



Energy
Security
Project

— Analysis and Simulation for Feed-In-Premium (FIP) Implementation for Existing PPAs

Kyiv, Ukraine
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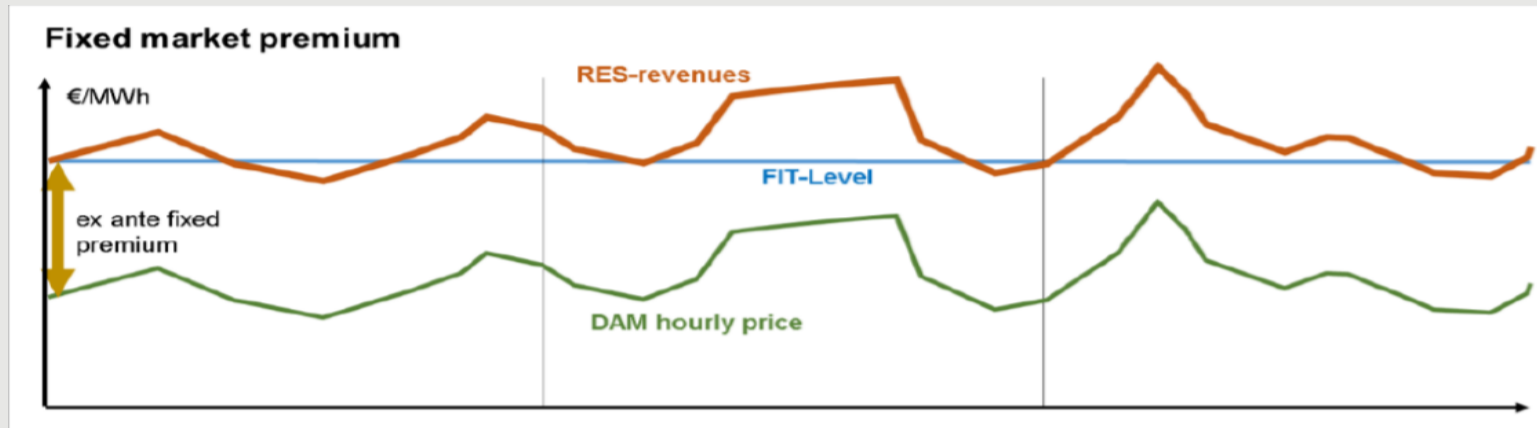
Status-quo in Renewable Energy Trading in the First Year of WEM

- High difference between total volume sold at DAM and IDM, and metered generation indicates significant improvement potential for Renewable Energy (RE) to **better manage the portfolio and reduce imbalances**.
- If FIP-like mechanisms are not introduced, **RE portfolio will prefer to stay in Guaranteed Buyer's Balancing Group** since they are exempted from imbalances within tolerance limits (5 % and 10 % for solar and wind) even after 2021.
- Right signals/incentives can **-without increasing total support costs-** encourage RE to better optimize bilateral contracts and spot markets, decrease the imbalance in BPM and help Ukrenergo to maintain system stability more easily.

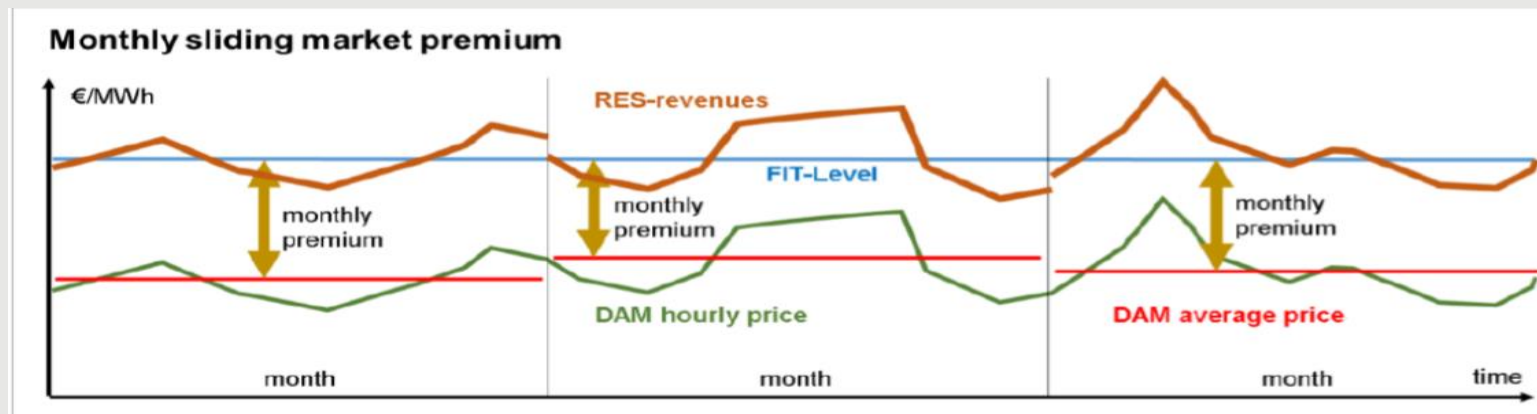
Month	DAM RE Selling (UAH/MWh)	DAM Price (UAH/MWh)	Difference	Metering (MWh)	Forecast (MWh)	Difference	Metering (MWh)	Volume Sold at DAM+ IDM (MWh)	Imbalance compared to DAM&IDM
July 19	1843,01	1643,48	12%	527682,2	464062,9	12%	527682,2	463966,8	14%
August 19	1849,46	1679,09	10%	597418,6	573168,2	4%	597418,6	567653,7	5%
September 19	1782,26	1623,41	10%	582250	602332,3	3%	582250	598055,5	3%
October 19	1764,87	1562,20	13%	448627,4	464943,7	4%	448627,4	457270	2%
November 19	1375,92	1367,55	1%	529595,5	564287,9	7%	529595,5	563463,8	6%
December 19	1221,68	1239,05	1%	445201	463450	4%	445201	430473,9	3%
January 20	1412,07	1424,98	1%	503635,2	508781,5	1%	503635,2	480782,4	5%
February 20	1234,12	1271,42	3%	685250,3	666824	3%	685250,3	650755,7	5%
March 20	1450,04	1391,23	4%	949757,5	876947,7	8%	949757,5	820190,1	16%
April 20	1193,27	1265,04	6%	1064201	1020754	4%	1064201	983780	8%
May 20	1386,36	1248,11	11%	921052,7	1026682	11%	921052,7	388526,7	137%
June 20	1351,96	1263,03	7%	1000502	1017489	2%	1000502	214472,7	366%
Average			7%			5%			48%

Feed-in-Premium (FIP) for Renewables Support Scheme

- FIP provides incentive for renewable plants to respond to demand and price signals in the electricity market
- FIP can encourage RE investors to consider tools/technologies for balancing and portfolio optimization in the engineering of the RE projects



Under FIP scheme, electricity from RE is typically sold on the spot market and RE producers receive a premium on top of the market price for their electricity production



FIP can be **fixed** (constant premium independent from market prices) or **sliding** (varying premium depending on the market price trend)

Summary of the FiP Approach and Modelling Assumptions

- The key condition is to keep total cost of RE support under FiP **less than or equal** to the current level based on FIT.
- An **incentive** should be provided for RE producers **to encourage leaving the Guaranteed Buyer's Balancing Group** while guiding RE producers **to bid reasonably at DAM** to avoid possible price collapses.
- **100% imbalance responsibility** is the mandatory condition for FiP implementation.
- **Monthly sliding premium** is considered for simplicity but **hourly sliding premium** is also possible.
- Simulations were done on actual annual data, using **dual imbalance pricing** (as it is in place since March 2020).
- General formula for FiP is:

$$FiP\ Payment = MV * (FIT - BP * (1 - K))$$

where:

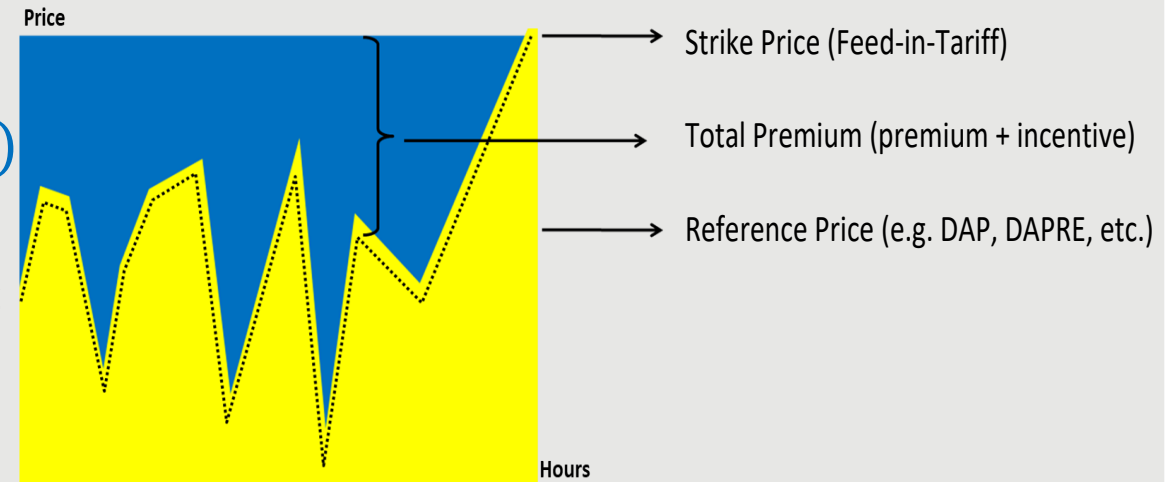
MV – net monthly metered value of the respective RES unit;

FIT – feed-in-tariff of the respective RES unit;

K- incentive coefficient;

BP – base price, which can be defined in different ways:

- **DAP**- average weighted monthly DAM price for the whole market;
- **DAPRE**- average weighted monthly prices of sold RES energy in DAM;
- **DAPRET**- average weighted monthly prices of sold RES energy in DAM per RE technology.



Incentive Coefficient with Average DAM Price as Base price - I

- For the calculations, common DAM average weighted monthly prices were taken.
- Accordingly, the average weighted incentive coefficient is calculated as **3,82 %**.

Month	Metered RE Generation (MWh)	DAM Price (UAH/MWh)	Actual Trading Revenue (UAH)	Coefficient
July 19	527 682,20	1 643,48	955 455 749,32	-10,17%
August 19	597 418,56	1 679,09	1 079 188 380,73	-7,58%
September 19	582 249,98	1 623,41	1 000 620 350,76	-5,86%
October 19	448 627,39	1 562,20	745 830 935,34	-6,42%
November 19	529 595,48	1 367,55	698 732 441,64	3,52%
December 19	445 201,01	1 239,05	505 919 760,69	8,29%
January 20	503 635,24	1 424,98	656 010 315,13	8,59%
February 20	685 250,31	1 271,42	811 811 493,90	6,82%
March 20	949 757,53	1 391,23	1 270 092 927,91	3,88%
April 20	1 064 200,55	1 265,04	1 199 116 290,64	10,93%
May 20	921 052,67	1 248,11	951 016 429,27	17,27%
June 20	1 000 501,77	1 263,03	1 046 237 766,38	17,21%
Year	8 255 172,70		10 920 032 841,71	3,87%
			Average weighted	3,82%

Incentive Coefficient with Average DAM Price as Base price - II

- RES support under FIT is calculated based on average weighted FIT per month and compared with **FIP result** below

$$FIPResult = MV * (FiT - BP * (1 - 0,0382)) + Actual Trading Revenue$$

where BP - base price, equals to DAP- average weighted monthly DAM price

Month	FIT (UAH/MWh)	RES support under FIT (UAH)	FIP Result (UAH)	Difference
July 19	4 816,51	2 541 586 597,94	2 662 906 504,12	4,7734%
August 19	4 684,14	2 798 392 150,22	2 912 740 971,17	4,0862%
September 19	4 468,84	2 601 982 009,56	2 693 403 243,90	3,5135%
October 19	4 148,19	1 860 991 669,52	1 932 814 808,48	3,8594%
November 19	3 453,35	1 828 878 561,22	1 830 940 117,12	0,1127%
December 19	3 417,12	1 521 305 275,29	1 496 579 674,43	-1,6253%
January 20	3 388,41	1 706 522 686,96	1 672 287 263,75	-2,0062%
February 20	3 491,06	2 392 249 929,77	2 365 975 855,61	-1,0983%
March 20	3 691,23	3 505 773 476,39	3 505 212 950,86	-0,0160%
April 20	4 202,48	4 472 281 539,97	4 376 423 824,65	-2,1434%
May 20	4 187,85	3 857 230 428,25	3 702 458 401,69	-4,0125%
June 20	4 273,26	4 275 404 210,76	4 107 052 146,73	-3,9377%
Year		33 362 598 535,84	33 258 795 762,51	-0,3111%
			Average monthly	0,1255%
			Average hourly	-1,2892%

Incentive Coefficient with Average RE DAM Price as Base Price - I

- For the calculations, average RE DAM weighted monthly selling price at DAM is used as the Base Price (BP)
- Accordingly, the average weighted incentive coefficient is calculated as **8,37%**

Month	Metered RE generation (MWh)	DAM Price (UAH/MWh)	Actual Trading Revenue (UAH)	Coefficient
July 19	527 682,20	1 843,01	955 455 749,32	1,76%
August 19	597 418,56	1 849,46	1 079 188 380,73	2,33%
September 19	582 249,98	1 782,26	1 000 620 350,76	3,58%
October 19	448 627,39	1 764,87	745 830 935,34	5,80%
November 19	529 595,48	1 375,92	698 732 441,64	4,11%
December 19	445 201,01	1 221,68	505 919 760,69	6,98%
January 20	503 635,24	1 412,07	656 010 315,13	7,76%
February 20	685 250,31	1 234,12	811 811 493,90	4,01%
March 20	949 757,53	1 450,04	1 270 092 927,91	7,78%
April 20	1 064 200,55	1 193,27	1 199 116 290,64	5,57%
May 20	921 052,67	1 386,36	951 016 429,27	25,52%
June 20	1 000 501,77	1 351,96	1 046 237 766,38	22,65%
Year	8 255 172,70		10 920 032 841,71	8,15%
			Average weighted	8,37%

Incentive Coefficient with Average RE DAM Price as Base Price - II

- RES support under FIT is calculated based on average weighted FIT per month and compared with **FIP result** below

$$FIPResult = MV * (FiT - BP * (1 - 0,0837)) + Actual Trading Revenue$$

where BP - base price, equals to DAPRE- average weighted monthly prices of sold RES energy in DAM

Month	FIT (UAH/MWh)	RES support under FIT (UAH)	FIP Result (UAH)	Difference
July 19	4 816,51	2 541 586 597,94	2 605 847 706,38	2,5284%
August 19	4 684,14	2 798 392 150,22	2 865 071 314,56	2,3828%
September 19	4 468,84	2 601 982 009,56	2 651 615 614,11	1,9075%
October 19	4 148,19	1 860 991 669,52	1 881 354 704,86	1,0942%
November 19	3 453,35	1 828 878 561,22	1 859 804 361,21	1,6910%
December 19	3 417,12	1 521 305 275,29	1 528 743 173,81	0,4889%
January 20	3 388,41	1 706 522 686,96	1 710 872 946,34	0,2549%
February 20	3 491,06	2 392 249 929,77	2 429 003 154,59	1,5363%
March 20	3 691,23	3 505 773 476,39	3 514 100 689,35	0,2375%
April 20	4 202,48	4 472 281 539,97	4 507 617 599,31	0,7901%
May 20	4 187,85	3 857 230 428,25	3 638 031 109,09	-5,6828%
June 20	4 273,26	4 275 404 210,76	4 082 967 309,44	-4,5010%
Year		33 362 598 535,84	33 275 029 683,04	-0,2625%
			Average monthly	0,2273%
			Average hourly	-1,5671%

Incentive Coefficient Using RE Imbalance Tolerance - I

- Additional simulations were done considering RE imbalance tolerance defined by Law (5% for solar and 10% for wind). Average tolerance was taken as 6,89% using RE generation by source (breakdown for solar and wind also possible).
- This simulation considers **what would the imbalance cost of the GB be on top of FIT costs** if plants prefer to stay.
- Hence, with the incentive, **total cost for the GB remains the same even for the ideal situation while benefits are achieved.**

Month	DAM price (UAH/MWh)	RE sell price (UAH/MWh)	FIP Result (UAH)	Coefficient if Base Price is DAM Price	Coefficient if Base Price is Renewable Selling Price at DAM
July 19	1 643,48	1 843,01	969 140 042,98	-11,75%	0,35%
August 19	1 679,09	1 849,46	1 093 450 363,21	-9,00%	1,04%
September 19	1 623,41	1 782,26	1 021 483 055,60	-8,07%	1,56%
October 19	1 562,20	1 764,87	785 482 121,58	-12,08%	0,79%
November 19	1 367,55	1 375,92	720 839 035,33	0,47%	1,08%
December 19	1 239,05	1 221,68	530 467 892,06	3,84%	2,47%
January 20	1 424,98	1 412,07	703 468 732,10	1,98%	1,08%
February 20	1 271,42	1 234,12	834 955 123,38	4,16%	1,27%
March 20	1 391,23	1 450,04	1 350 464 885,12	-2,20%	1,94%
April 20	1 265,04	1 193,27	1 271 708 545,00	5,54%	-0,14%
May 20	1 248,11	1 386,36	1 167 693 956,02	-1,58%	8,55%
June 20	1 263,03	1 351,96	1 273 985 596,80	-0,82%	5,81%
Year			11 723 139 349,16	-2,46%	2,15%
			Average weighted	-2,60%	2,34%

Incentive Coefficient Using RE Imbalance Tolerance - II

In cases when incentive coefficient is calculated zero or negative, it is still suggested to **offer a positive coefficient** for two reasons:

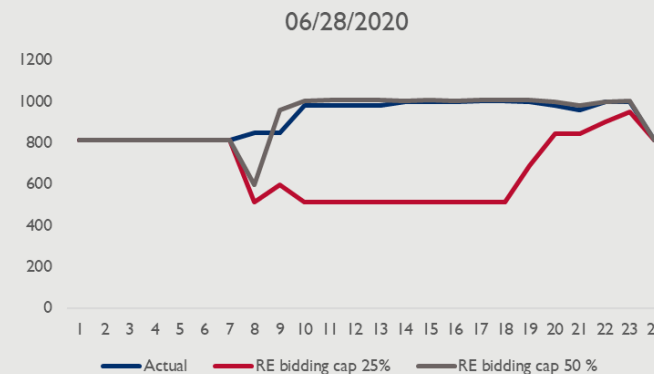
- (1) The calculations might be based on ideal scenarios, which is rarely the case
- (2) The RE plants will have an imbalance risk exposure and incentive coefficient can encourage them while help reduce costs of the GB.

Month	RES support under FIT (UAH)	FIP Result Using DAM Price (UAH)	Difference	FIP Result Using RE Selling Price (UAH)	Difference
July 19	2 541 586 597,94	2 643 491 497,21	4,0095%	2560958456,99	0,762%
August 19	2 798 392 150,22	2 888 722 991,91	3,2280%	2812792315,19	0,515%
September 19	2 601 982 009,56	2 678 234 621,88	2,9306%	2610022676,57	0,309%
October 19	1 860 991 669,52	1 945 628 076,19	4,5479%	1873229724,85	0,658%
November 19	1 828 878 561,22	1 825 469 293,77	-0,1864%	1838088357,49	0,504%
December 19	1 521 305 275,29	1 500 146 855,91	-1,3908%	1520606164,09	-0,046%
January 20	1 706 522 686,96	1 692 321 273,34	-0,8322%	1715465496,16	0,524%
February 20	2 392 249 929,77	2 355 964 110,37	-1,5168%	2401309450,83	0,379%
March 20	3 505 773 476,39	3 534 907 197,22	0,8310%	3511279997,93	0,157%
April 20	4 472 281 539,97	4 397 733 817,40	-1,6669%	4503826818,81	0,705%
May 20	3 857 230 428,25	3 875 349 335,07	0,4697%	3777890949,19	-2,057%
June 20	4 275 404 210,76	4 285 726 051,95	0,2414%	4228403719,75	-1,099%
Year	33 362 598 535,84	33 623 695 122,21	0,7826%	33353874127,84	-0,026%
Average			0,8888%		0,1092%

Possible FIP Impact on Day-Ahead Market - I

- Currently, the Guaranteed Buyer sells RE under FIT mechanism and deliberately **avoids bidding to low**, despite selling large volumes at Balancing Market as a reasonable revenue maximization strategy.
- There are hours during summer months when RE generation was higher than demand at DAM, yet RE bidding prices are not very low. It is **likely that RE under RIP will follow a similar strategy** for revenue optimization.
- Yet, decrease in DAM prices might be inevitable. Simulations for typical summer days show what would happen **if RE plants under FIP bid lower compared to the Guaranteed Buyer** (using applicable bidding cap) to sell more at DAM (extremely low bidding strategy is not considered as practically it hurts RE plants).

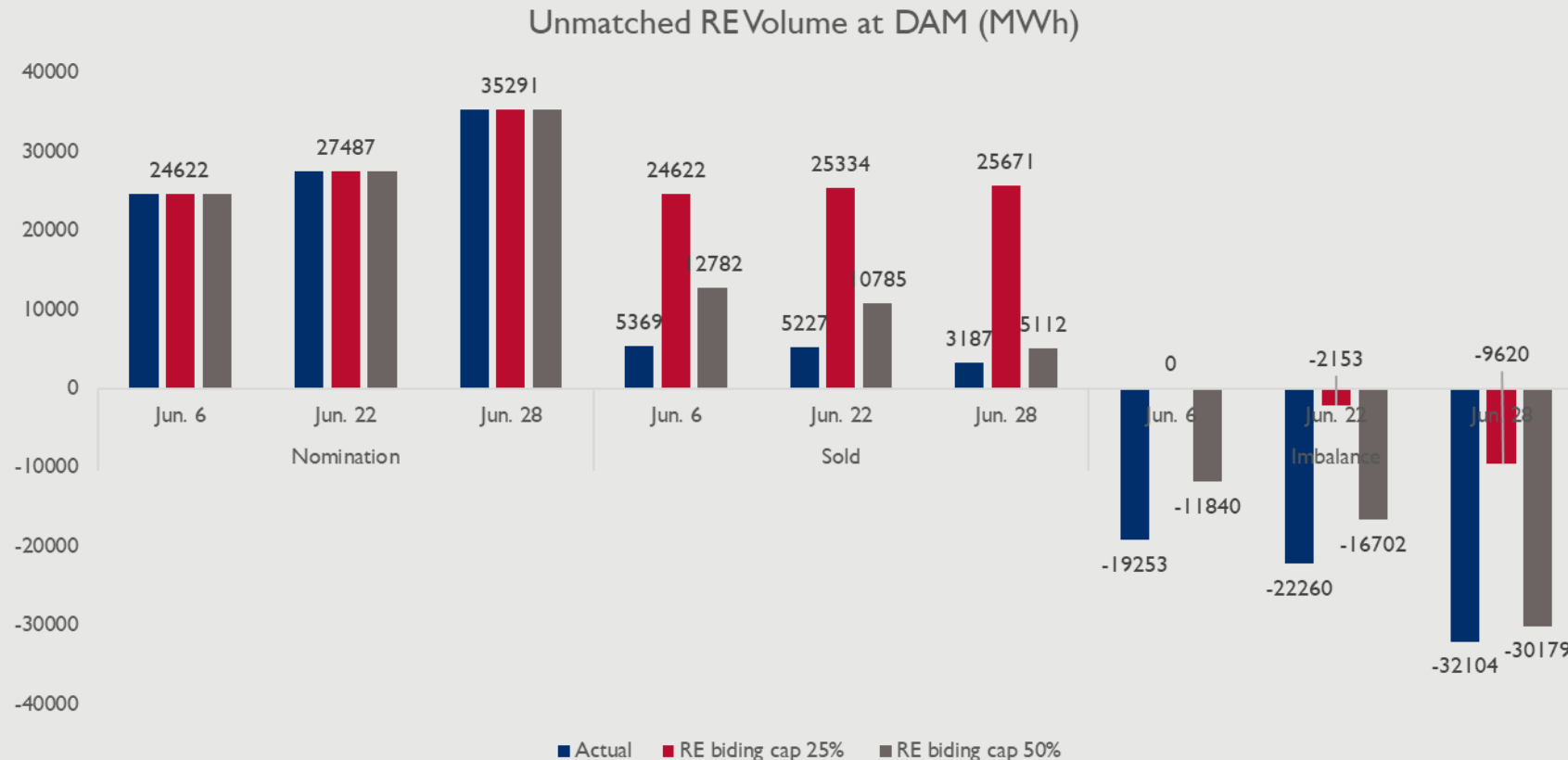
Average Weighted DAM Price (UAH/MWh)	Actual	RE Bidding Cap 25%	RE Bidding Cap 50%
6/2/2020	1374.51	1052.87	1108.76
6/22/2020	1335.84	878.34	1042.71
6/28/2020	926.41	683.07	929.56



* Note that days were specifically chosen to reflect days with **high RE generation** (e.g. June 6) and with **RE generation even higher than demand** at DAM (e.g. June 28)

Possible FIP Impact on Day-Ahead Market - II

- **Significantly decreased** bidding price (to 50 % or 25 % bidding caps compared to Guaranteed Buyer bids) can cause a decrease in the DAM price **but allows more RE to be sold** at DAM. Especially on June 6, all RE could be sold with no imbalance



Pros and Cons of Options for the Base Price (BP)

	Pros	Cons
DAP	Transparent as DAM prices are public	Specifics of RE technology not considered
	Incentive for portfolio optimization as actual RE selling price is higher	Possible decrease in DAM prices if right incentives are not provided
DAPRE	Reflects actual selling price for RE generation	Not public price and volumes data
		Possible risk perception by RE producers due uncertainty in selling price
	Incentive for portfolio optimization as actual RE selling price is higher	Specifics of RE technology not considered
		Possible decrease in DAM prices if right incentives are not provided
DAPRET	Incentive coefficient reflects specifics of each technology (i.e. solar, wind, etc.)	Complexity in calculations but doable (with some additional assumptions)
		Could make a reducing impact on DAM price
		Possible decrease in DAM prices if right incentives are not provided

- **DAP**- average weighted monthly DAM price for the whole market
- **DAPRE**- average weighted monthly prices of sold RES energy in DAM
- **DAPRET**- average weighted monthly prices of sold RES energy in DAM per RE technology

Concluding Remarks

- **Well-designed FIP** mechanism can provide the right signal for RE to leave GB's Balancing Group and to be active in the market and system operation while not creating significant negative impacts in WEM.
- Given that imbalance responsibility in year 2021 will be 50 % for RE, the **incentive coefficient could be tuned**. Moreover, **expected normal forecasting errors** in generation can be used to calculate the coefficient.
- Following considerations are important:
 - Incentive coefficient calculation is normally influenced by market conditions like legislation changes (e.g., imbalance pricing) or supply-demand anomalies (e.g., low demand due to pandemic combined with high RE generation). Therefore, **it must be dynamic and updated regularly** (e.g., every year).
 - Any FIP scheme changing the FIT must link the RE revenues to market prices **to guidance RE towards trading responsibly and not bidding low**. It must be noted that low DAM prices are bad for RE portfolio, as well. So, it is likely that **RE under FIP will develop trading strategies like** the Guaranteed Buyer;
 - In the case of effective trading of RE, the incentive coefficient **could be calculated as zero or even negative**, indicating the success in FIP. Yet, in order to encourage new technologies and approaches in imbalance management, still **a positive coefficient is suggested**. **Otherwise, the transition to FIP could be undesirably very limited** impeding the achievement of benefits.

THANK YOU!

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