equally to BSPs, providing aFRR BE to the German TSOs.

Energy price in national imbalance settlement system

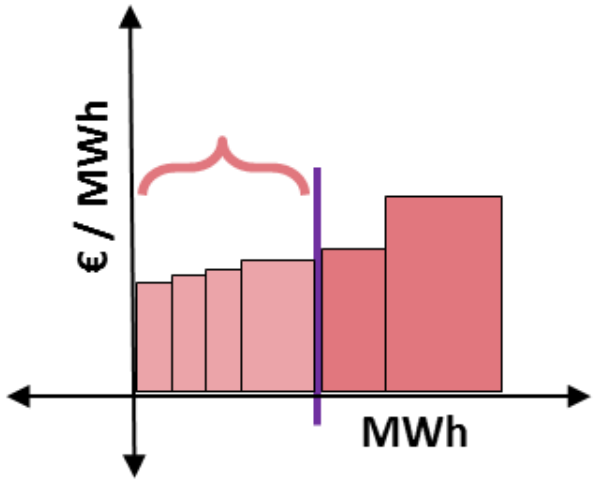
The exchanged energy is valuated with the settlement price to ensure a 100 % cost related pricing towards the BRPs.

Netting of energy in national imbalance settlement system

The exchanged energy and related cots are treated as a part of aFRR activation.

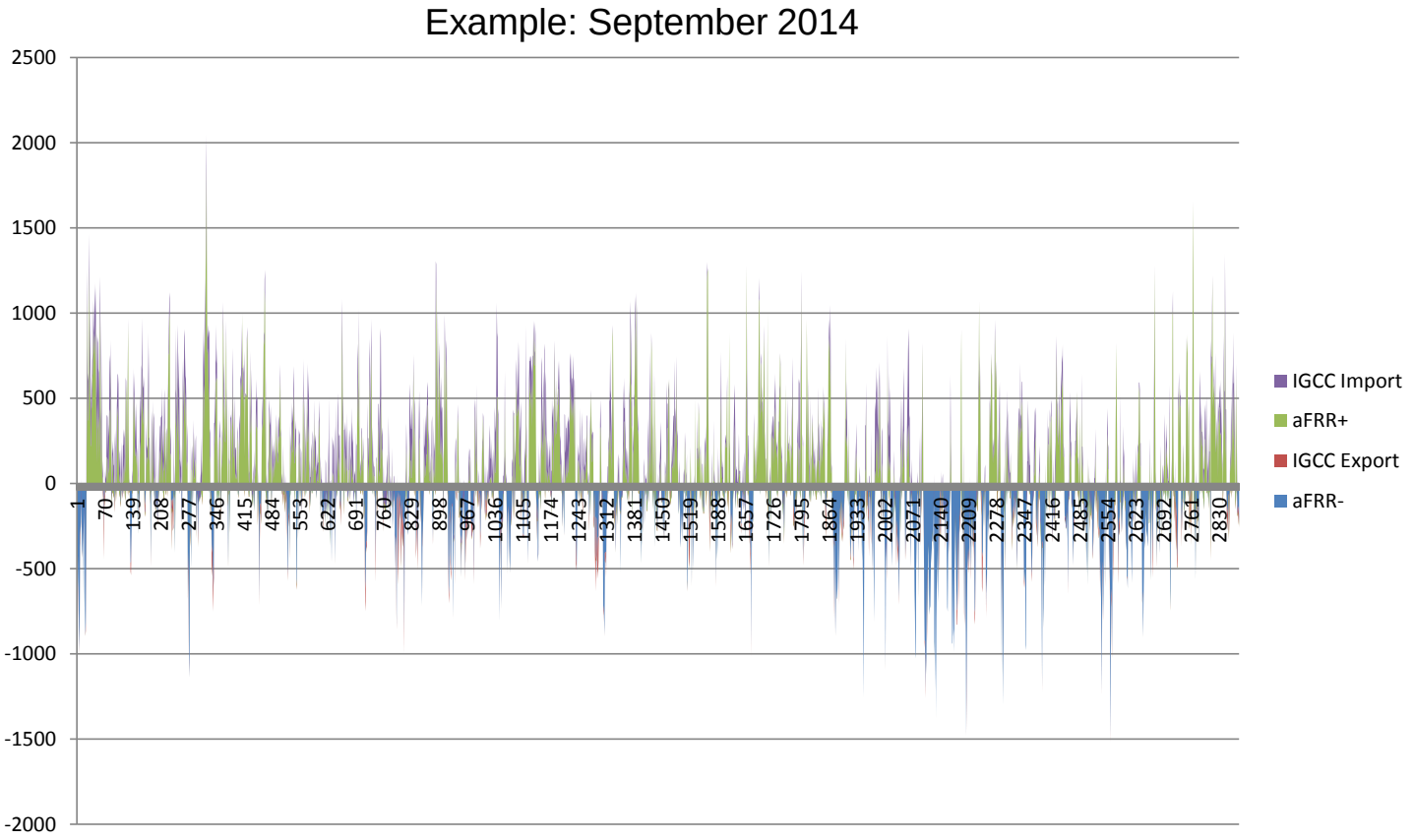
The determination of the imbalance price is typically equal to the total price of balancing energy (under certain conditions the price is capped, moreover there are surcharges/deductions in case of high imbalances, further information about German load-frequency-control concepts and market is available at www.regelleistung.net)

German Opportunity Price



Activated aFRR_+ in the ¼ h: + 100 MWh
Costs for activated aFRR in the ¼ h: 12.000 EUR
= Opportunity Price for IGCC Import: 120 EUR/MWh

Share on balance of the power system



The Netherlands

Fabian Heus - Fabian.Heus@tennet.eu

Interaction with other Balancing Services

Governance

System Code article 2.2.5

Mode of “activation”

Automatic adjustment of ACE

Influence on sizing of aFRR or mFRR

None

Incorporation into the Dutch imbalance settlement system

Dutch Features:

- ¼ h settlement
- reactive balancing regime
- BRPs responsible, TSO only residuals
- activation of aFRR: merit order list based on bid prices, settled with BRP and BSP via marginal pricing methodology
- No netting of positive and negative aFRR energy deliveries
- Determination of Opportunity Prices: D+1, 10.00 CET

IGCC correction signal:

- results in a direct adjustment of ACE (Virtual Tie-line; administrative);
- is seen as another provider of aFRR (ACE corrected via IGCC, does not have to be corrected via a local BSP), thus:

The Dutch IGCC opportunity price(i)

Dutch Opportunity prices based on Dutch imbalance prices

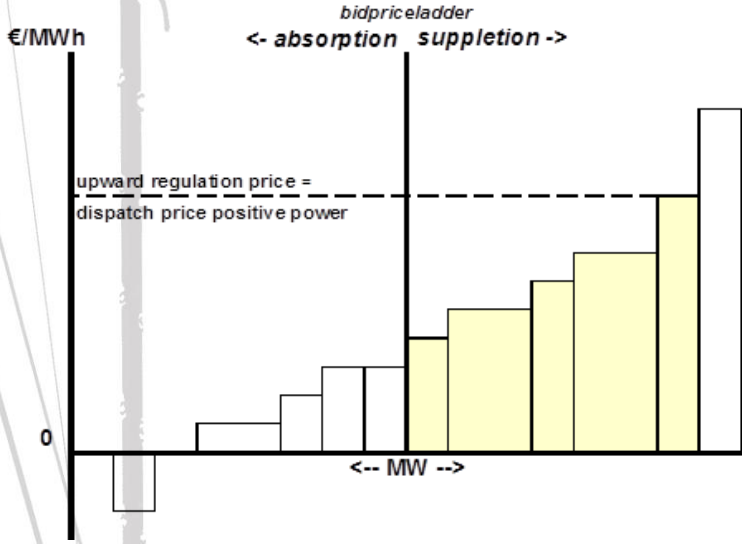
Each PTU:

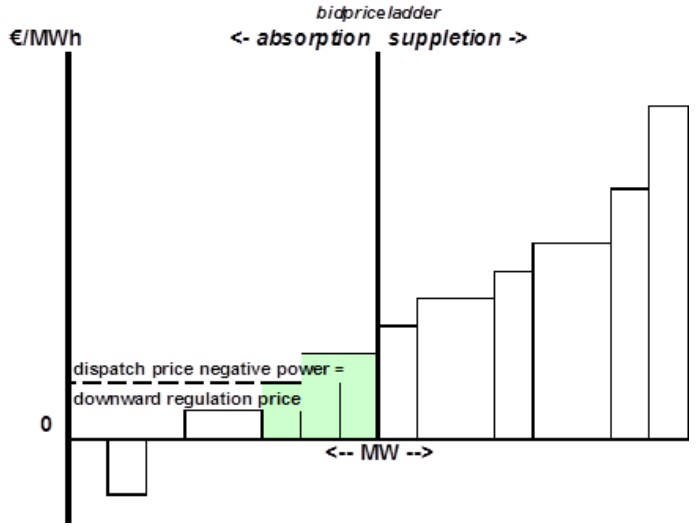
- a price for upward and/or downward dispatch(BSP);
- always a imbalance price for short and for long positions (BRP);
- imbalance price constituted via activation on a merit order list (price based) with marginal pricing.

If in a PTU no upward and downward dispatch has been requested, the mid-price will be used to settle imbalances with BRP:

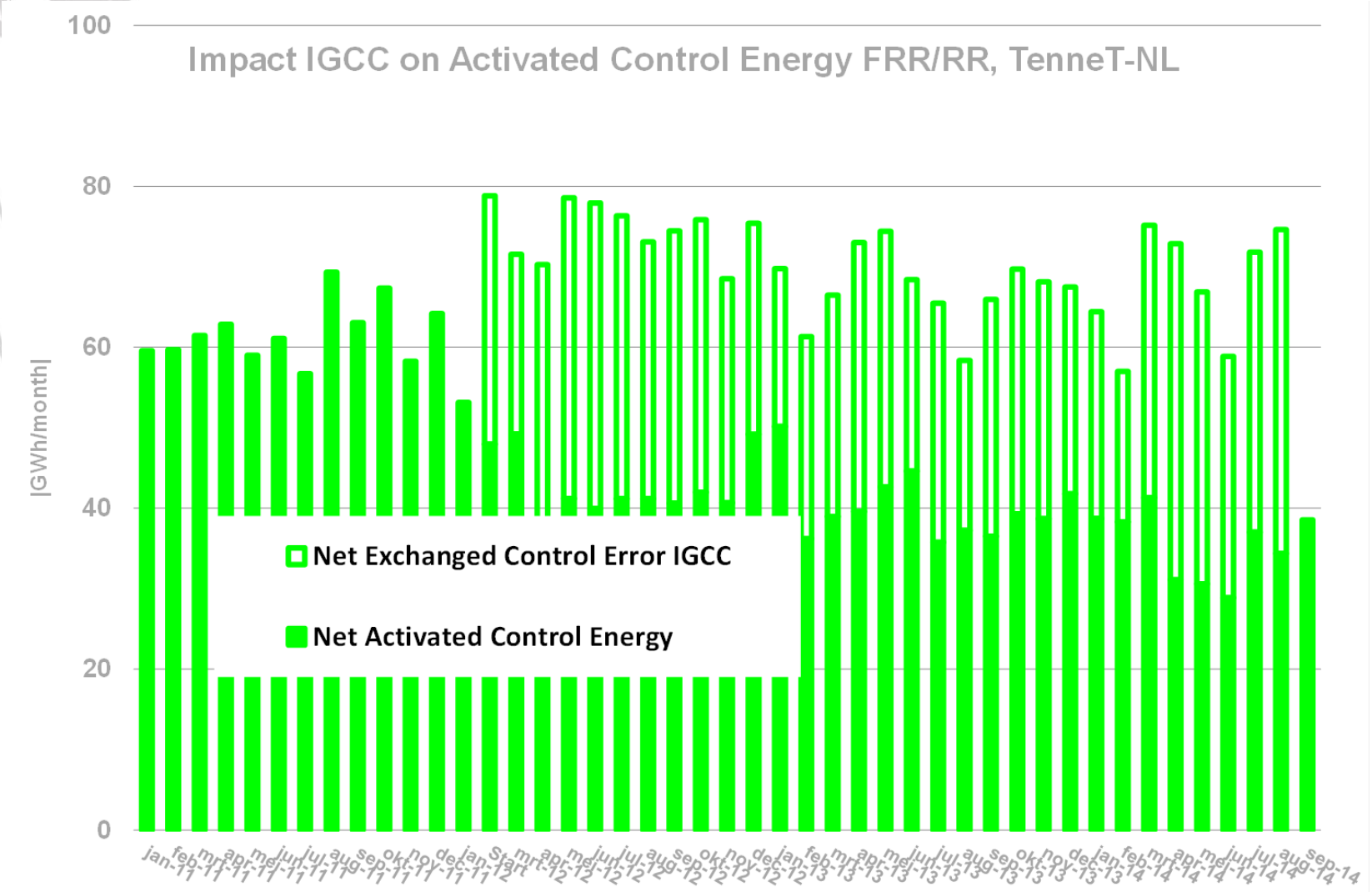
Average of the less costly upward regulation bid and the most costly downward regulation bid

The Dutch IGCC opportunity price (II)

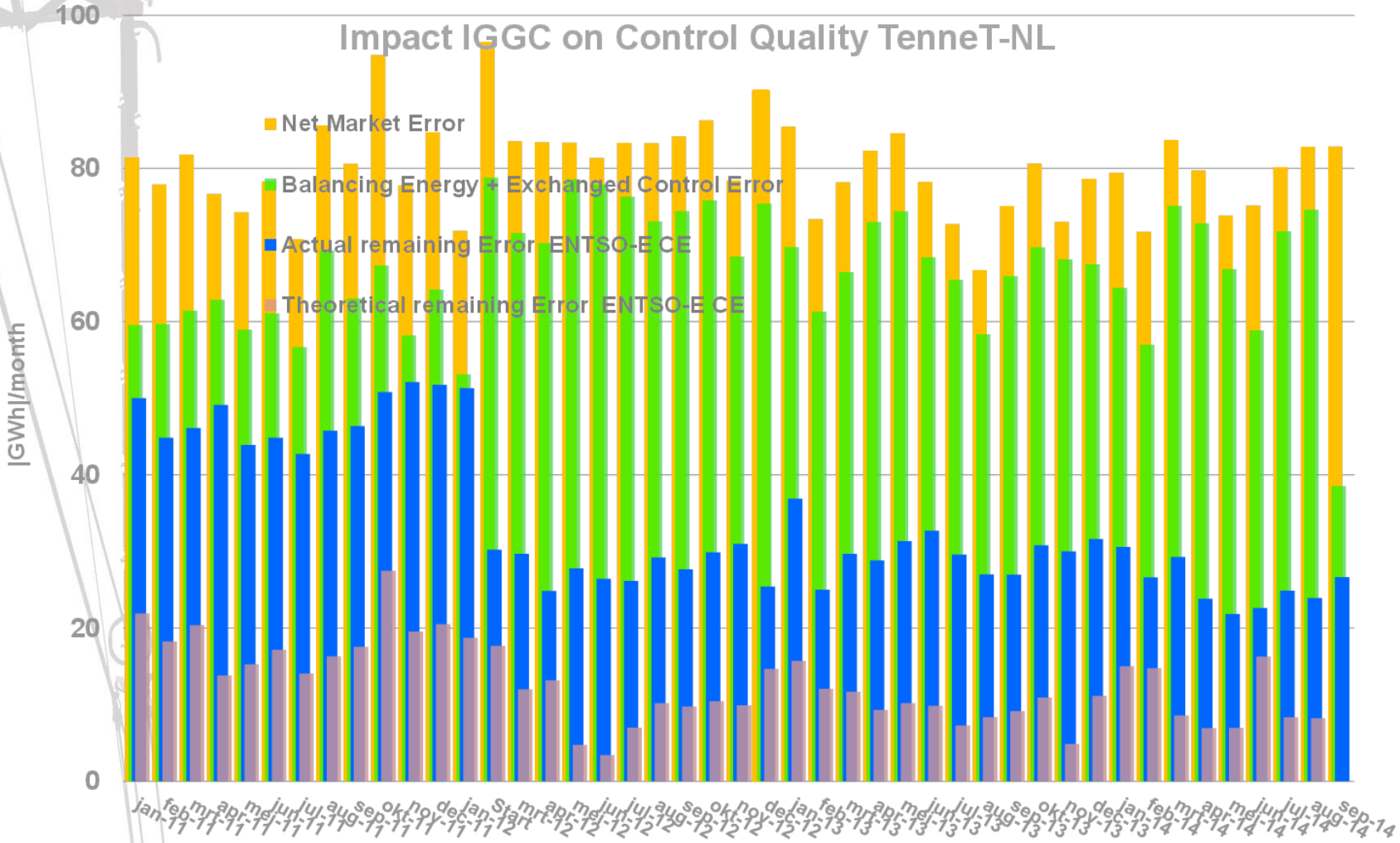




Share: Impact IGCC on activated control energy



Share: Impact IGCC on control quality TenneT NL



Switzerland

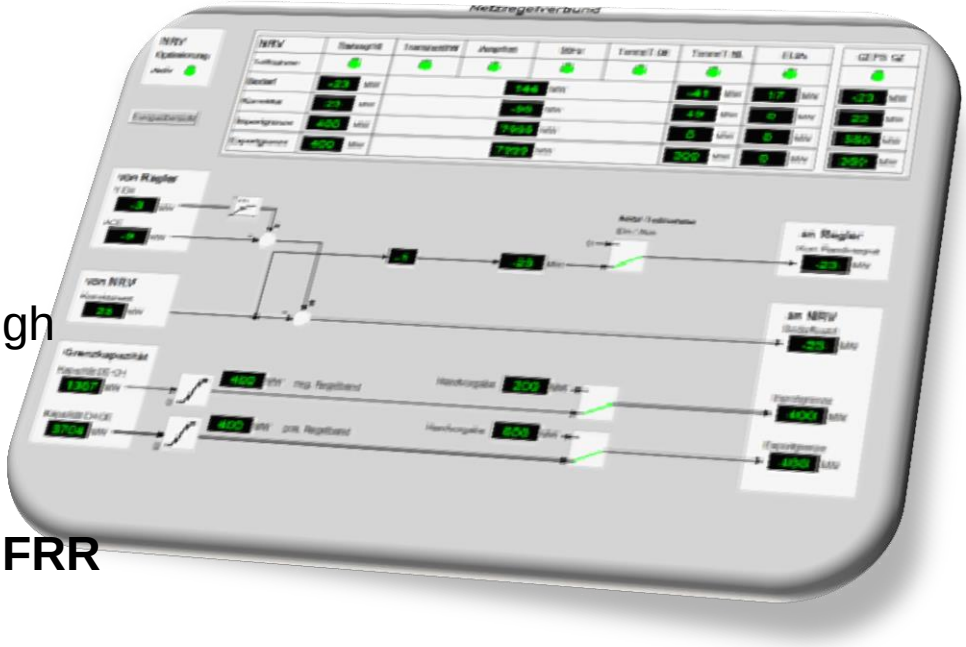
Iason Avramiotis - Iason.Avramiotis@swissgrid.ch

Interaction with other Ancillary (Balancing) Services

Governance
Swiss Transmission Code and Balance Groups (BG) regulations

Mode of “activation”
Automatic adjustment of ACE through “virtual tie-lines” concept, precedes aFRR activation

Influence on sizing of aFRR or mFRR
None



*Activation of aFRR in Switzerland is done Pro-Rata

Incorporation into the national imbalance settlement system

The BGs that deviate from their schedules are being charged for the imbalance energy needed to be covered by control energy

The needed imbalance energy is covered by:

- Activating control energy: aFRR Energy (or mFRR Energy)
- IGCC energy exchange

aFRR Energy:

- is netted in ¼ h intervals (no separately for positive/negative)
- the price is coupled to the SwissIx spot energy price

IGCC :

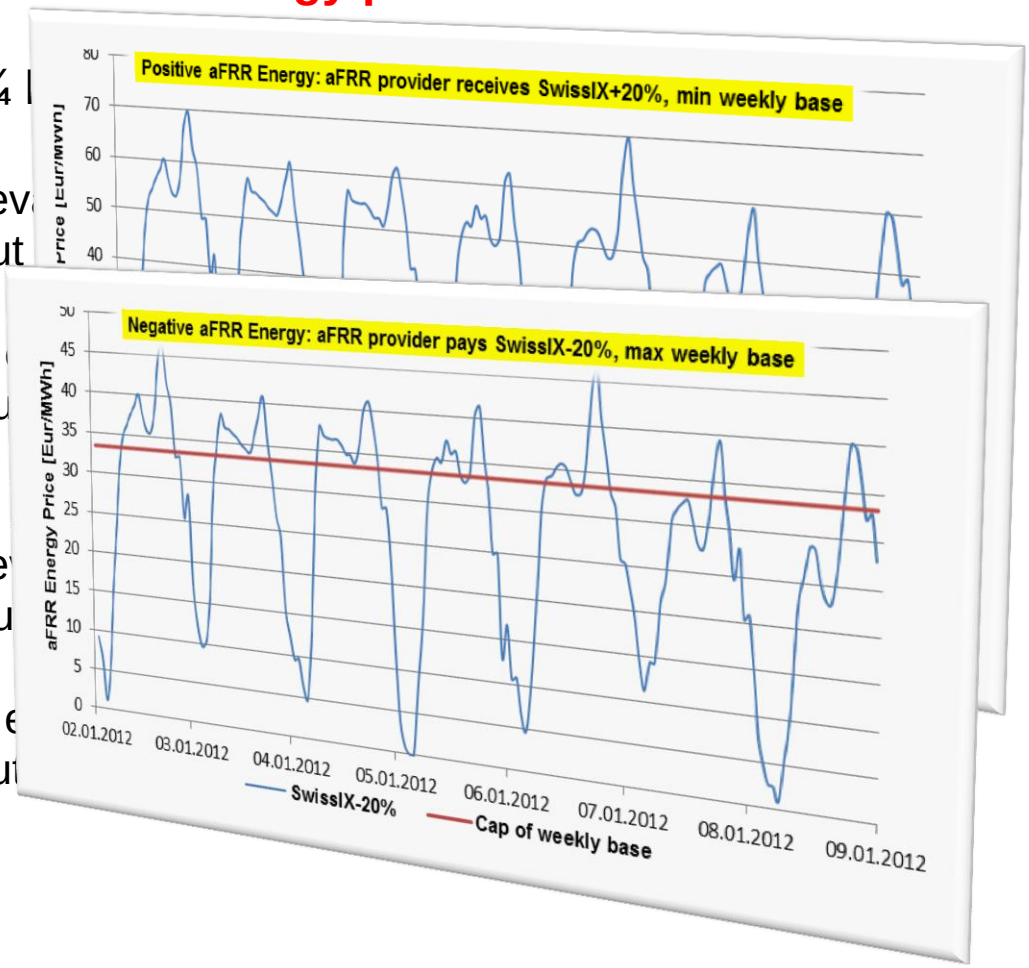
- The ACE corrected via IGCC, does not have to be corrected via a local BSP, thus less control energy is used

The Swiss IGCC opportunity price(i) – aFRR Energy price

Swiss IGCC Opportunity prices are coupled with the Swiss aFRR energy price

aFRR energy price for every ¼ h

- Swissix price is positive:
  - Positive aFRR Energy is ev
    with an addition of 20% but
    base price.
  - Negative aFRR Energy is
    with a reduction of 20% bu
    price.
- Swissix price is negative:
  - Positive aFRR Energy is e
    with a reduction of 20% bu
    base price.
  - Negative aFRR Energy is e
    with an addition of 20% bu
    price.



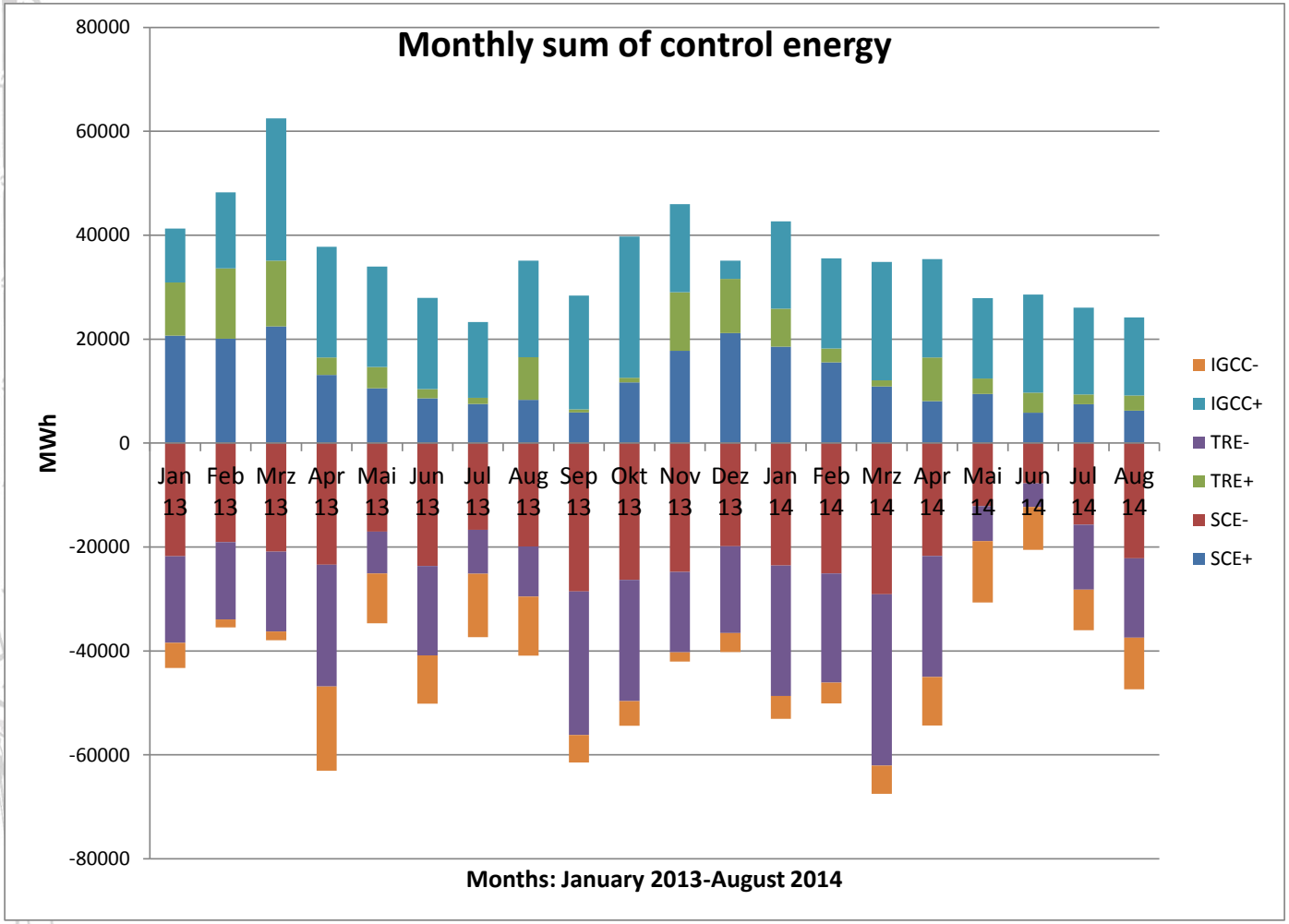
The Swiss IGCC opportunity price(ii)

The balance of aFRR Energy delivery without IGCC energy exchange is determined

- If positive balanced demand for aFRR Energy (energy shortage):
  - ➢IGCC opportunity price is the aFRR Energy positive price
- If negative balanced demand for aFRR Energy (energy surplus):
  - ➢IGCC opportunity price is the aFRR Energy negative price

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

Share on balance of the power system



Future development

General Framework

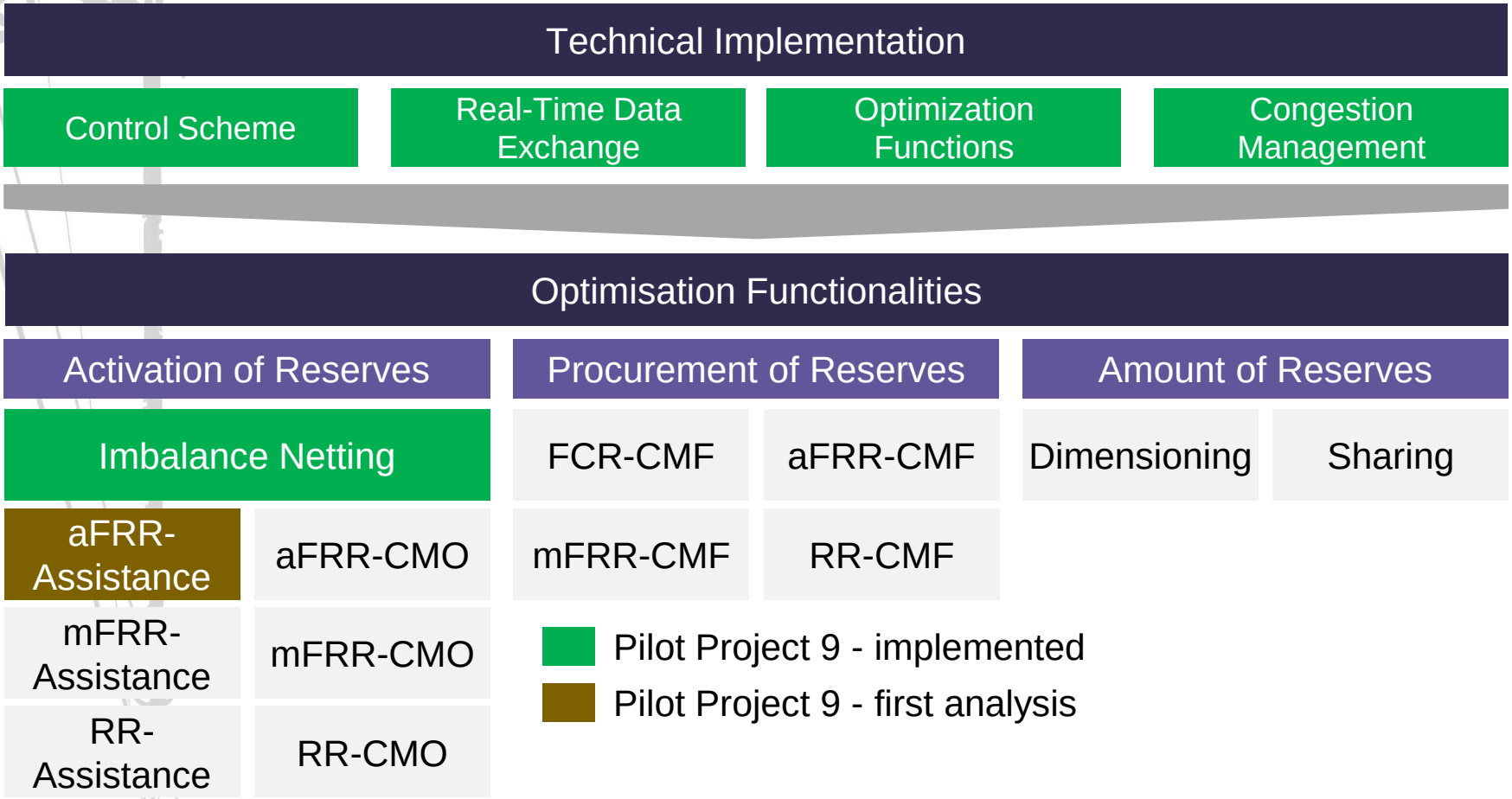
Technical Implementation

Control Scheme	Real-Time Data Exchange	Optimization Functions	Congestion Management

Optimisation Functionalities

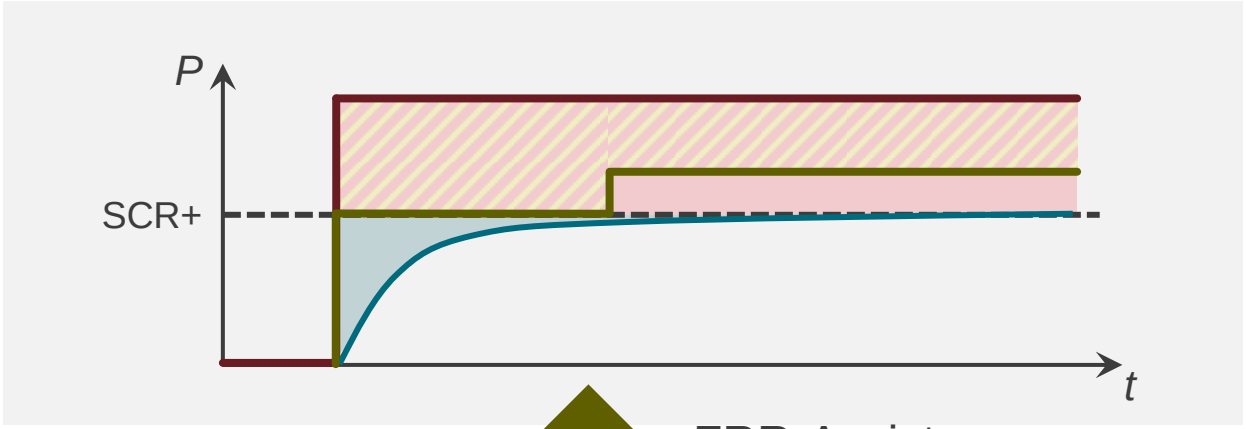
Activation of Reserves		Procurement of Reserves		Amount of Reserves	
Imbalance Netting		FCR-CMF	aFRR-CMF	Dimensioning	Sharing
aFRR-Assistance	aFRR-CMO	mFRR-CMF	RR-CMF		
mFRR-Assistance	mFRR-CMO				
RR-Assistance	RR-CMO				

General Framework



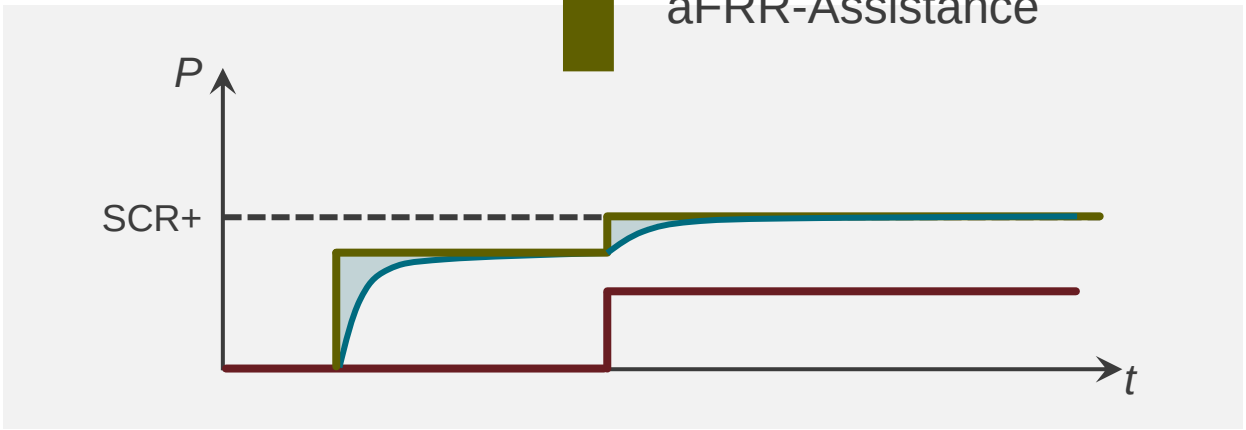
Under Discussion: aFRR-Assistance

Control Area A



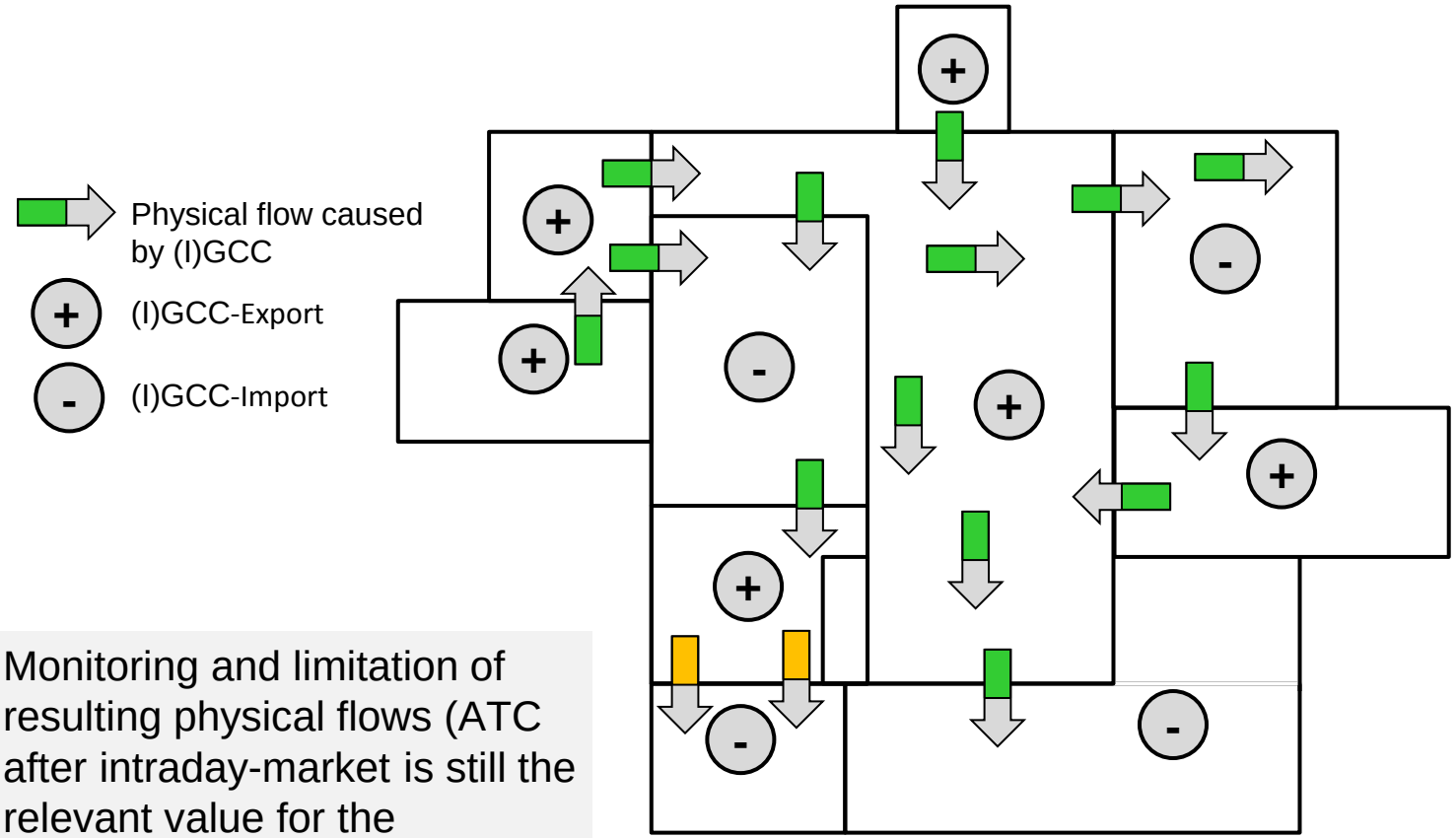
aFRR-Assistance

Control Area B



aFRR-demand
aFRR activation
ACE (dynamic)
ACE (lack of aFRR)
aFRR-demand corrected by SCR-Assistance
aFRR-Assistance

Under Discussion: aFRR-Assistance



Monitoring and limitation of resulting physical flows (ATC after intraday-market is still the relevant value for the maximum interchange)

Topics / Developments

- Interactions with other cooperations (Imbalance Netting or CMO)
- Continuous monitoring of the settlement approach
- Increase of operational transparency
- Participation of other TSOs

Closing remarks

Succesful cooperation

- 10 TSO’s
- 7 Countries
- Imbalance netting is a real-time balancing process
- Various balancing philosophies
- Historical regulatory and legal differences

- **Challenging but successful cooperation**

Thank you and goodbye

- Today was intended to give you insight into the cooperation today and the future of the IGCC
- Feel free to contact your local IGCC Member
- The presentation will be sent to all participants

Questions?