



MSP Software Penalty Cost Parameters for 2010

2010 SEM Parameters for the Determination of Required Credit Cover

Document History

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1 Introduction

1.1 Purpose

Under Section N.25 of the Trading & Settlement Code, at least 4 months before the start of each Year, the Market Operator (MO) is required to propose parameters used in the MSP Software for that Year. This document provides the MO's proposals for these parameters for the Year 2010.

1.2 Audience

The target audience for this document is Market Participants and the Regulatory Authorities.

1.3 Scope

This document provides proposals for the following parameters to be used in the MSP Software for the Year 2010:

- a. the Over-Generation MSP Constraint Cost
- b. the Under-Generation MSP Constraint Cost
- c. the Aggregate Interconnector Ramp Rate MSP Constraint Cost
- d. the Energy Limit MSP Constraint Cost
- e. the Tie-Breaking Adder

1.4 Background

The core algorithm of the MSP software attempts to optimise for a non-linear mixed integer constrained objective with non-linear constraints. On occasion the mathematical problem posed may be infeasible (i.e. there will be no solution that will satisfy all the constraints). In these cases, rather than return no answer, it is customary in numerical solutions to produce an answer where some of the constraints have been breached slightly. To achieve this, slack variables are introduced with suitably chosen coefficients, that ensure these variables are only used in the case of infeasibility. In addition the setting of these coefficients can prioritise the order in which constraints will be breached for a given situation.

The current values of the parameters were determined for 2007/2008 using the method detailed in AIP/SEM/07/439 and were further analysed and retained for 2009 in AIP/SEM/08/104B. Since Market Go-Live in Nov 2007, none of the penalties (a) – (d) have been incurred over hundreds of runs of the MSP Software. In addition, further analysis undertaken by SEMO described in this report demonstrates the robustness of the current settings. SEMO has re-examined these settings using a number of days between Nov 2007 to July 2009.

2 Recommendations

SEMO proposes that the MSP Constraint Parameters retain their existing values for 2010 (unless significant changes in the T&SC Rules dictate their re-evaluation).

Parameter	Proposed Penalty Settings for 2010
Over-Generation MSP Constraint Cost	73
Under-Generation MSP Constraint Cost	73
Aggregate Interconnector Ramp Rate MSP Constraint Cost	292
Energy Limit MSP Constraint Cost	38
Tie-Breaking Adder	0.001

Parameter	Proposed Penalties to be used by MSP Software for 2010
Over-Generation MSP Constraint Cost	365 x Max Offer
Under-Generation MSP Constraint Cost	365 x Max Offer
Aggregate Interconnector Ramp Rate MSP Constraint Cost	1460 x Max Offer
Energy Limit MSP Constraint Cost	190 x Max Offer
Tie-Breaking Adder	0.001

It should be noted that this set of values represents one of a range that could achieve the objective of ensuring that the slack variables are only used to alleviate a feasibility. This set have proved to achieve this over hundreds of runs of the MSP Software to date and the tests described here have demonstrated that the values are safely above the level where they would be breached for economic reasons.

3 Analysis of MSP parameters

The MSP Software allows for 20 price-quantity pairs for each slack variable costs (a) – (d). For each step a price and quantity can be set by the operator. The prices and the quantities must be strictly monotonically increasing. The price of the last offer step used is multiplied by a factor equal to 5 times the maximum offer price for the day. Regardless of the offer quantity set for the final step, the MSP internally imposes no limit on the quantity that can be scheduled from the final step.

The proposed method for setting the penalties is to use just one offer step and to enter a relatively low penalty factor in the cost field. This factor effectively sets the penalty used internally to be that factor multiplied by 5 and multiplied by the greatest offer price during the day (assuming that offer price exceeds 0.1). This approach results in penalty values that vary from day to day.

Example

- Set penalty using one price quantity pair. The price is set to be 73 and the quantity to be zero (this is allowed only for the last price quantity pair).
- Suppose the maximum offer price for the day is €500.
- The effective penalty will be $73 \times 5 \times €500 = €182500$
- The quantity of violation allowed will be infinite.

The specific penalty functions are:

1. The Over-Generation MSP Constraint Cost
2. The Under-Generation MSP Constraint Cost
3. The Aggregate Interconnector Ramp Rate MSP Constraint Cost
4. The Energy Limit MSP Constraint Cost

Setting penalties is not arbitrary. The MSP Software will only incur a penalty if it (a) results in a lower production cost than other options available or (b) if the schedule would be infeasible otherwise. If the penalties are set incorrectly then constraints could be violated simply because it is cheaper to do so. In other words the penalties could be incurred for purely “economic” reasons. In accordance with paragraph N17.4 of the Trading & Settlement Code, this should not occur and the penalties should only be incurred in cases where the schedule would otherwise be infeasible.

To ensure that these settings are robust in circumstances that may not have arisen to date, a set of tests were carried out to understand at what point the slack variables would be used. Similar to last year’s report, 8 sample days from the period January 2008 to July 2009 were chosen and the effects of different levels of penalties were studied. The purpose of these tests were to ensure that the penalties will only be incurred to alleviate an infeasibility.

3.1 Under Generation

3.1.1 Context

In an Under-Generation situation the Under-Generation slack supplies demand that physical facilities cannot supply i.e. the quantity scheduled is the amount by which the generation requirement exceeds scheduled generation. The penalty cost applies to each trading period on a per MW rate of violation. In an Under-Generation situation the shadow price will be capped at the maximum energy price: the Market Price Cap, PCAP.

The Under-Generation slack variable is used to alleviate infeasibilities as that would result from Insufficient Capacity Events. This slack variable should only be used in cases of infeasibility. Therefore, the cost of using this slack variable and other slack variables should be always greater than the cost of other options.

In the case where the schedule would be infeasible due to an Insufficient Capacity Event and where the Under-Generation Penalty cost was less than other penalties that could alleviate this infeasibility (i.e. the Interconnector Ramp Rate Penalty and Energy Limit Penalty), the Under-Generation penalty would be incurred. This highlights the importance of the relative costs of the different penalties that could alleviate the same infeasibility. This will be dealt with further in the sections on Interconnector Ramp Rate Penalties and Energy Limit Penalties.

3.1.2 Analysis

It is possible to analytically calculate the level at which the penalty will be incurred for economic reasons. The MSP Software calculates the Internal Under-Generation Penalty using:

$$\text{Internal Under Generation Penalty} = \text{Under Generation Penalty} \times 5 \times \text{Max Offer}$$

The penalty is incurred in Trading Periods where:

$$\text{Internal Under Generation Penalty} < \text{Max Shadow Price}$$

Using the above two relationships, if

$$\text{Under Generation Penalty} < \frac{\text{Max Shadow Price}}{5 \times \text{Max Offer}}$$

then the penalty will be incurred. Based on the above relationship, it is unlikely that a penalty setting of above 0.2 would result in the penalty being incurred for economic reasons as the Max Offer would be less than the Internal Under Generation Penalty.

For the 8 days analysed, Figure 3.1 shows the level at which the Under-Generation Penalty was expected to be incurred using the above relationships (Calculated Penalty), the level at which it was incurred in the tests (Test Penalty) and the current penalty that is proposed to be retained (Proposed Penalty).

In all cases tested, reducing the value within the range of 0.025 to 0.195 resulted in the constraint being violated. The current setting of 73 is more than 2 orders of magnitude greater than the values at which the penalty was incurred.

There are instances when the penalty may be incurred above 0.2. These may occur when in order to meet Demand the MSP Software must start another unit at Min Stable Generation. In these cases, if,

$$\text{Internal Under Generation Penalty} < \frac{\text{Start Up Cost}}{\text{MinGen} \times \text{MinUpTime}}$$

then the penalty will be incurred. This can be written in terms of the Under Generation Penalty as,

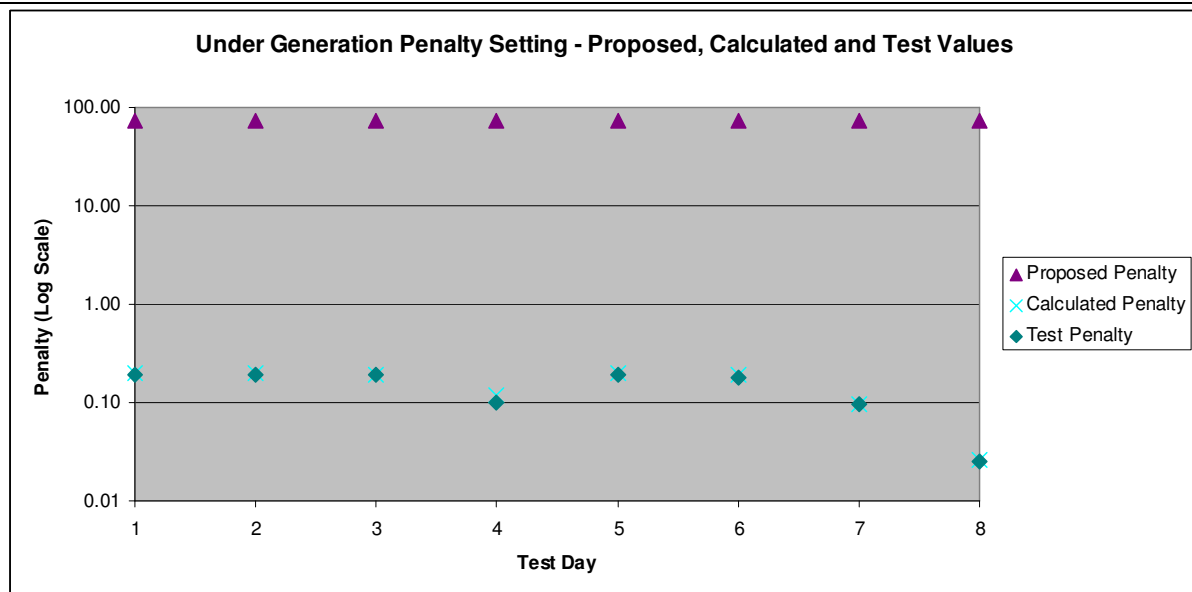


Figure 3.1 Under Generation MSP Constraint Cost

$$\text{Under Generation Penalty} < \frac{\text{Start Up Cost}}{\text{MinGen} \times \text{MinUpTime} \times \text{MaxOffer}}$$

As units with high Start Up Costs generally have higher MinGen levels and Min Up Times, this acts to limit the magnitude of the right hand side. Also, as Start Up Costs rise as a result of underlying fuel prices, so too does Max Offer. Using actual data from the 8 days analysed, the following limit was established

$$\text{Max} \left\{ \frac{\text{Start Up Cost}}{\text{MinGen} \times \text{MinUpTime} \times \text{MaxOffer}} \right\} < 4.5$$

If the Under Generation Penalty is set at 73, an order of magnitude above this, it highly unlikely that the penalty would be incurred for economic reasons.

3.1.3 Conclusion

SEMO propose that 73 value is retained as it will ensure that the Under-Generation Penalty is only incurred to alleviate an infeasibility due to an Insufficient Capacity Event in line with paragraph N17.4 of the T&SC.

3.1.4 Recommendation

SEMO recommends retaining the Under-Generation MSP Constraint Cost setting of 73 for Year 2010.

3.2 Over Generation

3.2.1 Context

In an over-generation situation, the over-generation slack absorbs physical supply that exceeds demand i.e. the quantity scheduled is the amount by which scheduled generation exceeds the generation requirement. The penalty cost applies to each trading period on a per MW rate of violation. In an over-generation situation the shadow price will be truncated to the minimum energy price: the Market Price Floor, PFLOOR.

For the Over-Generation Penalty to be incurred for economic reasons, it must be cheaper to schedule generation beyond the level of the Schedule Demand and incur the penalty than to meet the demand. To date in SEM, there have been no circumstances where this has occurred.

3.2.2 Analysis

The existing setting for the Over Generation MSP Constraint Cost is **73**. This was reduced to 0.001 and there were no instances where this penalty was incurred.

The analysis for the Under-Generation Penalty applies to the Over-Generation Penalty. For a given penalty, if it is not economic to incur this penalty for Under Generation it follows that it would not be economic to incur this penalty for Over-Generation.

3.2.3 Conclusion

To ensure it is not economic to incur the Over-Generation Penalty, it is proposed that the current value of 73 be retained as it will ensure that the Over-Generation Penalty is only incurred to alleviate an infeasibility due to an Excessive Generation Event in line with paragraph N17.4 of the T&SC.

3.2.4 Recommendation

SEMO recommends retaining the Over-Generation MSP Constraint Cost setting of 73 for Year 2010.

3.3 Aggregate Interconnector Ramp Rate MSP Constraint Cost

3.3.1 Context

A single ramp rate applies for the Interconnector. This can be violated in either direction, i.e. increasing or decreasing flow between trading periods beyond the allowed ramp rate. The penalty cost applies to each trading period on a per MW rate of violation.

A key consideration of whether this will be incurred is whether the Interconnector Ramp Rate is binding on a particular day. As the Interconnector Ramp Rate needs to be binding before this penalty can be incurred, there will never be cases of Interconnector Ramp Rates penalties being incurred unless the Interconnector Ramp Rate is binding.

As the Modified Interconnector Unit Nominations are calculated such that they are feasible for Interconnector Ramp Rates, it is unlikely that there will ever be incidences where the Interconnector Ramp Rates are binding in the MSP Software with the current level of Interconnector Capacity. However, to ensure in these instances that the Interconnector Ramp Rate Penalty is not incurred for economic reasons, a number of tests were carried out to understand the level at which this would occur if the Interconnector Ramp Rate was binding.

3.3.2 Analysis

Tests were run over the 8 historical days using an Interconnector Ramp Rate Penalty of 0.001 and resulted in no incidences of the penalty being incurred. This was due to the fact that the Interconnector Ramp Rate was not binding in any of the cases examined.

An artificially low Interconnector Ramp Rate of 100MW/Trading Period was used to rerun the 8 days. This resulted in a number of periods where the Interconnector Ramp Rate was binding. Using the existing setting for the Interconnector Ramp Rate Penalty of 292, there were no incidences of the penalty being incurred.

In the presence of a binding ramp rate, the Interconnector could be used to alleviate an infeasibility due to an Insufficient Capacity Event or an Excessive Generation Event by incurring the Interconnector Ramp Rate Penalty. It is desirable that the Under-Generation Penalty is used for an Insufficient Capacity Event and Over-Generation Penalty is used for the Excessive Generation Event so the Interconnector Ramp Rate Penalty is set to be higher than the Under- and Over-Generation Penalties. As the Interconnector Ramp Rate is measured in MW/Trading Period and the Under/Over-Generation Penalties are measured in MW, setting the Interconnector Ramp Rate Penalty at four times the Under/Over-Generation Penalties, ensures that the latter take precedence.

3.3.3 Conclusion

It is proposed that the current value of 292 be retained as it will ensure that the Aggregate Interconnector Ramp Rate Penalty is only incurred to alleviate an infeasibility in line with paragraph N17.4 of the T&SC.

3.3.4 Recommendation

SEMO recommends retaining the Aggregate Interconnector Ramp Rate MSP Constraint Cost setting of 292 for Year 2010.

3.4 Energy Limit MSP Constraint Cost

3.4.1 Context

This penalty applies to the MWh violation of energy limits, maximum reservoir levels and minimum reservoir levels.

A key consideration of whether this will be incurred is whether the Energy Limit is binding on a particular day. As the Energy Limit needs to be binding before this penalty can be incurred, there will never be cases of Energy Limit penalties being incurred unless the Energy Limit is binding.

In addition the Energy Limited Unit must be capable of increasing output in the period where the Energy Limit Penalty is incurred. So for an Energy Limit Penalty to be incurred the Energy Limit must first be binding and secondly, the availability of the Energy Limited Unit must not be binding.

As Energy Limits are measured in MWh, breaking an Energy Limit in one Trading Period yields 2MW of extra generation. Based on the reasoning discussed in the Under-Generation section, we can expect that it is unlikely that a penalty of greater than 0.1 would result in a penalty being incurred as it would be cheaper to use the Max Offer.

3.4.2 Analysis

Figure 3.4 below shows the level at which it was incurred in the tests (Test Penalty) and the current penalty that is proposed to be retained (Proposed Penalty). The current setting for the Energy Limit MSP Constraint Cost is 38.

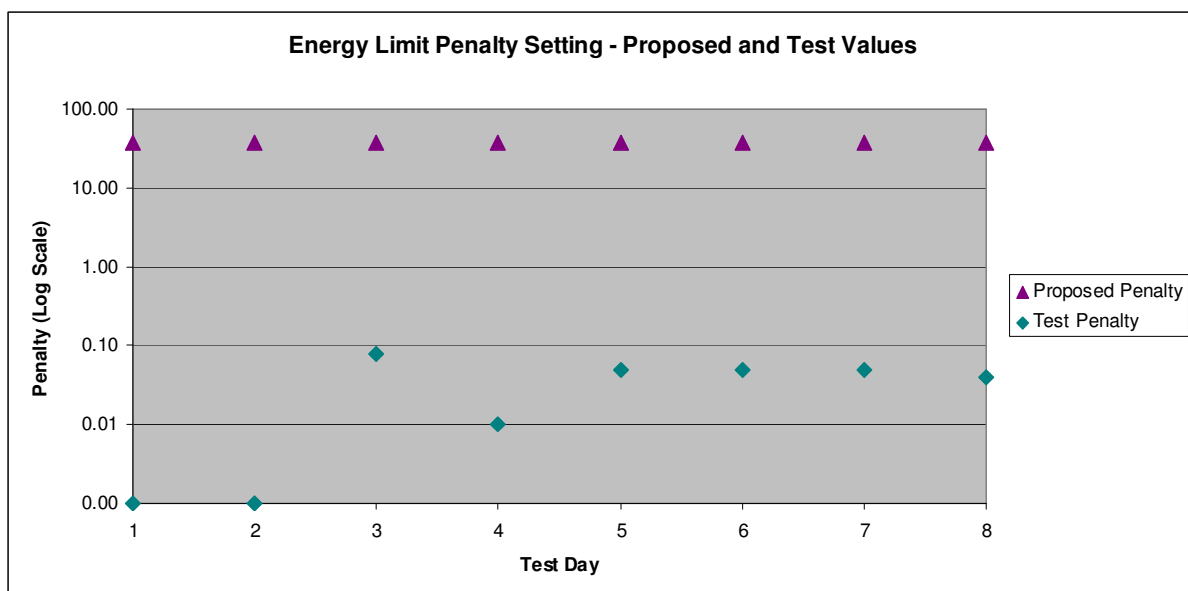


Figure 3.4: Energy Limit Penalty Setting

As can be seen from the results of the tests, all values where the penalty was incurred were all below 0.1. Furthermore, due to the conditions described at the beginning of this section not being place on 2 of days, it was not possible to incur the Energy Limit Penalty as either the Energy Limit was not binding or the Availability of the Energy Limited Unit was binding.

Similar to the Interconnector Ramp Rate, breaking an Energy Limit could be used to alleviate an infeasibility due to an Insufficient Capacity Event or an Excessive Generation Event. It is desirable that the Under-Generation Penalty is used for an Insufficient Capacity Event and Over-Generation Penalty is used for the Excessive Generation Event. As the Energy Limit is measured in MWh, a penalty of 36.5/MWh would be equivalent to the Under/Over-Generation penalties of 73/MW. Setting the Energy Limit Penalty at 38/MWh ensures that the Under- and Over-Generation Penalties take precedence.

3.4.3 Conclusion

It is proposed that the current value of 38 be retained as it will ensure that the Energy Limit Penalty is only incurred to alleviate an infeasibility in line with paragraph N17.4 of the T&SC.

3.4.4 Recommendation

SEMO recommends retaining the Energy Limit MSP Constraint Cost setting of 38 for Year 2010.

3.5 The Tie-breaking Adder

3.5.1 Context

The Tie-breaking Adder is used to adjust Prices for individual Generator Units in the event of a Tie-Break.

3.5.2 Analysis

While the MSP Software will allow prices and costs of up to €99,999.99 to be specified without material loss of precision, the tie-breaking feature cannot be operated so as to apply an adder significantly less than €0.001 while being reflected in prices and costs for any price or cost above €9,999.99. This is because the MSP Software records costs to a precision of seven significant figures and such a small tie-breaking adder would appear in the eighth significant figure over any number above €9,999.99.

3.5.3 Conclusion

A Tie-breaking Adder of €0.001 is the lowest possible adder that can be resolved at seven significant figures up to €9999.99.

3.5.4 Recommendation

SEMO recommends retaining Tie-breaking Adder of €0.001 for Year 2010.