MIP v LR Study

Title	**MIP v LR Study –Scope of study**
Date	**15th Dec 2009**
From	**SEMO**

Introduction

The Market Scheduling and Pricing (MSP) software used by SEMO is provided by ABB. As part of the delivery of market systems prior to the start of the SEM, ABB provided a software solution that could utilise two commercial standard market solvers. One of these is a proprietary piece of software developed by ABB which solves markets using Lagrangian Relaxation (LR) methods. The other solver is CPLEX's implementation which uses Mixed Integer Programming(MIP).

Both MIP and LR are certified solvers and can be used for publication in accordance with the Trading & Settlement Code.

During the development of the SEM, it was considered that as ABB's LR solution had already been implemented in other markets around the world while the CPLEX solution was not, SEMO would make use of the LR solution as its normal day to day solver, and retain the CPLEX solver for back up purposes only. However, either can be used by the Market Operator

As a result, Lagrangian-Relaxation (LR) is used as the default solver to generate and publish market schedules. MIP has been run if certain predefined events occur, and only published if certain predefined criteria are met, namely around extreme price events driven by established bidding patterns. At present it is neither practical nor feasible to run both solvers and compare results for each run given the current market deadlines and system and resource constraints.

Participants became aware of SEMO's limited use of the MIP solver in study cases during presentations in relation to the Dual Rated modification (Mod 34_08). In response to suggestions from the Regulatory Authorities and to provide some assurance to Participants, SEMO hosted a MOST (Market Operator Single Topic meeting) in August 2008 to explain to Participants the high level workings of the solvers and the process adopted by SEMO when assessing whether a schedule should be reviewed with the MIP solver and when the publication of a solution from the MIP solver was warranted. This was noted in the SEM Committee report for the first year of the SEM, the RAs encouraged SEMO to make Participants aware of the internal business processes which were being used to determine when Market Schedules and Prices were published with the MIP solver.

To provide further transparency to Participants, SEMO agreed to include in its Monthly Market Operator Report a listing of all Ex-Post Initial MSP runs where the MIP solution had been published.

SEMO also undertook to complete a comparative study of the two solvers.[1] The intent of this study is to provide comparative analysis to Participants in the SEM and the Regulatory Authorities. It is hoped that this would provide assurance to Participants with regard to the issue of solver choice in the SEM.

The intention of this study to provide observations on the merits of each solver and recommendations to SEM

[1] It was originally planned that this study might take place in Q4 2008 and Q1 2009. However, issues discovered with the MSP Demand meant a change in priority for the SEMO which was to analyse the MSP Demand issue and provide details of this analysis to Participants.

Scope

A short literature review of peer reviewed studies will be completed prior to commencing or during the study. This should assist in the understanding of the results and also increase confidence in the method adopted.

It is proposed that 150 Trading Days from the start of the SEM will be studied. All days will be studied using the 1.4.11 version of the software. This means that previous schedules published to the market, which may have included defects such as the incorrect MSP Schedule Demand value, will be run using all available solver methodologies. These are –

- LR
- MIP 300
- MIP 600 (run only where MIP300 did not reach the optimality gap required)
- MIP1800 – unlimited (run only where MIP600 did not reach the optimality gap required)

A limited number of further runs will be completed for the following issues:

- LR ALTCOM Limits – Changing the ALTCOM 1 & 2 Limits
- Consecutive Run Dates
- Modifying wind share in the MSP Demand
- MIP Optimality Gap

This will ensure that there are no incorrect observations caused by comparing a MIP run using 1.4.11 against an LR run completed using an earlier version of the software.

The dates selected will be based on the following criteria –

- Standard Trading Days:
  - dates from different seasons;
  - weekdays;
  - weekends;
  - holidays;
  - Christmas/Easter period;
  - high/low wind days;
- Special Cases:
  - Activity on Interconnector (high exports for example);
  - dates observed where Energy Limited Generators Units are not scheduled to their full Energy Limit;
  - dates with unusual Pumped Storage solutions (recent EA day where PS units were not used);
  - dates with price spikes;

Assumptions

The following assumptions are made in connection with this study –

- The use of the outputs of the MSP software in the Capacity Payments Mechanism is only in the marginal factors (Capacity Payments Price Factor and Capacity Payments Generation Price Factor). As a result, it is considered that the impacts of changes to these values is of such a small magnitude that it will not be considered.
- All data remains constant for a Trading Day (that is inputs are fixed across all run types unless otherwise stated)
- Resources are available to complete the work to schedule.
- Systems are available that allow the required study runs be completed.
- All days will be studied using the 1.4.11 version of the software.

Results and Review

The resulting analysis will focus on the results of these runs based on the following areas –

- Productions costs;
- Consumer Costs;
- Market volatility;
- Unit commitment outcomes;
- Market Schedule Quantities,
- System Marginal Prices and Generator Revenues;
- Results viewed by fuel type;
- Constraint Payments.
- Solution times
- Optimality Gap

It would also be desirable to have some studies completed with increased wind generation to assess how the MIP solver might behave with higher penetration of wind as currently proposed. Based on this further studies will be undertaken by SEMO.

A final report will be prepared based on this study. It is the intention that this study will be published in Q1 2010 (end of January is the current proposal) and will be accompanied by a MOST session for Participants.

It is hoped that this will provide a detailed input to the discussion on whether to move the SEM to use a MIP solver or to keep with the LR option.

Timelines

The MIP-LR Study project will follow the timelines set out below.

Study runs completed	August to November 2009
Analysis of outputs	September 2009 to January 2010
Draft report for peer review	January 2010
Peer review	February 2010
Final Report to market	March 2010
MOST presentation	End March 2010