Market Report

FREQUENCY OF MARKET OPERATOR SOLVER POLICY USE (JANUARY TO MARCH 2013)

Table of Contents

1. EXECUTIVE SUMMARY

This report was undertaken to examine whether the frequency of Market Operator Solver Policy use had increased during the recent winter period, and the factors that may have contributed to any increase.

Taking into account the increased number of pricing runs as a result of Intraday Trading and seasonal effects, the results show there was no increase in the solver policy use in January or February of 2013 compared to previous years. However, there was an increase in solver policy use during March 2013.

The contributing factors to the increased solver policy use for March 2013 were:

- High demand during March
- Reduced availability of generation
- Reduced availability of flexible plant
- Changing profile of price taker generation at key times

In many cases it was a combination of these factors that led to price making generation needed to be scheduled for very short durations to meet demand. This had the effect of increasing System Marginal Price in order to fully recover Production Costs and therefore triggered the solver policy use.

All instances of solver policy use showed that the solvers were providing solutions that adhered to the high level objectives of the market rules as defined in the Trading and Settlement Code.

2. BACKGROUND

2.1 INTRODUCTION

SEMO has recently received queries about the number of times the Market Operator Solver Policy[1] has been used during the current winter period. To understand the recent trends, this report has been prepared looking at the January to March period for 2013[2].

Since 2011, SEMO has had in place a Market Operator Solver Policy (referred to in this report as the 'solver policy'). This solver policy confirms price and schedule outputs, using an alternative solver, where a significant price event occurs.

These significant price events are defined as:

1. System Margin Price (SMP) > €500/MWh and Shadow Price ≠ Price Cap (currently = €1,000/MWh)
2. Shadow Price = Price Cap (currently = €1,000/MWh)
3. Shadow Price = Price Floor (currently = -€100/MWh)

Where a significant price event occurs in the Market Schedule, determined using the Primary Solver (Lagrangian Relaxation (LR)), the alternate solver (Mixed Integer Programming (MIP)) is run to produce an alternative schedule.

The two schedules are then compared against a set of decision criteria[3] to determine which schedule will be published for the given pricing run and Trading Day.

2.2 OBJECTIVE

The objectives of this report are to:

- Determine whether there has been a change in the frequency of solver policy use
- Determine the contributing factors for the triggering of the solver policy use
- Confirm that the solvers are continuing to provide solutions based on the market rules

[1] The "Market Operator Solver Policy" can be found @ http://www.sem-o.com/Publications/General/Market%20Operator%20Solver%20Policy.pdf
[2] This report considers data available up to Trading Day 21st March 2013.
[3] The decision criteria are fully detailed in the Market Operator Solver Policy

3. ANALYSIS

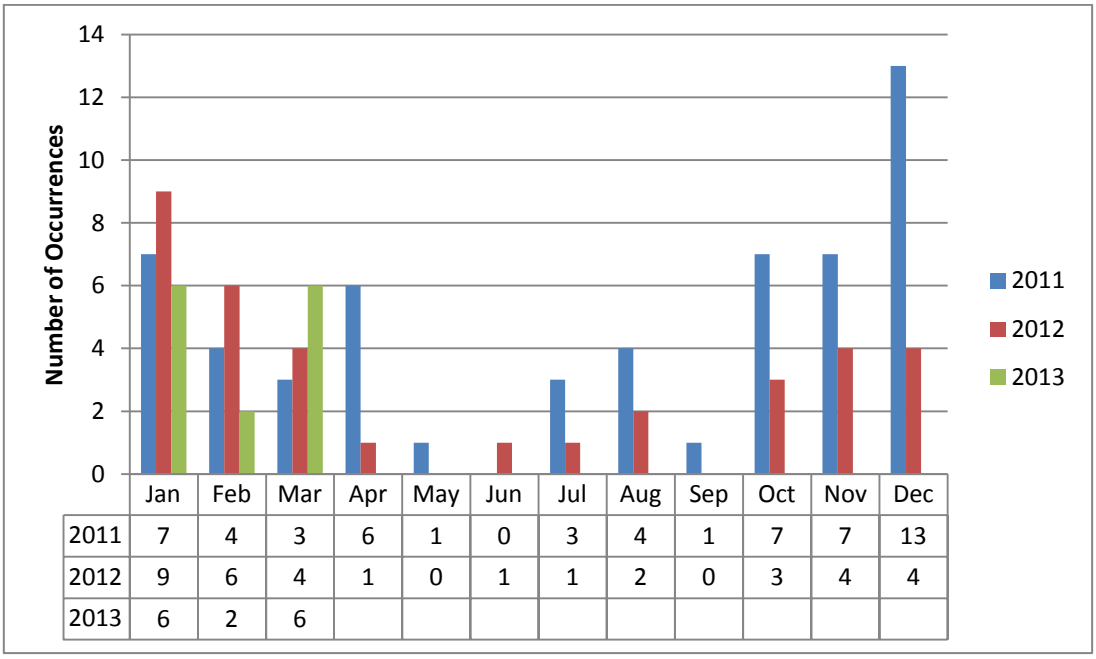
3.1 FREQUENCY OF SOLVER POLICY USE

Impact of Intraday Trading

Since 22nd July 2012, Intraday Trading has been active in the market. This has increased the number of pricing runs completed for each Trading Day from three to five (i.e. EA2 and WD1 have been added). Given there are now more pricing runs per day in the market, there is an increased likelihood that the solver policy will be triggered.

To allow a true comparison with periods prior to the inclusion of Intraday Trading, Figures 1 and 2 only consider solver policy use for EA1/EP1/EP2 pricing runs. EA2 and WD1 pricing runs are excluded as they were only introduced with Intraday Trading (IDT)[4].

Figure 1 below shows the number of times the solver policy has been triggered per month since January 2011.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	7	4	3	6	1	0	3	4	1	7	7	13
2012	9	6	4	1	0	1	1	2	0	3	4	4
2013	6	2	6									

Figure 1: Trends in Solver Policy Use (EA1/EP1/EP2 only)

Seasonal Trends

A seasonal trend is apparent with a higher number of occurrences of solver policy use during winter months and a lower volume of use during summer months. The reasons for this trend are discussed in section 3.2 below.

2013 Winter Period

Looking at the January and February period there has been no increase in the frequency of solver policy use for 2013 relative to previous years. In fact the number of occurrences has generally decreased.

March 2013 does show an increase in solver policy use relative to previous years.

[4] For completeness, in the January to March period of 2013, there were four additional occasions of solver policy use relating to EA2 and WD1 in February, and also four in March.

Significant price events are the trigger for the solver policy use. The contributing factors that give rise to these significant price events, and why there has been an increase in solver policy use in March 2013, is provided in the next section.

3.2 CONTRIBUTING FACTORS IN SOLVER POLICY USE

The contributing factors for triggering the solver policy use can be categorised into two groups.

1. Macro factors that show as trends when looking at average values over an extended period of time
2. Micro factors that relate to the conditions present on a given day or trading period

3.2.1 MACRO CONTRIBUTING FACTORS

Figure 2 shows the occurrence of solver policy use and the key contributing macro factors. As discussed above, to allow like for like comparison, only solver policy use that relates to EA1/EP1/EP2 is considered since the introduction of IDT on the 22nd July 2012.

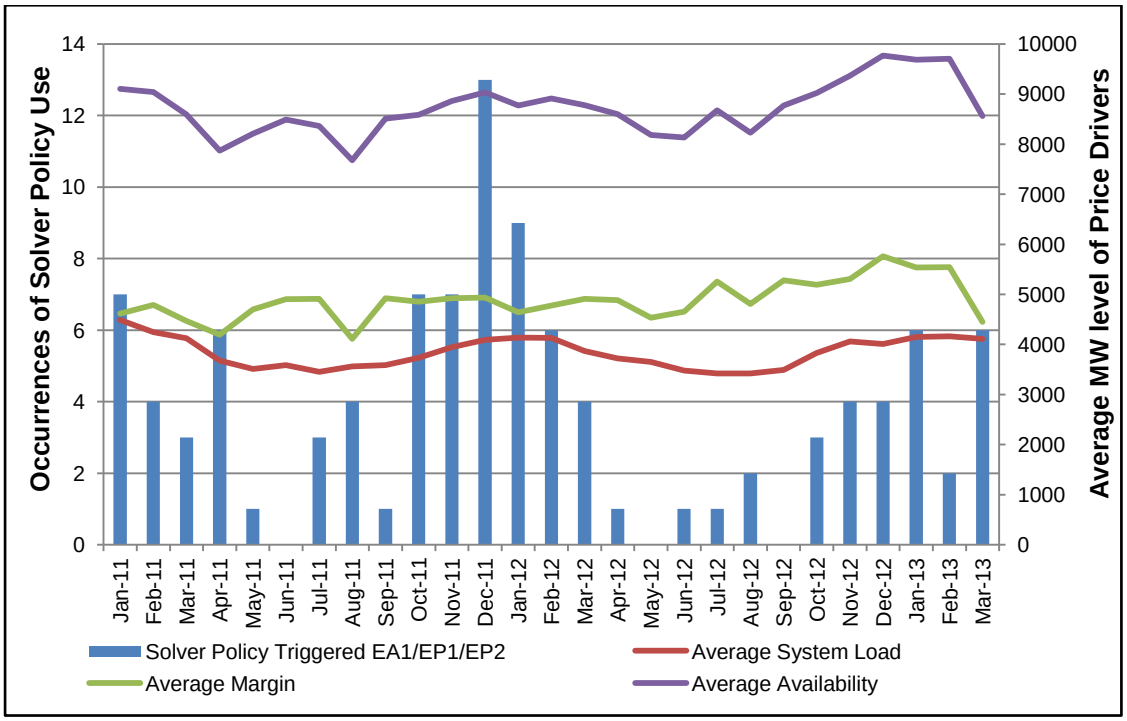


Figure 2: Solver Policy Use and Contributing Marco Factors[5]

Demand

Figure 2 shows that the solver policy is used more during periods of high demand (represented here by System Load). During the winter months demand increases as does the occurrence of solver policy use. The trend is consistent year on year.

The driver behind this trend is that increased demand leads to increased likelihood that more expensive units will need to be scheduled. This in turn tends to lead to higher System Marginal Prices (SMP).

[5] Margin in the analysis uses Actual Availability as opposed to Eligible Availability (which is used in the Trading and Settlement Code Margin variable). The difference between Actual Availability and System Load better represents the generation available to the Market Scheduling and Pricing software.

Availability and Margin

There is also evidence of a trend with more frequent solver policy use during periods of lower generator availability and therefore reduced margin. This trend is particularly evident during August of each year where plants availability, and therefore margin, is reduced due to planned maintenance outages. This reduces the generation options available to meet demand, leading to an increased likelihood of price events.

The increased solver policy use in April 2011 reinforces this macro trend as it coincides with a period of reduced availability (and therefore margin).

Availability of Flexible Plant

The availability of interconnection and pump storage is also an important element to consider. These units are of benefit in the schedule as they offer flexibility for both demand and generation to balance variations in the System Load which can impact on SMP[6].

These units are able to ramp relatively quickly (in the region of 150 to 300 MW/min) compared to typically less than 10 MW/min for a conventional thermal plant. This can allow steep ramping in demand to be mitigated, negating the need to satisfy such ramp requirements via scheduling of less economic conventional units. Where such units are unavailable greater variances in SMP have been seen which leads to increased use of the solver policy.

Figure 3 below shows solver policy use compared to Interconnector and Pump Storage availability. In the graph only import on interconnectors and generation from pump storage units are represented. However, a similar correlation for export on the interconnectors and pumping for pump storage units were also observed. As discussed earlier to allow like for like comparison only solver policy use that relates to EA1/EP1/EP2 is counted for periods from 22nd July 2012 onwards.

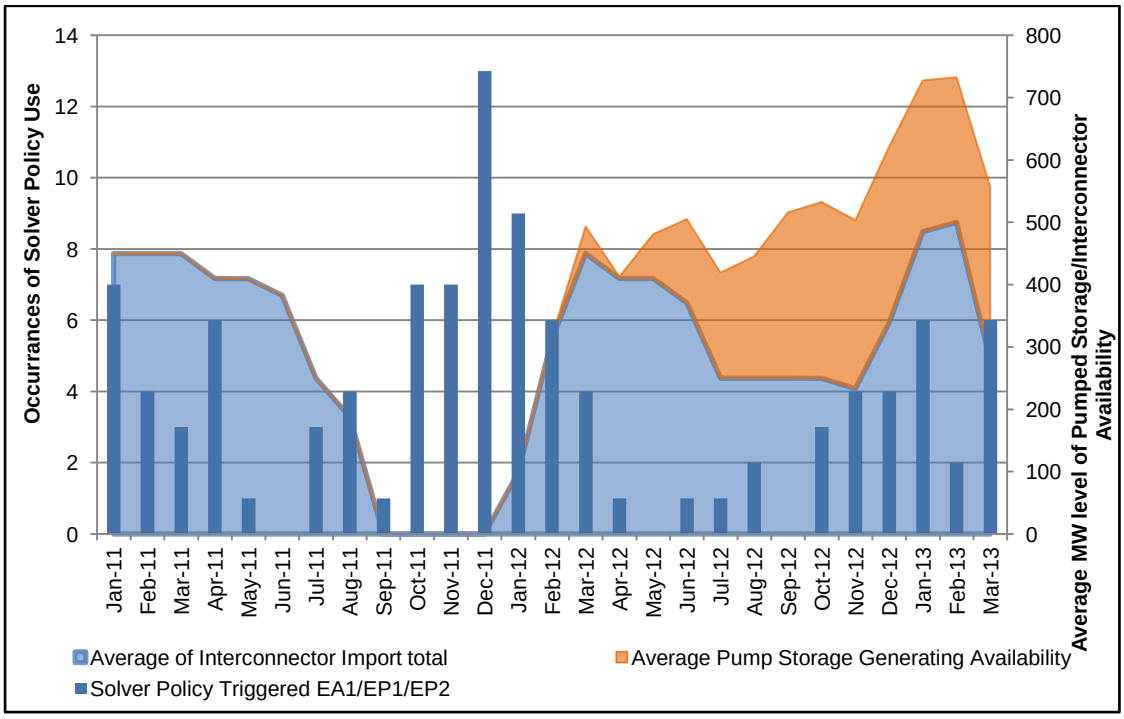


Figure 3: Solver Policy Use compared to Interconnector and Pumped Storage Availability

[6] Note that Pumped Storage scheduling is limited by Energy Limits based on target reservoir levels and that Interconnector scheduling is limited by Interconnector Units suitability to trade as represented by their Commercial Offer Data.

Figure 3 illustrates that the availability of pump storage units and interconnectors may also be a contributing factor to the number of instances of solver policy use. During the 2011 and the early 2012 period increases in solver policy use coincided with a period of unavailability for pump storage and reduced levels of interconnection capacity. This was particularly evident in the September to December 2011 period where no pump storage or interconnection was available at all. In this period there were 28 instances of solver policy use. Comparing this to September to December 2012 where, even though average demand was similar to 2011, there was upwards of 500MW of pump storage and interconnection available and only 11 occurrences of policy solver use.

Also of note is that for March 2013 there was a decrease in flexible plant availability, related to the outage of the East-West Interconnector. This coincides with the increased solver policy use in March 2013.

Price Taker Generation[7] and Price Maker Generation

Price maker generation dictates SMP. The level of price maker generation required is not determined by demand alone though. Price taker generation effectively determines the level of price maker generation required to meet demand.

Figure 4 below shows the effect of price taker generation on price maker generation requirement. In particular, the increases in solver policy usage in August 2011 and March 2013 coincide with a drop in price taker generation as well as decreases in margin and availability of flexible plant already discussed.

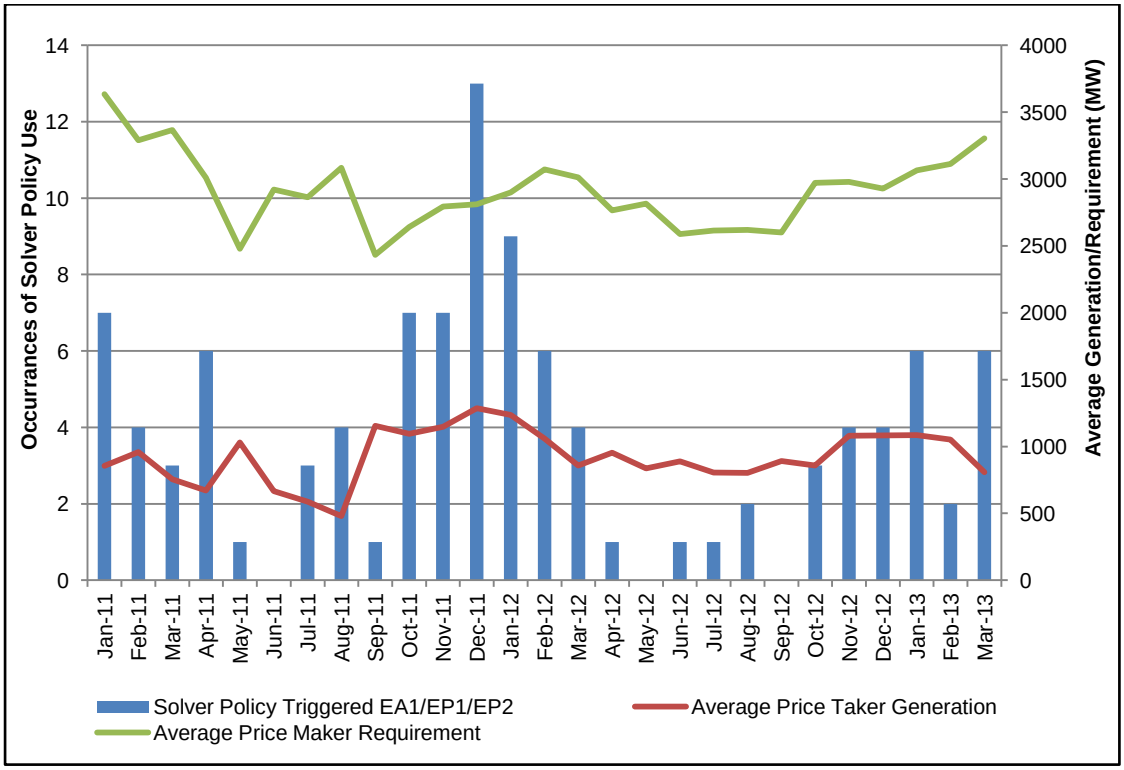


Figure 4: Solver Policy Use compared to Price Taker Generation and Price Maker Requirement

[7] Price taker generation is composed of Autonomous and Variable Price Takers, Predictable Price Takers and Predictable Price Makers which are under test.

Marco Factors affecting March 2013

Considering the information provided in Figure 2 to Figure 4 above, the contributing macro factors that have led to an increase in solver policy use in March 2013, relative to the same period in previous years can be summarised as:

- Unseasonal high demand
- Reduced generator availability leading to lower margins
- Reduced availability of flexible plant particularly with East-West Interconnector on an outage since 5th March
- Reduced price taker generation leading to larger price maker generation requirements

3.2.2 MICRO CONTRIBUTING FACTORS

Not all instances of the solver policy use can be attributed to the macro factors described in the previous section. There are exceptions to the general trends. Even when the macro factors may indicate it is unlikely that significant price events will occur, there may still be instances where price events do result. In order to understand these micro contributing factors, more detailed analysis of individual days or trading periods is needed.

Daily Average Margin and Price Maker Generation

Figure 5 below depicts daily averages of margin and price maker generation along with vertical lines to indicate if the solver policy was triggered for any run type on that Trading Day. It also shows where the solver policy use occurred for EP2 runs in particular.

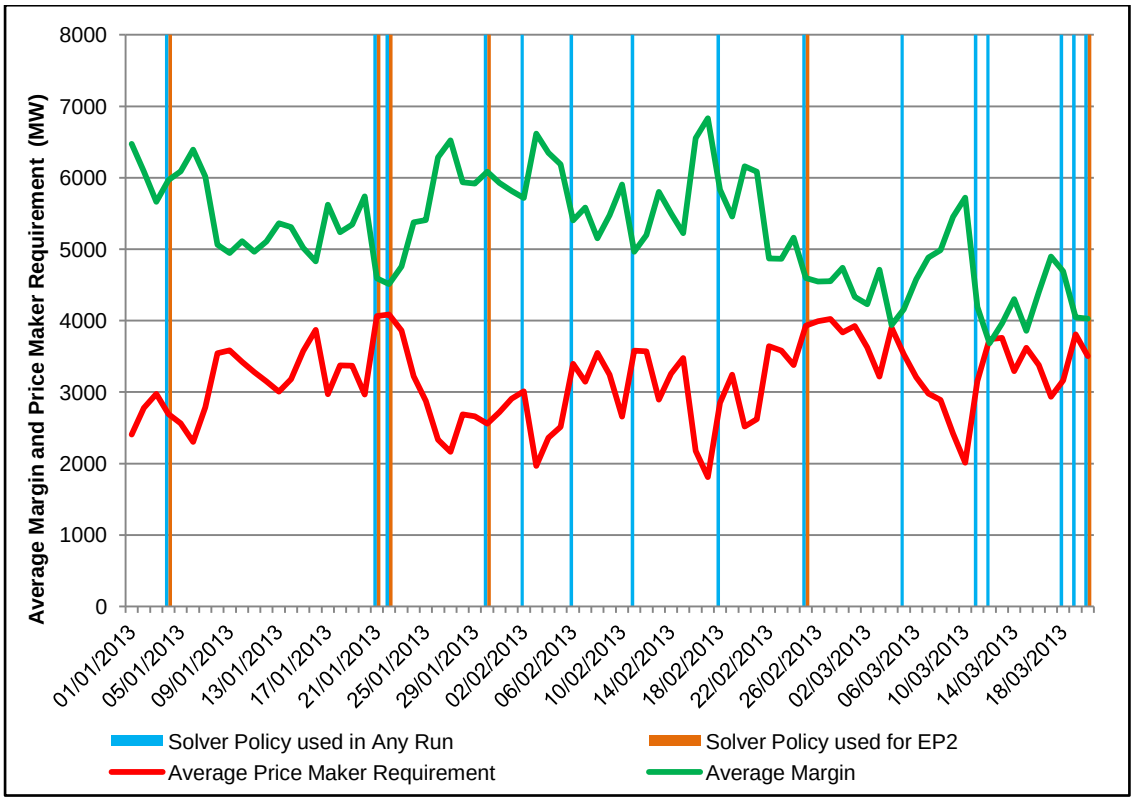


Figure 5: Solver Policy Use in relation to Daily Average Margin and Price Maker Requirement

The predominant trend is for solver policy use to occur on days where margin was relatively low and price maker generation needed for meeting demand is relatively high. Examples of this trend can be observed on January 21st and 22nd, February 25th and March 20th 2013.

However, there are exceptions to this. For example, on the 30th January the solver policy was used for EP1 and EP2, but the price maker generation needed for meeting demand was relatively low and margin relatively high. In this instance it is not obvious from the daily average data what factor(s) contributed to the solver policy use. More detailed analysis of the actual profile of the relevant factors for the Trading Day is required.

The following provides detailed analysis of two trading dates: one explicitly following the general trend (21st January) and one that does not (30th January).

Analysis of Specific Trading Days

The solver policy was triggered for both the Ex-Post Initial (EP2) Market Schedules on the 21st and 30th of January 2013. Looking at the profile of margin, as well as the price maker and price taker generation required to meet demand on these Trading Days provides further insight into the factors affecting the solver policy use.

Figure 6 and Figure 7 show the profiles across the 30 hour Optimisation Time Horizon for each candidate day. The preceding Trading Day, which did not require solver policy use, has also been plotted in each instance for comparison. On all days the interconnection availability was the same at 500MW import and 480MW export.

- 21st January – Solver Policy Use due to Margin and Price Maker Generation

The 21st of January serves as an example of solver policy use being triggered due to the low level of margin and high price maker requirement to meet demand.

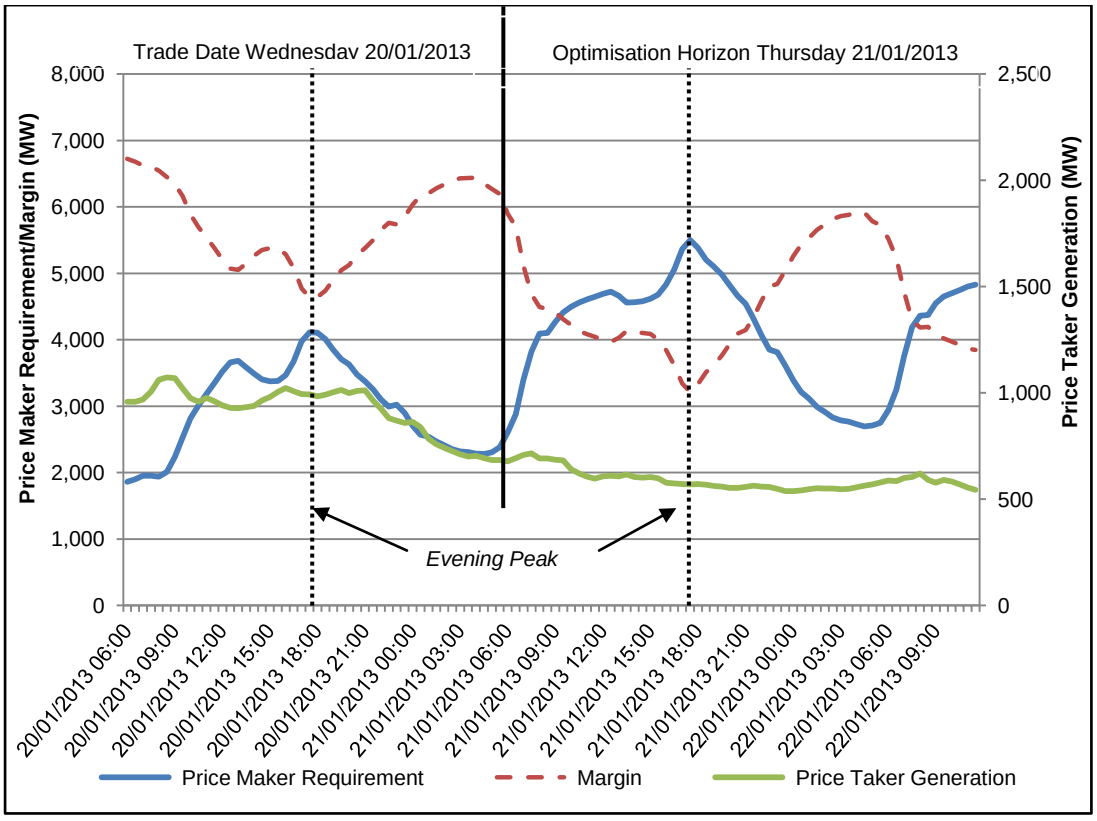


Figure 6: Solver Policy Use Factors for Trading Day 21/01/2013

Figure 6 shows that the margin is significantly lower on the 21st January relative to the 20th January, particularly around the evening peak. Conversely, the price maker requirement is significantly higher on 21st January due in part to lower price taker generation. In addition, there was also a reduction in pumped storage availability ahead of the evening peak. All of which lead to a situation of less flexibility in being able to meet the required evening peak and

caused a significant price event which triggered the solver policy use on the 21st January. This is consistent with the trends shown in the daily average margin and daily average price maker requirements evident in the analysis of Figure 5.

- 30th January – Solver Policy Use due to Rate of Change of Price Maker Requirement

The 30th January serves as an example in which the triggering of the solver policy use is not evident from looking at the daily average margin and price maker generation requirement.

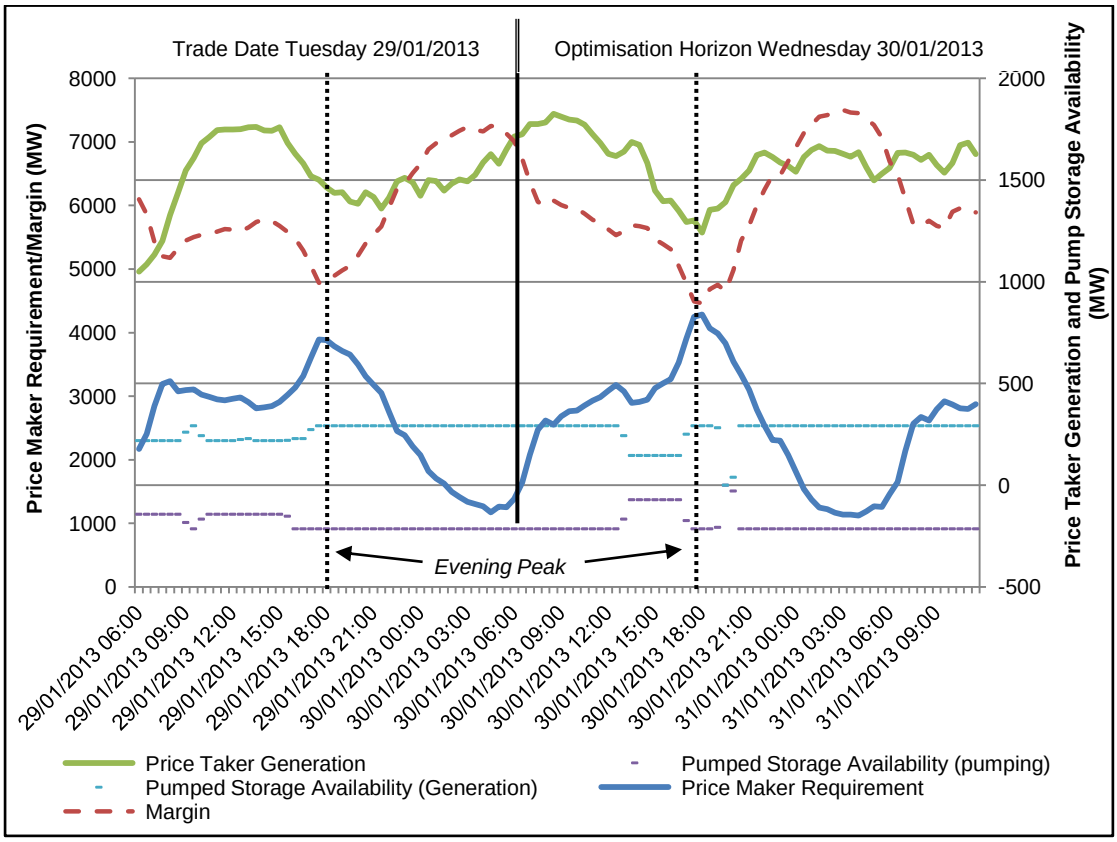


Figure 7: Solver Policy Use Factors for Trading Day 30/01/2013

Comparing the profiles of the 30th January (in Figure 7) to the profiles of the 21st January (in Figure 6) shows that the overall increase in price maker requirement to meet demand and decrease in margin observed in the 21st January, is not evident on the 30th January. Yet the solver policy was still triggered.

Figure 7 also shows that the margin and price maker requirements at the evening peak for both the 29th and 30th of January were similar. Yet the 29th did not require solver policy use and the 30th did. The key difference between these two Trading Days is in the rate of change of price maker generation requirement over the evening peak which is partly due to price taker generation falling away slightly during the rise to the evening peak and, conversely, increasing during the ramp down from the evening peak. This causes a sharper peak on the price maker requirement and therefore steeper ramping at the peak demand for the Trading Day. Because the price maker requirement rises and falls steeply around the evening peak, there is a need to quickly increase and then decrease generation. One way to do this is to bring an additional unit on for a short duration. Where this is the most efficient approach in terms of minimising Production Costs, this is what will be scheduled.

This solution to the scheduling problem is further exacerbated in this instance by reduced pump storage availability leading up to the evening peak. The flexible generation available from pumped storage and interconnection could have been used for peak shaving. This would have reduced the severity of the peak by generating/importing heading up to the peak and

pumping/exporting as the price maker requirement dropped off. This would have effectively decreased the rate of change of generation required.

Explanation of Other Trading Days with Solver Policy Use

Table A1 in the appendix provides details of the main contributing factors for each significant price event (i.e. SMP > €500) in the January to March 2013 period. In all cases at least one of the contributing factors discussed above was present. Namely:

- *High price maker generation requirement*: due to high demand, high rate of change of demand, or variance in price taker generation at key times.
- *Low margin:* due to unavailability or high demand
- *Unavailability of flexible plant:* Such as interconnection and pumped storage, which are used to meet rates of change of demand - particular at peak demand times.

Of the 21 instances of significant price events in January to March 2013, 18 of the price events occurred around the evening peak. In all these cases, this meant the solver needed to schedule mid merit/peaker units for short durations to meet demand peaks and in doing so incurred high Uplift.

Scheduling of Units for Short Durations

In the case of 18 events related to the evening peak, if revenues paid based on Shadow Price[8] would not compensate such a unit for its full market Production Costs, then Uplift is added to the Shadow Price. This is to ensure that SMP is high enough to cover full Production Costs. This is often (but not exclusively) due to total MW output for the scheduled period being too low to allow for such recovery through Shadow Price alone. To minimise overall cost and deviation of SMP from Shadow Price, Uplift is optimised across a consecutive period of scheduling.

This is done after Market Schedule Quantities (MSQs) have been fixed and Shadow Price set by the bid price of the marginal unit[9]. Shadow Price covers at least the running costs of all units scheduled. Uplift is then applied where Shadow Price alone is not sufficient to cover generators Start Up costs.

All units must recover their full Production Costs and if this is not achieved in the MSP software run, then a Make Whole Payment will be assigned to the affected trading period during settlement.

Even with the contributing factors discussed above, it is still rare for a short, low output scheduling of a high cost unit to occur. However, in extreme cases where the profile of price maker requirement represents a particularly difficult problem to solve this situation can occur. This is usually where price maker requirement is very low in the night valley or extremely high and/or steep at the evening peak.

Taking an example to illustrate this concept further:

Consider a theoretical unit with start up costs of €40,000, incremental operating costs of 50 €/MWh, no load costs of 2000 €/h and Minimum Stable Generation of 100 MW.

The unit is part of an optimised schedule where it is brought on at Minimum Stable Generation for one half hour Trading Period only. Tthe Production Costs of the unit in this Trading Period are:

$$\text{Cost of Running} = €40{,}000 + 0.5\,((50\ €/MWh \times 100MW) + 2000\ €/h) = €43{,}500.$$

This unit will receive a corresponding Energy Payment of:

$$\text{Energy Payment} = 0.5\,(SMP \times 100MW)$$

[8]Shadow Price is the component of SMP that does not include Uplift

[9] Occasionally, Shadow Price is the product of intertemporal events – these are not covered in this report; also, hydro electric and pumped storage units can set the Shadow Price based on an adopted price through displacement which is also beyond the scope of this report.

In order to recover the total Production Costs of € 43,500, this scenario produces a minimum SMP of:
0.5 (SMP × 100 MW) ≥ € 43,500
SMP ≥ 870 €/MWh

For the other three instances where the price event did not coincide with the evening peak the explanations are given below:

- *Monday 25th February:* this was a unique example where a unit was coming back from outage in the last minute of the Trading Day resulted in a high Uplift and a Price Cap in that Trading Period. Detailed analysis is provided in a Market Incident Report published on the 15th March 2013[10].
- *Tuesday 05th March:* Price taker generation was extremely low during the morning rise and System Load was increasing particularly steeply at the same time resulting in a price event at 08:30.
- *Monday 18th March:* Was a public holiday therefore with a different load curve from a regular working day. This is another example where wind generation was extremely low during the morning rise. Both EA1 and EP1 had price events of the same value but in different Trading Periods. The price in each run was due to the same unit being brought on for one Trading Period at Minimum Stable Generation.

3.3 SOLVER IN ACCORDANCE WITH MARKET RULES

For all the January to March 2013 solver policy use cases analysed in this report, the scheduling decisions were made in accordance with the market rules as detailed in Appendix N of the Trading and Settlement Code.

The operation of the Market Scheduling and Pricing (MSP) software applies these market rules to minimise Schedule Production Costs. Although it is infrequent for an optimised solution to contain such short periods of high cost unit operation, where the Unit Commitment problem is difficult to solve (as a result of the contributing factors discussed above) it can occur and is providing solutions in accordance with the application of the Trading and Settlement Code rules.

[10] The Market Incident Report can be found at http://www.sem-o.com/Publications/General/Market%20Incident%20Report%20-%2025%20Feb%202013.pdf

4. CONCLUSION

There has been no increase in the frequency of the Market Operator Solver Policy use during January or February of 2013.

There has been an increase in the use of the Market Operator Solver Policy in March 2013 compared to previous years. The trigger for the use of the solver policy is significant price events. These significant price events can be attributed to:

- Unseasonal high demand during March
- Reduced availability of generation
- Reduced availability of flexible plant
- Changing availability of price taker generation at key times

The interrelationship of these factors determines the extent and frequency of the significant price events that lead to the use of the Market Operator Solver Policy. For example, if demand is high due to cold weather and increasing toward an evening peak, wind generation is decreasing as evening peak approaches, interconnectors are out of service, and pump storage availability is limited, then the likelihood of significant price events is increased.

All instances of use of the solver policy in the January to March 2013 period were the result of the application of Uplift due the need for short duration scheduling of plant mostly during the evening peak.

All the pricing runs with significant price events that were investigated in the January to March 2013 period provided solutions were in keeping with the market rules as defined in the Trading and Settlement Code.

5. APPENDICES

Note: Comments in table A1 are based on analysis of EP2 data in all instances. This is regardless of which pricing run was affected. This approach has been taken because the final market prices and schedules are based on ex-post pricing and actual conditions on the trading day not on forecast data.

Trading Day	Run Type	Trading Period and Value of Price Event	Level of Price Maker Requirement	Level of Margin	Level of Pump Storage and Interconnector Availability
04/01/2013 (Friday)	EP2	17:30 (590.74)	=	=	↑
21/01/2013 (Monday)	EP1 EP2	17:30 (616.88) 17:30 (616.88)	↑	↓	=
22/01/2013 (Tuesday)	EP2	17:30 (590.06	↑	↓	=
30/01/2013 (Wednesday)	EP1 EP2	18:00 (634.59) 18:00 (594.32)	↑	↓	=
02/02/2013 (Saturday)	EA2	17:30 (667.52)	↑	↓	↑
06/02/2013 (Wednesday)	WD1	18:00 (600.34)	↑	↓	↑
11/02/2013 (Monday)	EA1	18:00 (611.45)	↑	↓	↑
18/02/2013 (Monday)	WD1	18:00 (604.32)	↑	=	=
25/02/2013 Monday)	EP2	05:30 (1068.17)	↑	↓	=
05/03/2013 (Tuesday)	EA1	08:30 (€586.55)	↑	↓	↓
11/03/2013 (Monday)	WD1 EP1 EP2	19:00 (€629.46) 19:00 (€1,350.64) 19:00 (€1350.64)	↑	↓	↓
12/03/2013 (Tuesday)	EA2	19:00 (€561.28)	↑	↓	↓
18/03/2013 (Monday)	EA1 EP1	17:00 (€576.04) 10:00 (€576.04)	=	=	↓
19/03/2013 (Tuesday)	EA2	19:00 (€682.41)	↑	↓	↓
20/03/2013 (Wednesday)	EP2	17:30 to 19:00 (€625.32)	↑	↓	↓
21/03/2013 (Thursday)	WD1	19:00 (€596.97)	=	=	↓

Table A1: Instances of Solver Policy Use in January to March 2013 period

Legend: = *Stable or Moderate Level,* ↑ *High or Increasing Level,* ↓*Low or Decreasing Level*