Flow based day-ahead capacity calculation
Intraday capacity calculation

Nordic CCM Stakeholder Group meeting

1 December 2016 | Nils Ræder, Statnett

FB/CNTC and ID/DA have most components in common

- Methodologies for the inputs
  - ✓ Security margins
  - ✓ Operational security limits, contingencies relevant to capacity calculation and allocation constraints
  - ✓ Generation shift keys
  - ✓ Remedial actions to be considered in capacity calculation
- Methodology for the capacity calculation
  - ✓ Mathematical description of the applied capacity calculation approach
  - ✓ Rules for avoiding undue discrimination
  - ✓ Previously allocated cross-zonal capacity
  - ✓ Application of remedial actions
- Methodology for the validation of cross-zonal capacity
- Fallback procedure

- Contents specific to FB/CNTC or DA/ID:

	Day ahead	Intraday
Flow based	Description of the calculation of power transfer distribution factors and margins	The frequency at which capacity will be reassessed
Coordinated net transmission capacity	Rules for calculating cross-zonal capacity, including rules for efficiently sharing the among different bidding zone borders	

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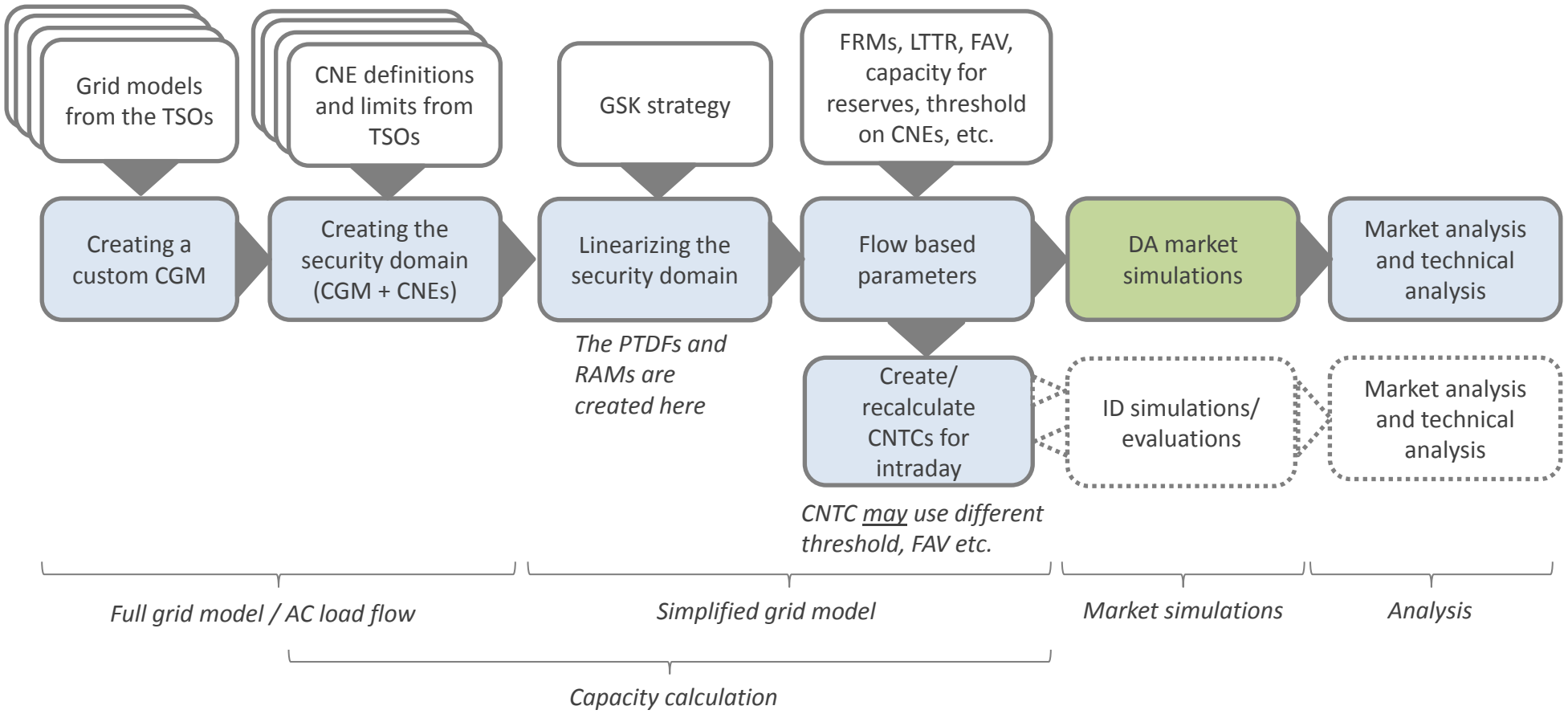
Status of the test systems

Flow based day-ahead	**Prototype tools** **Custom CGM** **Market simulations ongoing**	*Flow based intraday*	**Assumed to be the same as day-ahead flow based**
		CNTC intraday	**Assumed to be the same as day-ahead CNTC**
CNTC day-ahead	**Proof of concept**	*Flow based intraday*	**Not considered**
		CNTC intraday	**Assumed to be the same as day-ahead CNTC**

Flow based calculation prototype tools



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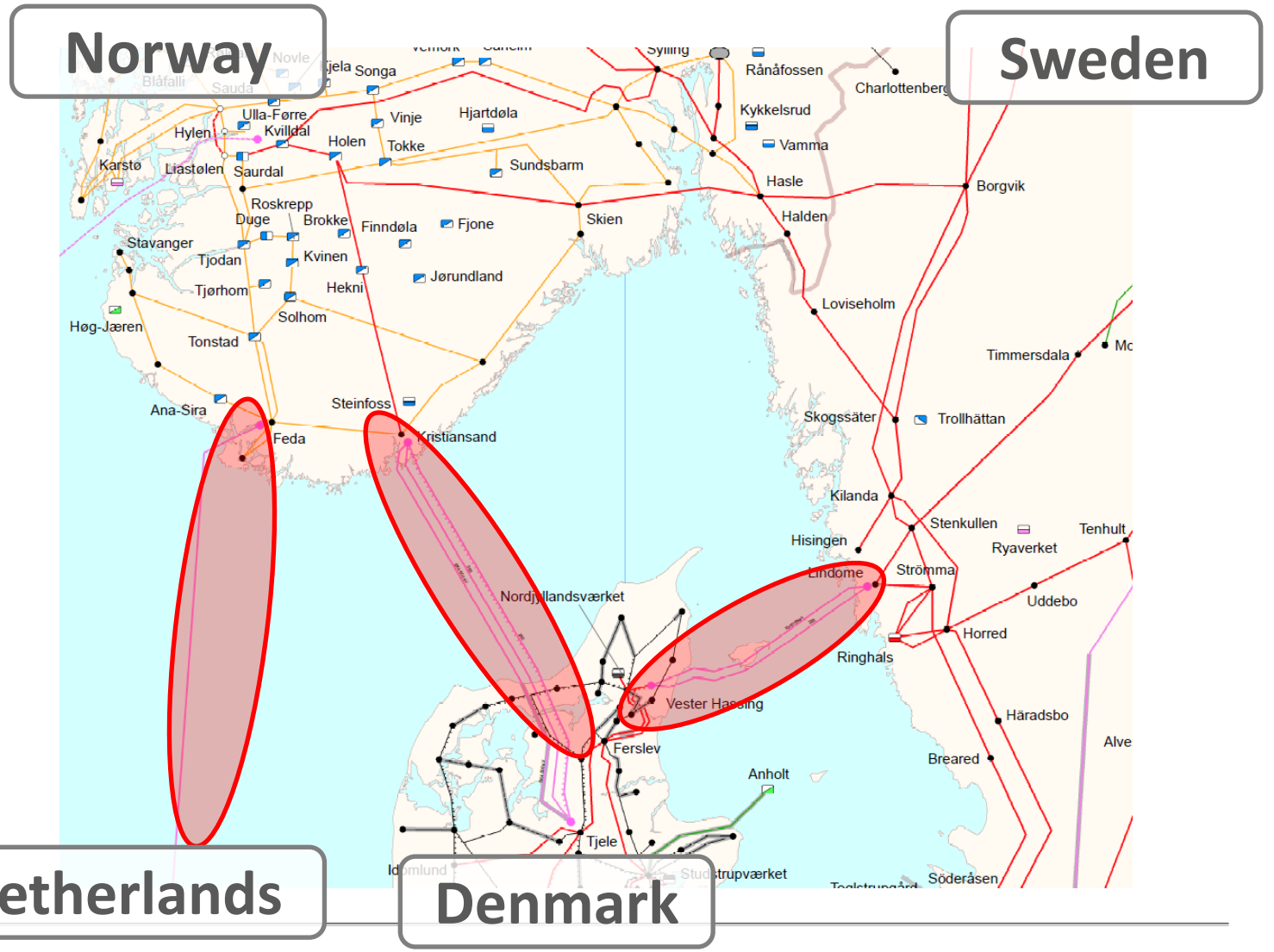
HVDC interconnectors in flow based

- HVDC interconnectors are different – we cannot use fixed PTDFs to describe the flow like we do for the AC borders
- These interconnectors are controllable: commercial exchange is the same as scheduled exchange



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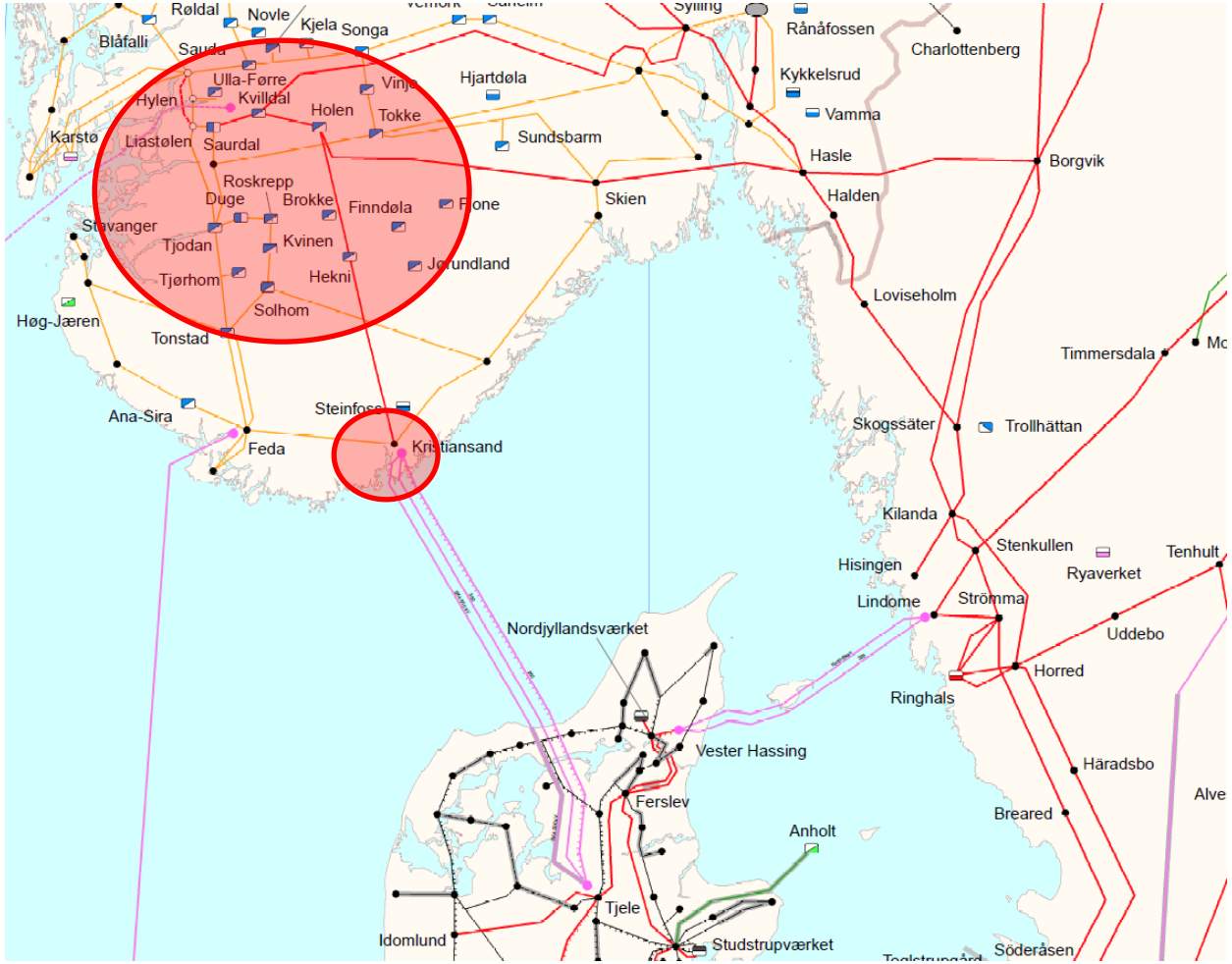
- These interconnectors also have a different impact on the grid compared to the average producers and consumers in the area
- We would therefore like to have a unique set of PTDFs that describe how the import/export on these interconnectors influence the grid



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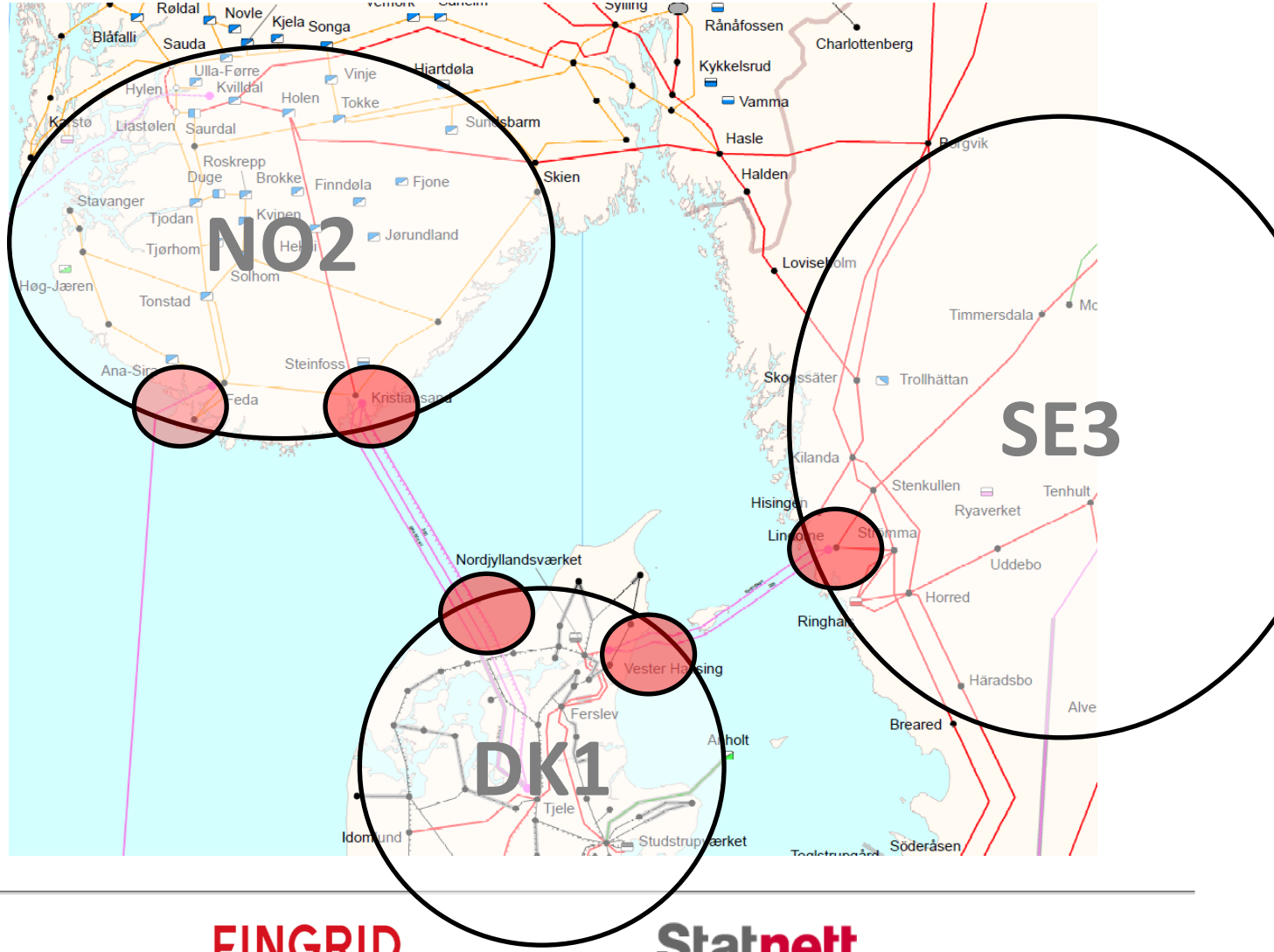
- We do this by creating virtual areas representing the terminal point of the HVDC interconnectors



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Disclaimer for the results

- Prototype tools have been used for the simulations
- Although operators are consulted in the review stage, they are not personally involved in the FB capacity calculation process yet
- The grid models used are not yet the target (CGMES) models. Indeed those are in the process of being implemented. The quality of the grid models is the best we can have at this moment in time; they do not allow for dynamic analysis and detailed voltage/reactive power analysis though.
- Merging software for creating the CMG from the IGMs evolves over time. Improvements made for the later weeks have not been applied for the earlier ones
- CNE selection (review and possible removal of non-significantly impacted CNEs) has not been implemented at this stage yet
- The market simulations are done in the European Power Exchanges' Simulation Facility, limited to the Central Northern European market, and by using historical order books
- FRMs are not included

Example results for week 10 2016

The PTDF matrix describe the interdependency between border flows

Commercial exchange between areas …

… impact on scheduled flow

	DK1-DE	DK1-SE3	DK1-NO2	DK1-DK2	DK2-DE	DK2-SE4	FIN-EE	FIN-SE3	FIN-NO4	FIN-SE1	NO1-NO2	NO1-NO3	NO1-NO5	NO1-SE3	NO2-NL	NO2-NO5	NO3-NO4	NO3-NO5	NO3-SE2	NO4-SE1	NO4-SE2	SE1-SE2	SE2-SE3	SE3-SE4	SE4-DE	SE4-LT	SE4-PL
DK1-DE	1																										
DK1-SE3		1																									
DK1-NO2			1																								
DK1-DK2				1																							
DK2-DE					1																						
DK2-SE4						1																					
FIN-EE							1																				
FIN-SE3								1																			
FIN-NO4									0																		
FIN-SE1									1	1																	
NO1-NO2			0								0.9		0.2			0.7		0.2									
NO1-NO3								0	0.1		0	0.4	0.1	0.2			0.2	0.4	0.2	0.1	0.1		0				
NO1-NO5			0								0.1		0.8			0.6		0.7									
NO1-SE3								0	0.1		0	0.6		0.8			0.2	0.6	0.2	0.1	0.1		0				
NO2-NL															1												
NO2-NO5			0								0.1		0.2			0.3		0.2									
NO3-NO4									0.2			0.1		0			0.5	0.1	0.2	0.2	0.3	0.1					
NO3-NO5													0.1			0.1		0.1									
NO3-SE2									0.2		0	0.4		0.1		0	0.4	0.4	0.6	0.2	0.2	0.1	0				
NO4-SE1									0.6	0		0.1		0			0.4	0.1	0.1	0.6	0.5	0.1					
NO4-SE2									0.1			0.1					0.1	0.1	0.1	0.1	0.2	0					
SE1-SE2									0.4	0		0.1		0			0.5	0.1	0.1	0.3	0.6	0.9					
SE2-SE3								0	0.1		0	0.6		0.2		0	0.2	0.6	0.2	0.1	0.1		1				
SE3-SE4																								1			
SE4-DE																									1		
SE4-LT																										1	
SE4-PL																											1

- The table show how a commercial exchange between two areas – production in one and consumption in the other – create flows on the bidding zone borders
- The checkered area shows that the Norwegian and Swedish grids are highly interconnected
- Any trades that would change the net positions in these areas create transit flows on multiple borders
- There is not a one-to-one relationship between commercial exchange and power flow

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Example results for week 10 2016

The PTDF matrix describe the interdependency between border flows

- This table shows only the checkered part
- Some borders have a low correlation between commercial exchange, and actual impact on the grid
- The most extreme being NO3-NO5, where only 6 % of the power will take the shortest route

Commercial exchange between areas …

… impact on scheduled flow

	FIN-NO4	FIN-SE1	NO1-NO2	NO1-NO3	NO1-NO5	NO1-SE3	NO2-NL	NO2-NO5	NO3-NO4	NO3-NO5	NO3-SE2	NO4-SE1	NO4-SE2	SE1-SE2	SE2-SE3
NO1-NO2			0.9		0.2			0.7		0.2					
NO1-NO3	0.1			0.4	0.1	0.2			0.2	0.4	0.2	0.1	0.1		
NO1-NO5			0.1		0.8			0.6		0.7					
NO1-SE3	0.1			0.6		0.8			0.2	0.6	0.2	0.1	0.1		
NO2-NL							1								
NO2-NO5			0.1		0.2			0.3		0.2					
NO3-NO4	0.2			0.1					0.5	0.1	0.2	0.2	0.3	0.1	
NO3-NO5					0.1			0.1		0.1					
NO3-SE2	0.2			0.4		0.1			0.4	0.4	0.6	0.2	0.2	0.1	
NO4-SE1	0.6			0.1					0.4	0.1	0.1	0.6	0.5	0.1	
NO4-SE2	0.1			0.1					0.1	0.1	0.1	0.1	0.2		
SE1-SE2	0.4			0.1					0.5	0.1	0.1	0.3	0.6	0.9	
SE2-SE3	0.1			0.6		0.2			0.2	0.6	0.2	0.1	0.1		1

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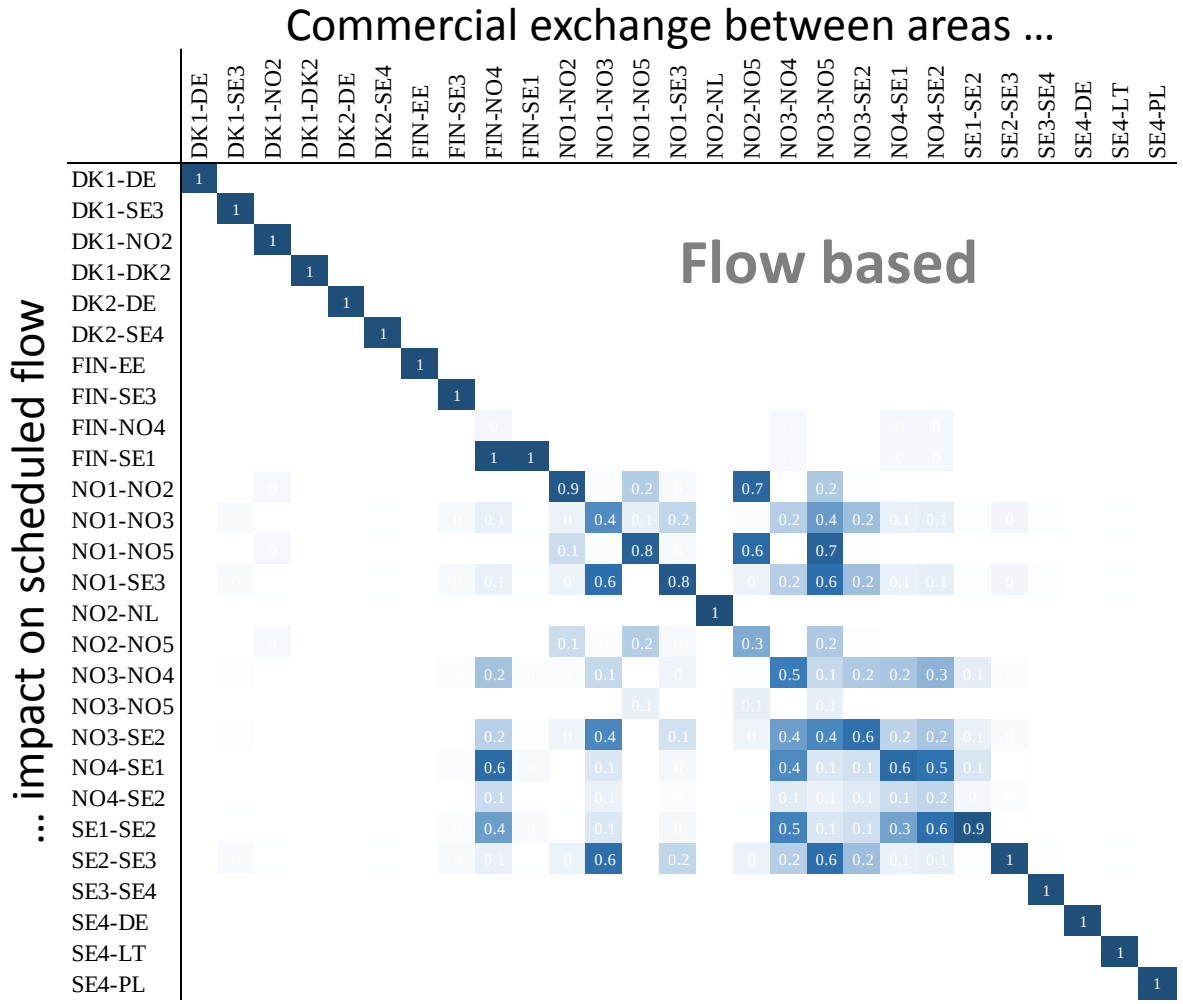
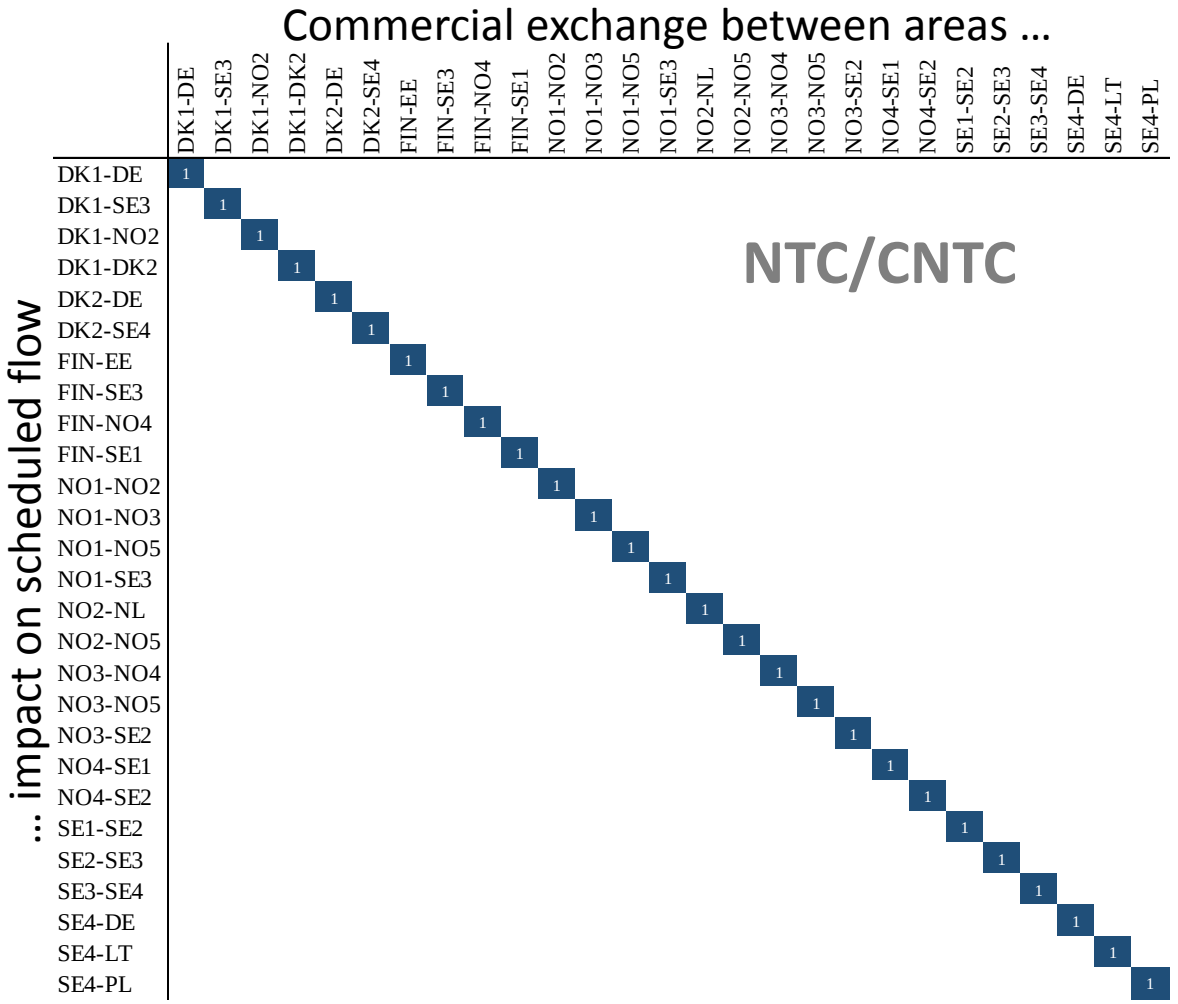
The PTDF matrix describe the interdependency between border flows





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Example results for week 10 2016

Max/min net positions

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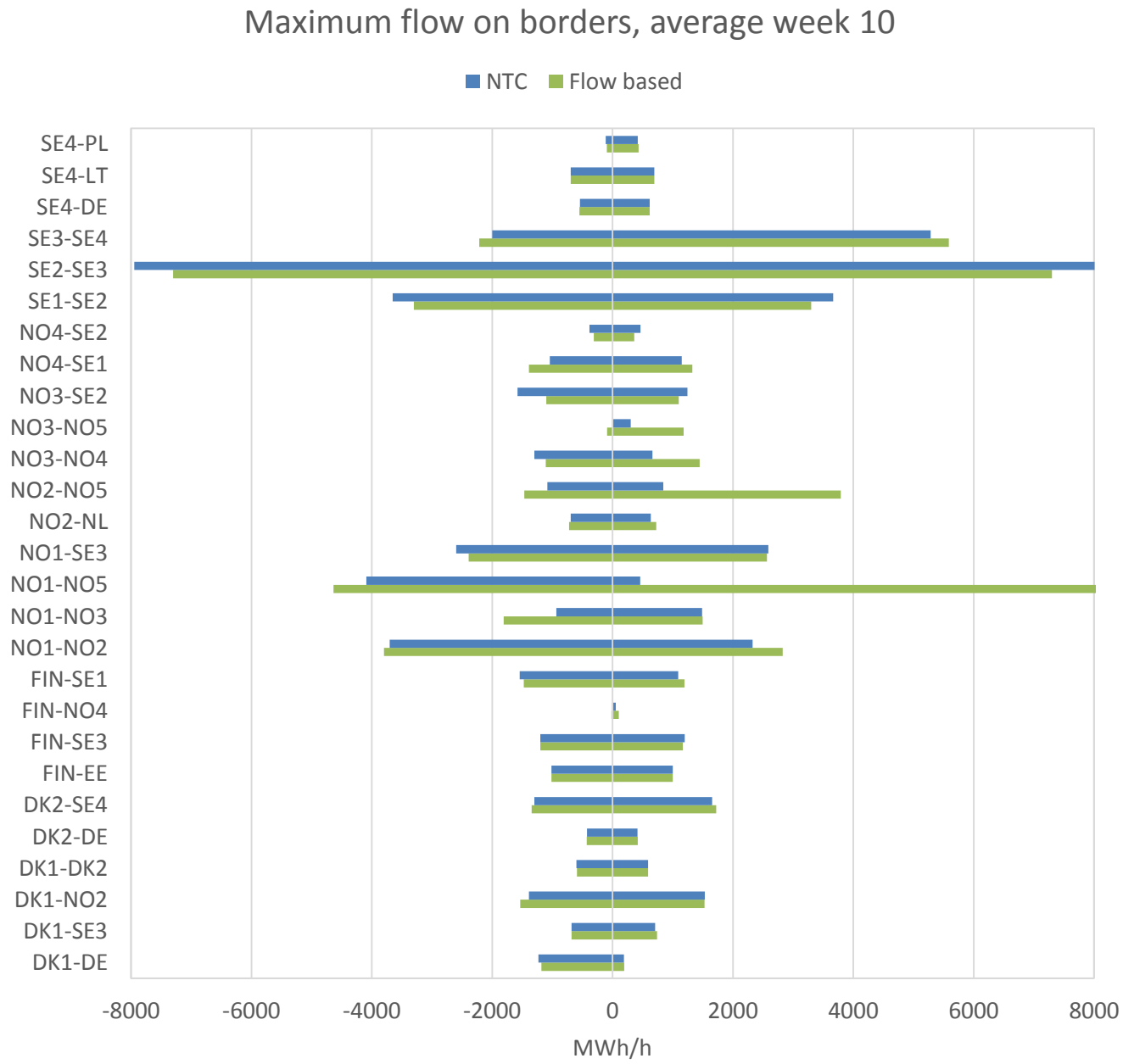
Example results for week 10 2016

Max/min border flow



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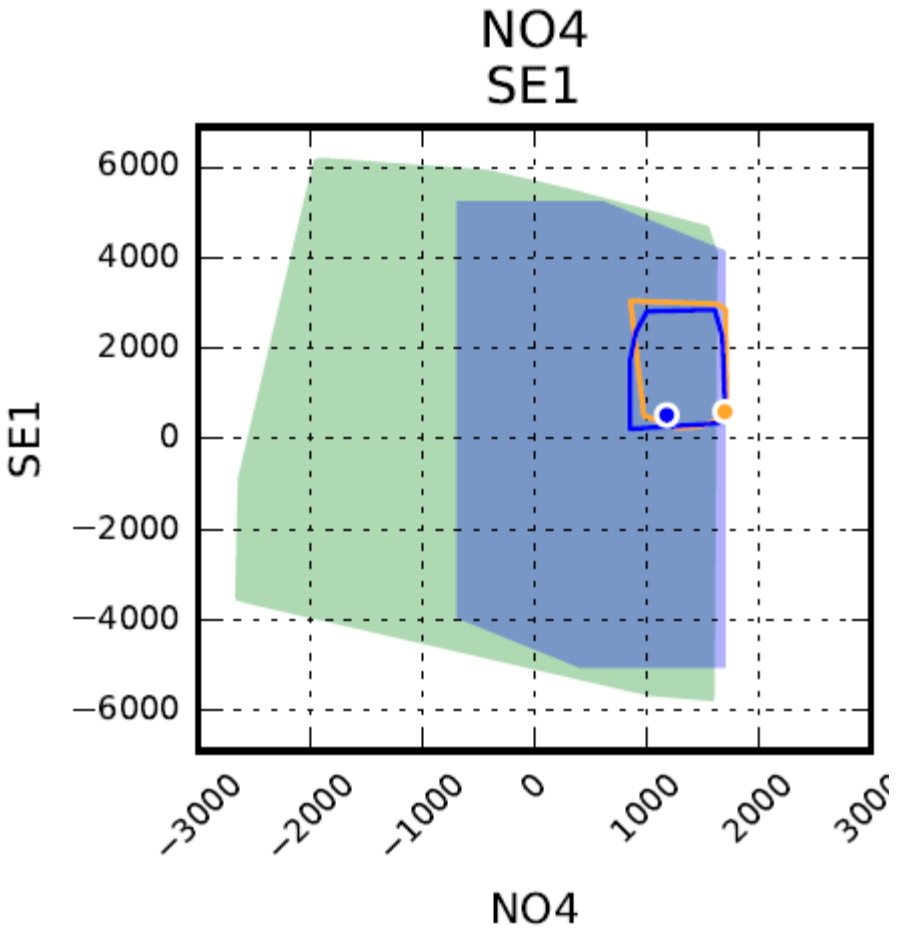
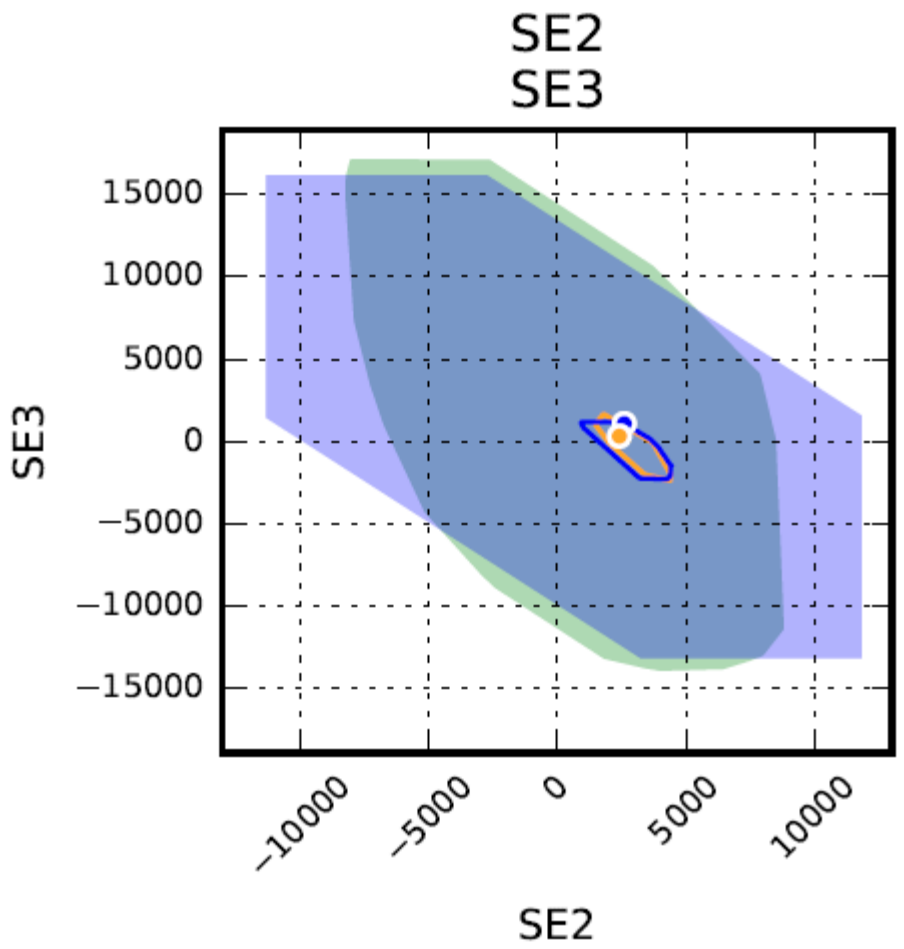
Example results for week 10 2016

Interdependency of area net positions





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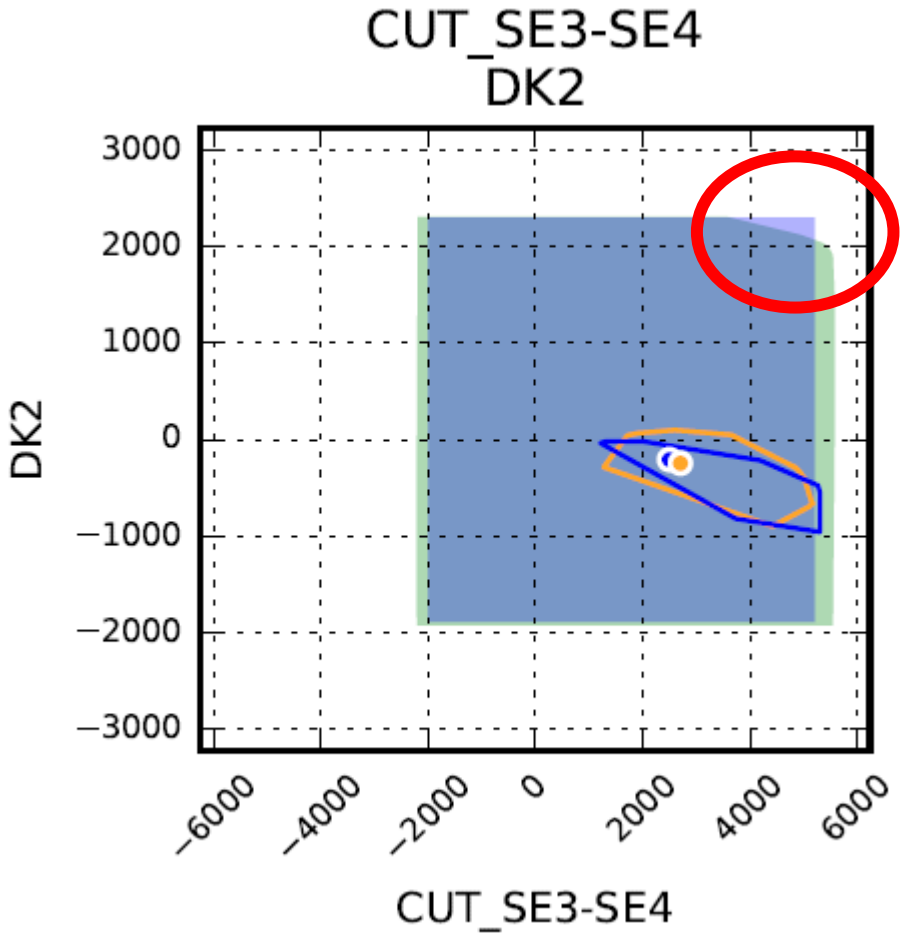
Example results for week 10 2016

Interdependency of area net positions



It's not possible with maximum flow SE3-SE4 at the same time as maximum flow DK2-SE4

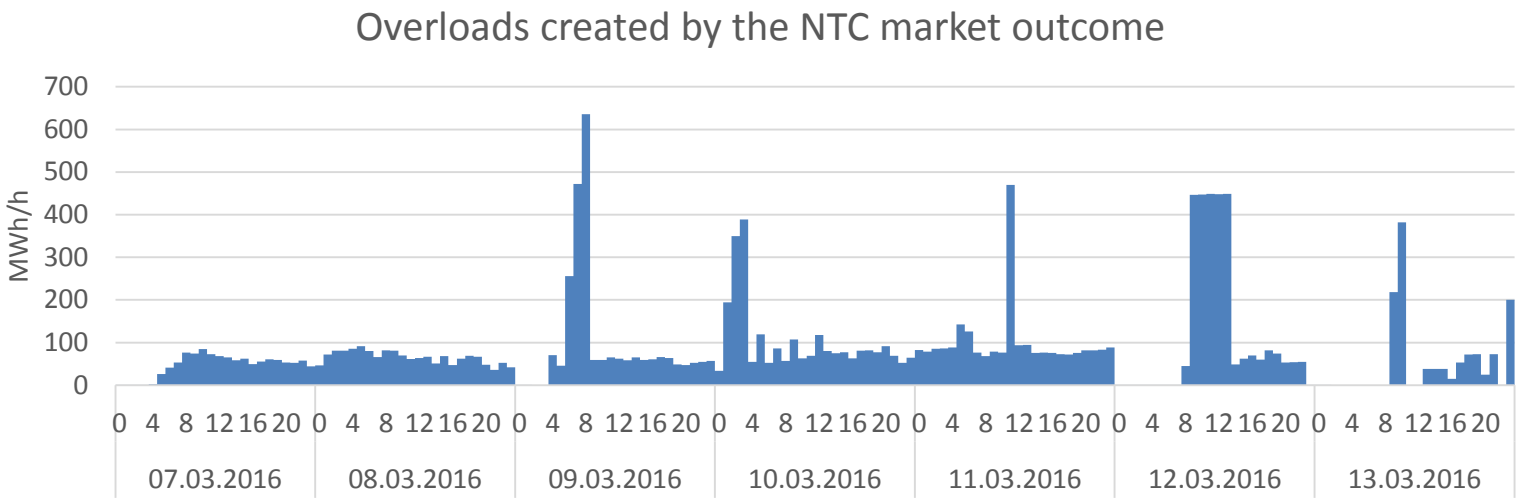
The corner is "cut" in flow based

Time: 2016-3-13 01:00

Example results for week 10 2016

NTC capacity sometimes larger than FB capacity

- The FB capacity is more restrictive than NTC in some locations most of the time
- In the market simulations we see this is overloads on the CNEs, which (may) require remedial actions
- Therefore we need to compare both the economic and technical/security aspects of the market simulations



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