



Preliminary observations based on Flow-Based market simulations

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Internal parallel run results – Disclaimers regarding the capacity calculation data

- Two DC-interconnectors are missing in the FB domains
- The CGMs used are not yet fully operational
Adjustments and additional information is still pending (temperature dependency, operational forecasting...)
- The FB domains are yet not fully validated from an operational point of view
- The NTCs are operational (i.e. from the DA market), thus not based on the CGMs applied for FB – The missing DCs has been removed
- Market results are obtained by using the PX simulation facility



Internal parallel-run results – week 35, 36

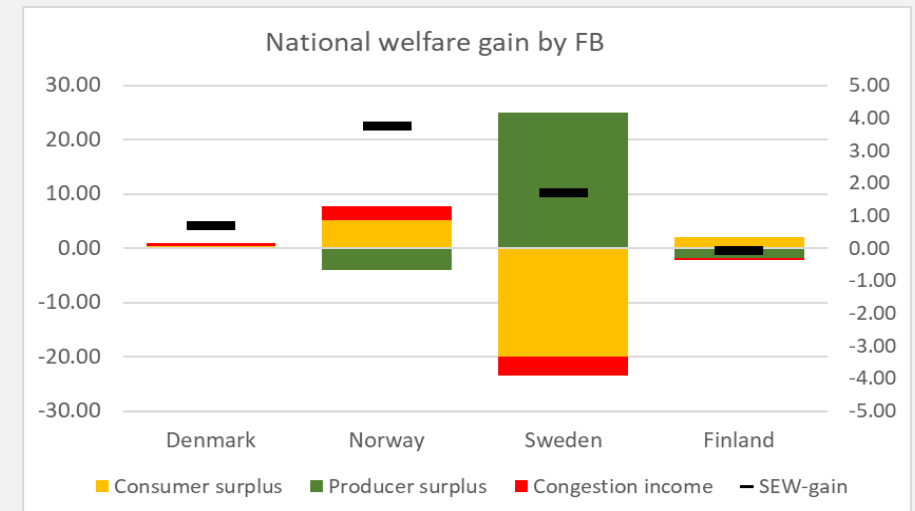
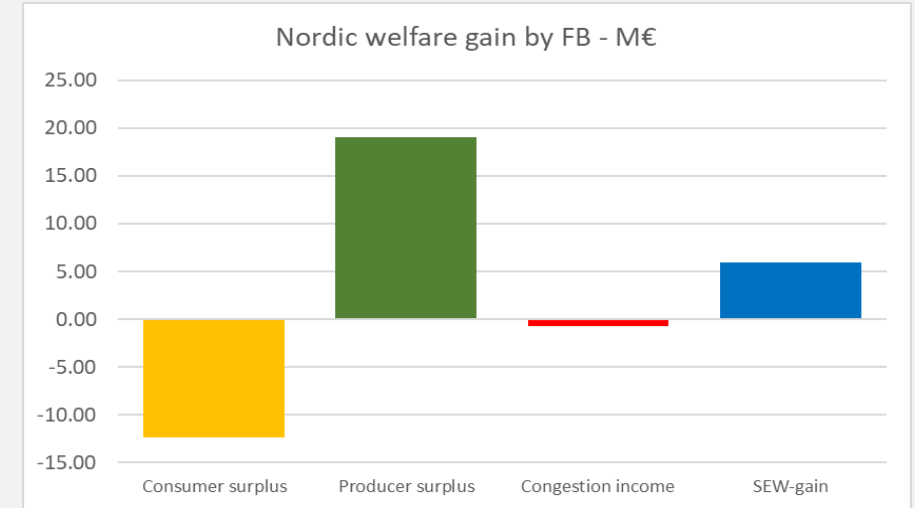
Some highlights

Nordic in total

- Welfare economic gain,
- Lower consumer surplus
- Higher producer surplus
- Lower congestion income

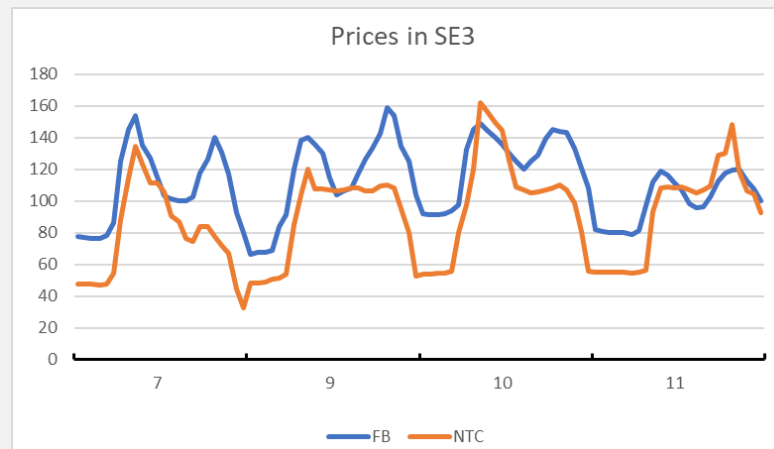
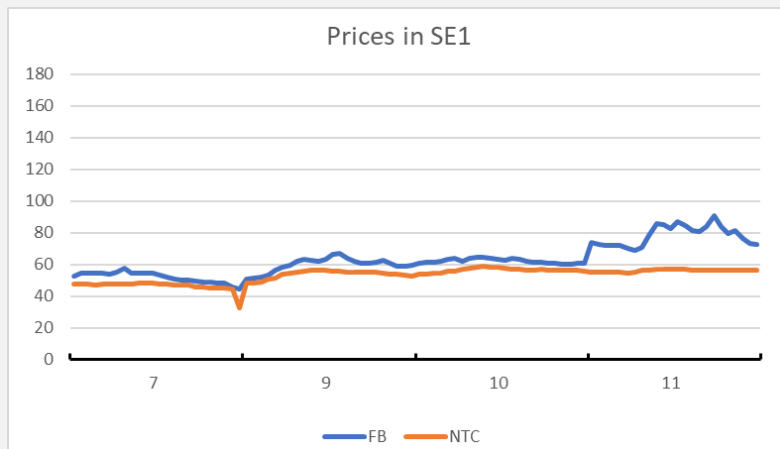
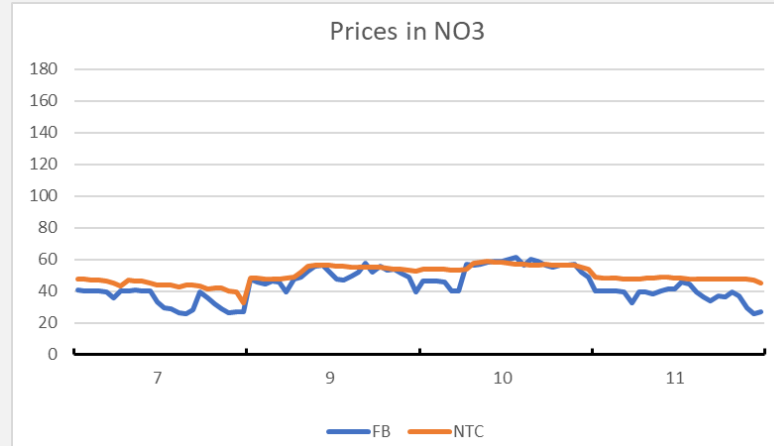
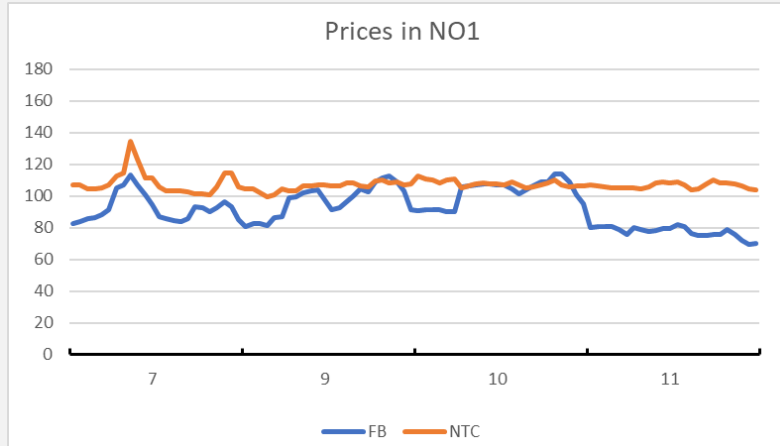
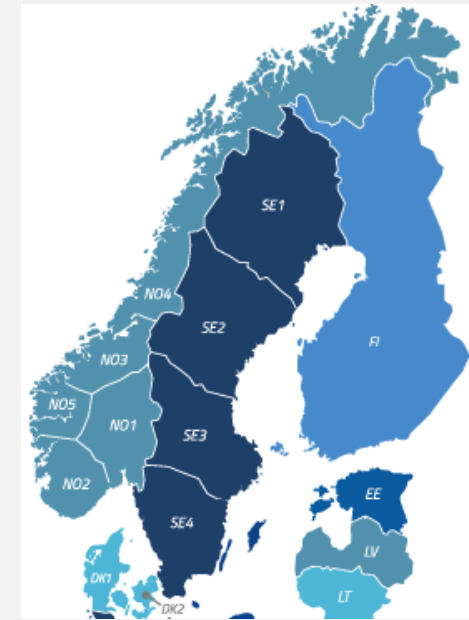
Main effects are in Sweden and Norway

- Higher degree of meshed AC-grid in these two countries
- Consumer surplus reduced in Sweden while increased in Norway
- Producer surplus increased in Sweden while reduced in Norway



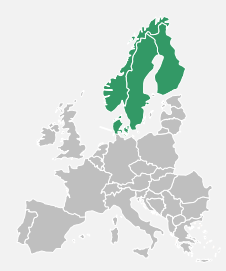


IPR results – week 36: Prices (1/2)

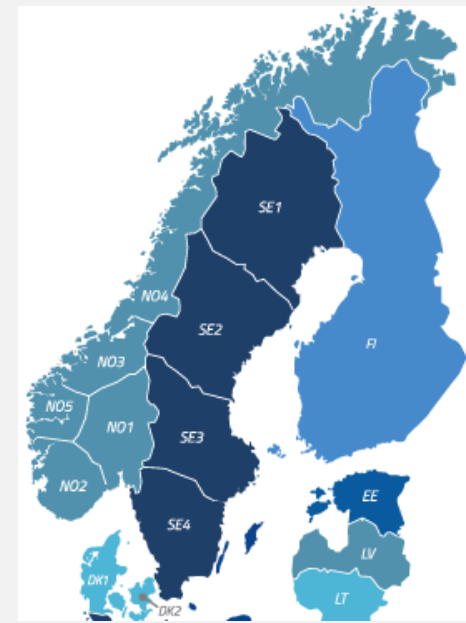
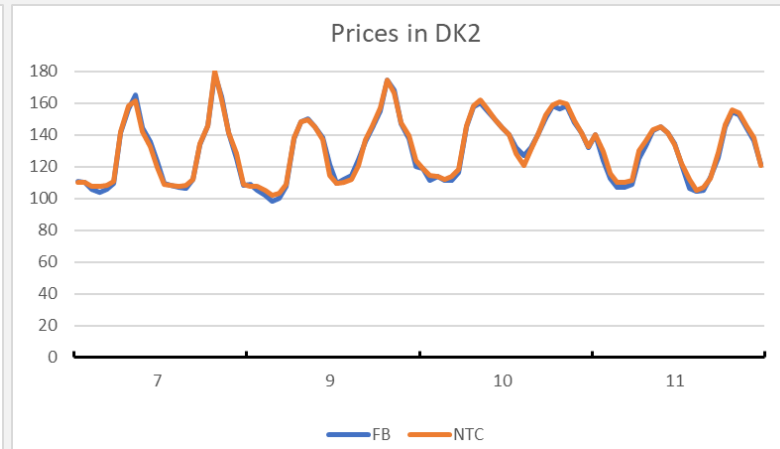
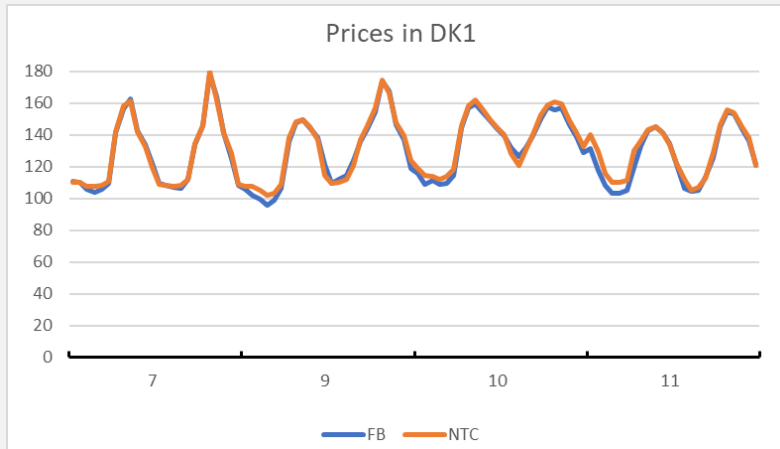
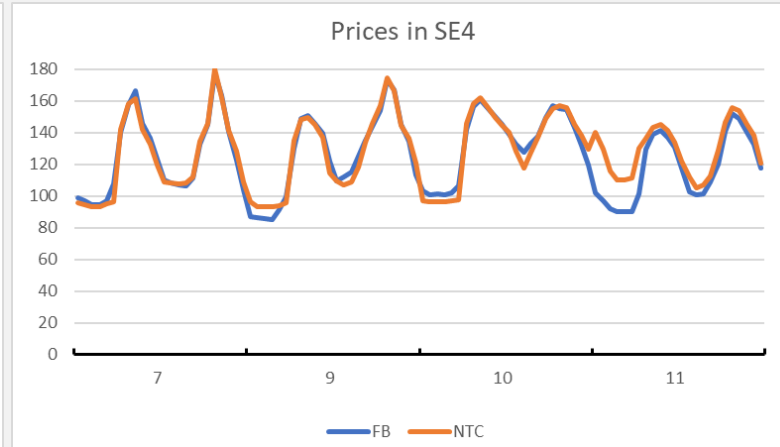
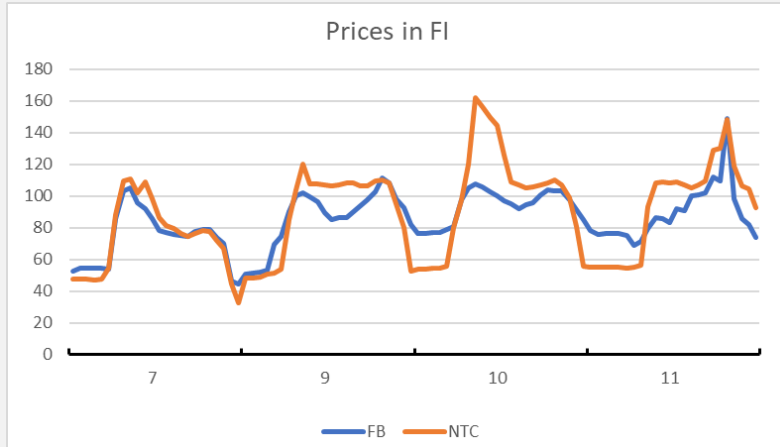


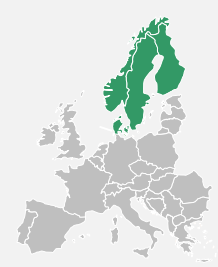
Some highlights

- Higher prices in the SE1 because of better market access for the cheap hydropower
- Lower prices in NO1 and NO3 because of better access to cheap hydropower from SE1
- Increased prices in the highly populated SE3 because of more power is transferred to the southern DCs and also to NO1

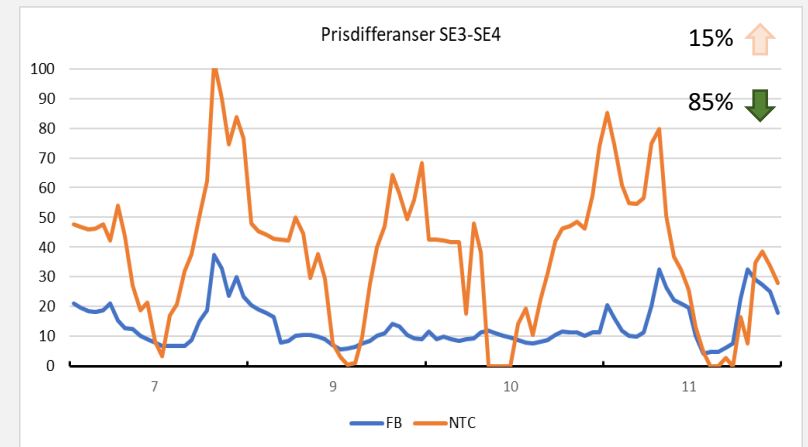
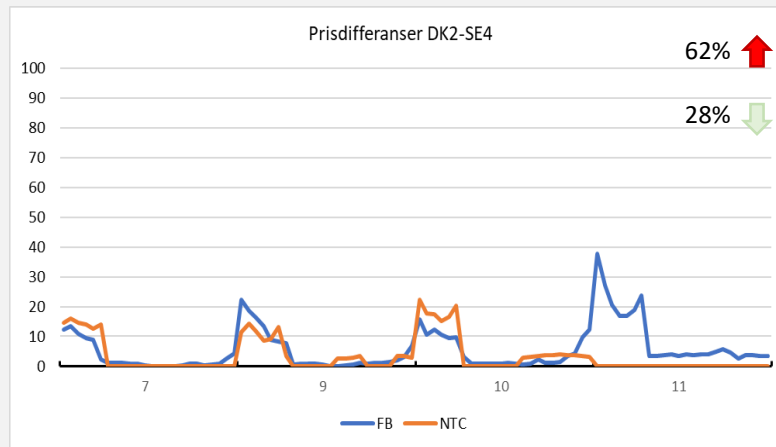
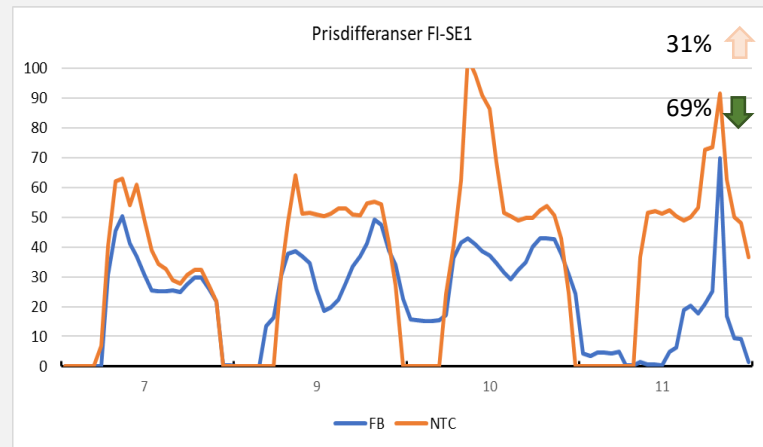
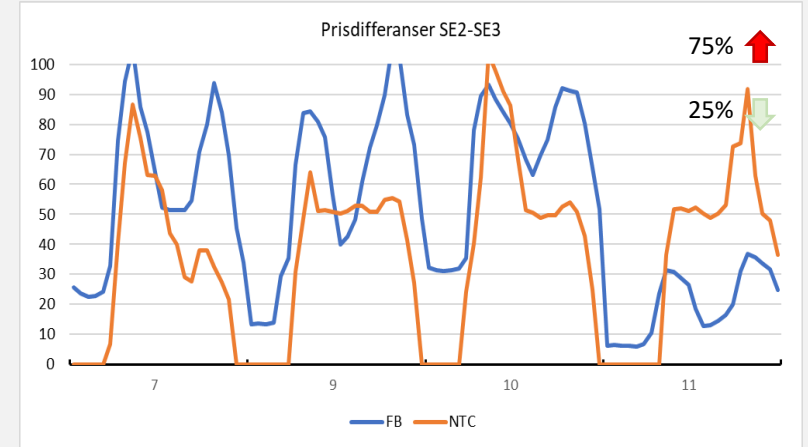
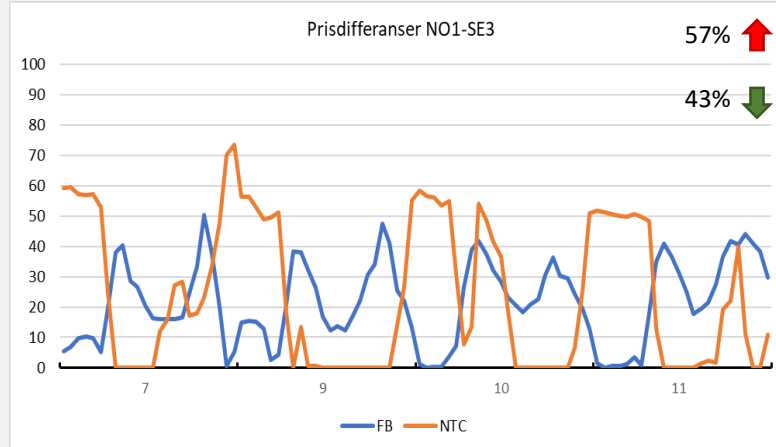
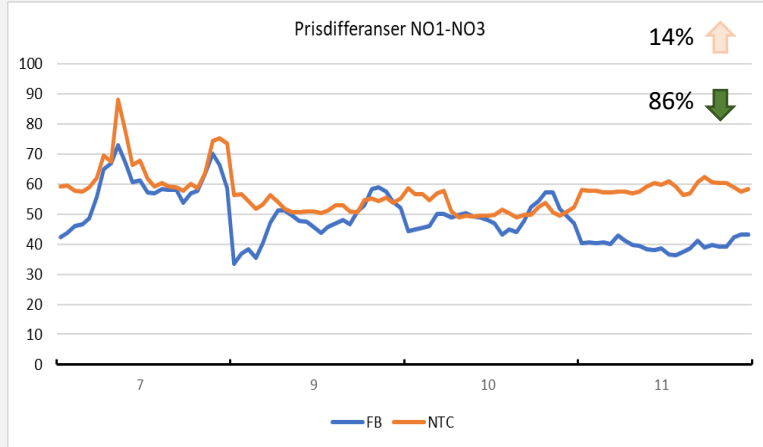


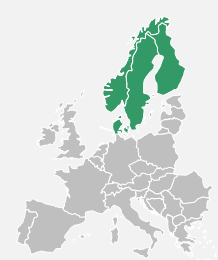
IPR results – week 36: Prices (2/2)





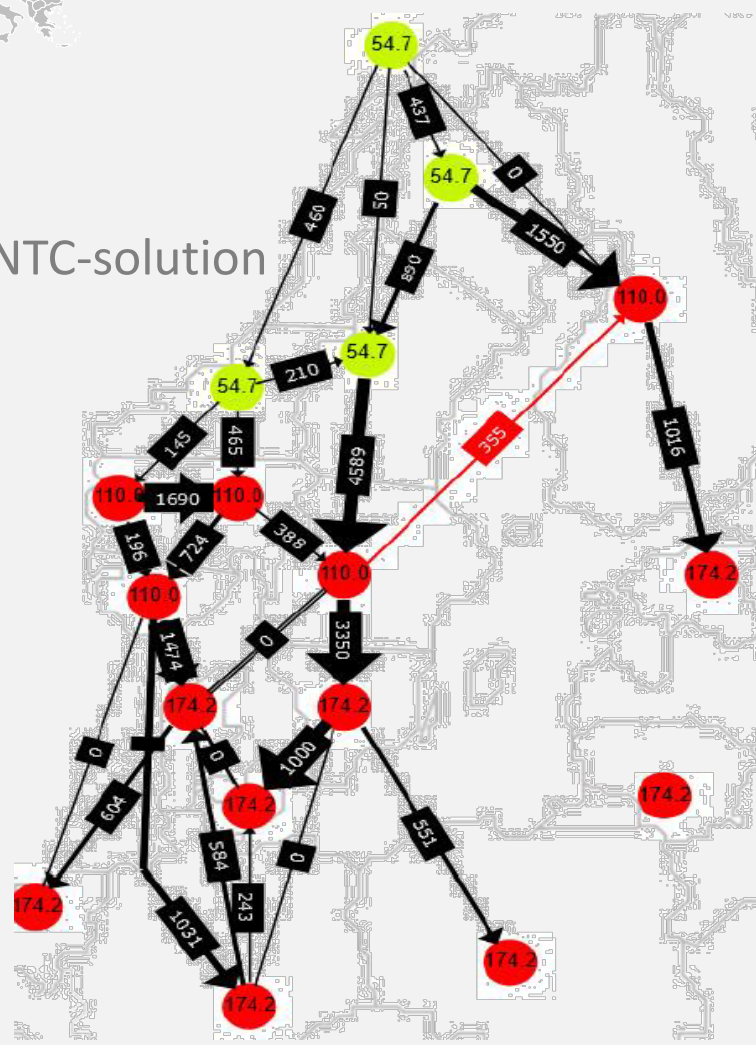
IPR results – week 36: Price differences



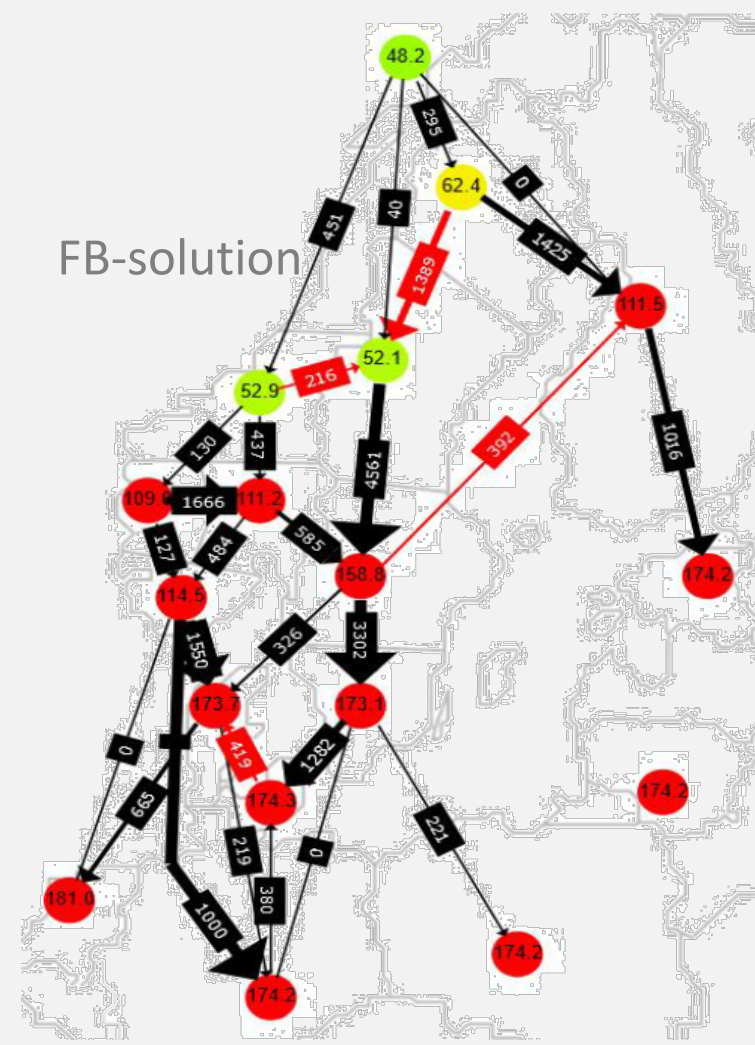


Deep-dive: Solutions for 09/09 2021, 19:00

NTC-solution

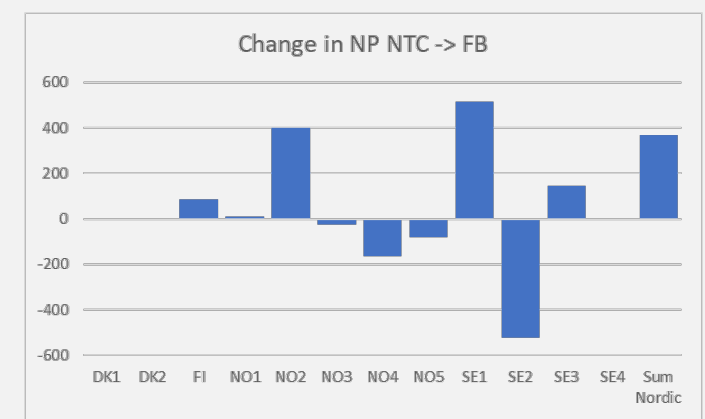


FB-solution



Some highlights

- Higher price in SE3 & SE1
- Non-intuitive AC-flows
- Non-intuitive DC-flows
- Higher flows on most DCs





Definition of an optimal FB market equilibrium

- The first order condition for a global welfare optimum* is:

$$P^i = \lambda - \sum_n \rho_n PTDF_n^i$$

P^i = The price in bidding zone i

λ = The Price in the slack node (not the system price)

ρ_n = Shadow price of a constraining grid element n
Increase in the SEW by a marginal relaxation for the constrained element n

$PTDF_n^i$ = The zone-to-slack PTDF of bidding zone i on CNE n

$PTDF_n^{ij}$ = The zone-to-zone PTDF for BZ_i - BZ_j on CNE n

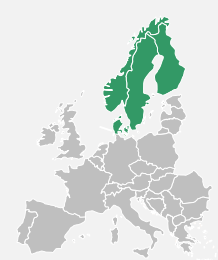
- The marginal value of a bilateral trade from BZ_i to BZ_j can be derived from the first order condition:

$$(P^j - P^i) = \sum_n \rho_n * PTDF_n^{ij}$$

$$\rho_n \geq 0 \quad \text{and} \quad \rho_n (RAM_n - \sum_i NP_i * PTDF_n^i) = 0$$

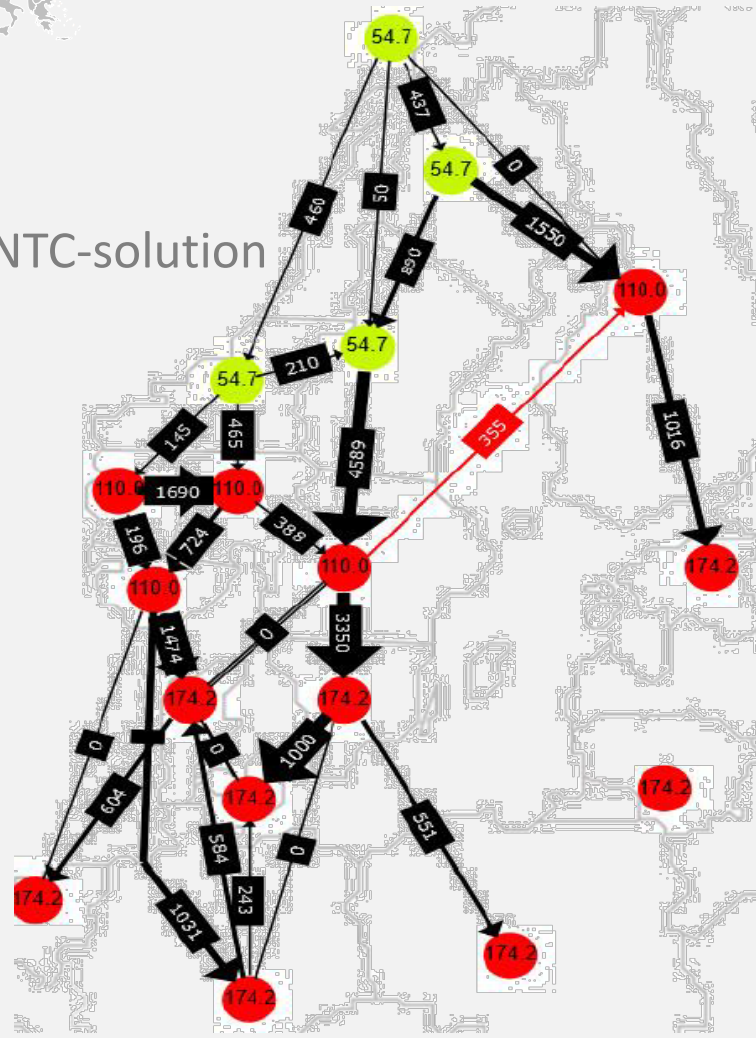
- A non-intuitive flow from high price to low price will have an exactly offsetting impact on the grid

* Darryl R. Biggar & Mohammad Reza Hesamzadeh (2014): "The Economics of Electricity Markets", IEEE Press and John Wiley & Sons Ltd, ISBN 978 11 18775752

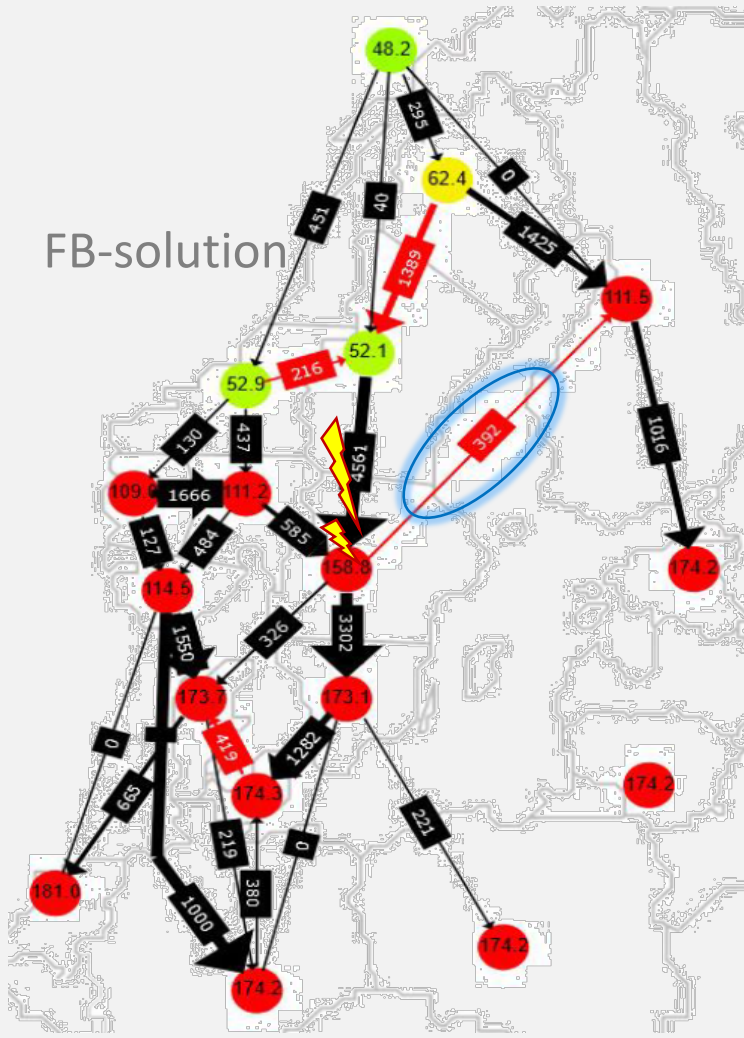


Deep-dive: Solutions for 09/09 2021, 19:00

NTC-solution



FB-solution

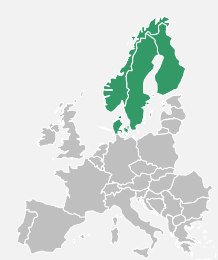


$$P_{Fin} - P_{SE3} = -47,258$$

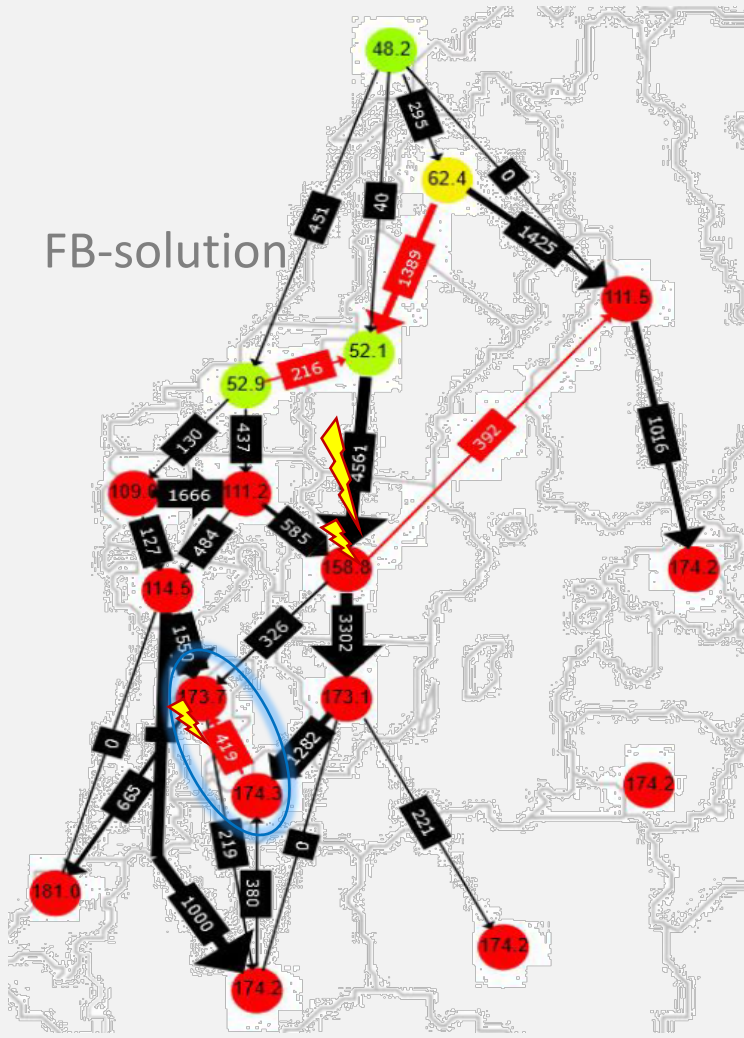
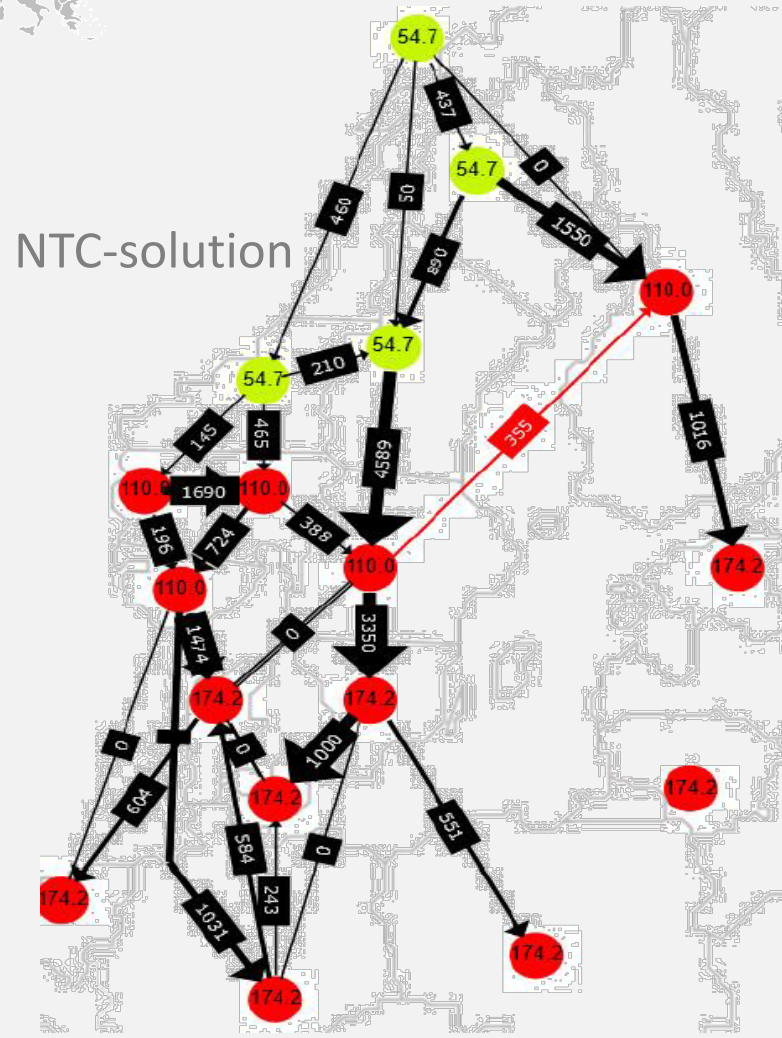
$$\rho_1 * PTDF_1^{SE3-FI} = -45.274$$

$$+ \rho_2 * PTDF_2^{SE3-FI} = -1.984$$

$$= -47,258$$



Deep-dive: Solutions for 09/09 2021, 19:00



$$P_{DK1} - P_{DK2} = -0,623$$

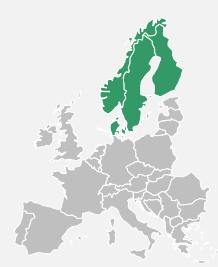
$$\rho_1 * PTDF_1^{DK2-DK1} = -0.027$$

$$+ \rho_2 * PTDF_2^{DK2-DK1} = 0.007$$

$$+ \rho_3 * PTDF_3^{DK2-DK1} = -0.603$$

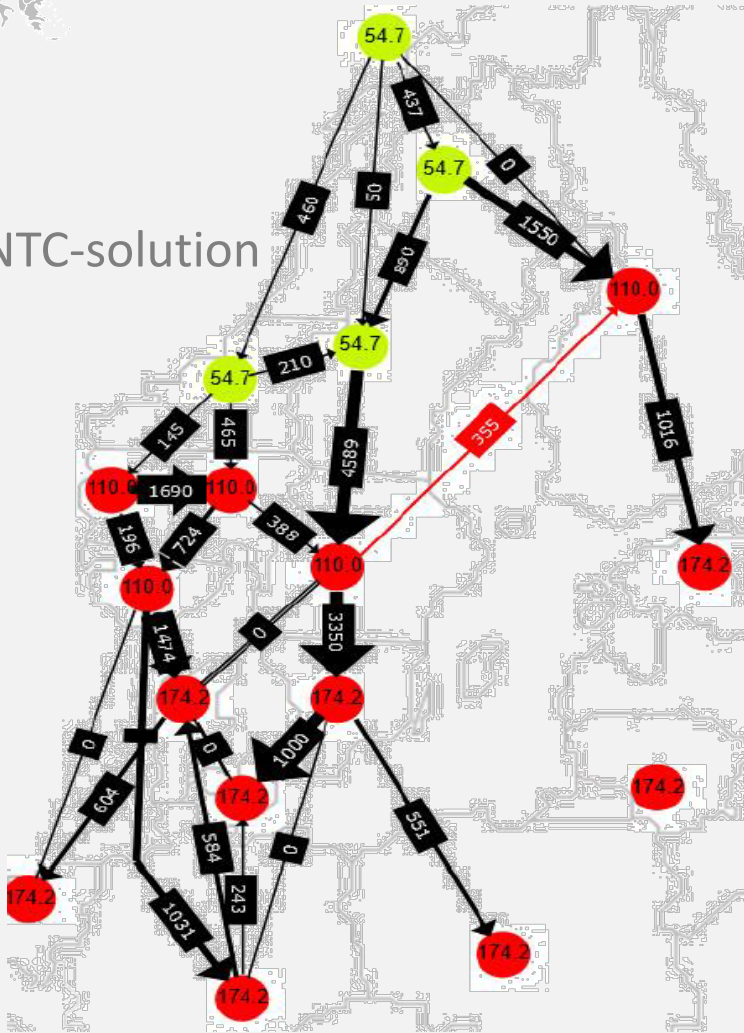
$$= -0,623$$

Why an impact on CNEC1 and CNE2?
 The border between DK2 and SE4 is actually AC-4 lines. Due to the DC-model being without AC losses, a bilateral trade between DK2 and DK2_storebælt generates two opposite, but equally sized, flows on these AC-lines. Thus, a very small relief is generated on the high cost CNEC1.

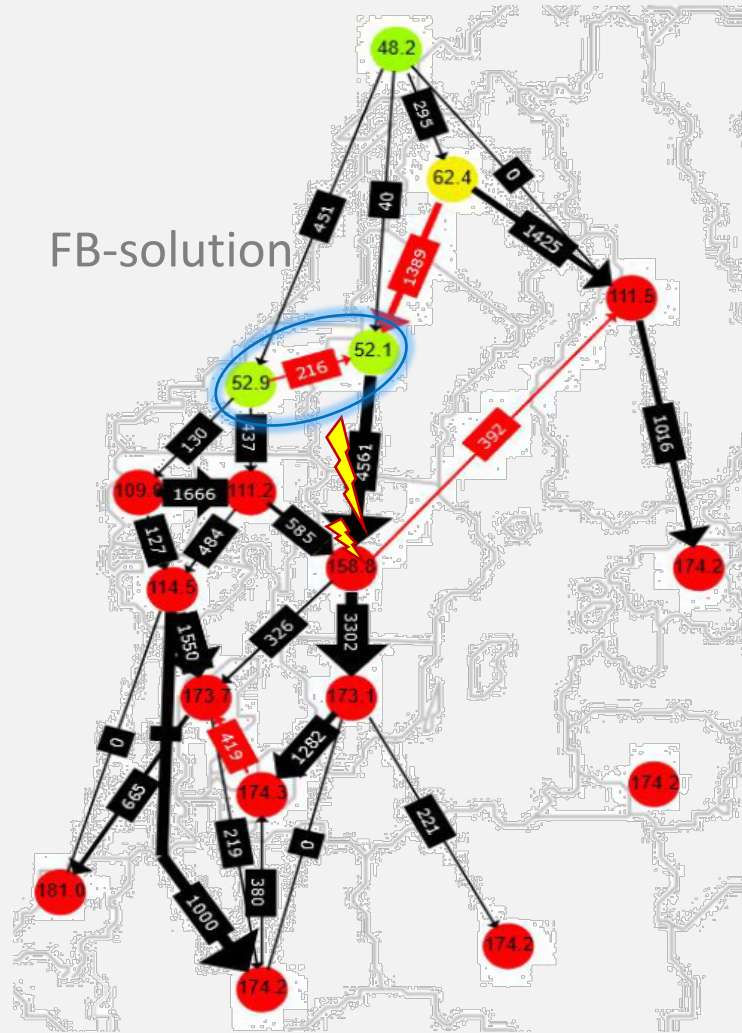


Deep-dive: Solutions for 09/09 2021 - 19:00

NTC-solution



FB-solution



$$P_{SE2} - P_{NO3} = -0,833$$

$$\rho_1 * PTDF_1^{NO3-SE2} = -6.619$$

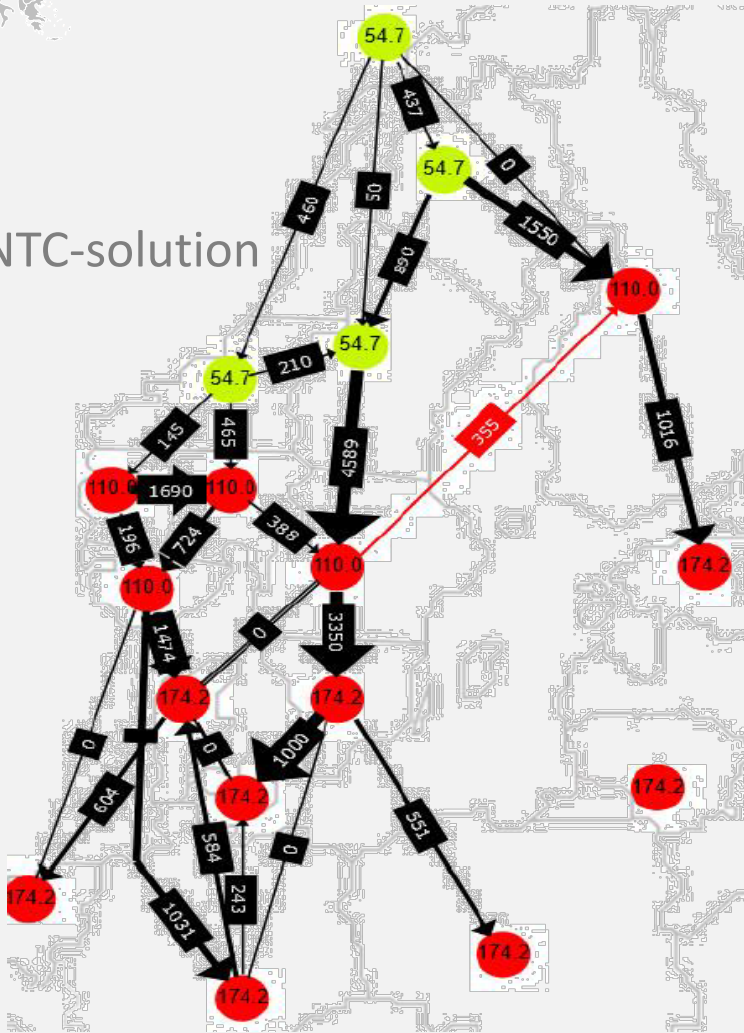
$$+ \rho_2 * PTDF_2^{NO3-SE2} = 5.788$$

$$= -0,833$$

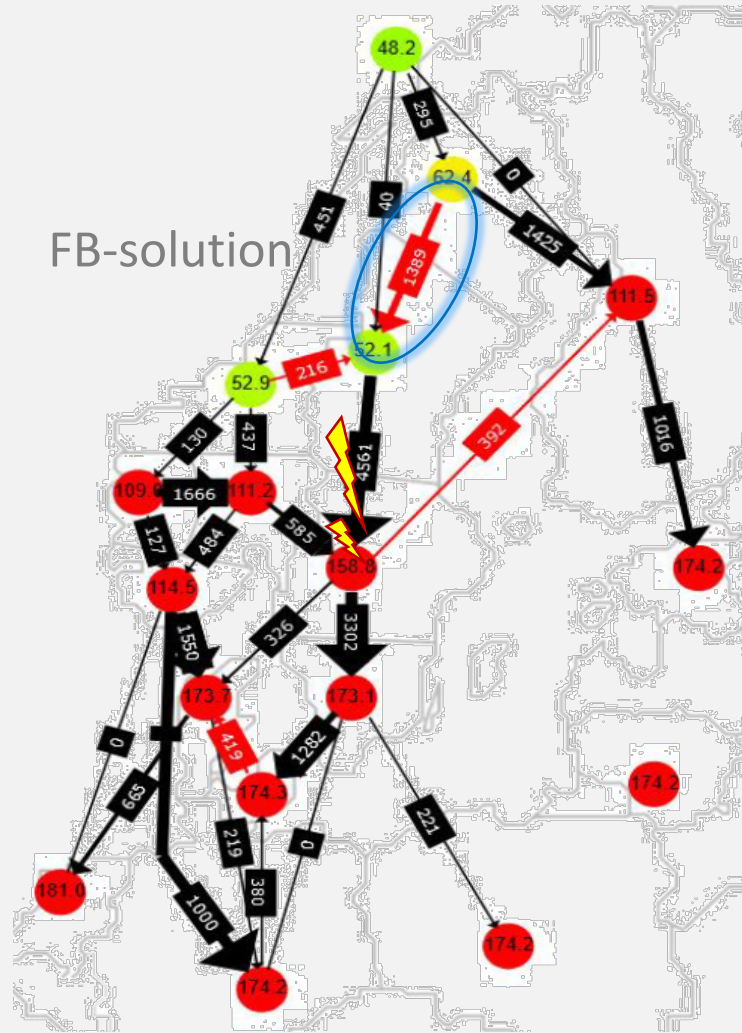


Deep-dive: Solutions for 09/09 2021 - 19:00

NTC-solution



FB-solution



$$P_{DK2} - P_{DK1} = -10,330$$
$$\rho_1 * PTDF_1^{DK2-DK1} = -10.320$$
$$+ \rho_2 * PTDF_2^{DK2-DK1} = -0.010$$
$$= -10,330$$