

# Instructions for vSPD model runs

## Introduction

The Electricity Authority's vSPD model is a replica of the SPD model used for scheduling, pricing and dispatch in the New Zealand electricity market. We used the Electricity Authority's vSPD model<sup>1</sup> to estimate the impact on system costs of a:

- MWh-based charge
- diluted HAMI charge

Both of these alternatives were calculated relative to the status quo HAMI charge for the HVDC. The following document provides instructions to setup the different model runs and interpretation of the results.

## Model installation

vSPD is written in GAMS and the user would need to have GAMS installed on their computer to run the model. To install the model<sup>2</sup>:

1. Copy the provided zip file into an appropriate location on your computer (e.g. C:\TPM)
2. Unzip the files (you should have an Input subfolder, an Output subfolder and a Programs subfolder
  - a. The Input subfolder should contain daily input GDX files for the simulation horizon (01 Aug 13 to 31 Jul 14<sup>3</sup>)
  - b. The Programs subfolder contains all the model run files. A separate subfolder (\hvdcddata) has been created within the Programs subfolder relating to additional inputs needed for this analysis. These are described further in the next section.
  - c. The Output subfolder will contain the model output files after a successful model run.

To run the model with a given input configuration, e.g. for a MWh charge:

1. Go to the Programs subfolder
2. Open the HVDCsettings.inc file
  - a. Set the scalar MWhCharge to 7.14
  - b. Set the scalar diluteHAMI to 0
  - c. Close and save this file
3. Open the VSPDRunFile.xls file (select options to run/enable macros if prompted)
  - a. Go to the Settings worksheet and select the directory where GAMS is located on your computer
  - b. Select your licensed solver from the SolverName list

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<sup>1</sup> vSPD v1.3 was used as the base model for this analysis.

<sup>2</sup> This is referring to the provided model. For instructions to install and purchase GAMS please visit [www.gams.com](http://www.gams.com)

<sup>3</sup> These daily GDX files can be downloaded from the EA's emi website ([http://www.emi.ea.govt.nz/Datasets/Browse?directory=%2FArchives&parentDirectory=%2FDatasets%2FWholesale%2FFinal\\_pricing%2FGDX](http://www.emi.ea.govt.nz/Datasets/Browse?directory=%2FArchives&parentDirectory=%2FDatasets%2FWholesale%2FFinal_pricing%2FGDX))

- c. Ensure the Vectorisation flag is set to 1
4. Go to the InputFiles worksheet
  - a. Select the input GDX files corresponding to the modelling period 01 Aug 13 to 31 Jul 14 from the \Input subfolder
5. Go to the MainMenu worksheet
  - a. Specify a run name
  - b. Run vSPD
  - c. The model execution window should appear
6. A subfolder corresponding to the run name specified in the MainMenu worksheet should be created within the \Output folder.

Each day typically takes a few minutes to solve (3-5 minutes)<sup>4</sup>.

Within the HVDCsettings.inc file, the user can specify the scenario to run (MWh charge or the value of N for diluted HAMI and the diluteHAMI flag). A description of these is provided below.

## MWh analysis

The following settings are needed for the MWh analysis.

MWhCharge	'HVDC MWh charge'	/7.14/
diluteHAMI	'Flag to use diluted HAMI'	/0/
\$setglobal numPeaks 10000		

Even though the numPeaks is not used under the MWh charge alternative, a numPeaks value must be specified (i.e. either 10000 or 25000).

The calculated MWh charge is added to grid-connected energy offers in the South Island as illustrated in Figure 1.

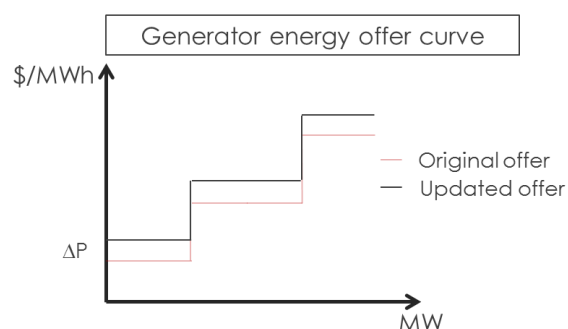


Figure 1: Schematic of MWh adjustment to SI grid-connected energy offers

## Diluted HAMI

<sup>4</sup> Solves that require inter re-solves require additional solve time.

The following settings are needed for the diluted HAMI analysis. For the numPeaks ensure the appropriate value of N is specified (e.g. N=10000 or N= 25000 as in the example below). The diluteHAMI flag has to be set to 1 and the MWh charge set to 0.

\$setglobal numPeaks 25000

MWhCharge 'HVDC MWh charge' /0/

diluteHAMI 'Flag to use diluted HAMI' /1/

The SI grid-connected energy offers are adjusted based on the expected incremental cost of increasing generation that increases HAMI as illustrated in Figure 2.

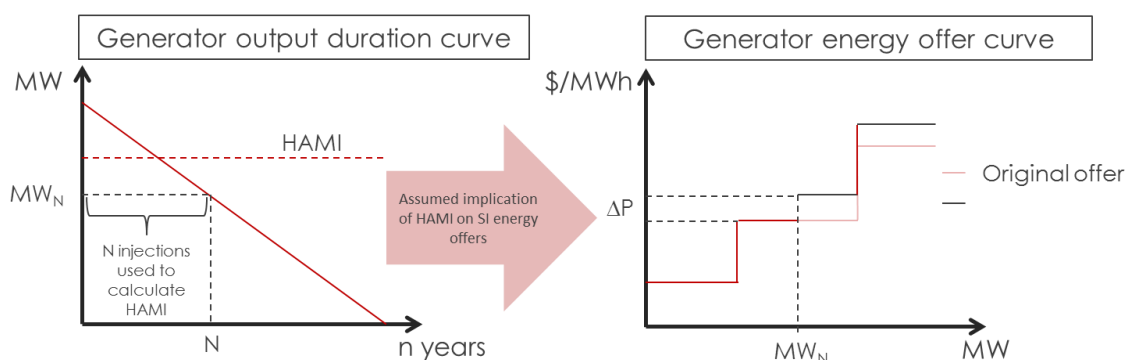


Figure 2: Schematic of diluted HAMI adjustments of energy offers

A summary of the relevant input parameters for each of the scenarios are provided in the table below.

Scenario	MWhCharge	numPeaks	diluteHAMI
MWh	7.14	Either 10000 or 25000 <sup>5</sup>	0
HAMI10000	0	10000	1
HAMI25000	0	25000	1

Table 1: Description of user-specified inputs for each scenario

## Additional input files

In the \Programs\hvdccdata subfolder are the following files:

- hvdccdata.gdx: File contains information about the existing HAMI at each SI grid-connected station, daily (base case) energy production<sup>6</sup>, a list of stations (NI and SI) on catchments with larger storage capability<sup>7</sup> and some mapping sets

<sup>5</sup> Even though an N is specified (e.g. 10000) the diluteHAMI flag being set to zero will result in the MWh charge being applied.

<sup>6</sup> A small positive number (0.001) was added to the daily energy limits to reduce to potential for degeneracy in the solutions.

<sup>7</sup> In creating this list, we referred to the OPUS report (Lake Generation Potential History – October 2010) which is available from

[http://www.emi.ea.govt.nz/Datasets/Browse?directory=%2F20100630\\_Hydro\\_lake\\_storage&parentDirectory=%2F2FDatasets%2FEnvironment%2FHydrological\\_modelling\\_dataset](http://www.emi.ea.govt.nz/Datasets/Browse?directory=%2F20100630_Hydro_lake_storage&parentDirectory=%2F2FDatasets%2FEnvironment%2FHydrological_modelling_dataset)

- i\_Peak10000.gdx and i\_Peak25000 containing a list of the N highest injections at each SI grid-connected station, where N = 10000 and 25000 respectively. The corresponding files without the “I” prefix (peak10000.gdx and peak25000.gdx) are the peak injection lists which are updated as the simulation progresses.
- i\_stnMWhdelta.gdx is a blank initialisation file. The corresponding file without the “I” prefix (stnMWhdelta.gdx) records the unused energy at each of the larger storages from the previous day. This file is also updated dynamically as the simulation progresses to reflect potential additional energy available for use by hydro generators (with storage).

## Results from output files

After a simulation has successfully completed, a subfolder will be created within the output folder corresponding to the run name given to the simulation. The simulation results (output files) will be contained within this subfolder.

## System costs

We assumed market offers were representative of short-run marginal costs for the different generators. These original market offers were then used to calculate the impact on system costs relative to the base case.

These costs (actually twice the costs) are represented by the “OrigSystemCost” column in the XXX\_SummaryResults\_TP.csv output file. The value in this column needs to be halved to calculate the cost in \$.<sup>8</sup>

The difference between the “OrigSystemCost” of the alternate scenarios and the base case was used to provide an estimate of the system cost impact.

Out of the 17520 trading periods during the simulation horizon, 13 trading periods had ramp rate violations. These violations “corrupted” the system costs with constraint violation penalties (which have no economic basis). Adjusting for the constraint violation penalties would not completely correct the issue as this would imply that cheaper resources were used but violating physical constraints. To reduce this impact, we excluded these 13 trading periods from the assessment calculations. This exclusion does not impact the outcome of the analysis.

## Market costs

Load costs and generation revenue<sup>9</sup> represent the market costs and are located in the XXX\_IslandResults\_TP.csv output file. These quantities are already in \$.

Load market costs = aggregate costs faced by loads in the spot market (nodal price x quantity at each offtake location) and generation revenue = aggregate revenue earned by generators in the spot

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<sup>8</sup> This is because of the MWh conversion. The costs are calculated as price (in \$/MWh) multiplied by the scheduled quantity (in MW per hour) for each of the 48 (half-hour) trading periods. However the scheduled energy, which should be used, is actually scheduled quantity/2. Hence we end up with twice the total cost and having to halve the calculated costs.

<sup>9</sup> Generation revenue should include negative load revenue. Injection at some nodes is represented as negative load.

market (nodal price x quantity at each injection location). Negative load revenue is also generation and needs to be added to the generation revenue column.

The difference between the load market costs (and generation revenue) of the alternate scenarios and the base case was used to provide an estimate of the price-based outcomes (i.e. load market costs and generation revenue impact)

### **Market prices**

Prices at BEN2201, HAY2201, OTA2201, WKM2201, INV2201 and STK2201 are recorded in the XXX\_pricerep.csv output file. These were used to compare market prices from the different scenarios against the base case. Prices are reported in \$/MWh.