Title	**Market Incident Report**
Version	**1.0**
Date	**04th February 2010**

Introduction

The purpose of this document is to inform Participants and Parties to the SEM on the Market Schedule published for the Trade Date of January 20th 2010.

Executive Summary

For the Ex-Post Initial (EP2) run of the MSP software for the Trade Date of January 20th 2010, the solution contained the Price Cap (€1,000) in one Trading Period. This solution was produced using the Lagrangian Relaxation solver (LR) in line with agreed practices. The MSP software was rerun with the alternate solver available to SEMO, Mixed Integer Programming (MIP) as per SEMO's published policy. In keeping with this policy, the original schedule was published with the Price Cap as the MIP study did not produce a solution with cheaper MSP Production Costs.

An investigation into the causes of the Price Cap event has demonstrated the root cause of the Price Cap event lay in the inconsistent application of tolerance levels between different phases of the MSP program. This caused the Unit Commitment phase of the software to under-commit Generator Units and in turn led to the Economic Dispatch phase to produce an Under-Generation event with the ensuing Price Cap.

As a result, the Market Schedules and Prices for this day are questionable and may require adjustment.

In this report, SEMO recommends correcting the error through the Dispute process. Also SEMO recommends amendments to the SEMO policy on "Use of MIP for Determination of Market Schedules", and a change in the tolerance levels applied in the MSP software.

Background

On January 24th 2010, SEMO ran the MSP software for the Trade Date of January 20th 2010. This followed on from runs of the Ex-Ante schedule on January 19th and the Ex-Post Indicative (EP1) schedule on January 21st. Both these runs completed without incident and no issues were observed that could give rise to Data Queries in relation to this day.

The EP2 run was completed using normal processes and utilised the Langrangian Relaxation solver (LR). In the calculation of the System Marginal Price, the solver produced an SMP of €1,000 at 17:00. MSP Production Costs for this schedule were €4,243,199. In keeping with SEMO's policy on "Use of MIP for Determination of Market Schedules"[1], the schedule was re-run with MIP. This produced a schedule with a maximum price of €270.98 at 17:30. However, the MSP Production Costs for this run were €4,270,162. Consumer Costs are not assessed as part of this process but they are noted. The peak SMP in the LR run resulted in a total Consumer Cost across the Trading Day of €8,688,247, with almost €3,000,000 in the single Trading Period. This is almost 15% higher than the Consumer Cost observed in the MIP run which was €7,387,815.

No alarm or warning messages were produced by the MSP software to indicate what had caused the Price Cap and there was sufficient spare generation available but not committed.

As the MSP Production Costs for the LR run were lower, as required under the Trading & Settlement Code, paragraph 4.67, obligation to minimise MSP Production Costs across the

[1] http://www.sem-o.com/market_publications/image.aspx?id=d81ea2a5-bb38-4c86-a34b-08ddf871c4a3

optimisation horizon and documented in the SEMO policy, the LR schedule which included the Price Cap was published.

Analysis

A review of the schedule produced is presented in Figure 1 - Generator Status on 20/01/2010 below. As can be observed from this, no Generator can be identified as being in a marginal position at 17:00. All Generators committed that are not Price Takers are held at their Maximum Availability at this time.

While a number of Generators are unavailable, there is a sufficient number of Generators who are available and not committed at this time and who would therefore have been able to meet the generation requirement rather than deliver a schedule with an Under-Generation event.

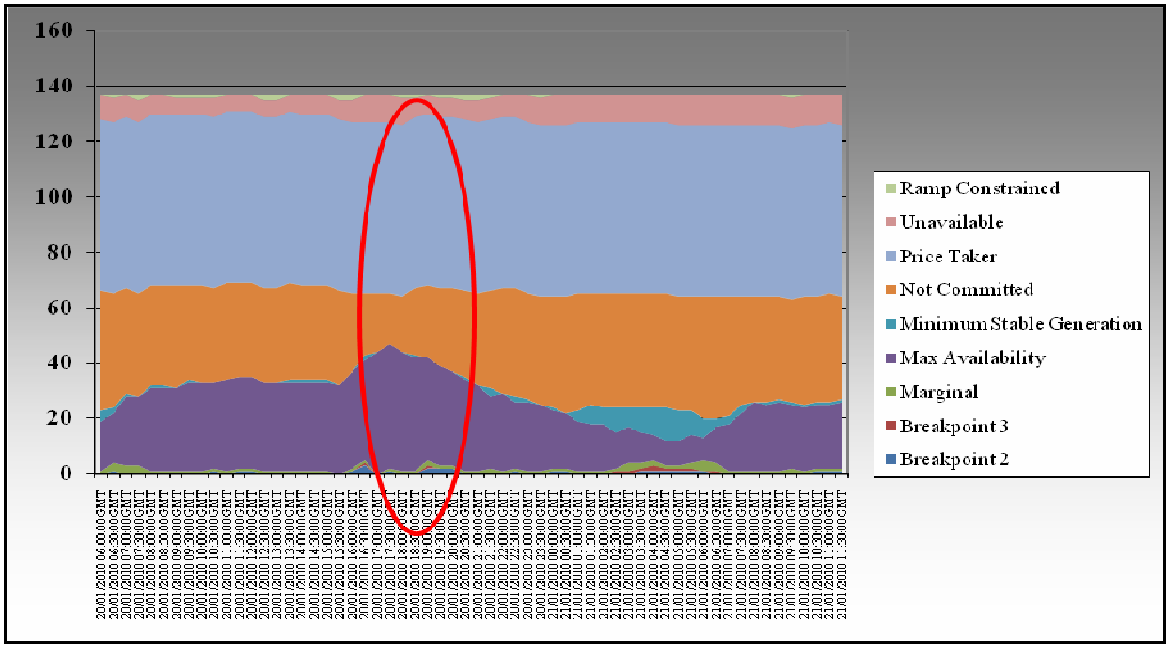

Figure 1 - Generator Status on 20/01/2010

Figure 2 - Total MSQ against Total Availability below demonstrates the Generator Availability against the schedules MSQs on this date. This clearly shows spare capacity available at 17:00.

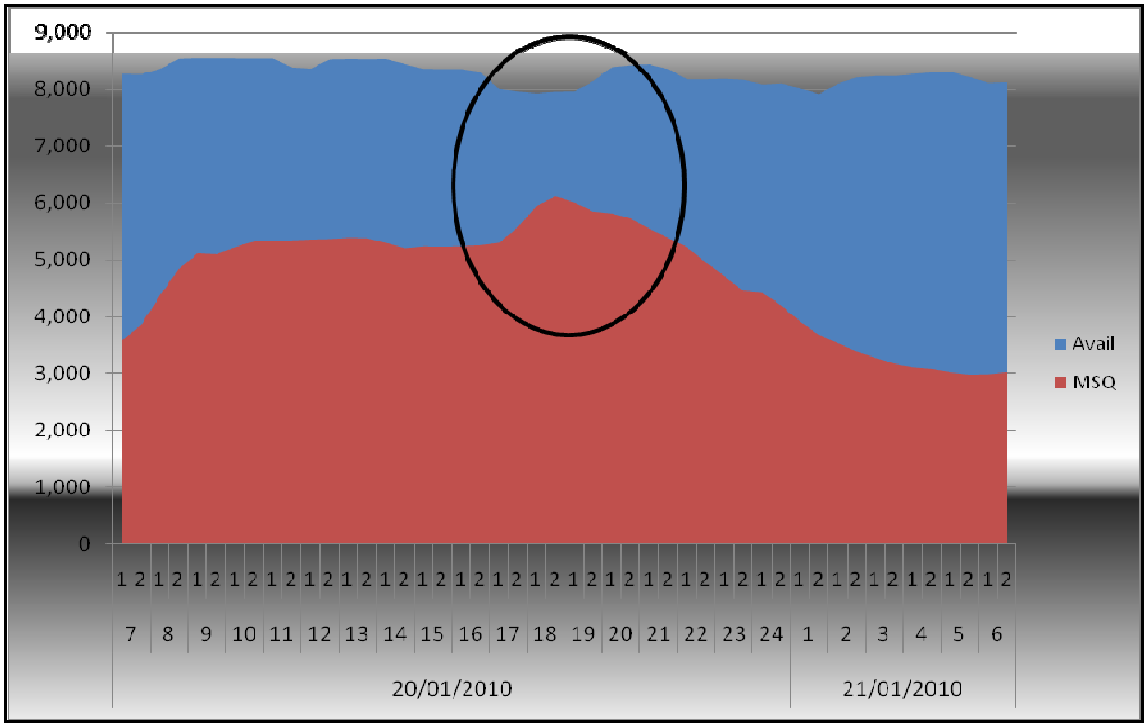

Figure 2 - Total MSQ against Total Availability

It is also worth noting the drop in Availability (including Interconnector Units) across the peak which corresponds to a sharp rise in the system load. This should not have caused the outcome observed. A study run was completed with Interconnector Unit availability adjusted.

It should also be observed that the solver sets the Shadow Price to Price Cap which indicates a breach of the constraints set out in paragraph N 17.4 of the Trading & Settlement Code.

To determine the cause of the Price Cap, SEMO undertook a number of study runs in respect of the date. The changes made and results observed are summarised in the table below.

Description	Solver Used	Price Cap Event	Marginal Unit
Original Schedule	LR	Y	None found
Original Schedule	MIP - 300	N	GU_500280
Original Schedule	MIP - 1800	N	GU_500280
With 0.05MW added to System Load	LR	Y	None found
With 0.05MW taken from System Load	LR	N	GU_500280
With 1MW added to System Load	LR	N	GU_400311
With 0.1MW added to System Load	LR	N	GU_400311
With Penalty Cost increased 10 times	LR	Y	None found
With Penalty Cost increased 100 times	LR	Y	None found
With MIUN > 0 for 1 Interconnector Unit	LR	N	Interconnector Unit

Table 1 - Summary of Study Runs

A study run was completed with the System Load increased by 0.05MW. The outputs of this run were identical to the original schedule. This confirmed that the Price Cap was being caused by an Under-Generation event (as the MSQ remained unchanged and therefore had not taken account of the extra MW values added to the requirement). As a result, this would be considered an infeasible solution. However, with the spare availability as noted above, this should not have occurred.

Re-running the case with a similar reduction in the System Load led to a feasible solution. This had GU_500280 (Ballylumford Unit 6) as the marginal generator setting the SMP with no Price Cap event. This is the same generator that was observed as marginal in the MIP – 300[2] run completed on the day (and in a further MIP study run allowed to run for 30 minutes).

Further runs were completed adding 1MW and then 0.1MW to the System Load. These changes also produced feasible solutions where GU_400311 (North Wall 5) was committed on to meet the extra requirement. This demonstrated that the solver was able to consider alternative solutions given small changes to the System Load. However, changes of 0.05MW were not solving. This indicated that the energy imbalance quantity was of a potentially small value. SEMO were not in a position to see the actual imbalance due to the precision of the front end of the system. This was confirmed by investigations by the vendor showing an actual imbalance of 0.00735MW or 7.35KW.

[2] MIP-300 refers to the length of time the MIP program is allowed to run. This is measured in seconds. A MIP-300 run is a five minute run of the optimisation software.

Considering that the Penalty Cost Coefficient for Under-Generation is applied on a per MW rate of violation, where the Penalty Cost is calculated as 73*5*Max Bid (€678 on the Trading Day), extra study runs were carried out to ensure that the MSP software had not considered that the Under-Generation event was the most economic solution. In these runs, the Penalty Cost Coefficient was increased by 10 to 730 and then by 100 to 7,300 (other Penalty Cost Coefficients were also increased by the same magnitude). In both of these runs, the original solution persisted with no change to System Marginal Prices or Generator MSQs being observed. These changes would have been enough to ensure the cost of the Under-Generation event was sufficiently uneconomic.

A further run was completed with an MIUN of 1 for one interconnector unit. (The total Metered Generation value was also adjusted down to ensure the System Load value was the same.) In this schedule, the original commitment decisions were still observed but 1MW was scheduled to the Interconnector Unit thereby alleviating the issue and producing a schedule with no energy imbalance. Because of how the MSP software treats Interconnector Units, their commitment status is fixed in the Ex-Ante schedules and their availability reflects this. As such, there are no commitment decisions in the Ex-Post run of the Unit Commitment phase and their MW values are set in Economic Dispatch. By adding 1MW of availability which would be scheduled in Economic Dispatch, this demonstrated that Unit Commitment phase was not committing sufficient generation.

The figure below demonstrates how the MSP software has been implemented. This uses 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 MSQs based on the input from the Unit Commitment phase, and
- Post Scheduling and Price Processing, which calculates Uplift and determines the final SMP.

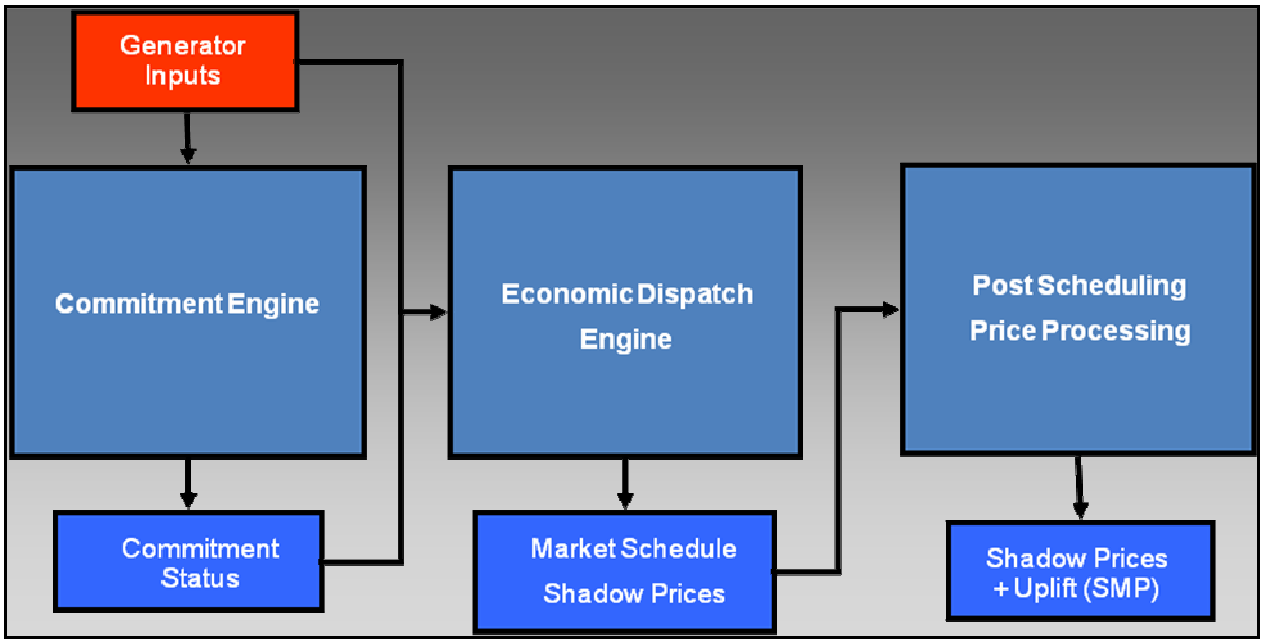

Figure 3 - Phases of the MSP software

Based on the investigations completed, this indicated that the Unit Commitment phase of the problem is solving without reporting an infeasible solution. However, based on the commitment decisions, the Economic Dispatch phase is unable to meet the generation requirement with the level of committed Generators. Considering the changes observed when the load was increased by 0.05MW, 0.1MW and 1MW, this indicates a tolerance in the Unit Commitment phase of the problem where the software considers the energy balance requirement has been satisfied. It would appear to be a value between 0.06MW and 0.1MW. However, the Economic Dispatch

would not appear to have such a tolerance as the shortage of 0.00735MW resulted in this phase of the problem setting the Shadow Price to Price Cap. This would also explain why changes to the Penalty Cost Coefficients had no impact on the outcome.

We have presented our analysis to the software vendors for comment and review. They have confirmed that there is a 0.1MW tolerance in the Unit Commitment phase which does not exist in the Economic Dispatch phase. The tolerance is set at this level based on previous implementations of the software which were for larger energy systems than the SEM. The software vendor has completed test runs using a prototype version of the software with the tolerance value set to 0.001MW. These have produced feasible schedules with no Price Cap in the solution.

Conclusions

1. A flaw currently exists in the MSP software where tolerance levels are applied inconsistently between the Unit Commitment and Economic Dispatch phases.
2. Based on our analysis and the vendors review, the solution delivered by the MSP software for the Trading Day of 20th January 2010 is incorrect. The commitment decisions which led to the energy imbalance should not have been taken and a different schedule should have been produced. The SMP at Price Cap should not have happened.
3. Because the application of this tolerance in this way will always result in an energy imbalance and a Price Cap event, it can be deduced that this tolerance has not previously had any adverse impact on the running of the MSP software.
4. SEMO acted on the day within the agreed processes and policies which have been circulated and communicated to all Participants and the Regulatory Authorities.
5. In this instance, the adherence to the agreed policy did not facilitate SEMO to consider the feasible solution from the MIP solver and led to the publication of the infeasible solution from the LR solver. As such, when dealing with infeasible solutions, MSP Production Cost should be a secondary measure.

Next Steps

SEMO will be taking the following actions -

1. A software fix is required to address this issue. This fix will be included in release SEMR.1.7.0 which is scheduled for April 29th, 2010.
2. Pending delivery of a software fix, the SEMO policy on "Use of MIP for Determination of Market Schedules" should be amended. Where a confirmed infeasible[3] solution is found, if the alternative solver can produce a feasible solution, then this feasible solution should be used regardless of MSP Production Costs.
3. Regardless of the causes of the current issue, changes to the SEMO policy on "Use of MIP for Determination of Market Schedules" should be enduring. This should allow SEMO make use of MIP as a back-up solver where no feasible solution is produced from LR which was the original intention of two solvers.

Recommendation

SEMO would recommend that the Trade Date of 20th January 2010 should be repriced. This could be completed under a Settlement Dispute raised under paragraph 6.107 (*Market Schedule Quantity has been calculated incorrectly*). This option rests with Participants in the SEM.

[3] Once Price Cap is found as the Shadow Price where no Participant has bid at this level, this indicates that one of the constraints set out in paragraph N 17.4 of the Trading & Settlement Code has been breached. The solution is therefore considered infeasible.

