Title	**Market Event Report – Price CAP on the 25th Feb 2013**
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Introduction

The purpose of this document is to inform Participants of the reasons behind the Price Cap observed on the last Trading Period of Trading Day 25th February 2013. For this Trading Period the Shadow Price (SP) was €52.88, but the resultant System Margin Price (SMP) was €1,000.

The initial analysis carried out on the day, confirmed that the price was calculated in accordance with the market rules. However, as such high prices are rarely produced by the SEM this report aims to clarify the circumstances around this price event.

Executive Summary

The Price Cap produced at 05:30am on the 26th February 2013 (Trade Date 25th February 2013) was correct based on the data submitted to the market and the specific conditions of the schedule in that period.

The reason for the high price was due to one generator being switched on in the last Trading Period of the Trading Day. The unit's availability had been fully re-declared to a value of 185MW. However, this occurred in the last minute of the Trading Period, resulting in an Average Availability of 6.16667MW (1/30 of the declared amount). This limited availability meant that the unit had to recover Start Up costs based on a considerably smaller amount of scheduled MWs than in the circumstances of full availability and standard Minimum Stable Generation.

The Shadow Price was insufficient to recover the full costs incurred by the unit on that Trading Period with a resulting large uplift.

The uplift calculation is designed to bring the price to the minimum level at which all individual units can recovery their full cost of running including Start Up costs. Uplift is outside the scope of the optimization function that aims to minimise Production Cost and it is only subject to the market Price Cap of €1,000.

In this particular case, the Price Cap was applied to an actual SMP of €1,068.17. The unit received corresponding Make Whole Payments in that Trading Period to make up for the remaining amount to recover.

This is in line with the Market rules for calculation of Uplift recovery of costs as set out in the Trading and Settlement Code (T&SC) Appendix N65 to N77.

Analysis

On Trading Date 25th February 2013, the SEM's Primary Solver - Lagrangian Relaxation (LR) - produced a SMP of €1,068.17, which was subsequently capped to €1,000.
This was not the result of an infeasible solution as it did not breach any schedule constraints. The high price was mostly composed of uplift as the Shadow Price was only €55.88.

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After observing the Price Cap in the results obtained from the Primary Solver , the alternative solver - Mixed Integer Programming (MIP) - was run in accordance with the 'Market Operator Solver Policy'[1] which confirmed the same SMP, but gave a lower Production Cost.

As previously advised by SEMO, the MSP software is run in three phases to solve a market schedule. These are:

- Unit Commitment, which produces a commitment schedule with basic MW quantities,
- Economic Dispatch, which produces Shadow Prices and final Market Schedule Quantities (MSQs) based on the input from the Unit Commitment phase, and
- Post Scheduling and Price Processing, which calculates Uplift and determines the final SMP.

This is illustrated in Figure 1 below.

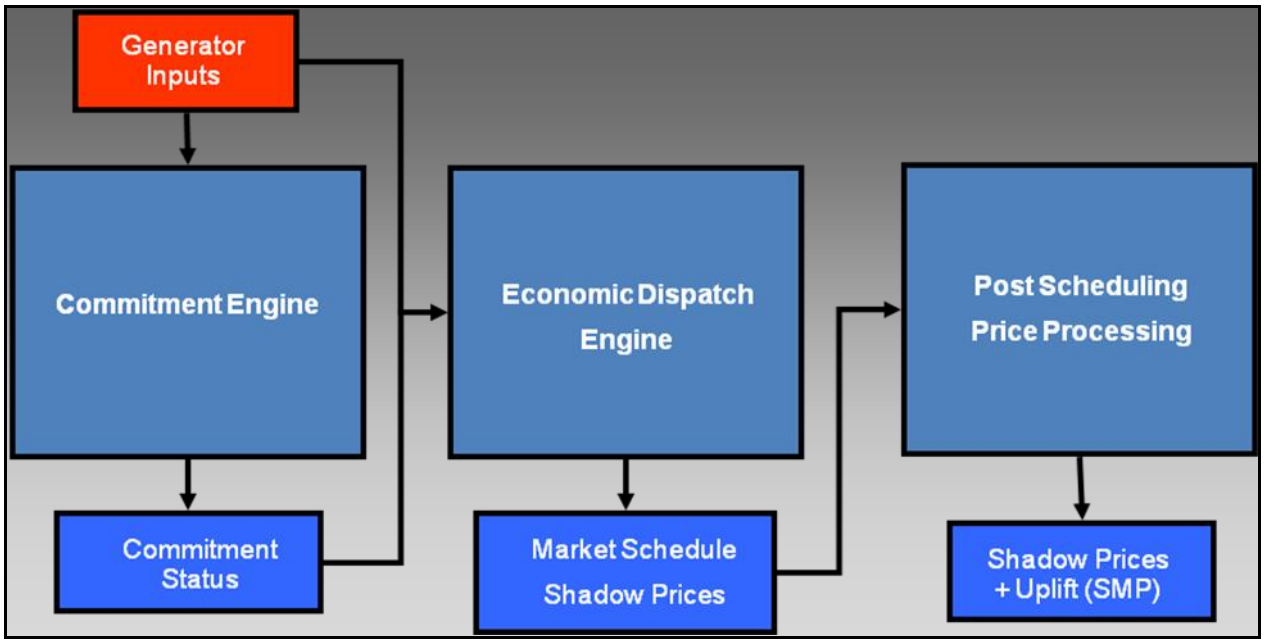

Figure 1 - Phases of the MSP Software

The solver choice (LR or MIP) is part of the Unit Commitment phase and does not impact on the subsequent phases. The uplift calculation is only performed as a final step to allow full recovery of the unit's costs. While the mathematical function of the Solver is to minimise Production Cost, which includes Start Up Costs, there is no provision that forces the minimisation of the SMP. A measure to potentially limit extreme results is to run the alternative solver MIP, to verify whether the price event obtained is a correct market signal or if a more optimal solution could have been found.

The 'Market Operator Solver Policy' states that where the Primary Solver's schedule produces a price event (i.e. SMP greater than €500), the alternative optimisation solver can be run for comparison. The solver to be used is based on a number of criteria as published in the policy.

In this case, 'Scenario 1' of the policy applied and the MIP version was published. The alternative solver did not remove the price event but a cheaper Production Cost was calculated and the solution was within the optimality band.

[1] This policy can be found on SEMO website at http://www.sem-o.com/Publications/Pages/GeneralPublications.aspx?documentarchivestatus=Active

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The schedules produced by both LR and MIP solvers were different in places; however, the Trading Period affected by the large uplift was scheduled the same way in both solvers, therefore the same price was produced.

The analysis below is based on the results of the published MIP run but could equally apply to the LR outputs for the Trading Period in question.

The initial step is to identify all units starting up at 05:30am that must recover their Start Up Costs through the SMP and only one unit GU_500823, Kilroot, was in that position. It was also noted that the unit was scheduled to a level well below its Minimum Stable Generation because of limited availability.

The unit re-declared itself available to a level of 185MW at 5:29am on the 26th February 2013, after a short period of unavailability. The resulting Average Availability for that Trading Period was 6.166667MW because the value was only effective for one minute out of 30.

With a competitive price of only 35.79€/MWh, while the marginal unit is running at 52.88€/MWh, both solvers choose to commit GU_500823 to its full availability for the remainder of the Optimisation Time Horizon to reduce the Production Cost. This was also necessary in order to cover the increase in load in subsequent periods of the Optimisation Time Horizon.

A summary of all Price Maker units scheduled at 05:30am (excluding Interconnectors) and respective costs of running are illustrated in Table 1 below:

PPMG units	05:30 Schedule Quantity (MW)	Unit Status	Bid Price €/MWh	No Load Cost	Cost of Running (Bid+No Load)
GU_400270	285	Max	€ 34.78	€ 891.93	€ 5,402.12
GU_400271	285	Max	€ 34.78	€ 891.93	€ 5,402.12
GU_400272	285	Max	€ 34.78	€ 891.93	€ 5,402.12
GU_400500	406	Max	€ 27.72	€3,504.00	€ 7,379.16
GU_400530	250	Price breakpoint from €42.59 to €52.99	€ 42.59	€5,456.00	€ 8,051.75
GU_400540	170	Price breakpoint from €43.04 to €57.43	€ 43.03	€6,317.00	€ 6,816.05
GU_400850	216	Min	€ 58.28	€6,741.09	€ 9,664.79
GU_400930	202.46	Marginal	€ 52.88	€6,285.00	€ 8,495.54
GU_401230	16	Max	-€ 5.27	€ -	-€ 42.16
GU_500040	260	Price breakpoint from €44.89 to €54.64	€ 44.89	€6,962.32	€ 9,316.86
GU_500822	185	Max	€ 35.79	€1,484.71	€ 4,052.93
GU_500823	***6.17***	***Max***	***€ 35.79***	***€1,484.71***	***€ 852.77***

Table 1 – Costs of running of PPMG units scheduled at 05:30am

Any other PPMG unit available to start was either too expensive to commit at their Minimum Stable Generation or unable to cover the load requirements on that Trading Period and the subsequent ones. Table 2 below shows the potential cost of running of all PPMG units available to start up compared with GU_500823[2].

[2] Hydro and Pump units have been excluded from this analysis due to the impact on their target values throughout the entire schedule.

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PPMG units	05:30 Schedule Quantity (MW)	Unit status	Bid Price €/MWh	No Load Cost	Cost of Running (Bid+No Load)
GU_400771	0	Available with Min Gen 12MW	182.59	1580.2	€ 1,885.64
GU_500130	0	Available with Min Gen 113MW	57.66	2641.56	€ 4,578.57
GU_500131	0	Available with Min Gen 113MW	57.65	2640.89	€ 4,577.67
GU_500140	0	Available with Min Gen 63MW	63.28	830.5	€ 2,408.57
GU_500823	***6.17***	***Max***	***€ 35.79***	***€1,484.71***	***€ 852.77***
GU_500901	0	Available only to a max of 3MW	84.11	53.68	€ 153.01
GU_500902	0	Available only to a max of 3MW	84.11	53.68	€ 153.01
GU_500903	0	Available only to a max of 3MW	84.11	53.68	€ 153.01

Table 2 – Total Cost of running of PPMG Units Available to Start at 05:30am

The other factor to consider in the calculation of Production Cost is the Start Up Cost. Table 3 below, shows the individual Start Up Cost for each PPMG unit available to start at 05:30am, .

PPMG units	Start Up Cost
GU_400771	€ 2,409.83
GU_500130	€ 21,889.91
GU_500131	€ 21,884.41
GU_500140	€ 14,843.92
GU_500823	*€ 31,730.59*
GU_500901	€ 1.76
GU_500902	€ 1.76
GU_500903	€ 1.76

Table 3 – Start up Cost of PPMG Units Available to Start

When looking purely at Start Up Costs, GU_500823 is the most expensive. However, when taking into consideration that unit GU_500823 is fully scheduled up to its max availability until the end of the Optimization Time Horizon, the decision to schedule GU_500823 is the most economical choice for the solver.

Table 4 below shows a comparison of the possible alternative scenarios in the schedule where other available Generators can be started up to replace the 185MW provided by GU_500823 in the remaining 12 Trading Periods of the Optimisation Time Horizon. Please note that this table gives a general indication of the total costs of 185MW scheduled for 12 Trading Periods and does not take into account other technical limitations of the units (like Ramp Rates and changes in availability throughout the period)[3].

PPMG units	Unit Max Availability	Bid Price €/MWh	No Load Cost	Cost of Running at 185MW (Bid+No Load)	Start Up Cost	Total production Cost at 185MW *12 TPs
GU_400771	51.8MW	182.59	1580.2	N/A	€ 2,409.83	N/A
GU_500130	246MW	57.66	2641.56	€ 6,654.33	€ 21,889.91	€ 101,741.87
GU_500131	246MW	57.65	2640.89	€ 6,653.07	€ 21,884.41	€ 101,721.25
GU_500140	98MW	63.28	830.5	N/A	€ 14,843.92	N/A
GU_500823	*185MW*	*€ 35.79*	*€1,484.71*	*€ 4,052.93*	*€ 31,730.59*	*€ 80,365.75*
GU_500901	3MW	84.11	53.68	N/A	€ 1.76	N/A
GU_500902	3MW	84.11	53.68	N/A	€ 1.76	N/A
GU_500903	3MW	84.11	53.68	N/A	€ 1.76	N/A

Table 4 –Comparison of Production Costs of Units Available to Rampup to 185MW

[3] GU_500823 has a Ramp Up Rate of 5.79MW/min while units GU_500130 & GU_500131 can Ramp Up at a rate of 3.1MW/min. In addition the availability of GU_500823, was at 151.27MW on TP 11:00am and 93MW on TP 11:30. This does not affect the principle that if GU_500130 & GU_500131 replaced the MW provided by GU_500823 it would result in a more expensive Production Cost

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The limited availability or the higher costs of running of all other units, make GU_500823 the cheaper overall option.

The Start Up Costs of the Kilroot unit, are generally recovered based on a scheduled amount equal or greater than its Minimum Stable Generation of 93MW and apportioned over the continuous period of generation.

In this case, however the costs incurred in one Trading Period had to be recovered on a limited availability of 6.166667MW.

The unit is fully scheduled over the Optimisation Time Horizon therefore the continuous period to recover its costs is made of 13 Trading Periods. The 1/13 portion calculated at 05:30 as per T&SC N70 to N75 is as follow:

Cost Recovery = ((6.166667MW *€35.79) +€1,484.71) * 0.5 + ((1/13)* €31,730.59)

= **€3,293.52**

Where:

- 6.166667MW = GU_500823 Availability and MSQ
- €35.79 = GU_500823 Bid Cost up to 185MW
- €1,484.71 = GU_500823 No Load Cost
- €31,730.59 = GU_500823 Hot Start Up Cost

To be able to recover the calculated cost with 6.17MW only, the minimum SMP must be greater that €1,000 as per the following:

SMP for GU_500823 recovery of cost = (€3293.52/6.166667MW)/0.5

= **1068.17€/MWh**

This matches the SMP produced by the MSP software before applying the cap of €1,000.

It shows that the uplift is entirely due to the recovery of the cost incurred in starting up unit GU_500823.

Conclusions

The analysis carried out by SEMO, has demonstrated that the results of the schedule are in line with the provisions of the Trading and Settlement Code.

The limited availability of unit GU_500823 (Kilroot) at 05:30am on the 26th February 2013 was identified as the reason behind the large uplift.

The unit is available for only one minute in the Trading Period where it is committed on. This means that the recovery of running costs and Start Up costs has to happen on a much lower scheduled MSQ amount.

The uplift calculation is designed to bring the SMP to a level at which all individual units can recovery their full cost of running including Start Up costs.

Uplift is outside the scope of the optimization function that aims to minimise Production Cost and it is only subject to the market Price Cap of €1,000.

The same results were obtained with both solvers and SEMO is satisfies that, based on the input conditions, the outputs are correct due to the absence of a viable alternative in the Trading Period.

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