CWE FB PLAIN MC VS CWE FB INTUITIVE

NRA Deliverable #9.10

Version	1.2	
Date	24-01-2017	
Status	☐ Draft	☒ Final

Document creation and distribution

Document Owner	FBvTF
Function	Response to regulatory request (Position Paper of CWE NRAs on Flow-Based Market Coupling)
File location	
Distribution	CWE NRAs

Approval

Version	Date	Name	Function	Signature
1.0	16.11.2016	FBvTF	Draft	
1.1	25-11-2016	FBvTF	Draft	
1.2	24-01-2017	FBvTF	Final	

Previous versions

Version	Date	Author	Summary of changes
1.0	16.10.2016	FBvTF	Draft
1.1	25-11-2016	FBvTF	Update following CWE JSC feedback
1.2	24-01-2017	FBvTF	Update following CWE JSC feedback

Attachments

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1. Executive Summary

In the 'Position Paper on Flow-Based Market Coupling '(March 2015), CWE NRAs requested the CWE Transmission System Operators (TSOs) and Power Exchanges (PXs) to prepare a comprehensive report based on one-year monitoring and comparison between Flow-Based Plain (FBP) and Flow-Based Intuitive (FBI) calculation modes. The aim of this document is to support CWE NRAs decision to "consider if a change towards the other version of the methodology is relevant and justified".

After a thorough analysis of the indicators simulated, the CWE TSOs and PXs have highlighted the main differentiating aspects between the two methods. In the general situation, Flow-Based Intuitive and Flow-Based Plain provide comparable results, though we notice a slightly better performance of the Plain calculation mode for most indicators.

However on exceptional market coupling conditions, Flow-Based Plain and Flow-Based Intuitive calculation modes produce more contrasted indicators: while Flow-Based Plain reduces significantly price differences, Flow-Based Intuitive is more likely to cause non desirable situations in a stressed market environment.

Nevertheless it should be highlighted that the Flow-Based method contributes to a more efficient determination of commercial transactions and results in electricity prices that better reflect the actual grid situation. As a result, price convergence and welfare have significantly increased under Flow-Based and for both calculation modes.

2. Introduction

CWE NRAs made the choice, upon the results of the CWE NRA-led public consultation, to launch CWE Flow-Based Day-Ahead Market Coupling under FB Intuitive calculation mode [1]. It has been agreed that the project will keep running and simulating FB Plain calculation mode[2] and provide CWE NRAs with a detailed monitoring on the results that would have been engendered under FBP. After 12 months CWE NRAs expect from the CWE project a comprehensive comparison report which would allow among others to consider if a change from FBI towards FBP is relevant and justified.

After presenting the data and the results considered to conduct the study, the document presents:

- An overview and a comparison of indicators identified by the project to be relevant to compare FBI and FBP over on year period,
- A deeper analysis on some exceptional market coupling conditions, where FBP and FBI modes produced contrasted indicators. Those exceptional Market coupling situations occurred:
    - In 2015 on the 22nd September, 15th and 16th of October where the market suffered from reduced availability of production units and grid because of maintenance;
    - In 2016 on the 8th of May because of high renewable production and low consumption.
- A rough calculation of the impact of the FB calculation mode on Intraday welfare.

[1] Calculation mode preventing MC solutions with non-intuitive exchanges
[2] Calculation mode allowing MC solutions with non-intuitive exchanges

Lastly the document concludes on the matters raised by NRAs such as:

- Capability of market parties to make good price forecasts and to bid efficiently under either FBP or FBI,
- Distribution of welfare, in particular between small and large bidding zones,
- Non desirable situations of Plain FB MC (low price days),
- Non desirable situation of Intuitive FB MC (price spike days),
- Impact on intraday timeframe,
- Impact on security of supply.

3. Data

The study covers one year (366 days). In particular, it should be noted that the results presented in this study should be interpreted in the context of the specific market and network conditions on the period between the 21/05/2015 and 23/05/2016.

The FBI results considered in this study are the MRC production results whereas the FBP results were produced by EPEX internal simulation tool running on a production-like environment. For each delivery date, the same version of Euphemia and the same input data (market and network data) were used to produce market coupling results.

Disclaimer: Due to some difference in the way the problem is modeled and in the systems[3] used to produce the results to conduct this study, intuitive Market results produced under FB plain calculation mode could slightly differ from intuitive Market results calculated under FB intuitive, even in case the intuitive patch is not active. However the differences are considered as negligible as they do not exceed in average (in absolute values) 1K€ for Welfare, 0.02€ for Prices and 16.5 MWh for Net Positions on normal days.

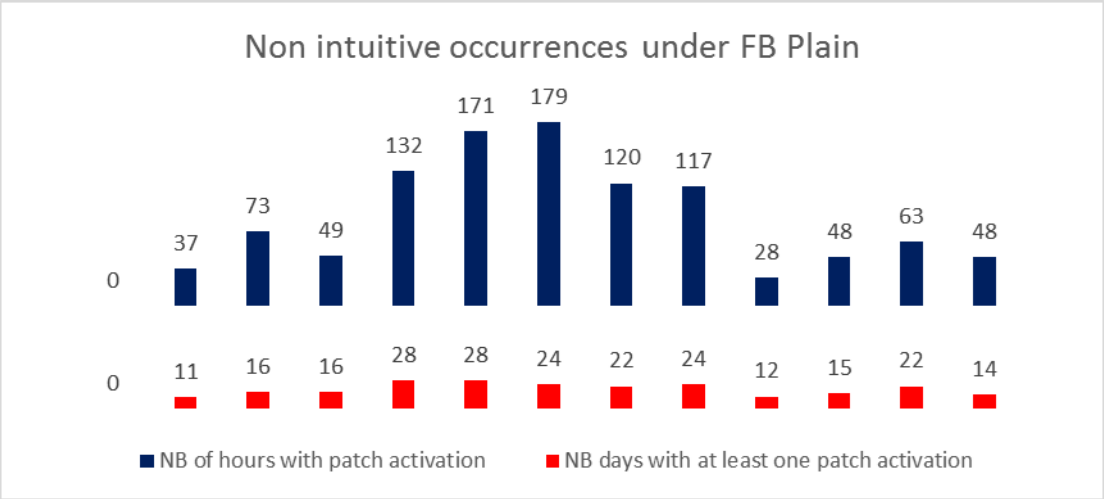
For the price spike days, the Project conducted an analysis which showed that the difference observed between FBP and FBI and reported in this study, are only due to the FB calculation mode and not due to the reproducibility issue.

4. CWE FB Plain MC vs CWE FB Intuitive: One year operation overview

4.1 Indicator: Frequency of non-intuitive situations under FB Plain

Observations:
The intuitive patch has been activated on 12% of the hours, on 63% of the days (around two days out of three). The largest frequencies have been observed during 2015 autumn.

[3] Especially differences could be due to the non-reproducibility of market coupling results " currently under investigation



4.2 Indicator: WELFARE

Observations:

The daily welfare differences between Flow-Based Plain and Flow-Based Intuitive is shown in Figure 1 for the CWE and MRC regions. The average gain with Flow-Based Plain for CWE is 4 k€/day and 9 k€/day for MRC with a maximum reached on 16th October 2015 with 415 k€ for CWE and 740 k€ for MRC.

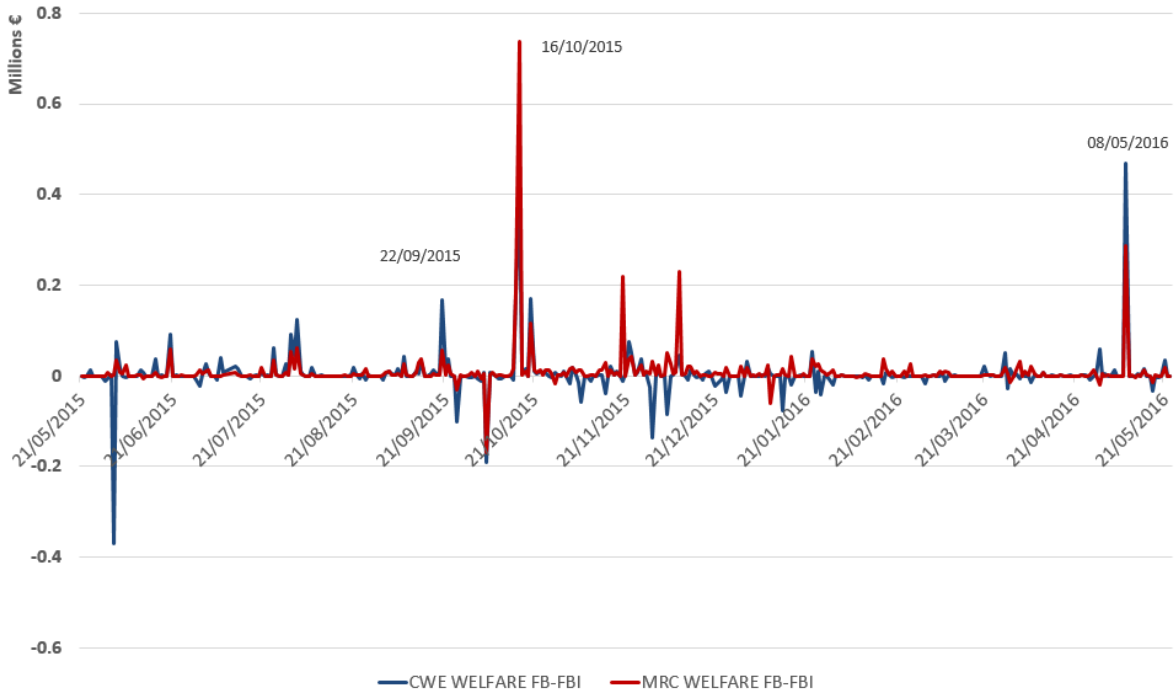


Figure 1: Daily welfare differences of MRC and CWE regions between Flow-Based Plain and Flow-Based Intuitive

One may witness the gain spikes which occurred in September and October 2015 certainly due to the price spikes of the Belgian hub. The differences between FBP and FBI seem to occur when commercial exchanges are constrained by the network capacities i.e. when market prices are different. Indeed, the differences between FBP and FBI are reduced after mid December 2015 which

corresponds to the beginning of a period with more price convergence (see Figure 2). Besides, after this period, there is one remaining "price spike day" (08/05/2016): this latter day was a day with high negative prices in Germany/Austria[4]. The three price spike days in Figure 1 will be further analysed in chapter 5.

For the delivery 01/06/2016, which is not a price spike day, we observe an important CWE welfare loss under FBP. For this day, the CWE welfare is mainly impacted by the CWE CR which was higher due to higher exports under FBI (17512MW more compared to FBP).

	MRC WELFARE	CWE SURPLUS	CWE CR	CWE WELFARE
01/06/2015	1 100 €	-45 326 €	-323 819 €	-369 145 €

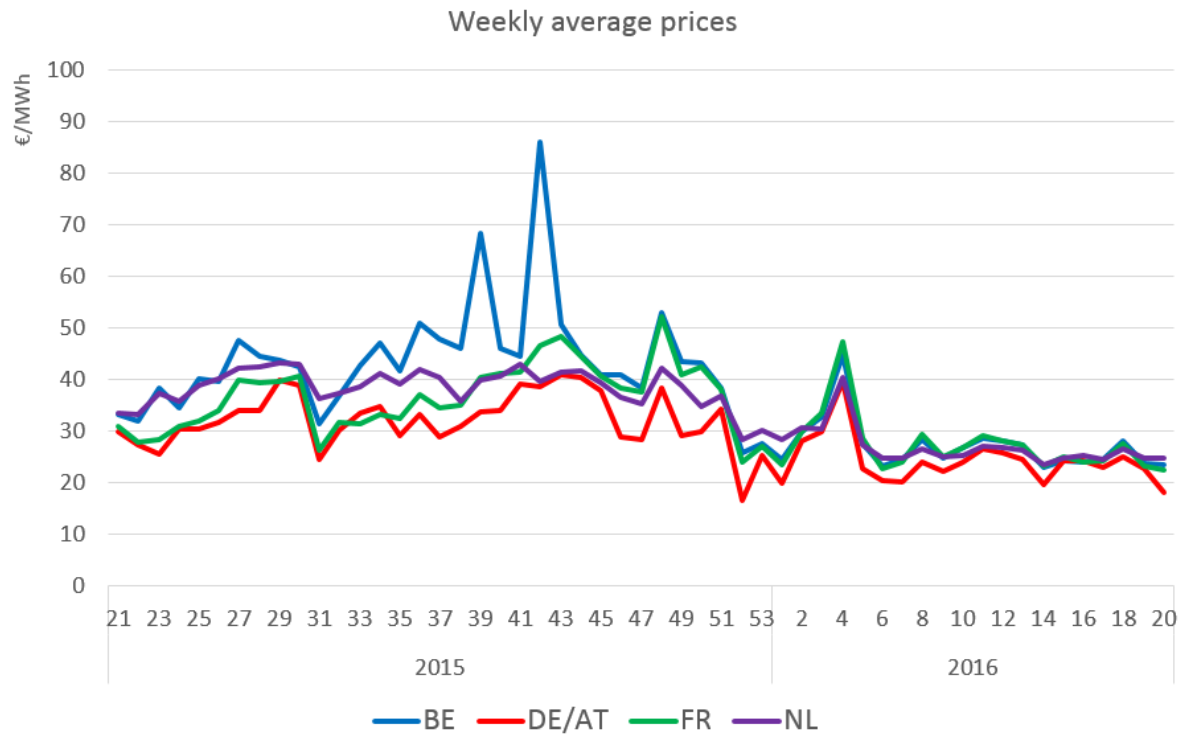


Figure 2: Weekly average prices of the CWE hubs from week 21 of 2015 to week 20 of 2016

If we now remove the "price spike days" (22/09/2015, 15/10/2015, 16/10/2015 and 08/05/2016), the average gain with Flow-Based Plain for CWE is around 1 k€/day and 6 k€/day for MRC (see Figure 3). As a matter of comparison, the average gain of FBI over ATC was around 250k€/day during the parallel run.

[4] Please note that notation Germany, Germany/Austria, DE/AT/LUX, DE/AT, DE/LUX or DE make all references to the German/Austrian/Luxembourg bidding zone

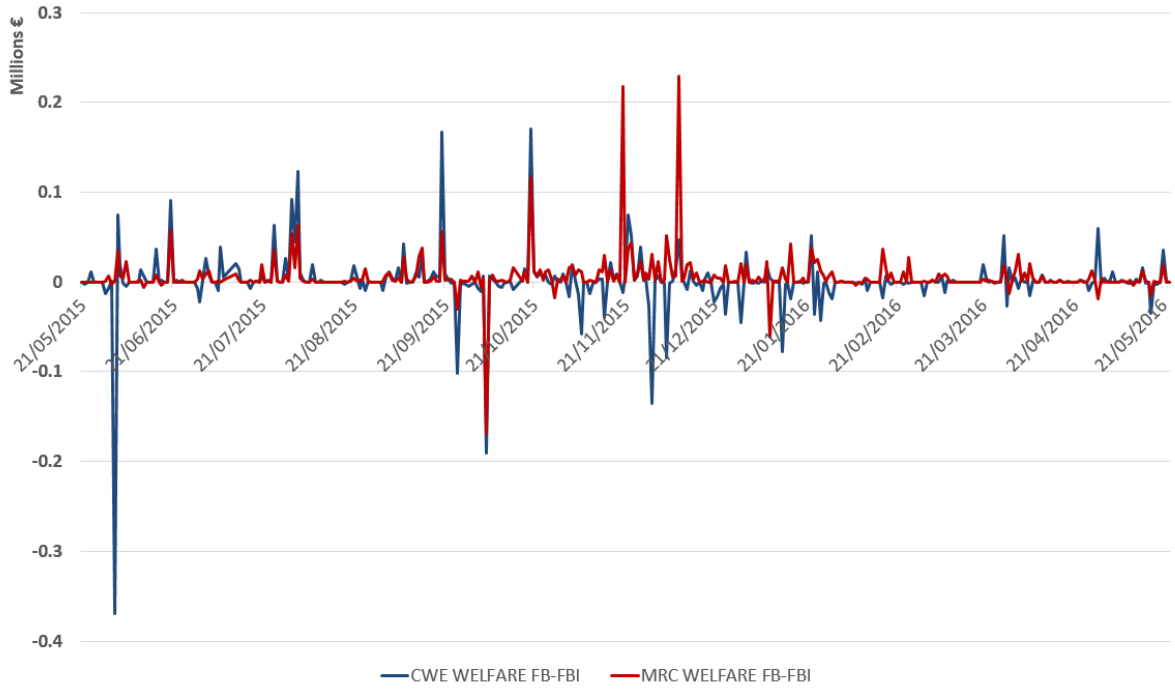


Figure 3: Daily welfare differences of MRC and CWE regions between Flow-Based Plain (FBP) and Flow-Based Intuitive (FBI) while excluding delivery dates 22/09/2015, 15/10/2015, 16/10/2015 and 08/05/2016

CWE Surplus and distribution per seller/buyer and per market

In this section, the market surplus differences are split between the CWE hubs in order to visualize the distribution of the gain of FBP over FBI.

In Figure 4, one can notice that all the hubs have positive market surplus gain with FBP compared with FBI: 10 M€ for Belgium, 1.9 M€ for Germany/Austria, 567 k€ for France and around 1 M€ for the Netherlands. Moreover, these gains are all in favor of the consumers except for Germany/Austria.

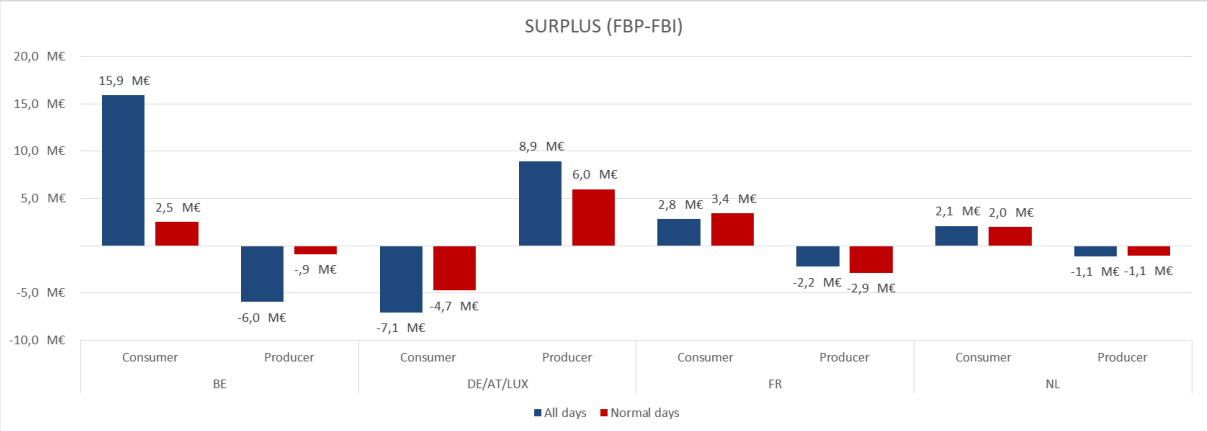


Figure 4: Distribution of the producer and consumer surplus per hub after one year: whole year overview and overview excluding price spike days

If we now remove the "price spike days", all the hubs have still a positive market surplus gain with FBP but the gain is less important for Belgium: 1.6 M€ for Belgium, 1.2 M€ for Germany/Austria, 559 k€ for France and around 0.9 M€ for the Netherlands (see Figure 4).

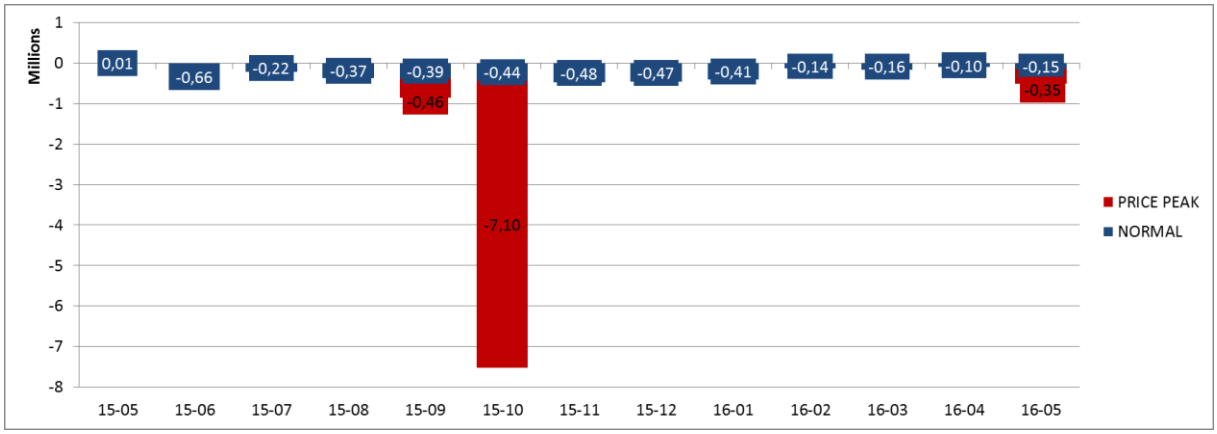
In terms of market surplus, during the observed period including the price spike days, all the hubs of CWE gain with Flow-Based Plain compared with Flow-Based Intuitive and around 75% of the gain goes to Belgium. If we analyse the same period without the "price spike days", the same observation can be made but the gain is more spread to the different hubs.

CWE Congestion rent

The congestion rent in the CWE area discussed is the gross congestion rent and does not take into account the remuneration of long term transmission rights. For each hour the congestion rent can be calculated as:

$$Congestion\ Rent_{CWE} = -\sum_{hub}^{4} CWE\ NP_i * MCP_i$$

For each month the gross congestion income is lower in FBP than in FBI. Although the differences are limited for "normal" days, non-intuitive situations during "price spike" days could result in a significant decrease in gross congestion income. This is line with previous conclusions; non-intuitive situations will increase the power exchanges between CWE hubs resulting in a higher price convergence.



Total (MRC) yearly welfare indicators

The tables below give an overview of a number of indicators presented in this study. For the MRC welfare, CWE surplus and CWE CR the minimum, average and maximum difference between FBP and FBI are given on a daily basis. Positive values mean that the value in FBP is larger than FBI.

Delta (FBP - FBI) over the whole period

	MRC welfare	CWE Surplus	CWE CR
Max	736 343 €	5 959 705 €	61 479 €
Average	9 054 €	36 413 €	-32 471 €
Min	-168 230 €	-244 328 €	-5 543 942 €

Delta (FBP - FBI) Normal days

	MRC welfare	CWE Surplus	CWE CR
Max	229 256 €	250 420 €	61 478 €
Average	5 739 €	11 919 €	-10 979 €
Min	-168 229 €	-244 328 €	-323 818 €

Delta (FBP - FBI) Spike days

	MRC welfare	CWE Surplus	CWE CR
Max	736 343 €	5 959 705 €	-351 702 €
Average	309 078 €	2 253 102 €	-1 977 481 €
Min	24 554 €	499 078 €	-5 543 942 €

4.3 Indicator: PRICES

Hourly Prices for "normal days"

Hourly price differences between FBP and FBI (FBP-FBI) of CWE markets on days where the intuitive patch has been activated (around 2 days out of 3) are presented in Figures . When the difference is **positive** (above the x axis), prices under **FBP are higher** than prices under FBI. When the difference is **negative** (below the x axis), prices under **FBP are lower** than prices under FBI.

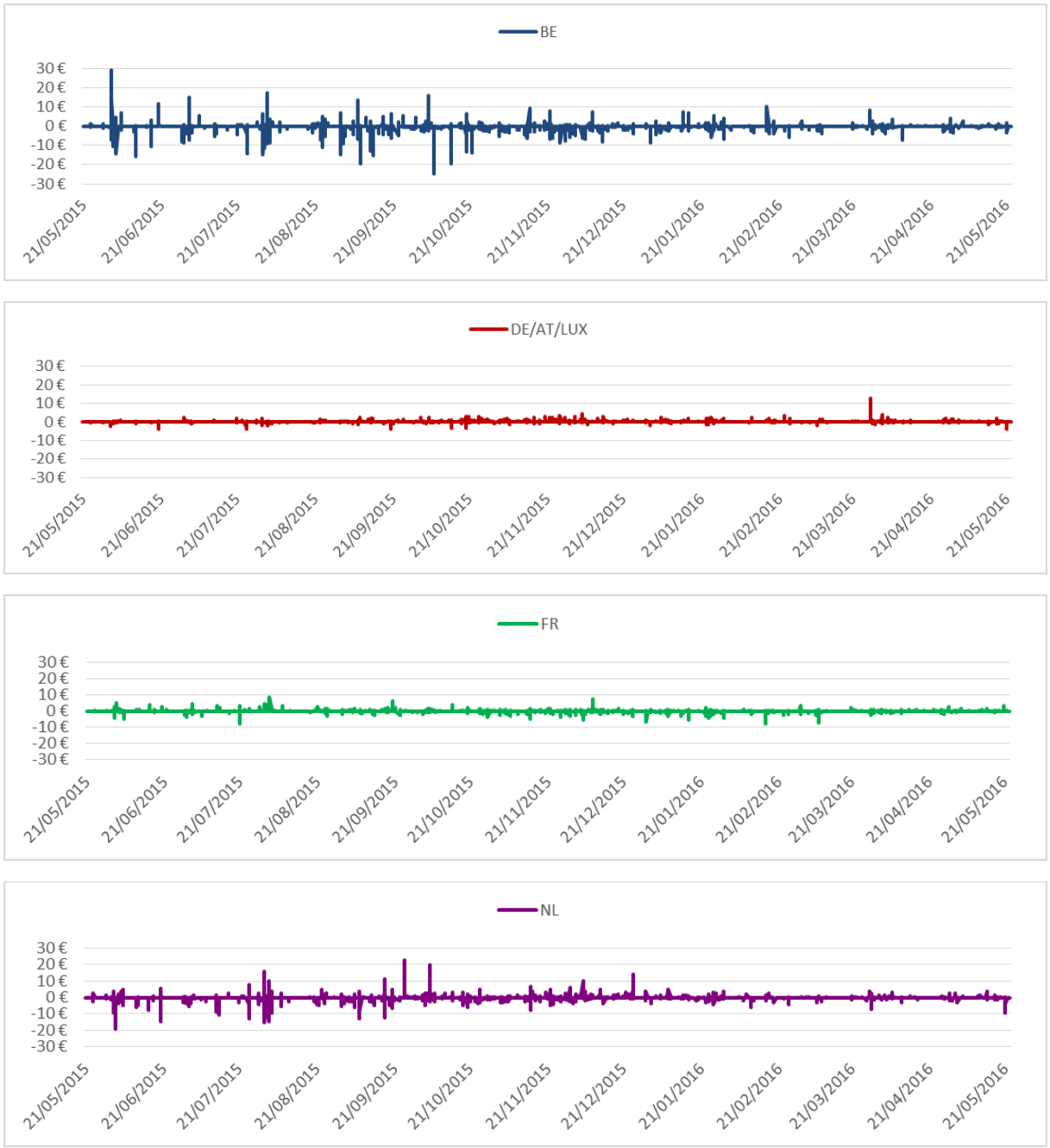
Observations:

The figures show that FB MC mode impacts prices. The impact is more significant on the smallest markets BE and NL than on larger markets DE/AT/LUX[5] and FR.
Prices under FBP can be either higher or lower than prices under FBI. FBP tends to increase DE/AT/LUX prices (and increase 13% of the time against a decrease 4% of the time) and to decrease BE, FR and NL prices (respectively decrease 13%, 11% and 12% of the time and increase 4%, 6% and 6%).

	BE	DE/AT/LUX	FR	NL
FBP > FBI	4%	13%	6%	6%
FBP < FBI	13%	4%	11%	12%

Figures 5 : Frequency where FBP prices are higher than FBI prices and where FBP prices are lower than FBI prices on normal days where the patch has been activated.

[5] Please note that notation Germany, Germany/Austria, DE/AT/LUX, DE/AT, DE/LUX or DE make all references to the German/Austrian/Luxembourg bidding zone



Figures 7: Price difference between FBP and FBI on Normal days.

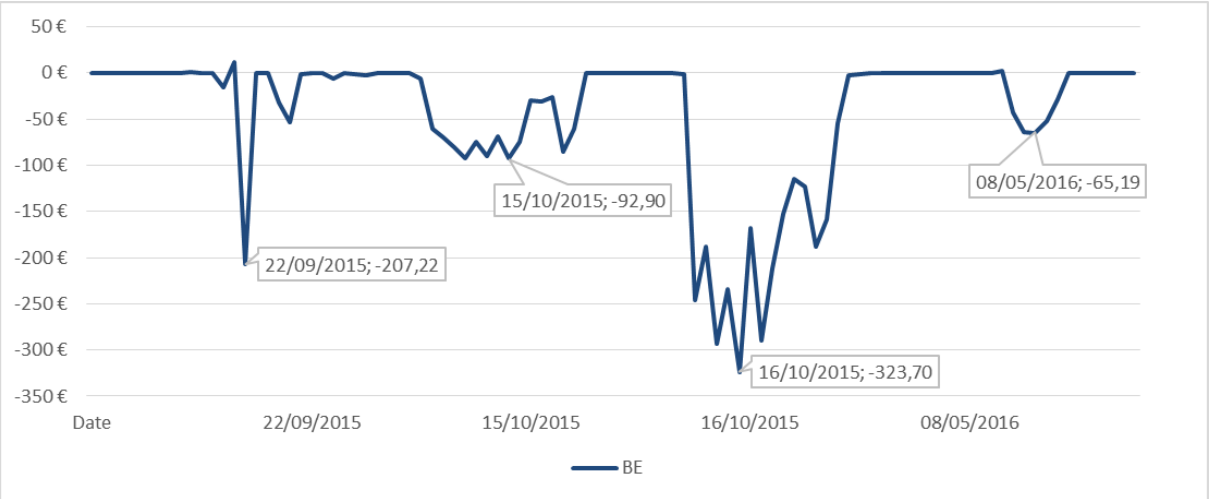
Hourly Prices on "price spike days"

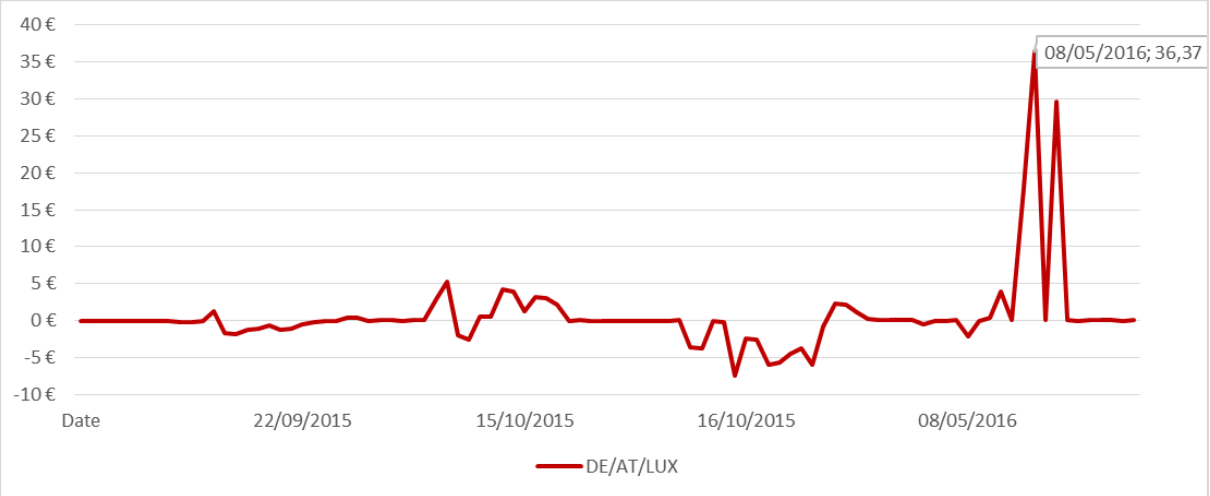
Hourly price differences between FBP and FBI (FBP-FBI) of CWE markets on price spike days are presented in 8. When the difference is **positive** (above the x axis), prices under **FBP are higher** than prices under FBI. When the difference is **negative** (below the x axis), prices under **FBP are lower** than prices under FBI.

The figures show that:

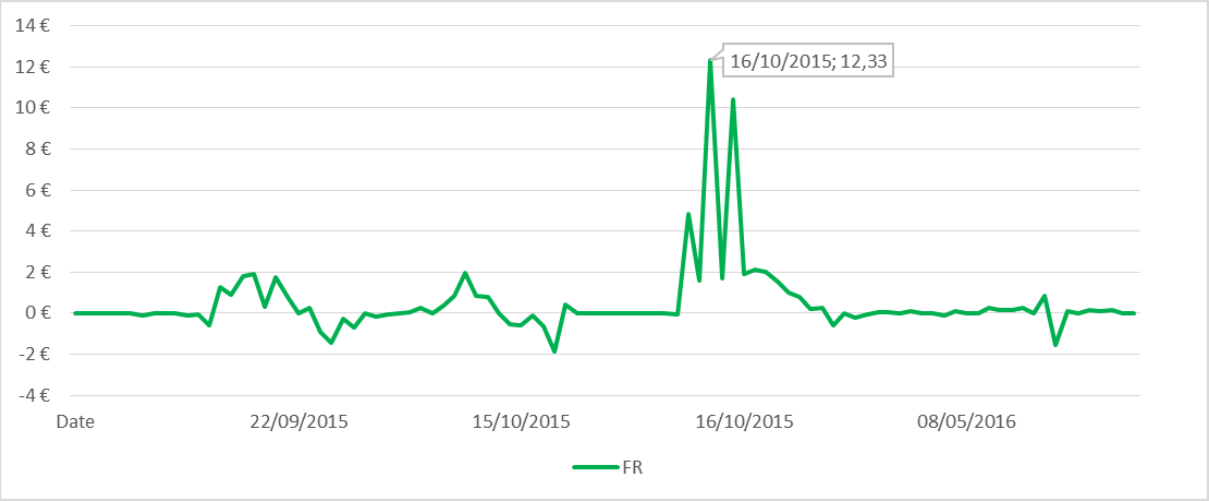
- Price difference between FBP and FBI observed can be higher for BE (up to -323€) and DE/AT/LUX[6] (up to 36€).
- On the 16/10/2015, hour 12, FBP would have decreased BE price to 125€ (instead of 448.7€ under FBI).
- On the 08/05/2016, hour 15, FBP would have increased DE/AT/LUX price to -93.72€ (instead of -130.09€ under FBI) and decreased BE price to -60.19€ (instead of 5€ under FBI).

Those price spike situations will be further investigated in section 5.





[6] Please note that notation DE/AT/LUX, DE/AT, DE/LUX or DE make all references to the German bidding zone



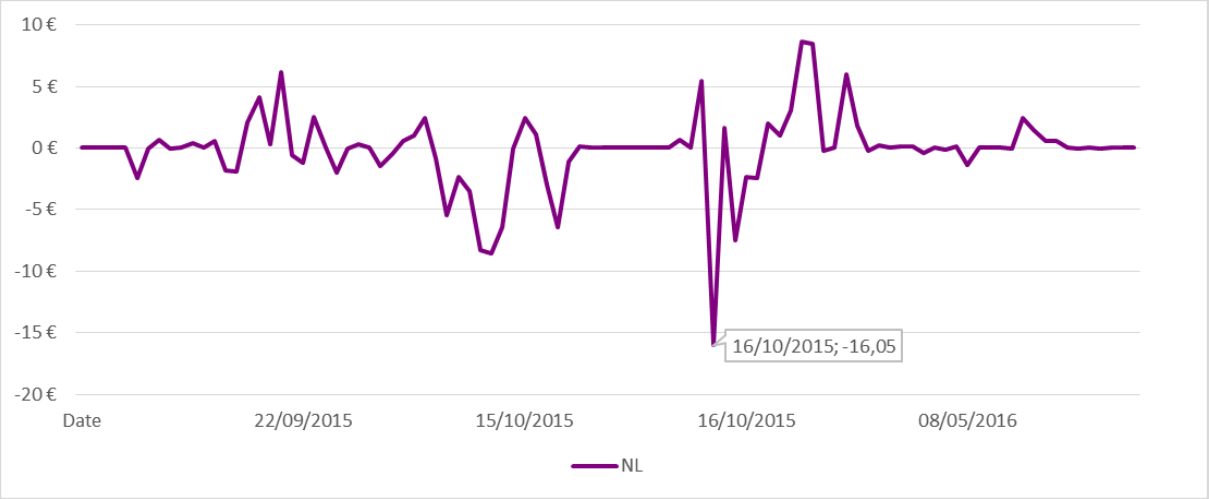


Figure 8: Price difference between FBP and FBI on price Spike days.

Price volatility

Hourly Price volatility (standard deviation of hourly prices over a year) for "Normal day" and price spike days, are presented in Figure 9 and Figure .

Annual base load volatility (standard deviation of baseload prices over a year) is presented in Table 1 : Base load price volatility over one year

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Observations:

Under Normal market condition, FBP and FBI produce comparable price volatility. The price volatility under FBP is slightly lower than volatility under FBI for BE and NL though.

On price spike days, we can observe an increase in price volatility on hours FBP would have reduced the extreme prices observed under FBI mode (BE on the 22/09/2015, 15/10/2015, 16/10/2015 and DE/AT/LUX on the 08/05/2016).

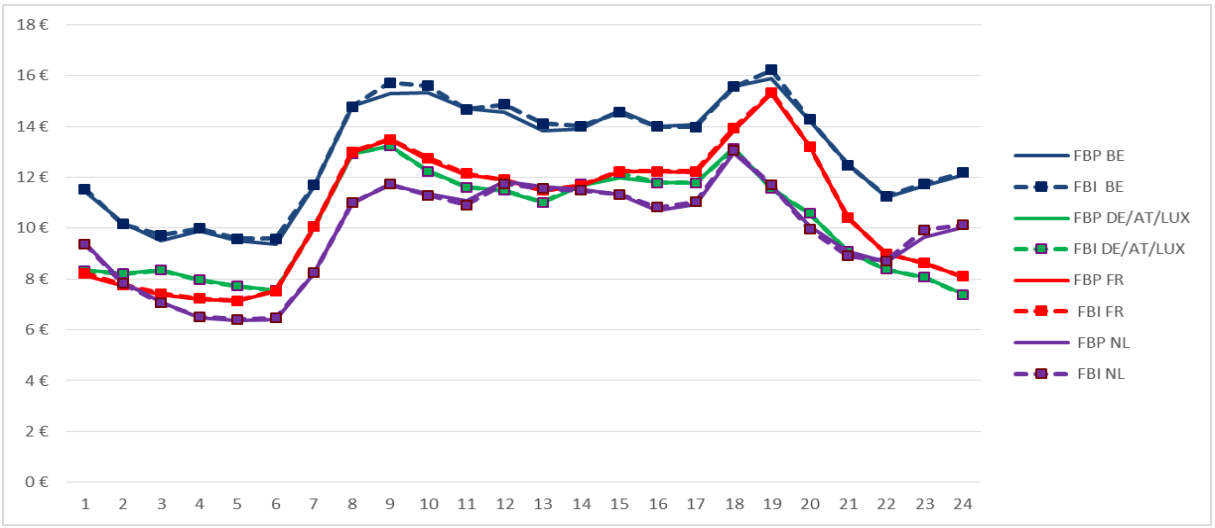


Figure 9: Hourly price volatility over one year while excluding delivery dates 22/09/2015, 15/10/2015, 16/10/2015 and 8/05/2016

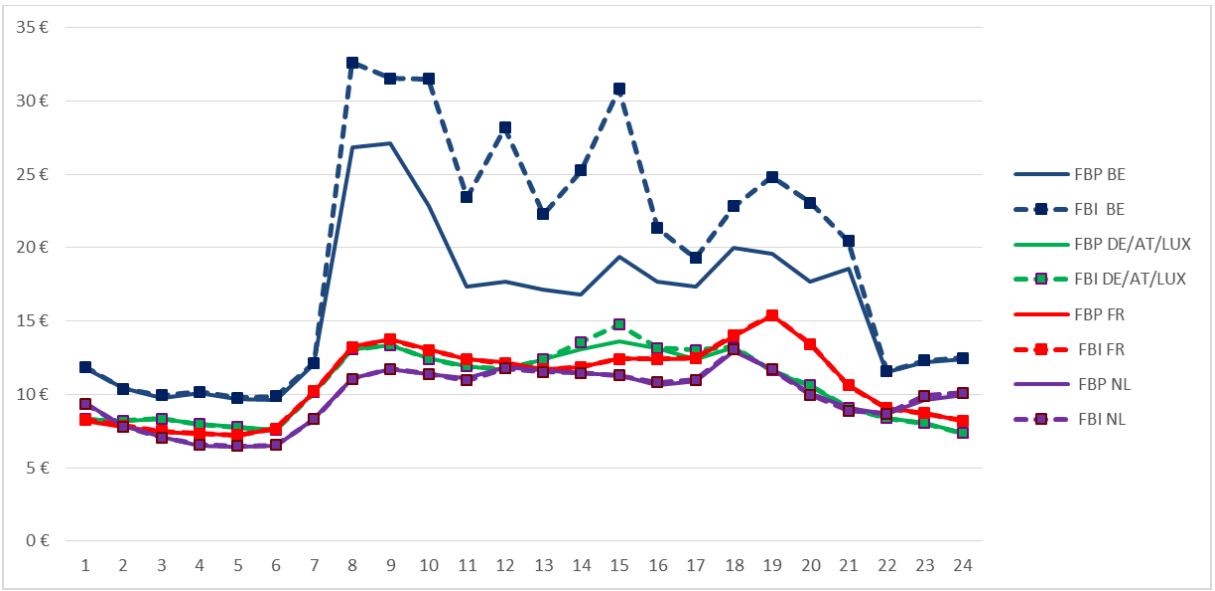


Figure 10: Hourly price volatility, over the whole period (including price spike days 22/09/2015, 15/10/2015, 16/10/2015 and 08/05/2016)

	BE	DE/AT/LUX	FR	NL
FBP	18,02	12,15	12,59	11,54
FBI	22,08	12,26	12,60	11,54

Table 1 : Base load price volatility over one year

Price convergence

Number of price areas under FBP and FBI are presented in Figure . When there are 4 price areas, there is full divergence. When there are 3 price areas, there is one partial convergence: two markets have same price but different from the prices of the other markets. When there are 2 price areas, there are either:

- Two couples of markets have same price, each couple of markets have different prices.

- Three markets have the same price different from the price of the 4th market.

Lastly, when there is 1 price area, there is full convergence.

Observations:

The figure shows that:

- The full price convergence is comparable under FBP and FBI
- FBI provides better partial convergence and less full divergence[7]

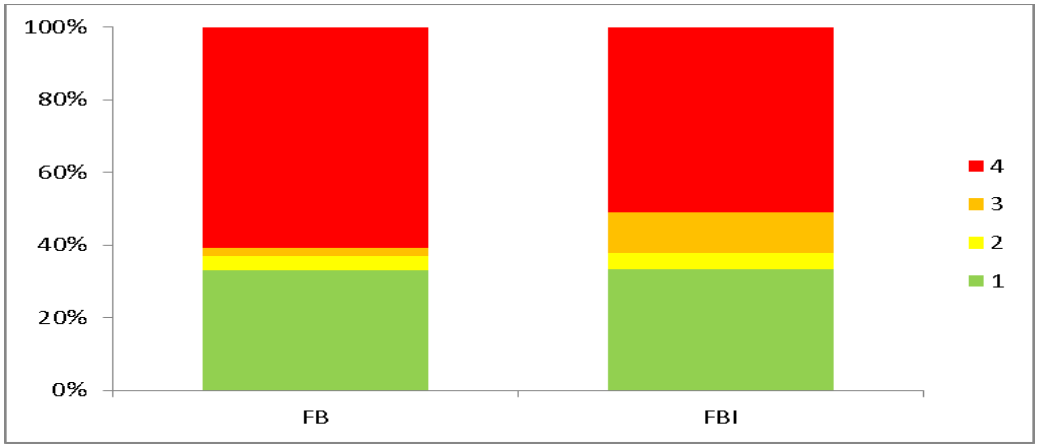


Figure 6 : Number of Price areas under FBP and FBI.

Full price convergence

Daily full price convergence under FBP and FBI are presented in Figure 7. It is reported as the percentage of hours for each delivery dates where all CWE prices are equal.

Observations:

The figure shows that FBP and FBI produce comparable daily full price convergence performance.

[7] See Annex 7.3 for details on why FB "intuitive" MC restores partial convergence of CWE_FB-MC_intuitiveness_report_v4_1_final.pdf on joa.eu.

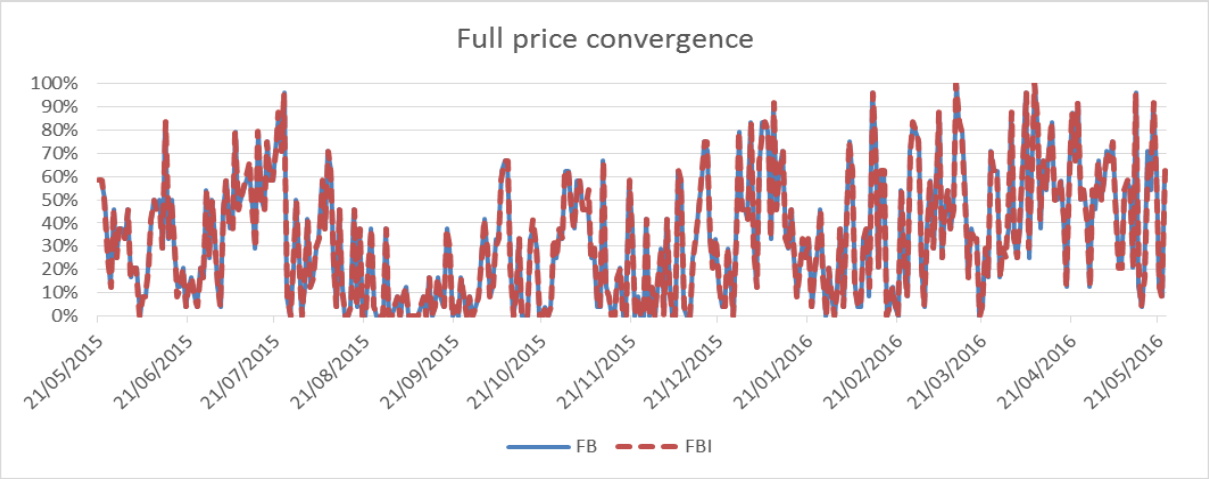


Figure 7: Daily full price convergence

Price spread indicator

Max price spread between CWE markets is presented in the graph below. On normal days FBI and FBP produce comparable price spreads, but in average, FBP slightly outperforms FBI.

On price spike days, the max price spreads under FBP and FBI are more contrasted. As already observed, as FBP allows reducing price spike magnitude, it also allows reducing price spreads.

	FBP	FBI
Normal days	8,71 €	9,11 €
Price spike days	67,11 €	109,38 €

Figure 13: Average Max price spread under FBP and FBI.

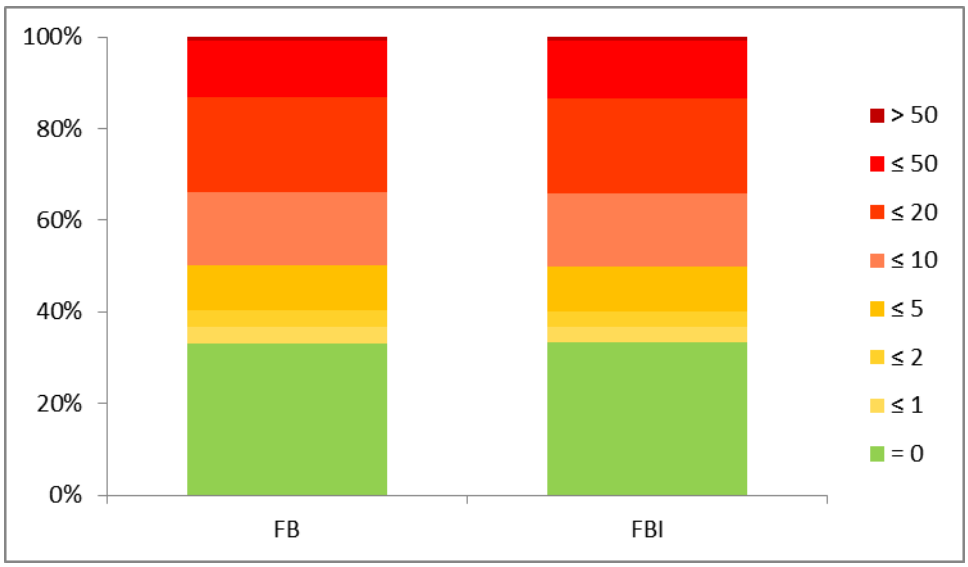


Figure 14: Max price spread levels under FBP and FBI.

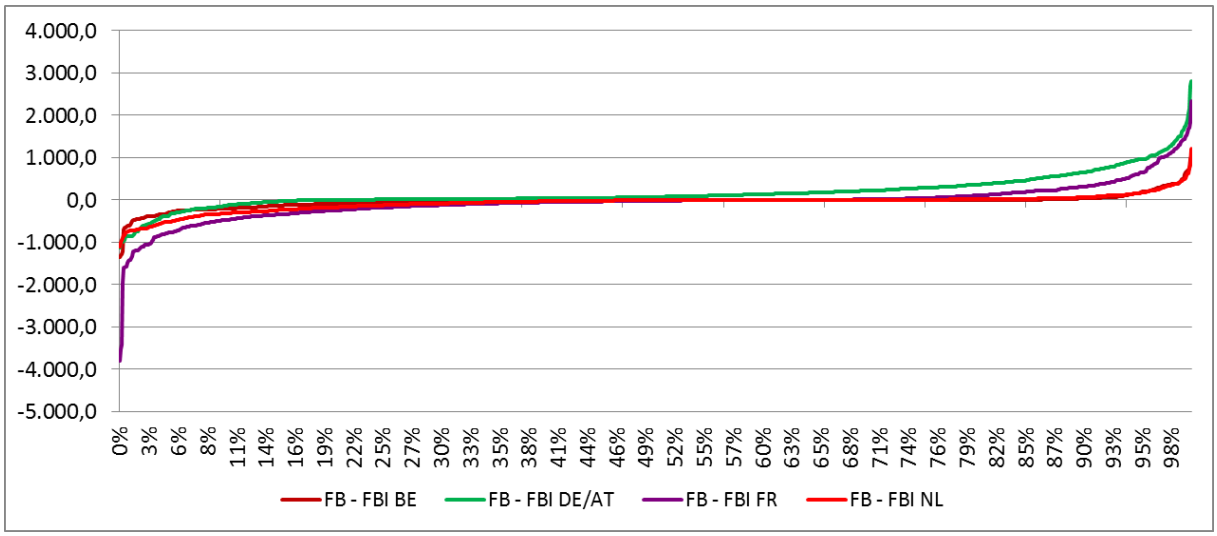
4.4 Indicator: Net Positions

Total Daily Exchanges

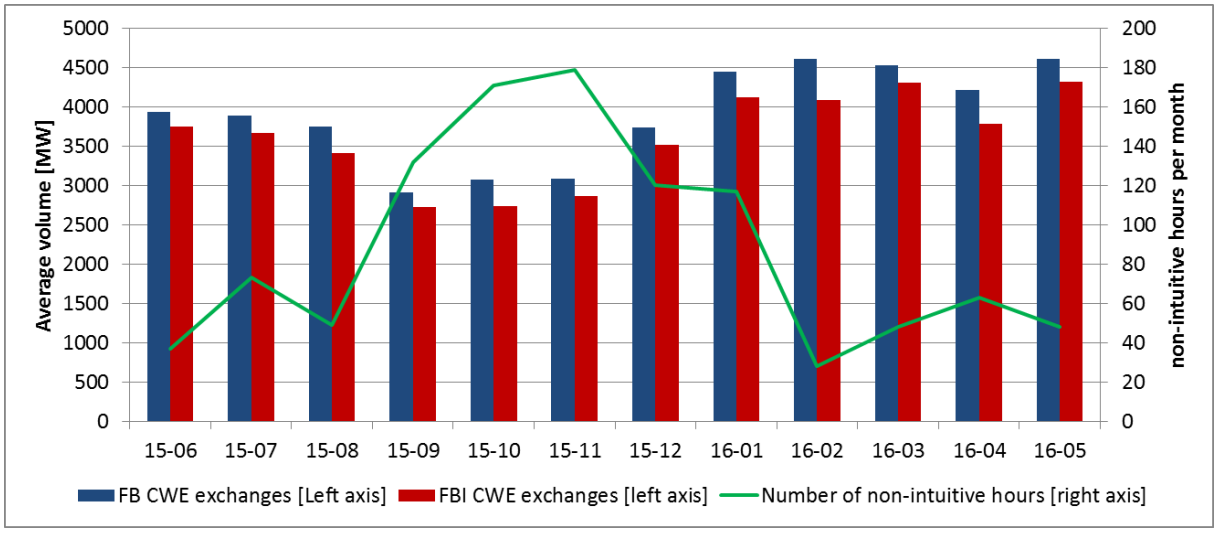
Observations:

- On average the exchanges are higher under FBP,
- Except for few delivery dates especially On the 1st of June,
- Under FB plain, there is a shift from FR to "outside" CWE compared to FBI MC.

The graph below gives an overview of difference in net positions for the different CWE hubs during non-intuitive hours. FB plain would allow exchanges of up to 4000 MW more in comparison with FBI. As expected, FBP would allow for a higher export of France and Germany/Austria under certain situations (right hand side of the graph), while especially France would profit of a higher import under extreme situations (left hand side of the graph).



When comparing the total CWE exchanges, calculated by taking the sum of the exporting hubs, it is clear that FBP would on average allow for higher exchanges within CWE. This is shown in the graph below where for each month the average exchanges during non-intuitive hours are compared for FBP and FBI. Furthermore, the number of non-intuitive hours per month is given.



Net Positions volatility

Observations:

- Studies show comparable volatility under FBP and FBI MC.

Please find the detailed graphs in annex of the report.

4.5 Indicator: Total volume executed

The total Market Cleared Volume (MCV = the matched supply + imports = the matched demand + exports) per market and for the whole CWE region are presented in Figure 16Figure 7.

Observations: the total Market Clearing Volume is higher under FBP mode than under FBI mode (+214GWh). Market Clearing Volume increases under FBP mode for all markets except France (-14GWh).

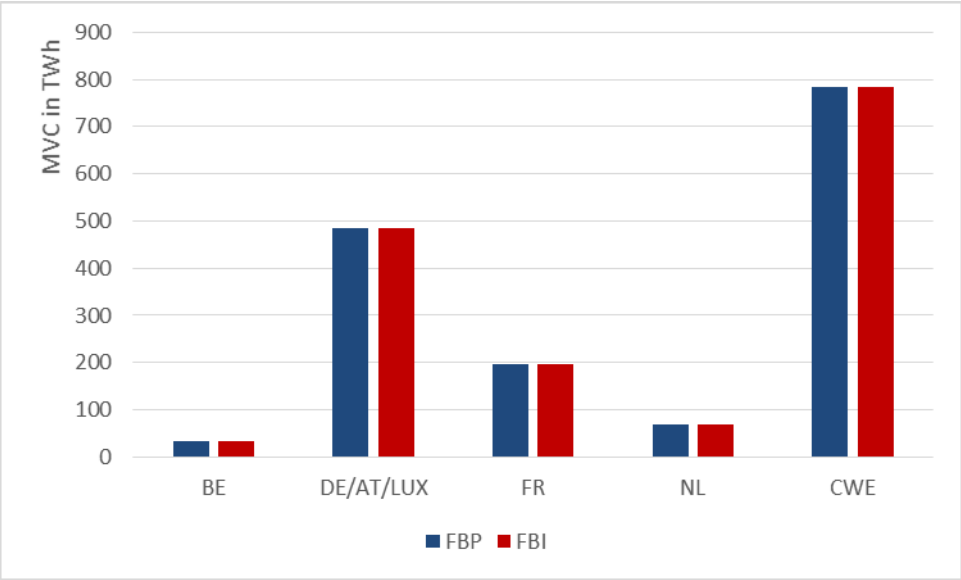


Figure 85: Total Market Cleared Volume per market over the period

	BE	DE/AT/LUX	FR	NL	CWE
FBP-FBI MCV in GWh	43	119	-14	65	214

Figure 96: Difference of MCV between FBP and FBI over the period

4.6 Indicator: PRBs

In Figure 17, we focus on the number of PRBs between the FBP and FBI runs, and more especially on those days where the intuitive patch was active. We can distinguish 3 situations:

Blue: days where FBP and FBI had the same number of PRBs;

Red: days where FBP has more PRBs than FBI;

Green: days where FBP has less PRBs than FBI.

Finally, the results are summarized in the table below. For most sessions the number of PRBs remains unchanged. For the days where there is a difference, we more frequently see an increase in PRBs under FBI. The average number of PRBs confirms this: for all markets the average number of PRBs increases under FBI.

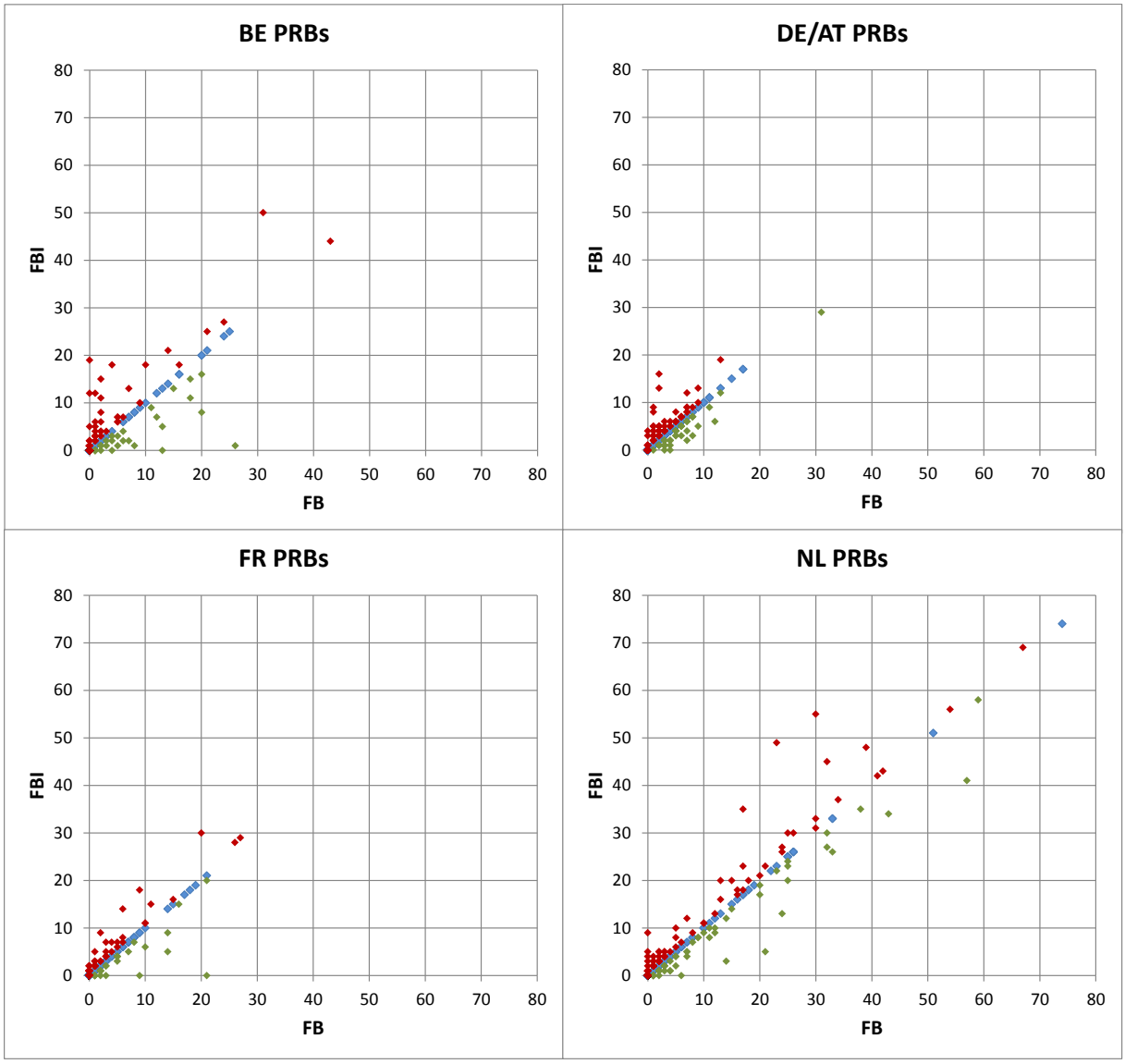


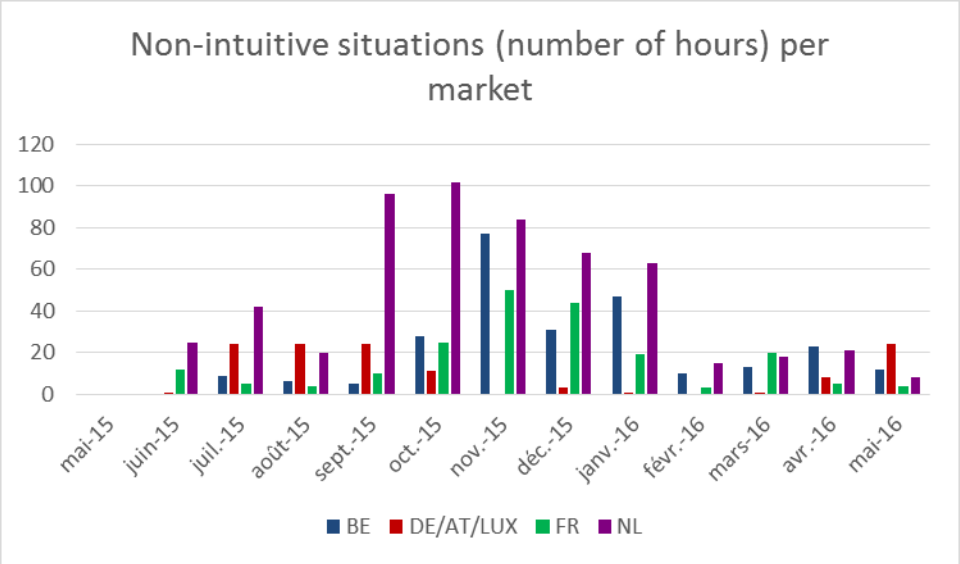
Figure 17: Difference in PRBs between plain and intuitive FB for days where the intuitive patch was active. Red dots corresponds to days where there were more PRBs under FBI, green dots correspond to days where there were more PRBs under FBP, blue dots correspond to days with equal PRBs between FBP and FBI.

		BE	DE/AT	FR	NL
Number of sessions where the number of PRBs between FBP and FBI relate as:	FBP = FBI	145	125	161	112
	FBP > FBI	31	43	25	49
	FBP < FBI	56	64	46	71
Average change in PRBs (FBP-FBI)		-0.33	-0.30	-0.10	-0.35

4.7 Involvement in non-intuitive situations per market

Observations:

NL is mostly involved in non-intuitive situations, followed by FR and BE. The observations also confirm that the smallest markets are more impacted than the bigger markets.



4.8 Performances

Figure 188 illustrates the time to first solution (a performance indicator) between the plain and intuitive FB runs. Please mind that the FBI results are the ones from production, whereas the FBP results are simulated ones. Below figure only contains data where the simulation results were computed by EPEX, to avoid creating a bias due to differences in hardware used to obtain the results. Finally the reported times are raw calculation times, and the reading of input data has been excluded.

The dots above the 45 degree line correspond to cases where intuitive FB required more time than plain FB, dots below the line intuitive FB required less time.

Finally two regression lines and their corresponding equations have been added. Both equations suggest that intuitive FB requires more time:

Red line: FBI requires 28% more time to find a first solution;

Blue line: FBI requires 43s more time;

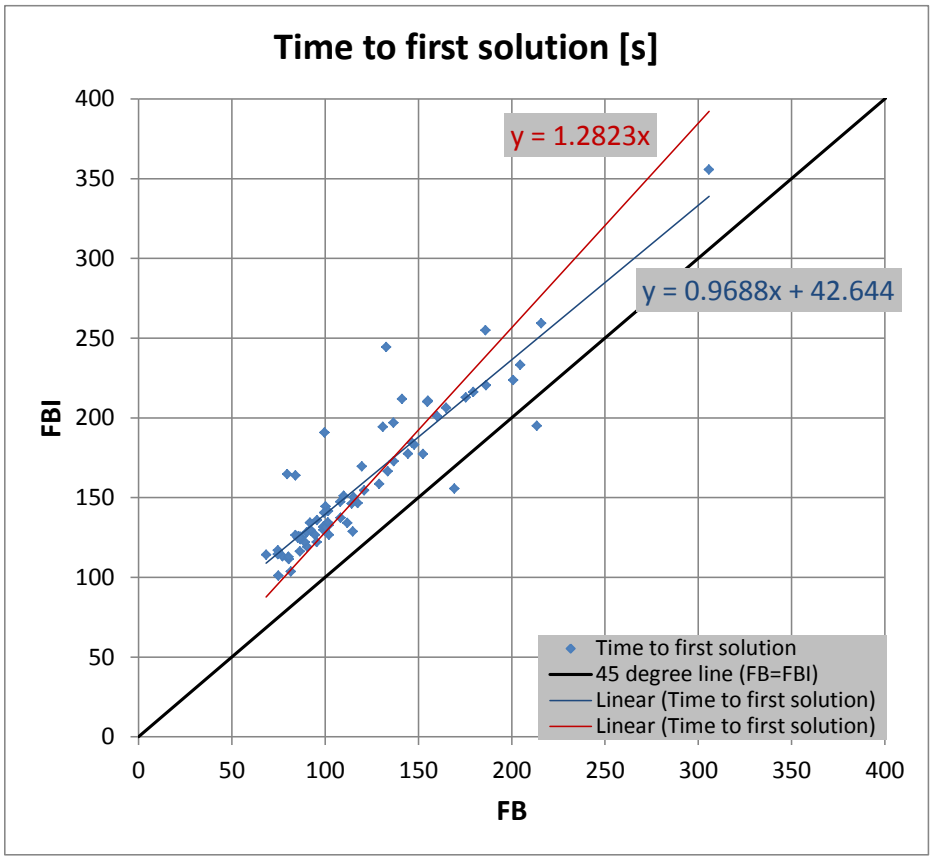


Figure 18 scatter of the time to first solutions between the plain FB and intuitive FB runs

4.9 Conclusion on one year FBI operation

Based on the indicators monitored, excluding delivery dates with extreme results, FBI and FBP calculation modes provide comparable performances. Even though differences are relatively small, FBP outperforms FBI on welfare, Total daily exchanges, PRB number, Total MCV and time to first solution (algorithm performance).

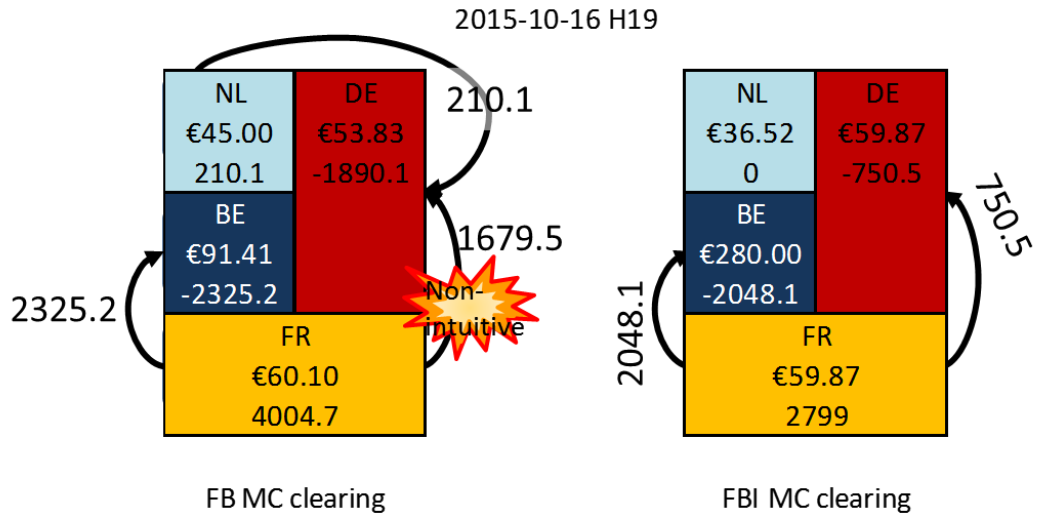
On exceptional Market coupling conditions, FBP and FBI modes produce more contrasted indicators and where FBP mode is outperforming FBI mode on most of the indicators and could be more beneficial than FBI mode to small markets (BE) and large markets (DE) as well. Those exceptional Market coupling situations occurred on the 22nd September, 16th of October and 8th of May and are further analyzed in the next section.

5. Focus on relevant intuitive and non-intuitive situations

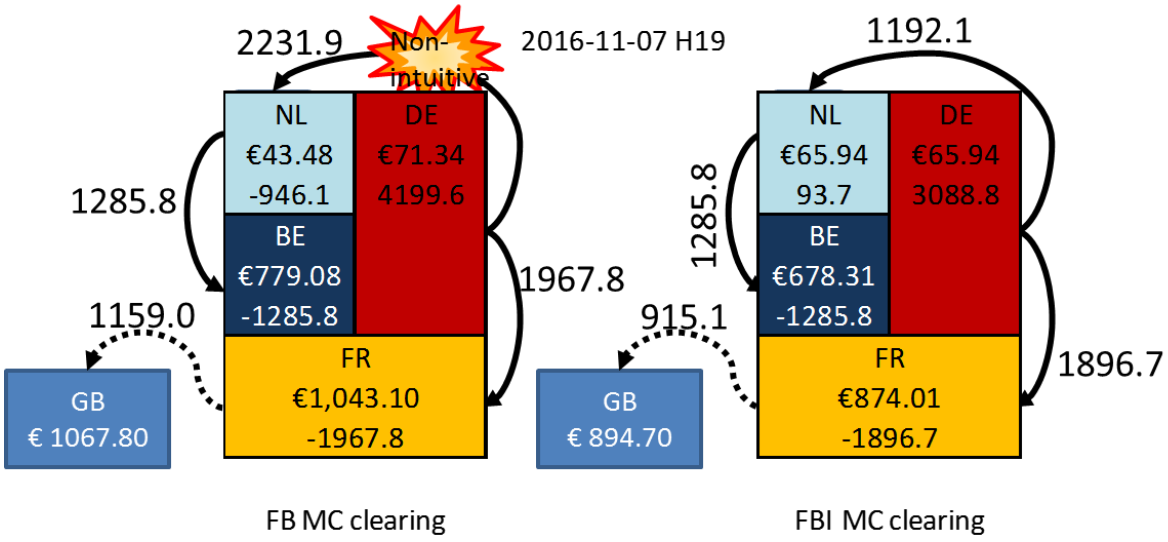
5.1 Intuitive patch

The intuitive patch consists into avoiding non-intuitive flows. This can occur either to prevent expensive market to export to less expensive market. Alternatively this can occur to avoid cheap market to import from more expensive market.

Example 1: 16/10/2015 h19, to allow the FB "plain" solution, DE/AT/LUX imports from FR, non-intuitively. FBI solves this, by creating a price convergence between DE/AT/LUX and FR and truncating NL to zero, to prevent it to import like DE/AT/LUX did before. The reduction in DE imports reduces the BE imports, and results in BE price to increase from €91 to €280.



Example 2: 07/11/2016 h19, to allow the FB "plain" solution, DE/AT/NL exports to NL, non-intuitively. FBI solves this, by creating a price convergence between DE/AT/NL and NL, so they can jointly export to BE and FR. This reduces FR imports. Counter intuitively the GB import is now reduced, letting FR price decrease in FBI: although within CWE the FR imports decrease, this is offset by the reduction in export to GB.

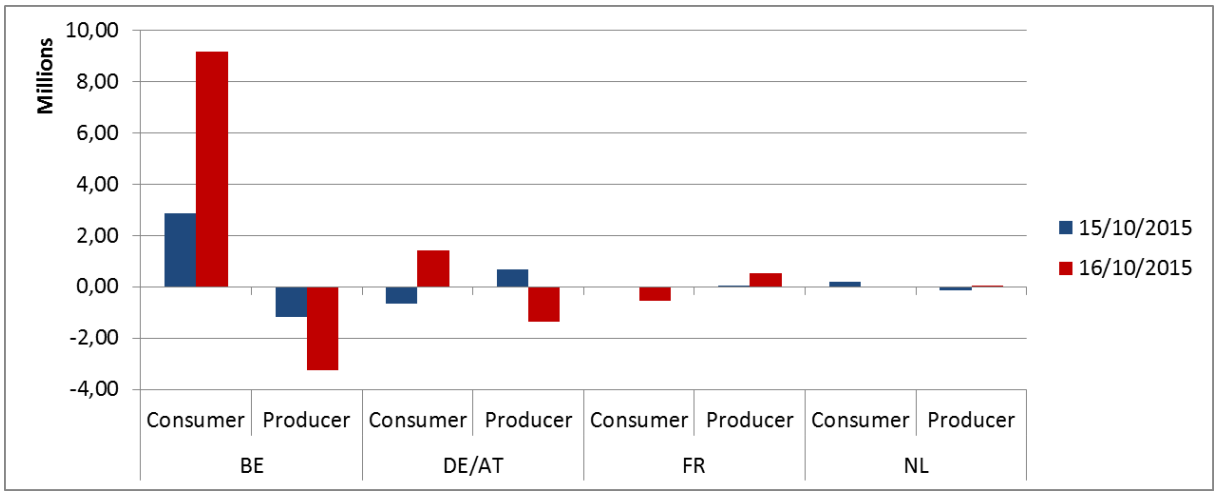


5.2 High price spike

This section focusses on the price spike days of 15 and 16th of October 2015. An extensive analysis of the price spike day of September 22th has already been performed and is available on the website of JAO. Additionally, an extensive reporting on the price spike mentioned is available on the website of the CREG[8] (Belgian regulator).

Indicator: WELFARE

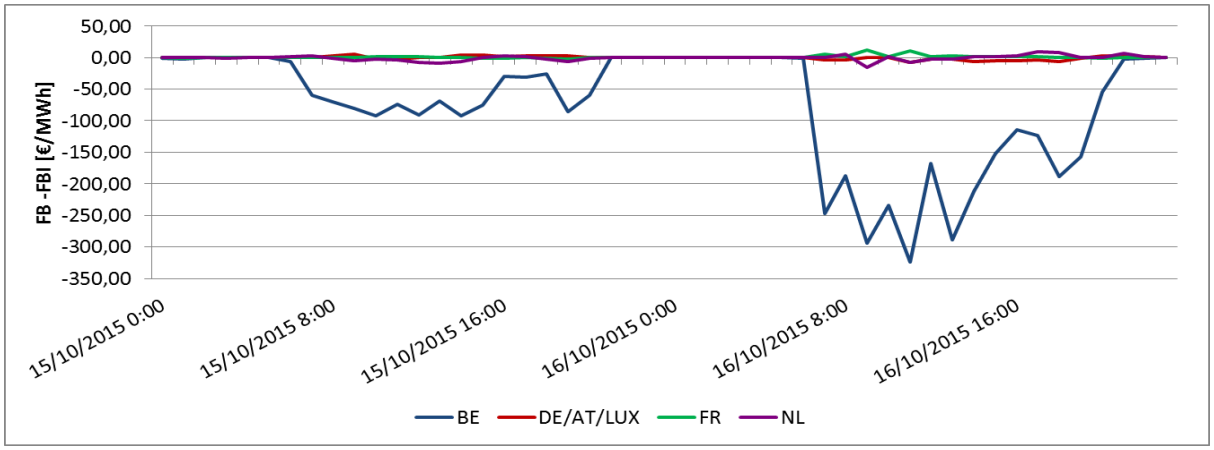
The figure below shows the difference in welfare between FBP and FBI. For both price spike days, FBP results in a significant shift of producer surplus to consumer surplus in Belgium, overall the welfare in Belgium increases. The total welfare increase for the 15th amounts to 1.7 M€, while the increase in welfare on the 16th amounts to 6 M€. For both days, France sees a very slight decrease in overall welfare (-30k€). Germany/Austria and The Netherland see a slight increase in welfare (82K€ and 65k€).



Indicator: PRICES

When looking at the price difference between the FBP and FBI results for the two considered business days, it is clear how these are linked with the change in welfare. For the 15th of October, FBP reduced the prices in Belgium with a maximum of 92.90 €/MWh, reducing the price from 199.00 €/MWh to 106.10 €/MWh. The largest deviation for the other CWE hubs was limited to a reduction of price in The Netherlands of 8.60 €/MWh and an increase of 5.20 €/MWh in Germany/Austria.

[8] http://www.creg.info/pdf/Studies/F1520EN.pdf



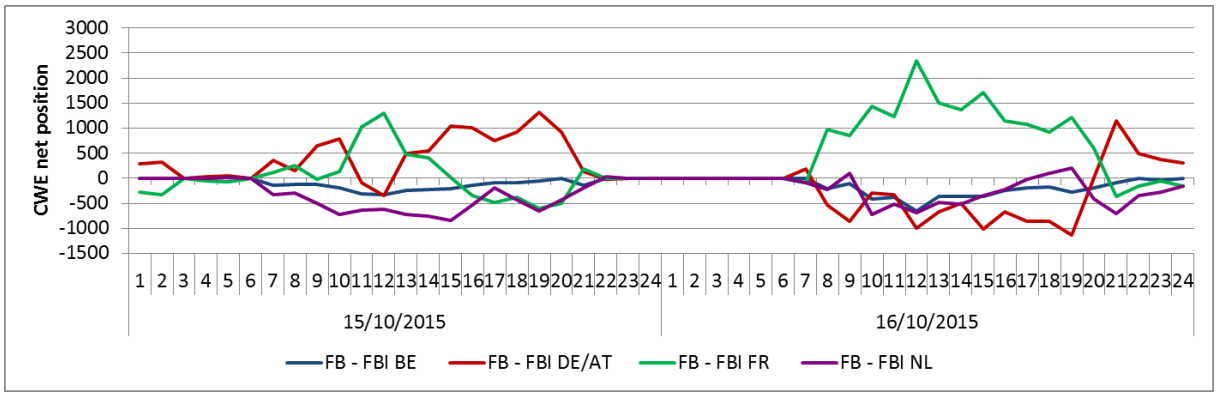
A bigger impact can be seen for the 16th of October, there FB plain would have reduced the prices in Belgium from 448.70 €/MWh to 125.00 €/MWh, a reduction of 323.70 €/MWh. The other CWE hubs remain largely unaffected by the application of FBP, in the Netherland the largest decrease in price happens at hour 10 (-16.05 €/MWh). France sees, again, an increase in price (with a maximum of 12.33 €/MWh for hour 10).

Table below gives some indicators to assess the impact of FB during the two considered days:

	15/10/2015				16/10/2015			
	BE	DE/AT	FR	NL	BE	DE/AT	FR	NL
Average Price difference [€/MWh]	-39,44	0,96	0,03	-1,67	-114,69	-1,72	1,66	0,42
Max price difference [€/MWh]	0,12	5,20	1,99	2,47	0,00	2,25	12,33	8,60
Minimum price difference [€/MWh]	-92,90	-2,62	-1,86	-8,60	-323,70	-7,47	-0,58	-16,05

Indicator: Net Positions

FBP allowed Belgium to import on average 99MW and 170MW more on the 15th and 16th of October respectively, with import increasing up to 335MW and 651MW for certain hours. To allow this increase in import, French export increased more than 2.3 GW more during hour 12 of the 16th. On the other hand, Germany/Austria and the Netherlands import more.



Indicator: Total volume executed

During the two price spike days in October, Belgium would have imported an additional 6445MWh while the Netherlands would also experience an increase in import totaling 13136MWh. For France,

the export increased on both days (total of 16435MWh) and Germany/Austria exported more on the 15th (9326 MWh) and imported more on the 16th (6180MWh). Overall exchanges within CWE increased by 28 904 MWh.

5.3 Low price spike

This section focusses on the low price spike day of 8th of May 2016 where negative prices have been reached.

Welfare

Observations:

The Figure 19 shows the difference in welfare between FBP and FBI. For 8th of May 2016 the FBP mode mainly impacted BE results and more largely DE/AT/LUX ones. Under FBP, we can observe a significant shift of surplus from DE/AT/LUX consumers towards DE/AT/LUX producers and to a lesser extend a shift of surplus from BE producers towards BE consumers. The total welfare increase under FBP is less significant than for the high price spike days and amounts 0.29M€.

CWE Surplus and distribution per seller/buyer and per market

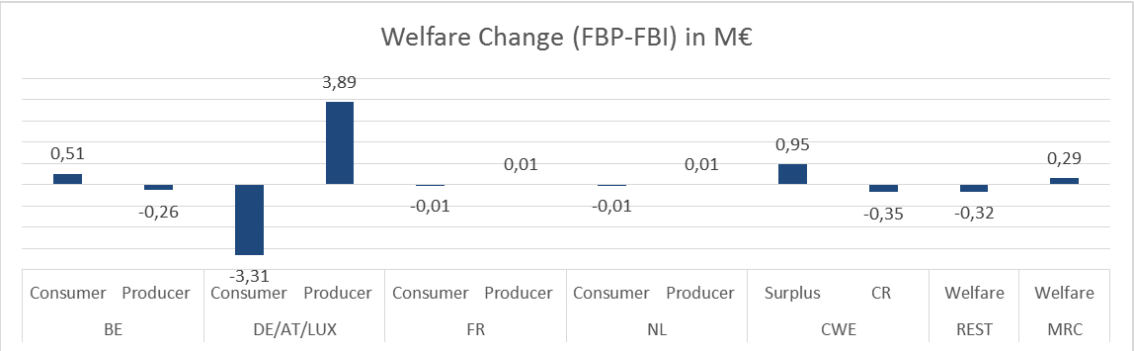


Figure 19: Distribution of welfare (producer and consumer surplus and CR) on the 08/05/2016

Indicator: PRICES

Observations:

The Figure 2020 illustrates the price differences between FBP and FBI in CWE. The Figure 21 shows DE/AT/LUX and BE prices under FBP and FBI modes. On both figures we retrieve the hours for which the intuitive patch has been activated. As for welfare indicators, the FBP mode mainly impacted DE/AT/LUX and BE prices. On the other markets, the impact on prices is very limited. FBP would have increased DE/AT/LUX prices (but would remained negative) and have reduced BE prices (to deeply negative value on some hours). As decreasing prices are favorable to consumers whereas increasing prices are favorable to producers, the price changes explain the changes observed in welfare.

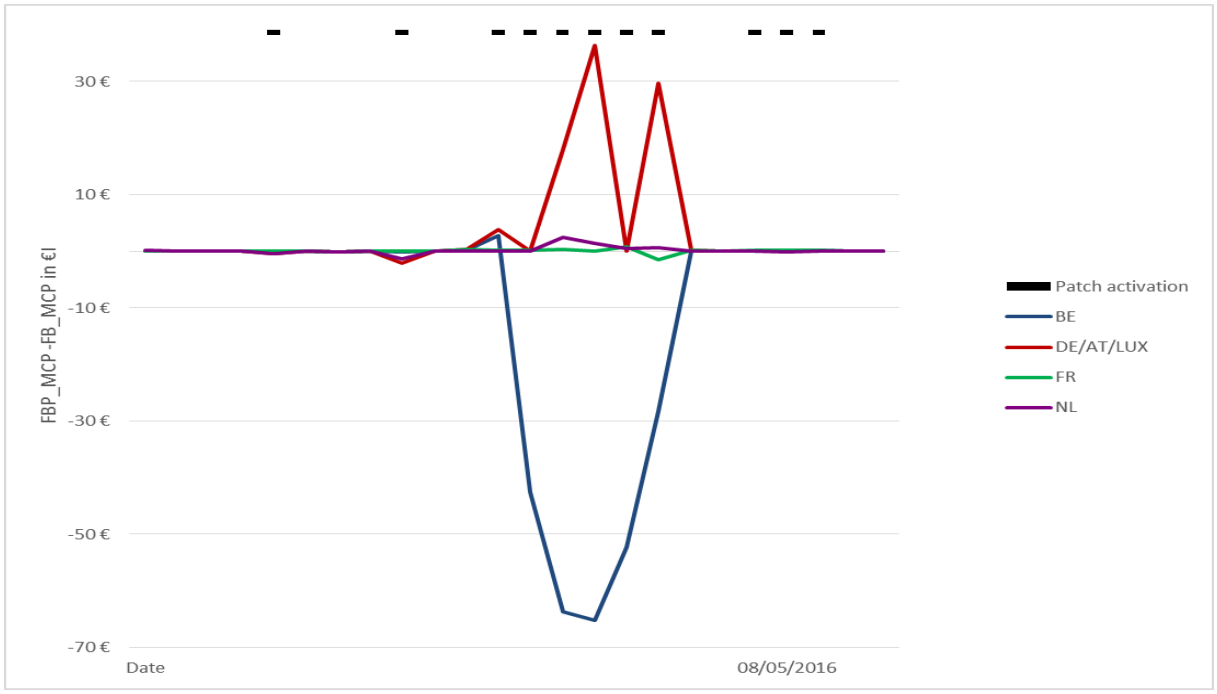


Figure 20: Price differences (FBP-FBI) on the 08/05/2016

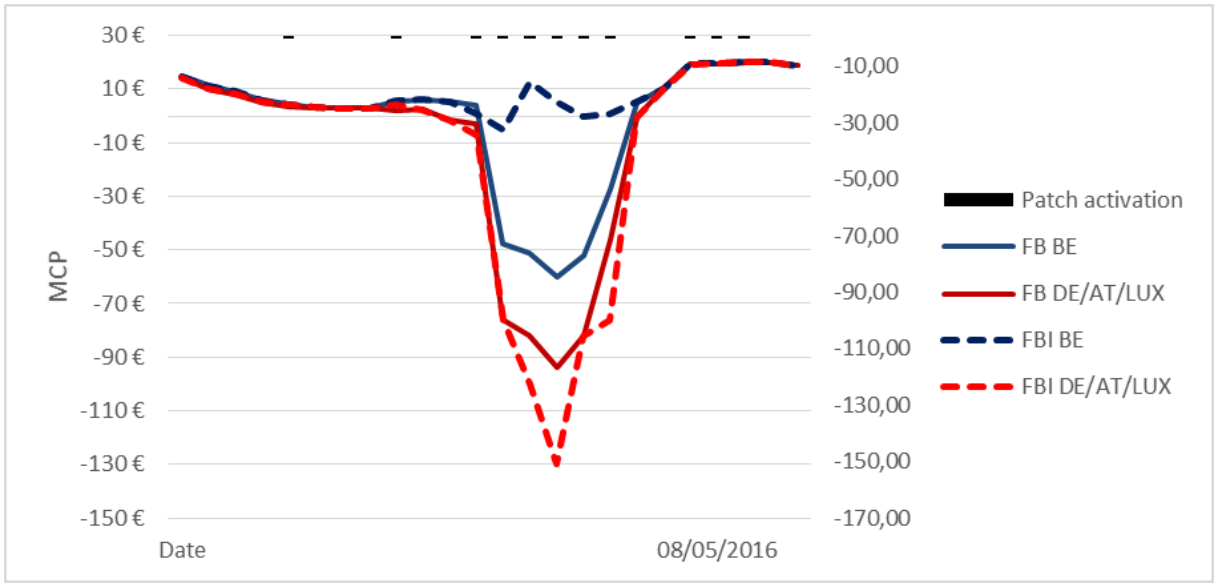


Figure 21: DE/AT/LUX and BE prices under FBP and FBI modes on the 08/05/2016

Indicator: Net Positions

The Figure 1022 shows the Net positions of DE/AT/LUX and BE under FBP and FBI modes. And Table 1 reports the total net positions (sum of the hourly net positions) in CWE.

The main differences Between FBP and FBI occur on hours 12-17 where the intuitive patch has prevented DE/AT/LUX to export and BE to import because this would have induced non intuitive flows.

On hour 15 for instance, to allow the FBP solution, BE, which has a negative price, imports from FR non-intuitively. FBI solves this, preventing BE imports. The consequence is that DE exports are reduced, aggravating the DE negative prices: price decreases from €-94 to €-130.

The table 1 shows that the total exchange would have been higher under FBP.

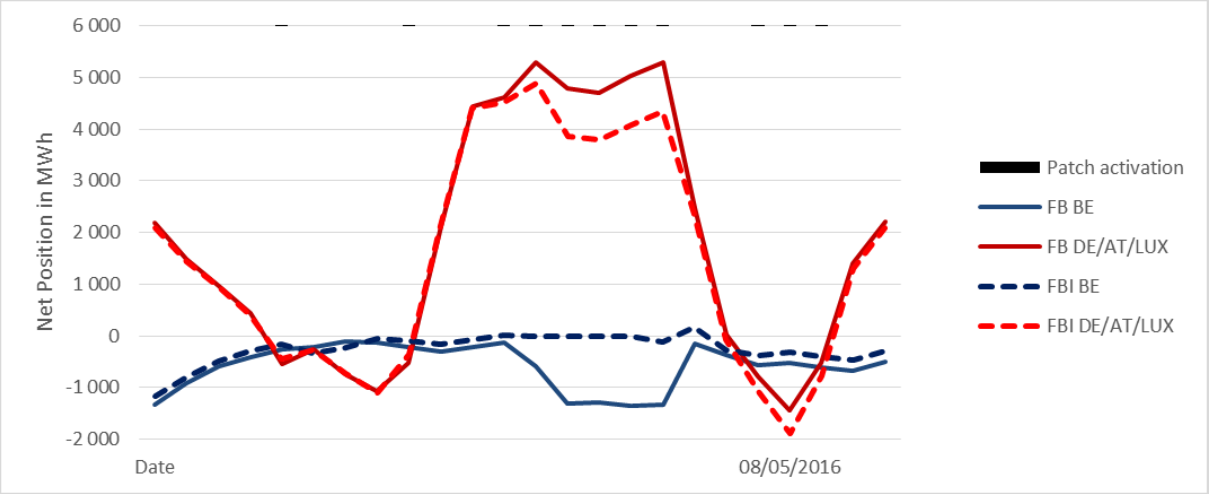


Figure 10: DE/AT/LUX and BE Net positions under FBP and FBI modes on the 08/05/2016

Net position	BE	DE/AT/LUX	FR	NL
FBP	-14060,8	41609,8	42732,6	-70281,5
FBI	-5908	35895,6	41781,9	-71769,4
FBP_NP-FBI_NP	More import of 8152 MW	More export of 5714 MW	More export of 950 MW	Less import of 1487 MW

Table 1 Total net position of CWE markets on the 08/05/2016

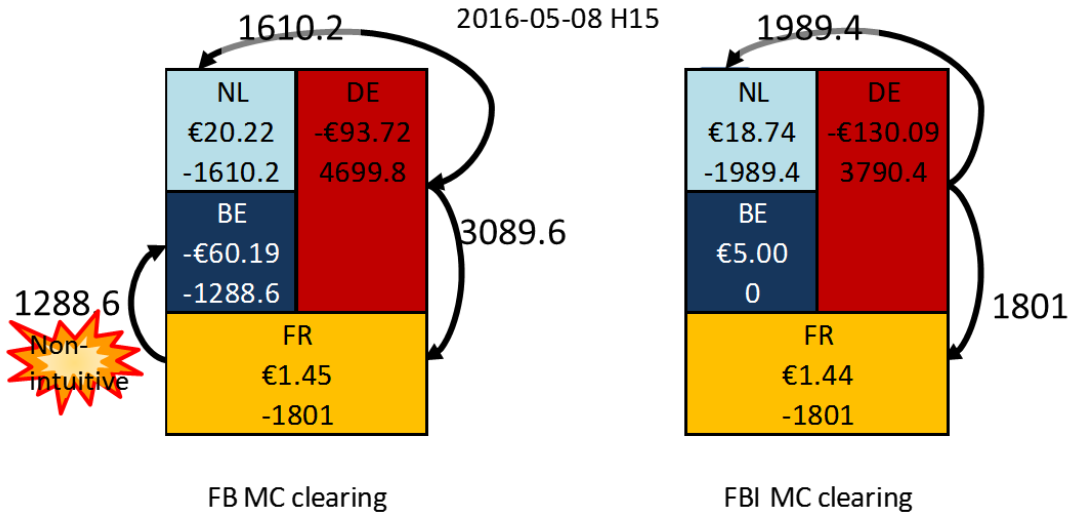


Figure 113: focus on FBP and FBI results on hour 15

Indicator: Total volume executed

The Table 2 presents the total volume executed under FBP and FBI mode in CWE and shows that FBP would have increased the total volume executed in CWE.

MCV	BE	DE/AT/LUX	FR	NL	CWE
FBP	60619	1512143	490109	131879	2194750
FBI	57025	1509191	491621	132498	2190335
FBP_MCV-FBI_MCV	3594	2952	-1512	-619	4415

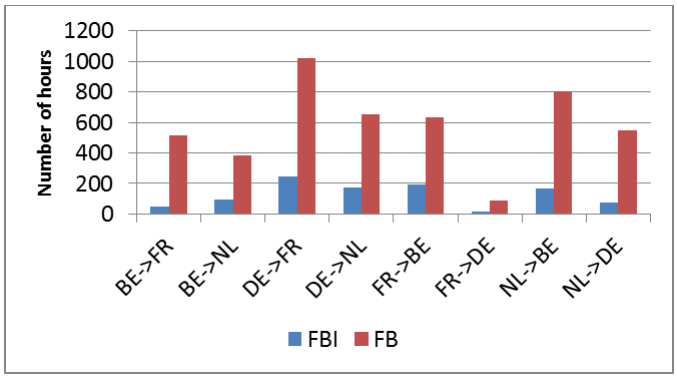
Table 2: Total volume executed in CWE

6. Impact on Intraday timeframe

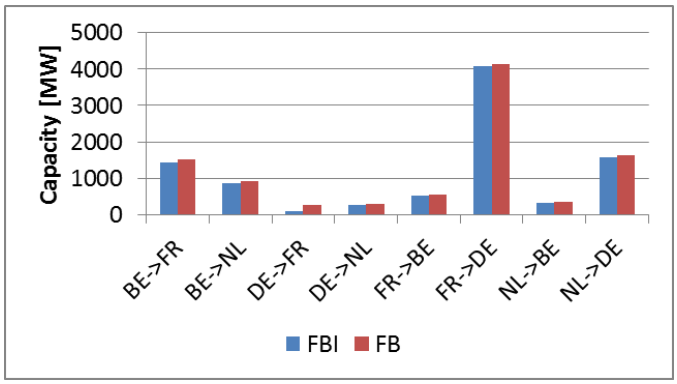
ID ATC: historical ID ATC (after Intuitive FB MC) vs ID ATC "after Plain FB MC"

If non intuitive situations occur then FBP will make better use of the available capacities available in the DA timeframe. Therefore, it is expected that under non intuitive situation the initial ID ATC capacities will be smaller with FBP than with FBI.

First, the number of hours with zero intraday capacity during non-intuitive hours is given. The expected increase in zero intraday capacity is evident.



However, when there is capacity available (so non-zero intraday capacity), the average value of this capacity is slightly higher under FB plain.

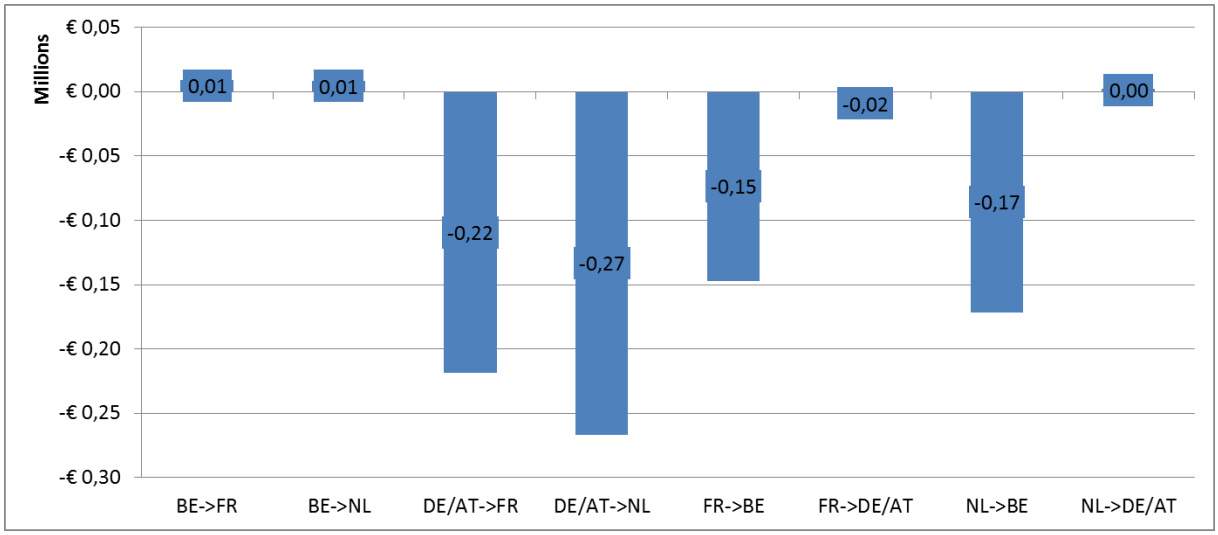


Proxy of welfare gain in ID (DA price spread multiplied by ID ATC)

The value of the remaining initial intraday capacity can be estimated by multiplying the remaining capacity times the DA market spread. There are multiple drivers which can influence the result of this indicator:

- Price: FBP will typically reduce the market spread between all CWE hubs by allowing more exchanges in non-intuitive situations;
- Volume: FBP will typically increase the amount of zero ID ATC capacity and non-zero capacity slightly increases.

Over the span of one year FBP the indicator decreased with 800 k€, or 30% of the value under FBI.



7. Conclusion on the matters raised by NRAs

Capability of market parties to make good price forecasts and to bid efficiently under either FBP or FBI

This section should be completed after the MPs' consultation conducted by CWE NRAs.

Distribution of welfare, in particular between small and large bidding zones

As a result from the analysis, it can be concluded that FBP would have resulted in a total market surplus gain of 13.3 Million Euros for the whole CWE region after one year. All CWE bidding zones would have observed higher market surpluses, with the highest increase of 10 Million Euros for the Belgium market. Surplus gains for the other markets are less significant, with 1.9 Million Euros for Germany/Austria, 0.6 Million Euros for France and 1 Million Euro for the Netherlands.

The gain in markets surplus has its origin in increased consumer surplus, except for the German/Austrian bidding zone, were the producer surplus is increasing. Average daily welfare for the CWE region would have been 4,000 Euros higher under FBP, and 9,000 Euros higher for the MRC region. This is mainly the result of welfare gains during a limited number of days with exceptional prices.

Impact on intraday timeframe

Welfare should be optimized for the whole time frame ranging from intraday to years ahead. Specifically, there is a risk that the gain of FBP versus FBI could be traded away in the intraday timeframe.

It can be concluded that there is an impact of FBP on the intraday market. Since FBP will make better use of the available Flow-Based domain by allowing non intuitive market situations, the initial ID capacity will be lower. Furthermore, with the help of a welfare proxy, it seems that this reduction in initial ID capacity leads to a reduction of possible welfare in the ID welfare. However, this effect is limited due to limited available initial ID capacity under FBP and FBI and the reduction of price spread under FBP.

Security of supply

Bidding zones can be dependent on import to ensure security of supply on the short term, i.e. avoiding curtailment in the DA market. While TSOs make available a certain FB domain, from which maximum combined import values can be derived, the application of the intuitiveness patch could in reality limit the maximum import of certain hubs. If under certain circumstances counter intuitive flows are required to allow a Bidding Zone to reach its maximum import, then these exchanges will be limited by the intuitiveness patch. This behaviour was noted for Belgium during some of the peak days.

ANNEX A

Net Positions volatility

Please find the detailed graphs which show comparable volatility under FBP and FBI MC