Electricity Balancing Pilot Projects 1 & 9 – Experience and Current Status
1. Scope of the Pilot Projects 1&9
2. Technical Implementation
3. Evaluation of IGCC-Benefits (Pilot Project 9)
4. Summary
### General Framework

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## General Framework

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### Optimisation Functionalities

**Activation of Reserves**

- Imbalance Netting
- aFRR-Assistance
- mFRR-Assistance
- RR-Assistance
## General Framework

### Technical Implementation

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### Optimisation Functionalities

**Activation of Reserves**

- **Imbalance Netting**
  - aFRR-Assistance ≠ aFRR-CMO
  - mFRR-Assistance ≠ mFRR-CMO
  - RR-Assistance ≠ RR-CMO

**Assistance is not related to costs! Only improvement of frequency quality!**
# General Framework

## Technical Implementation

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## Optimisation Functionalities

### Activation of Reserves

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### Procurement of Reserves

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<tr>
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**Definitions:**
- FCR-CMF: Fast Coordinated Market Failure
- aFRR-CMF: Activated Fast Reserve Coordinated Market Failure
- mFRR-CMF: Modified Fast Reserve Coordinated Market Failure
- RR-CMF: Reserve Coordinated Market Failure
- CMO: Coordinated Market Operation
Scope of Pilot Project 1

Technical Implementation

- Control Scheme
- Real-Time Data Exchange
- Optimization Functions
- Congestion Management

Optimisation Functionalities

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- Pilot Project 1 - implemented
- Pilot Project 1 - implemented but not submitted
  (► Pilot Project on FCR)
Scope of Pilot Project 9

Technical Implementation

- Control Scheme
- Real-Time Data Exchange
- Optimization Functions
- Congestion Management

Optimisation Functionalities

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- Pilot Project 9 - implemented
- Pilot Project 9 - first analysis
Two Pilot Projects in Two Bullet Points

Participants

- Pilot Project 1 (Germany)
- Pilot Project 9 (IGCC)

Focus

- Pilot Project 1: Grid Control Cooperation, full optimisation potential of TSO-TSO cooperation (harmonised framework)
- Pilot Project 9: International Grid Control Cooperation (IGCC) Imbalance Netting and technical aspects of aFRR

Imbalance Netting since 2008

06/2012

04/2014

02/2012

03/2012

10/2012

10/2011
1. Scope of the Pilot Projects 1&9

2. Technical Implementation

3. Evaluation of IGCC-Benefits (Pilot Project 9)

4. Summary
Technical Implementation – Basic Principle

Optimisation Potential!
Technical Implementation – Basic Principle

Control Area 1

- SCR-Activation
- SCR
- Control Area Balance
- SCR-Demand
- Correction
- ACE
- Secondary Controller
- SCR-Request

Control Area 2

- SCR-Activation
- SCR
- Control Area Balance
- SCR-Demand
- Correction
- ACE
- Secondary Controller
- SCR-Request

Control Area 3

- SCR-Activation
- SCR
- Control Area Balance
- SCR-Demand
- Correction
- ACE
- Secondary Controller
- SCR-Request

other Control Areas

- SCR-Demand
- Correction
Optimisation Algorithm

Parameters
- Optimisation Regions
  - Pilot 1
  - Prices (for CMO)
- Optimisation Functions
- Equal Treatment

Imbalances

SCR-Optimization
- Objective Function:
  \[ \min k^T x \]
- Constraints:
  \[ Ax = b \]
  \[ Cx \leq d \]
  \[ x_l \leq x \leq x_u \]

ATCs
Pilot 1
ATFs

Pilot 1
### IGCC: Pro-Rata Distribution of Netting Potential

<table>
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<tr>
<th>Control Block</th>
<th>ELIA</th>
<th>TEN</th>
<th>GER</th>
<th>CEPS</th>
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<tr>
<td>Imbalance (SCR demand) [MW]</td>
<td>100</td>
<td>50</td>
<td>-200</td>
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<tr>
<td>Correction without congestions [MW]</td>
<td>-100</td>
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**Diagram:**
- **IGCC correction**
- **IGCC interchange on border**

- **ELIA:** 100
  - **Corr. = -100**

- **TEN:** 50
  - **Corr. = -50**

- **GER:** -200
  - **Corr. = 100**

- **CEPS:** -100
  - **Corr. = 50**

- **SG:** 0
  - **Corr. = 0**
IGCC: Pro-Rata Distribution of Netting Potential

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- **IGCC correction**
- **IGCC interchange on border**
- **IGCC congestion (≤ ATC after market)**

**Diagram Notes:**
- ELIA: 100
- TEN: 50
- GER: -200
- CEPS: -100
- SG: 0

**Correction Values:**
- Corr. = -60
- Corr. = -30
- Corr. = 60
- Corr. = 30
- Corr. = 0
1. Scope of the Pilot Projects 1&9

2. Technical Implementation

3. Evaluation of IGCC-Benefits (Pilot Project 9)

4. Summary
## IGCC Settlement and Value of Netted Imbalances

### Opportunity Price as Input for Settlement in IGCC

- **without IGCC**
  
  \[
  \text{SCE}_{\text{before IGCC}} \times \text{SCE price}_{\text{before IGCC}} \]

- **with IGCC**
  
  \[
  \text{IGCC exchange} \times \text{SCE price}_{\text{after IGCC}} \]

### Calculation of IGCC Settlement Price

- IGCC Settlement Price \( (C_{\text{IGCC}}) \): **Energy weighted** \( (E_{\text{Imp},i} \text{ and } E_{\text{Exp},i}) \) average of the **opportunity prices** \( (C_{\text{Imp},i} \text{ and } C_{\text{Exp},i}) \)

- Single price for all IGCC exchanges

  \[
  C_{\text{IGCC}} = \frac{\sum_{i=1}^{n} (C_{\text{Imp},i}E_{\text{Imp},i} + C_{\text{Exp},i}E_{\text{Exp},i})}{\sum_{i=0}^{n} (E_{\text{Imp},i} + E_{\text{Exp},i})}
  \]

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

  \[
  R_{\text{IGCC}} = \sum_{i=1}^{n} (C_{\text{Imp},i} - C_{\text{IGCC}}) \cdot E_{\text{Imp},i} + \sum_{i=1}^{n} (C_{\text{IGCC}} - C_{\text{Exp},i}) \cdot E_{\text{Exp},i}
  \]

### Opportunity Price = Opportunity Value/IGCC Volume

\[
\frac{\left(\text{SCE}_{\text{before IGCC}} \times \text{SCE price}_{\text{before IGCC}}\right) - \left(\text{SCE}_{\text{after IGCC}} \times \text{SCE price}_{\text{after IGCC}}\right)}{\text{IGCC exchange}}
\]
Amount of Netted Imbalances per Country

Amount of Netted Imbalances (Short+Long) - Monthly Values (GWh)

Month | GWh
--- | ---
10/11 | 0
01/12 | 25
04/12 | 50
07/12 | 75
10/12 | 100
01/13 | 125
04/13 | 150
07/13 | 175
10/13 | 200

DE | DK | NL | CH | CZ | BE
Monetary Value of Netted Imbalances per Country
Remark: Value of Netted Imbalances surpassed €100 Million in Jan 2014
Total Value of Netted Imbalances per Country

Cummulated Value of Netted Imbalances per Member Country (Million €)

- DE: 27 months
- DK: 27 months
- NL: 23 months
- CH: 21 months
- CZ: 19 months
- BE: 15 months

Mil. € vs. 27 months
Average Value of Netted Imbalances per Country

Average Benefit per MWh Netted Imbalance per Country per Year (€/MWh)

Remark: Different prices for aFRR-energy lead to different benefits
1. Scope of the Pilot Projects 1&9

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4. Summary
## Summary

### Challenges
- 10 TSOs from 7 countries – high degree of coordination necessary
- Different frameworks for energy pricing

### Experience
- **6 years of experience** with Imbalance Netting in Germany
- **More than 2 years** of experience with Imbalance Netting between different countries, *value of netted imbalances in IGCC exceeds €100 Million*

### Outlook
- Further technical improvements will increase operational transparency and efficiency
- Multilateral governance structure