

Single Electricity Market

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| Final REcommendation ReportMod\_15\_12: Inclusion of ATC limit slack variables and associated penalty cost Parameters18 September 2012 |

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Document History

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| **Version** | **Date** | **Author** | **Comment** |
| 0.2 | 11 September 2012 | Modifications Committee Secretariat | Issued to Modifications Committee for review and approval |
| 1.0 | 18 September 2012 | Modifications Committee Secretariat | Issued to Regulatory Authorities for final decision |

Reference Documents

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| **Document Name** |
| [Trading and Settlement Code](http://semopub/MarketDevelopment/MarketRules/TSC.doc)  |
| [Mod\_15\_12](http://semopub/MarketDevelopment/ModificationDocuments/Mod_15_12%20-%20IDT%20Slack%20Variable%20Changes.docx): Inclusion of ATC limit slack variables and associated penalty cost Parameters |
| [Meeting 43 Presentation Slides](http://semopub/MarketDevelopment/ModificationDocuments/Mod_15_12%20-%20ATC%20slack%20variables.ppt) |

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# MODIFICATIONS COMMITTEE RECOMMENDATION

## Recommended for Approval subject to legal drafting to correct numbering error – unanimous Vote

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| --- |
| **Mod\_15\_12: Recommended for Approval** |
| Brian Mongan | Generator Alternate  | Approve |
| Iain Wright -Chair | Supplier Member | Approve |
| Julie-Anne Hannon | Supplier Alternate | Approve |
| Kevin Hannafin | Generator Member | Approve |
| Mary Doorly | Generator Alternate | Approve |
| Niamh Quinn | Generator Member | Approve |
| Patrick Liddy | DSU Member | Approve |
| William Carr | Supplier Member | Approve |

# Background

This Modification Proposal was raised by SEMO and received by the Secretariat on 17 July 2012. This modification proposes to more accurately describe the implementation of Intra-Day Trading related constraints and to document them in the Code.

The Modification Proposal was presented and discussed at Meeting 43 on 31 July 2012 where it was voted on.

# PURPOSE OF PROPOSED MODIFICATION

## 3A.) justification of Modification

Interconnector Unit Nominations calculated in EA2, WD1 and Ex-Post runs are limited in aggregate in each Trading Period in the relevant Optimisation Time Horizon by the Maximum Export Available Transfer Capacity (MEATC) and the Maximum Import Available Transfer Capacity (MIATC). This is currently described in Mod\_18\_10v2 in Appendix N.17.4 for EA2 and WD1. However, these limits also apply to the Ex-Post runs which is not mentioned in that sub-paragraph.

In this Modification Proposal, the specific references to EA2 and WD1 runs are removed, making the paragraph applicable to all MSP Software runs. It should be noted that the Interconnector Units would be bound individually by their capacity holdings in EA1 and by their MIUNs in EP1 and EP2. As such, MEATC and MIATC are only important in EA2 and WD1. However, as the problem formulation contains these constraints in the EA1, EP1 and EP2 MSP Software Runs, they have been included for completeness.

In addition, the software implementation of these limits has included the addition of two additional slack variables and associated penalty costs. This modification proposes to more accurately describe the implementation of these constraints. It also addresses drafting comments arising from the UUC Certification review.

The CMS vendor has introduced two additional slack variables into the Unit Commitment problem, Interconnector Import MSP Constraint Cost and Interconnector Export MSP Constraint Cost. Adding slack variables in constraints is a standard approach in Economic Dispatch and Unit Commitment. It allows optimisation engines to produce feasible solutions when constraints are not feasible.

These slack variables were introduced to account for the unlikely scenario that where there is a change (reduction) in ATC between MSP Software Runs and the MIUN calculator is not triggered in sufficient time to calculate new MIUN values corresponding to the new ATC limit.

The penalty costs associated with the Interconnector Import and Interconnector Export slack variables will be included in the annual T&SC parameters review sent to the Regulatory Authorities as annual settings. For IDT Go-Live the parameters have been set to values above the Over-Generation and Under-Generation MSP Constraint Costs, so that in case of infeasibility the Under and Over Generation constraints would be breached first and the Interconnector Import and Export constraints should never be breached for economic reasons.

The constraints detailed in paragraph N.17.4 are also referenced in Section 3 of the Market Operator Solver Policy. The policy document will be updated to include the new constraints.

## 3B.) Impact of not Implementing a Solution

The description of the treatment of slack variables and their associated penalty costs in the Central Market System shall not be fully transparent.

## 3c.) Impact on Code Objectives

This Modification Proposal aims to further Code Objective 1.3.5, namely;

“to provide transparency in the operation of the Single Electricity Market”.

# Assessment of Alternatives

No alternatives assessed.

# Working Group and/or Consultation

N/A

# impact on systems and resources

N/A

# Impact on other Codes/Documents

N/A

# MODIFICATION COMMITTEE VIEWS

## Meeting 43 - 31 July 2012

SEMO Member presented slides outlining proposal which arose out of UUC Certification review for the IDT systems release.

Supplier Alternate raised a query in relation to internal penalty costs. SEMO Member advised that internal penalty costs are applied to slack variables, in case an infeasible solution exists, there exists a precedence of which constraints can be broken in order to return a result rather than no result. MO Member noted that a case may exist to define MEATC and MIATC as hard constraints; this may be discussed with the vendor at a later stage if deemed necessary. Chair commented on numbering error in proposal.

# Proposed Legal Drafting

As set out in Appendix 1. (Secretariat has ensured numbering error is not present in proposal).

#  LEGAL REVIEW

Complete

# IMPLEMENTATION TIMESCALE

It is proposed that this Modification is implemented on a Trading Day basis with effect from one Working Day after an RA Decision.

# Appendix 1: Mod\_15\_12

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| **MODIFICATION PROPOSAL FORM** |
| **Proposer** | **Date of receipt** | **Type of Proposal** | **Modification Proposal ID** |
| **SEMO** | **17 July 2012** | **Standard** | **Mod\_15\_12** |
| **Contact Details for Modification Proposal Originator** |
| **Name** | **Telephone number** | **Email address** |
| **Niamh Delaney** | 1. **2370321**
 | **niamh.delaney@sem-o.com** |
| **Modification Proposal Title** |
| **Inclusion of ATC limit slack variables and associated penalty cost parameters** |
| **Documents affected** | **Section(s) Affected** | **Version number of T&SC or AP used in Drafting** |
| **T&SC** | **Appendix N, Glossary** | **V.10 and Mod\_18\_10v2** |
| **Explanation of Proposed Change***(mandatory by originator)* |
| Interconnector Unit Nominations calculated in EA2, WD1 and Ex-Post runs are limited in aggregate in each Trading Period in the relevant Optimisation Time Horizon by the Maximum Export Available Transfer Capacity and the Maximum Import Available Transfer Capacity for a given Interconnector. This is currently described in Mod\_18\_10v2 in Appendix N.17.4 for EA2 and WD1. However, these limits also apply to the Ex-Post runs, which are not mentioned in N.17.4. In addition the UUC Certification review has recommended that clause N.17.4 in Mod\_18\_10v2 become a sub-clause of N.17.3 as it more logically fits into this constraint group which describes constraints on the scheduling of energy.The UUC Certification review also recommended that the same constraint be included in N.18.3, as it also applies to the economic dispatch. As part of the software implementation of these limits for Intra Day Trading, the CMS vendor has included two additional slack variables and associated penalty costs. This modification proposes to more accurately describe the implementation of these constraints and to document them in the Code. |
| **Legal Drafting Change***(Clearly show proposed code change using* ***tracked*** *changes, if proposer fails to identify changes, please indicate best estimate of potential changes)* |
| N.17 The Unit Commitment Schedule shall have the following features:1. It shall be formulated, along with an energy schedule for each Price Maker Generator Unit that is not Under Test, so as to minimise the mathematical function comprising the sum of:
2. the sum of the MSP Production Costs incurred in each Trading Period in the Optimisation Time Horizon by each Price Maker Generator Unit that is not Under Test; and
3. the cost of violating any constraint where no feasible solution would otherwise exist, as described in paragraph N.17.4.
4. Constraints shall be imposed upon the Unit Commitment Schedule based on applicable Technical Capabilities, so that, in relation to each Generator Unit and subject to paragraphs N.17.4 and N.17.5:
5. the duration of each Contiguous Operation Period shall be less than or equal to the Maximum On Time for that Generator Unit (for Interconnector Units this limit is set to a value which will impose no restrictions on the Market Schedule Quantity of the Generator Unit);
6. the duration of each Contiguous Operation Period shall be greater than or equal to the Minimum On Time for that Generator Unit (for Interconnector Units this limit is set to a value which will impose no restrictions on the Market Schedule Quantity of the Generator Unit);
7. whenever that Generator is scheduled to stop producing Active Power, any applicable Minimum Off Time is observed relative to the Trading Period in which it was last scheduled to stop producing Active Power (which Trading Period can be in a prior Trading Day as determined by the Preceding MSP Run or Preceding MSP Runs) (for Interconnector Units this limit is set to a value which will impose no restrictions on the Market Schedule Quantity of the Generator Unit);
8. in the case of Pumped Storage Units, the Generator Unit shall be scheduled to be committed in either Pumping Mode or generating mode and all committed Pumped Storage Units linked to the same reservoir shall, while committed, be committed in the same mode – a Pumped Storage Unit must have a scheduled level of Output of not more than 0 MW when in Pumping Mode and a scheduled level of Output of not less than 0 MW when in generating mode, and for the avoidance of doubt, a Pumped Storage Unit can simultaneously be committed, have a scheduled level of Output of 0 MW, and be in either, but not both, of Pumping Mode or generating mode;
9. when a Generator Unit other than a Pumped Storage Unit is operating its average scheduled Output over each Trading Period is at a level not less than its Lower Operating Limit (see Appendix N.40) and not greater than its Higher Operating Limit (see Appendix N.37);
10. in any Trading Period where a Generator Unit is scheduled to perform a Market Schedule Start, its Output level shall be not more than the greater of its Lower Operating Limit and the sum of the Block Load corresponding to its Market Schedule Warmth State and half the Single Ramp Up Rate (a Block Load value of zero is to be used for Generator Units that are Pumped Storage Units or Interconnector Units);
11. in the last Trading Period prior to when a Generator Unit is scheduled to stop operating, having been operating, its Output level shall be not more than the greater of its Lower Operating Limit and half the Single Ramp Down Rate; and
12. in implementing the above conditions the relevant data for the Market Schedule Warmth State of the Generator Unit shall be used.
13. Constraints shall be imposed on the scheduling of energy so that, subject to paragraphs N.17.4 and N.17.5:
14. in each Trading Period, the total Output of all Price Maker Generator Units that are not Under Test shall be scheduled so as to equal Schedule Demand in that Trading Period;
15. limits, determined by the Single Ramp Up Rate and the Single Ramp Down Rate, on the maximum amount by which each Generator Unit’s Output can change between Trading Periods shall be observed (including relative to the Generator Unit’s Output from the last Trading Period of the previous Trading Day as determined by the Preceding MSP Run);
16. limits determined by the Aggregate Interconnector Ramp Rate, on the maximum amount by which total flow on an Interconnector can increase or decrease between Trading Periods shall be observed (including relative to the total flow scheduled on that Interconnector from the last Trading Period of the previous Trading Day as determined by the Preceding MSP Run);
17. in each Trading Period, the total flow scheduled in respect of Interconnector Units for a given Interconnector shall not be less than the most recently Accepted Maximum Export Available Transfer Capacity and not more than the most recently Accepted Maximum Import Available Transfer Capacity for that Interconnector;
18. the energy scheduled from any Energy Limited Generator Unit on both the Trading Day and (separately) in the Ending Overlap Optimisation Period shall not exceed the relevant Energy Limit over the relevant period;
19. the energy (in MWh) maintained within each Pumped Storage Unit reservoir shall be not less than its Minimum Storage Capacity (PSMINLut) and not more than its Maximum Storage Capacity (PSMAXLut);
20. the energy (in MWh) maintained within each Pumped Storage Unit reservoir shall meet the Target Reservoir Level in the final Trading Period of the Trading Day, and the level calculated in accordance with paragraph 5.117 in the final Trading Period of the Optimisation Time Horizon; and
21. a relationship is observed whereby the generation of each 1 MWh from a Pumped Storage Unit in generating mode lowers its associated reservoir by 1 MWh while the pumping of each 1 MWh by a Pumped Storage Unit in Pumping Mode raises the associated reservoir by a number of MWh equal to the Pumped Storage Cycle Efficiency for that Pumped Storage Unit.
22. The MSP Software shall include the following variables, which allow such constraint limits to be violated at a high cost if no feasible solution would otherwise exist:
23. the Over-Generation MSP Constraint Cost, which shall apply in any Trading Period in which total scheduled Output as calculated by the MSP Software, for Price Maker Generator Units which are not Under Test, exceeds Schedule Demand, and these circumstances comprise an Excessive Generation Event for the relevant Trading Period;
24. the Under-Generation MSP Constraint Cost, which applies in any Trading Period in which total scheduled Output as calculated by the MSP Software, for Price Maker Generator Units which are not Under Test, is less than Schedule Demand, and these circumstances comprise an Insufficient Capacity Event for the relevant Trading Period;
25. the Aggregate Interconnector Ramp Rate MSP Constraint Cost, which applies to an Interconnector in any Trading Period in which the Aggregate Interconnector Ramp Rate for that Interconnector is breached;
26. the Maximum Export Available Transfer Capacity MSP Constraint Cost, which applies to an Interconnector in any Trading Period in which the Maximum Export Available Transfer Capacity for that Interconnector is breached;
27. the Maximum Import Available Transfer Capacity MSP Constraint Cost, which applies to an Interconnector in any Trading Period in which the Maximum Import Available Transfer Capacity for that Interconnector is breached; and
28. the Energy Limit MSP Constraint Cost, which applies to each relevant Generator Unit in any Trading Period in which the Energy Limit for an Energy Limited Generator Unit or any of the reservoir target levels or reservoir capacities for a Pumped Storage Unit is breached.

N.18 The Economic Dispatch shall have the following features:1. It shall be formulated to determine the Shadow Price (SPh) value, and the Market Schedule Quantity (MSQuh expressed in MW) for each Price Maker Generator Unit that is not Under Test, for each Trading Period, so as to minimise the mathematical function comprising the sum of:
2. the total MSP Production Cost incurred by all Price Maker Generator Units that are not Under Test in all Trading Periods in the Optimisation Time Horizon; and
3. the cost of violating any constraint where no feasible solution would otherwise exist, as described in paragraph N.18.4.
4. Constraints shall be imposed on Market Schedule Quantities determined as part of Economic Dispatch and based on the Unit Commitment Schedule so that, subject to paragraphs N.18.4 and N.18.5 :
5. a Generator Unit shall have a Market Schedule Quantity of 0 MW in any Trading Period in which the Generator Unit is not scheduled to operate;
6. a Pumped Storage Unit that is scheduled to operate shall have an Output not less than 0 MW if the Pumped Storage Unit is committed and in generating mode;
7. a Pumped Storage Unit that is scheduled to operate shall have an Output not more than 0 MW if the Pumped Storage Unit is committed and in Pumping Mode;
8. when a Generator Unit is scheduled to operate, its Output is at a level not less than its Lower Operating Limit (see Appendix N.40) and not greater than its Higher Operating Limit (see Appendix N.37);
9. in a Trading Period where a Generator Unit is scheduled to start operating, its Output shall not be greater than the maximum Output level allowed for that Trading Period in the Unit Commitment Schedule; and
10. in a Trading Period where a Generator Unit is scheduled to stop operating, its Output shall not be greater than the maximum Output level allowed for that Trading Period in the Unit Commitment Schedule.
11. Constraints shall be imposed on the Market Schedule Quantities determined as part of Economic Dispatch so that subject to paragraphs N.18.4 and N.18.5:
12. in each Trading Period, the total Output of Price Maker Generator Units that are not Under Test (calculated as the sum of their Market Schedule Quantities) shall equal Schedule Demand in that Trading Period;
13. limits, determined by the Single Ramp Up Rate and the Single Ramp Down Rate, on the maximum amount by which each Generator Unit’s Output can change between Trading Periods shall be observed (including relative to the Generator Unit’s scheduled Output from the last Trading Period of the previous Trading Day as determined by the Preceding MSP Run);
14. limits, determined by the Aggregate Interconnector Ramp Rate, on the maximum amount by which total flow on an Interconnector can increase or decrease between Trading Periods shall be observed (including relative to the total flow on that Interconnector from the last Trading Period of the previous Trading Day as determined by the Preceding MSP Run);
15. in each Trading Period, the total flow scheduled in respect of Interconnector Units for a given Interconnector shall not be less than the most recently Accepted Maximum Export Available Transfer Capacity and not more than the most recently Accepted Maximum Import Available Transfer Capacity for that Interconnector;
16. the energy scheduled from any Energy Limited Generator Unit on both the Trading Day and (separately) in the Ending Overlap Optimisation Period shall not exceed the Energy Limit over the relevant period;
17. the energy (in MWh) maintained within each Pumped Storage Unit reservoir shall be not less than its Minimum Storage Capacity (PSMINLut) and not more than its Maximum Storage Capacity (PSMAXLut);
18. the energy (in MWh) maintained within each Pumped Storage Unit reservoir shall meet the Target Reservoir Level in the final Trading Period of the Trading Day, and the level calculated in accordance with paragraph 5.117 in the final Trading Period of the Optimisation Time Horizon;
19. a relationship is observed whereby the generation of each 1 MWh from a Pumped Storage Unit in generating mode lowers its associated reservoir by 1 MWh while the pumping of each 1 MWh by a Pumped Storage Unit in Pumping Mode raises the associated reservoir by a number of MWh equal to the Pumped Storage Cycle Efficiency for that Pumped Storage Unit.

N.25 The Market Operator shall make a report to the Regulatory Authorities at least four months before the start of each Year, proposing values for each of the following parameters to be used in the MSP Software for that Year: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;
5. the Maximum Export Available Transfer Capacity MSP Constraint Cost;
6. the Maximum Import Available Transfer Capacity MSP Constraint Cost; and
7. the Tie-Breaking Adder.

Glossary

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| Maximum Export Available Transfer Capacity MSP Constraint Cost | means a value that is used within the MSP Software as set out within Appendix N: “Operation of the MSP Software”. |
| Maximum Import Available Transfer Capacity MSP Constraint Cost | means a value that is used within the MSP Software as set out within Appendix N: “Operation of the MSP Software”. |

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| **Modification Proposal Justification***(Clearly state the reason for the Modification)* |
| Interconnector Unit Nominations calculated in EA2, WD1 and Ex-Post runs are limited in aggregate in each Trading Period in the relevant Optimisation Time Horizon by the Maximum Export Available Transfer Capacity (MEATC) and the Maximum Import Available Transfer Capacity (MIATC). This is currently described in Mod\_18\_10v2 in Appendix N.17.4 for EA2 and WD1. However, these limits also apply to the Ex-Post runs which is not mentioned in that sub-paragraph. In this Modification Proposal, the specific references to EA2 and WD1 runs are removed, making the paragraph applicable to all MSP Software runs. It should be noted that the Interconnector Units would be bound individually by their capacity holdings in EA1 and by their MIUNs in EP1 and EP2. As such, MEATC and MIATC are only important in EA2 and WD1. However, as the problem formulation contains these constraints in the EA1, EP1 and EP2 MSP Software Runs, they have been included for completeness.In addition, the software implementation of these limits has included the addition of two additional slack variables and associated penalty costs. This modification proposes to more accurately describe the implementation of these constraints. It also addresses drafting comments arising from the UUC Certification review.The CMS vendor has introduced two additional slack variables into the Unit Commitment problem, Interconnector Import MSP Constraint Cost and Interconnector Export MSP Constraint Cost. Adding slack variables in constraints is a standard approach in Economic Dispatch and Unit Commitment. It allows optimisation engines to produce feasible solutions when constraints are not feasible. These slack variables were introduced to account for the unlikely scenario that where there is a change (reduction) in ATC between MSP Software Runs and the MIUN calculator is not triggered in sufficient time to calculate new MIUN values corresponding to the new ATC limit. The penalty costs associated with the Interconnector Import and Interconnector Export slack variables will be included in the annual T&SC parameters review sent to the Regulatory Authorities as annual settings. For IDT Go-Live the parameters have been set to values above the Over-Generation and Under-Generation MSP Constraint Costs, so that in case of infeasibility the Under and Over Generation constraints would be breached first and the Interconnector Import and Export constraints should never be breached for economic reasons.The constraints detailed in paragraph N.17.4 are also referenced in Section 3 of the Market Operator Solver Policy. The policy document will be updated to include the new constraints. |
| **Code Objectives Furthered***(State the Code Objectives the Proposal furthers, see Section 1.3 of T&SC for Code Objectives)* |
| This Modification Proposal aims to further Code Objective 1.3.5, namely“to provide transparency in the operation of the Single Electricity Market”.  |
| **Implication of not implementing the Modification Proposal***(State the possible outcomes should the Modification Proposal not be implemented)* |
| The description of the treatment of slack variables and their associated penalty costs in the Central Market System shall not be fully transparent.  |
| **Working Group***(State if Working Group considered necessary to develop proposal)* | **Impacts***(Indicate the impacts on systems, resources, processes and/or procedures)* |
| No | No systems changes necessary. |
| ***Please return this form to Secretariat by email to*** *modifications@sem-o.com* |