POWER AND WATER CORPORATION

ASIM CONFIGURATION GUIDE

CHAPTER 1 INTRODUCTION

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CHAPTER 1 INTRODUCTION

1 Introduction

1.1 Purpose

The Asim Configuration Guide shows how to configure ASIM to perform simulations to achieve specific outcomes and/or perform specific analysis; for example conducting NPV analysis, system stability, asset management (generator replacement requirements) or solar/diesel hybrid system feasibility assessments.

Refer to the Asim Reference Manual for an exhaustive list of all configuration options, operational parameters and algorithms.

Refer to the Asim Quick Start Guide for information regarding where to access Asim and how to undertake a simple simulation.

1.2 Document Conventions

This is a note or a warning containing important information that will assist the reader.

This is an example task containing detailed steps to attain a specific outcome by using Asim.

2 Install Asim

Instructions for installing Asim are located in the Quick Start Guide, located in the docs folder of your installation.

- Asim is compatible with Excel versions from 2003 to 2013. Both xls and xlsx document types may be used.
- It is recommended to use the document format that matches your version of Excel.

3 First Look

3.1 Using the Wizard

When you open the Example spreadsheet, you are greeted with the quick start wizard, shown in Figure 1.
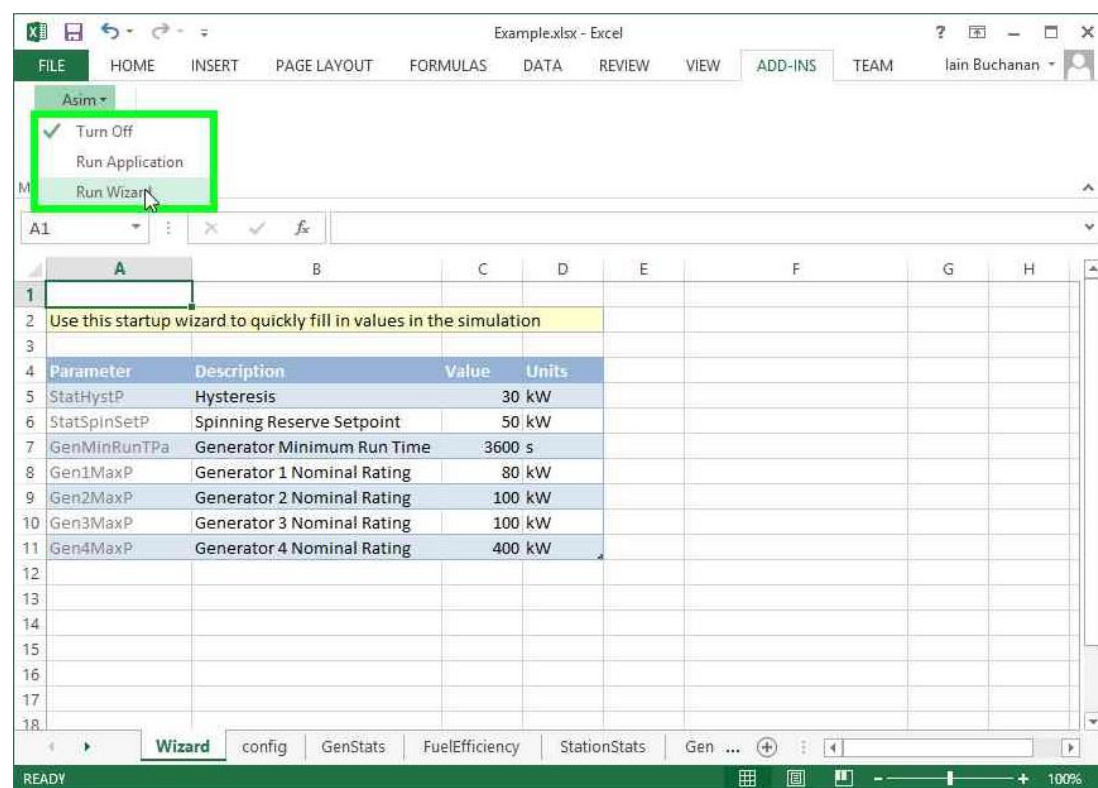
Figure 1: Asim Quick Start Wizard

The WIZARD tab can be used to easily set common values required for the simulation.

Use the wizard tab to run a basic simulation.

1. Enter the required values in the *Value* column
2. From the Asim menu select *Run Wizard*. This will copy the entered values into the following tabs in their correct position.

3. You will see OK after each value that was copied correctly
4. From the Asim menu select *Run Application* to start a simulation

3.2   Configuration

Figure 2 shows the configuration tab that is used to set parameters for the simulation.

Figure 2 Configuration tab
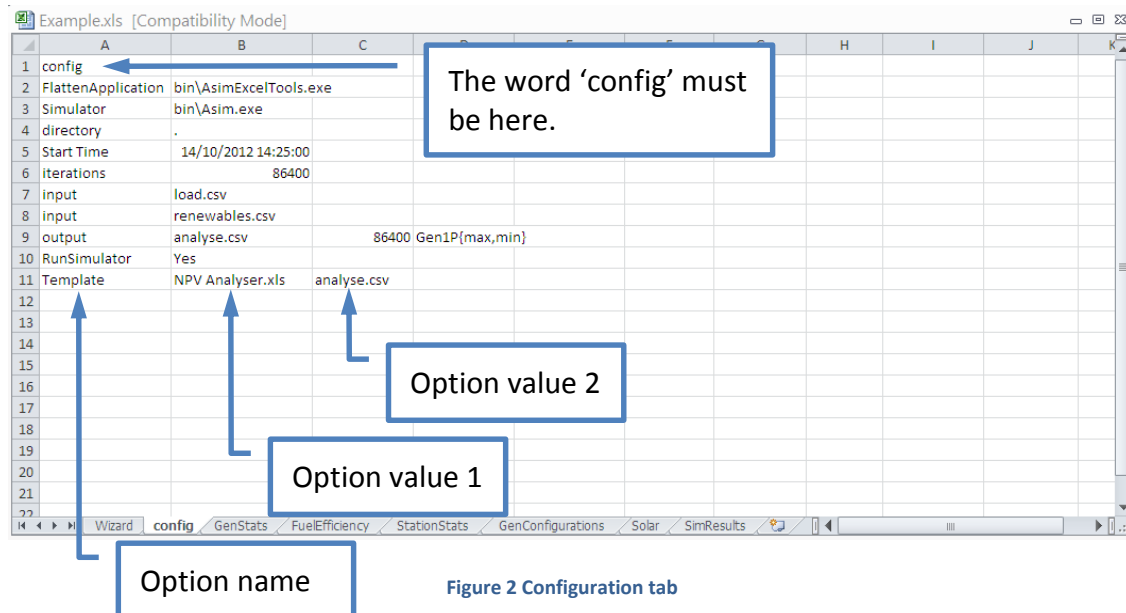
3.2.1   Setting the path

The *Flatten Application* and *Simulator* file paths (to AsimExcelTools.exe and Asim.exe) should be set already. If not, read on to see how to set up the file paths.

The following instructions demonstrate how to set up the *FlattenApplication* path to AsimExcelTools.exe. These same steps can be followed to also set up the *Simulalor* path to Asim.exe.

The paths can be set up either by using an **Absolute Path** or a **Relative Path**.

3.2.1.1   ABSOLUTE PATH

An Absolute Path represents the location of a file or folder starting from the disk drive label, e.g. C: or D:

1. Select the cell adjacent to the cell containing FlattenApplication.
2. A popup similar to Figure 3 will appear. Locate your Asim installation directory and open the bin folder. Select AsimExcelTools.exe.
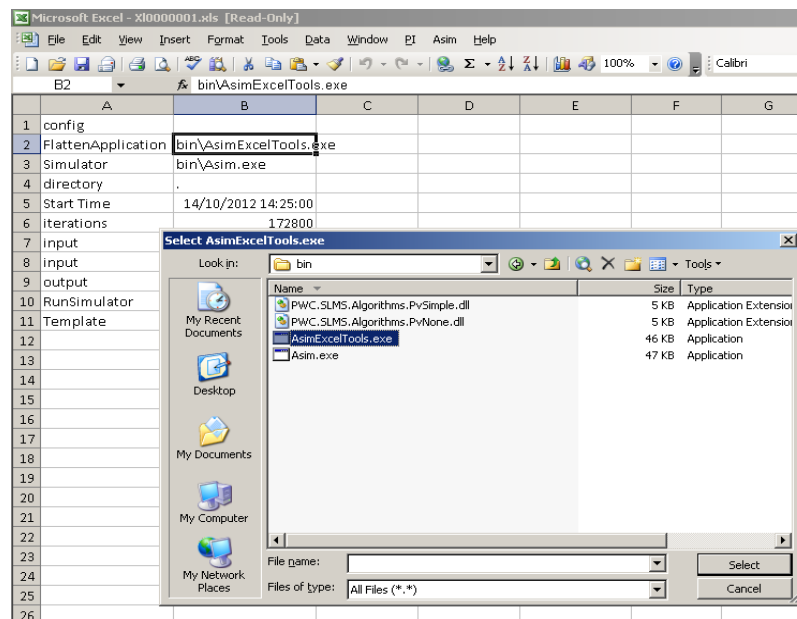
Figure 3: FlattenApplication popup

3. The cell adjacent FlattenApplication will now have an absolute path reference to AsimExcelTools.exe shown in Figure 4 and the path name to AsimExcelTools.exe is now the full path name, for example: `F:\userguide example\Asim\bin\AsimExcelTools.exe`
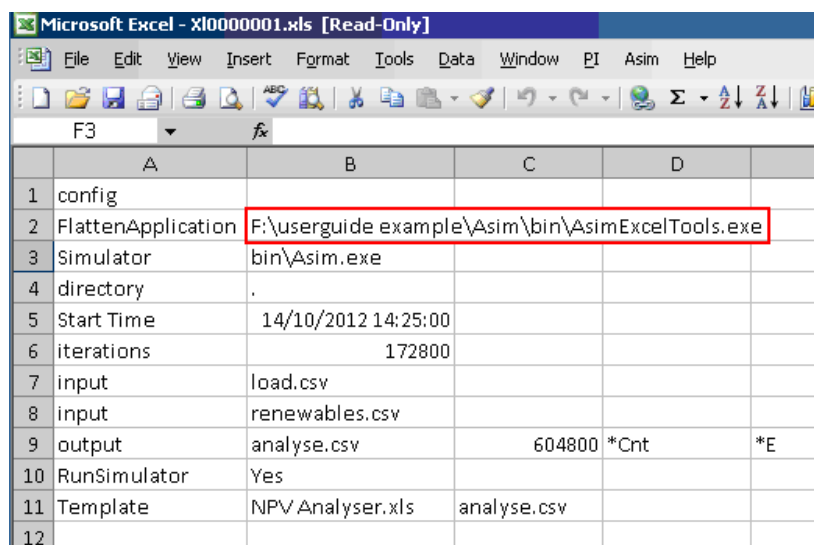
Figure 4: Absolute path to AsimExcelTools.exe

3.2.1.2 RELATIVE PATH

A Relative Path represents the location of a file or folder, relative to another file or folder.

You can set up a relative path by simply specifying the location of AsimExcelTools.exe relative to the Directory option. For example if the Directory option is

`F:\userguide_example\Asim`

then the relative path is the additional location from Asim onwards:

`bin\AsimExcelTools`.

3.2.2 Setting the Directory

The directory is the base for all relative paths used for input files, output files, and program paths.

To set the directory to the same as the spreadsheet you are editing, use ".". Then you can place files in the same folder as the spreadsheet, and refer to them by filename without a path.

3.2.3 Start Time

The Start Time must be in a standard time format such as: dd/mm/yyyy hh:mm:ss AM/PM. Or yyyy-mm-ddThh:mm:ss.

The Start Time cell has two functions.

1. If the input file uses date-time values, then values before the start time will be ignored. (See Figure 5 Input file with date-time)
2. If the input uses seconds values, then 0 seconds will be converted into the start time. (See Figure 6 Input file with seconds)

Figure 5 Input file with date-time

Figure 6 Input file with seconds

3.2.4   Iterations

The Iterations option specified the length of time to run the simulation. Clicking on the cell will bring up a box shown in Figure 7. Entering a time period will convert that period into seconds. For example, for a simulation run over 1 year, enter 1 in the year box and the number 31536000 will be inserted, which is the number of seconds in 1 year.
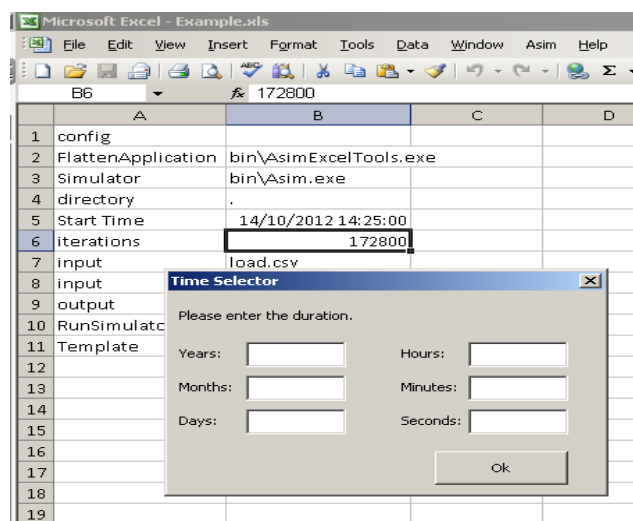
Figure 7: iterations popup

4   An Example Simulation

This is a step-by-step example Asim simulation based on a fictitious solar/diesel mini-grid in the Northern Territory. Please note that the data included in this demonstration is example data only.

CHAPTER 4 AN EXAMPLE SIMULATION

Three input files are used for the simulation:

1. The community load profile *Asim Example Load.csv*. This is the load profile (kW) over time.
2. The available solar power *Asim Example PV.csv*. This is the maximum PV power available (kW) over time based on the size of the PV array and solar radiation.
3. A scaling factor *ScaleLoad.csv* applied to the load to account for community load growth projections.

4.1   Configure Input files

Using the example spreadsheet, set up some input files.

1. Insert a new row, by right clicking row 7 and selecting insert.
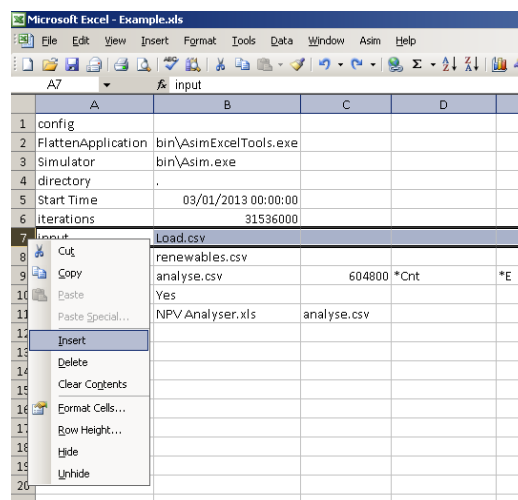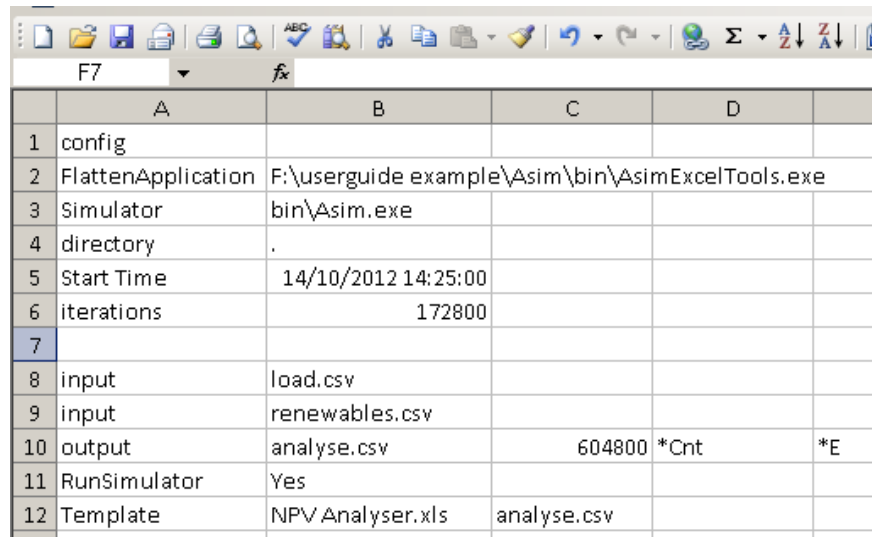
Figure 8: Inserting a new row

Figure 9: Config tab with new row inserted

2. Select cell A7 and a dropdown menu should appear, select input.
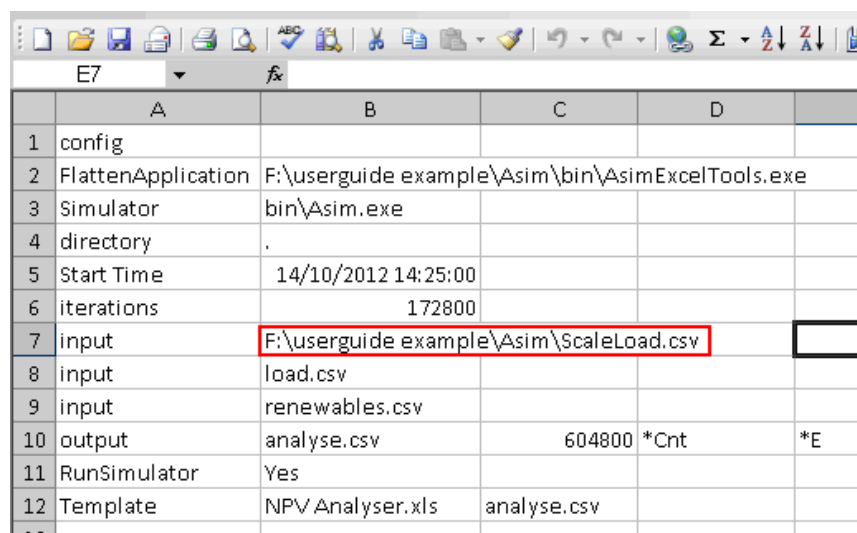
Figure 10: Input field selected from dropdown menu

3. Select cell B7, a pop up should appear allowing you to select the input file *ScaleLoad.csv*. If you use the pop up window to select the file, an absolute path to the input file will be inserted. See Figure 11.

Figure 11: Absolute path to ScaleLoad.csv file

4. An alternative method is to exit the pop up by pressing the escape key and writing the file name *ScaleLoad.csv* into Cell B7.

Figure 12: relative path to ScaleLoad.csv input file

5. Insert or edit the remaining input options for *Asim Example Load.csv* and *Asim Example PV.csv*. The Example.xls config worksheet should now look like Figure 13.

Figure 13: Example spreadsheet

4.2 Configure Generators

Use the example spreadsheet to configure generator parameters to be used in the Asim simulation

1. Select the tab called *GenStats* (see Figure 14).
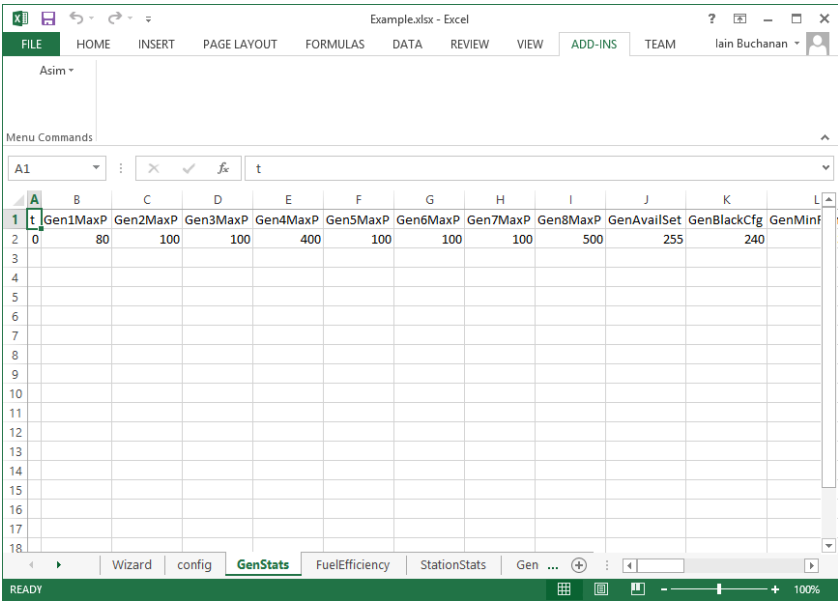
Figure 14: GenStats tab

At our example site, there are three diesel generators which have capacities of 500kW, 450kW and 700kW.

The parameters Gen1MaxP to Gen8MaxP are the rated capacities of generators 1 to 8. The simulator can take up to 8 generators. In this example 3 generators are used.

2. Select the cell under Gen1MaxP and enter the value of 500. Do the same for Gen2MaxP and Gen3MaxP using values of 450 and 700 respectively. The values assigned to Gen4MaxP to Gen8MaxP can remain as these will not be used in our demonstration (see Figure 15).

3. Select the cell below GenAvailSet and a pop up with tick boxes will appear.
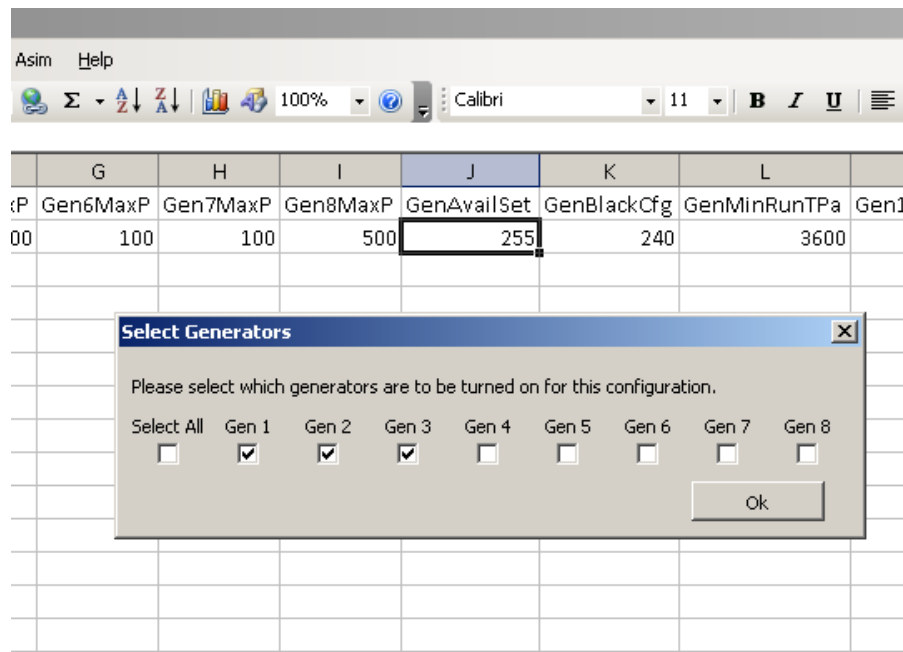
Figure 15: GenAvailSet tick box pop up

4. GenAvailSet determines which generators are available for use. In this case, since there are 3 generators on site, select the boxes Gen1, Gen2 and Gen3.

5. GenBlackCfg determines which generators to start in case of a black start. If you leave all boxes unchecked Asim automatically determines which engines to bring online based on the smallest generator that can satisfy the current load. For this example we leave all boxes unchecked.

6. GenMinRunTPa is the minimum run time for all engines. Minimum run times for individual engines can also be specified. In this example set GenMinRunTPa to 2 hours which is 7200 seconds.

It is possible to begin a simulation with existing run hours on a generator. To do this create a new input file that sets Gen#RunCt for each generator at t=0 (see Figure 16).
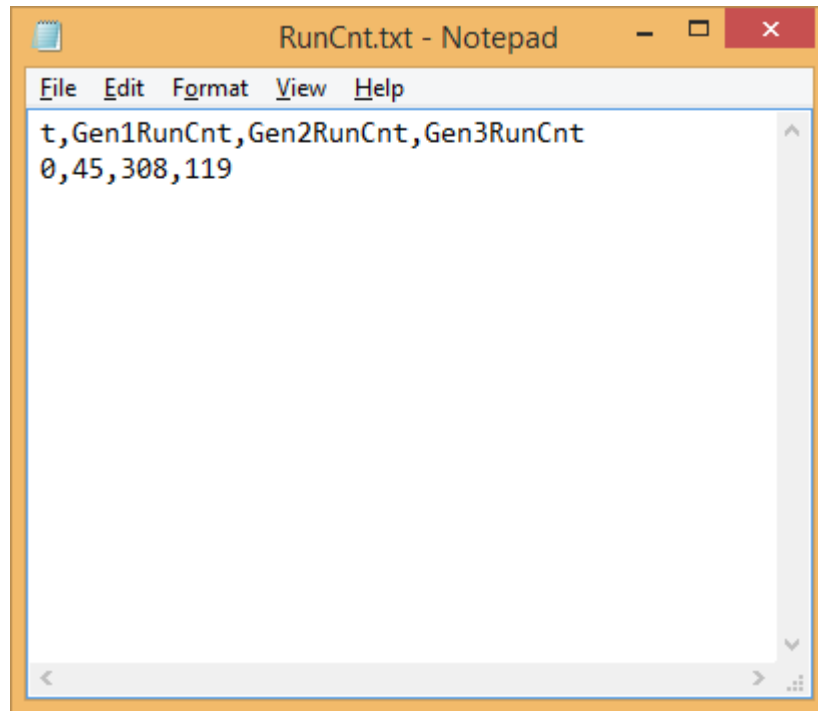
Figure 16 Initial Generator Run Hours

Similarly, to model a new generator being added to the configuration (e.g. old age/load growth), the same method can be used to reset Gen#RunCnt at a particular time.

4.3   Configure Fuel Usage

The Fuel Efficiency tab is where the user can specify the fuel efficiency curve for each generator (see Figure 14).

Use the example spreadsheet to configure Fuel Efficiency parameters to be used in the Asim simulation.
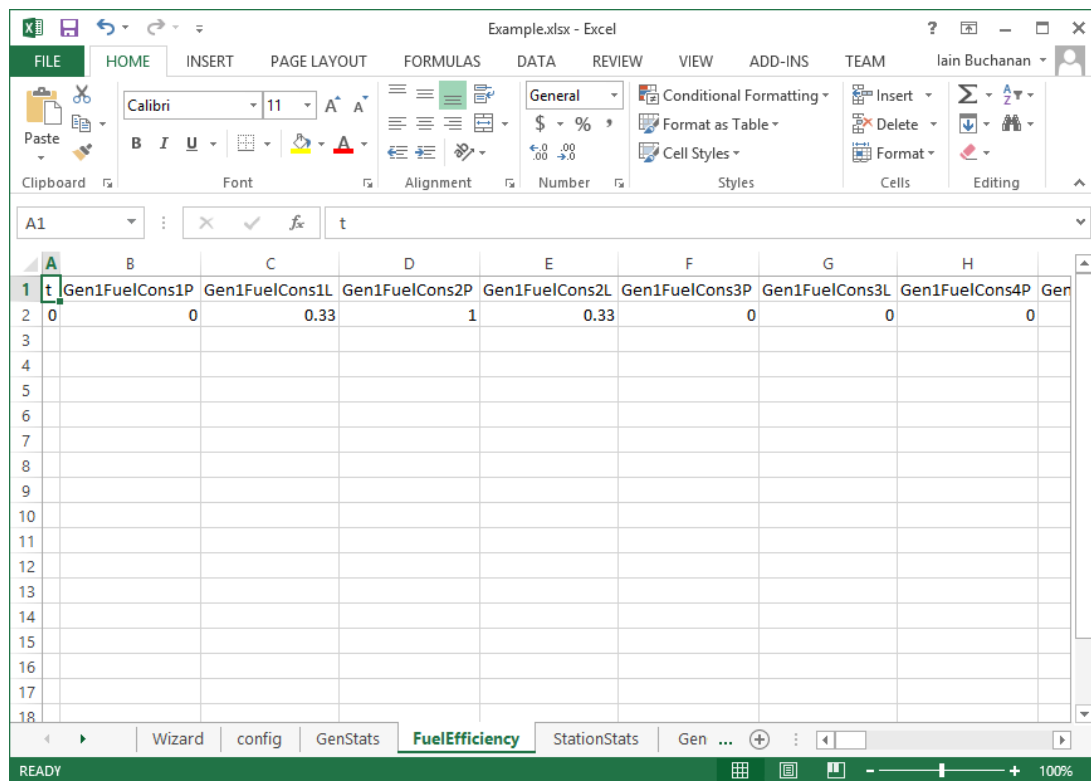
Figure 17: Fuel Efficiency tab

Five parameters (for each generator) can be used to configure the fuel consumption at specific loads.

For generator 1, the parameters are Gen1FuelCons1P to Gen1FuelCons5P; and Gen1FuelCons1L to Gen1FuelCons5L.

The parameter ending in P is a specific load factor (1 = 100%, 0.1 = 10% etc), and the parameter ending in L is the fuel efficiency (in L/h) at the corresponding load factor.

Error! Reference source not found. Table 1 shows sample fuel consumption figures for a 500kW generator, and Figure 18 shows the figures charted on independent axes.

Load %	100	90	80	70	60	50	40	30	20	10
L/kWh	0.262	0.261	0.261	0.266	0.273	0.284	0.301	0.329	0.386	0.549
L/h	131.0	117.5	104.4	93.1	81.9	71.0	60.2	49.4	38.6	27.5

Table 1 Fuel Consumption Values
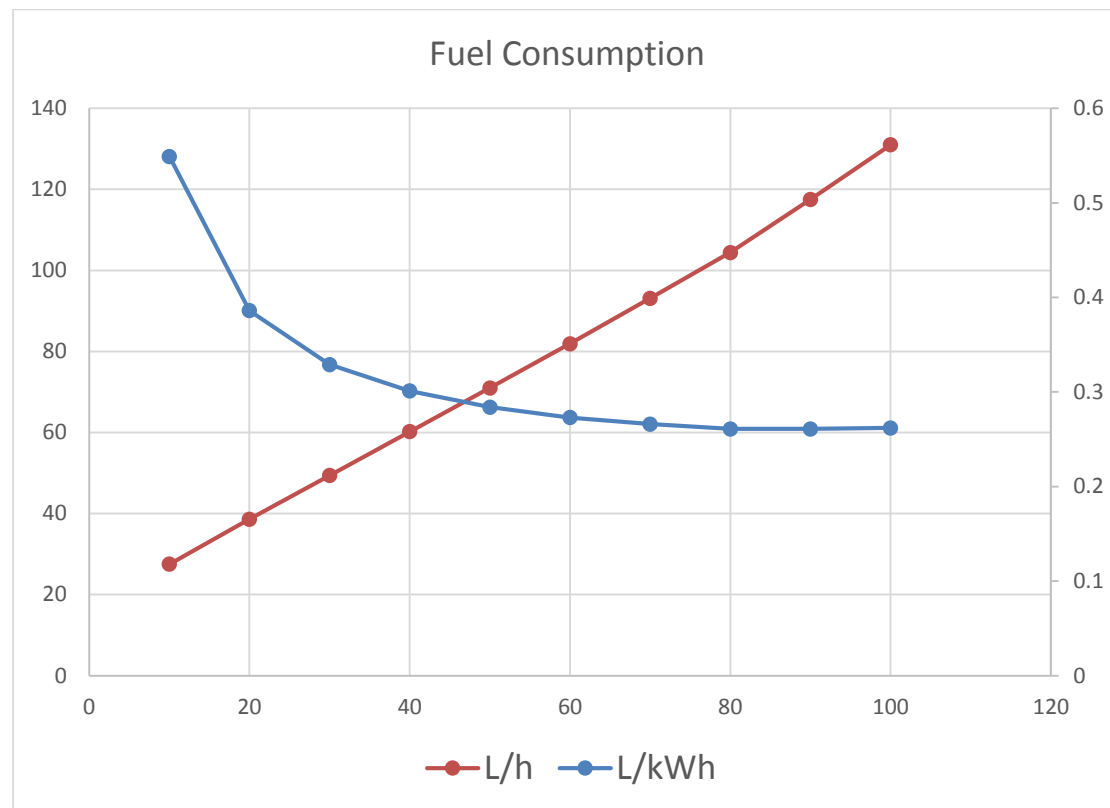
Figure 18 Fuel consumption chart

Asim uses L/h fuel consumption. Since the L/h values are almost linear, we will select three points for this example: one at 10% load, one at 80% load, and one at 100% load. Load factors less than 10% or greater than 100% will use the function of the nearest two points.

Gen1FuelCons1P	0.1	Gen1FuelCons1L	27.5
Gen1FuelCons2P	0.8	Gen1FuelCons2L	104.4
Gen1FuelCons3P	1.0	Gen1FuelCons3L	131
Gen1FuelCons4P	0[1]	Gen1FuelCons4L	0[1]
Gen1FuelCons5P	0[1]	Gen1FuelCons5L	0[1]

1.   Fill in these fuel consumption values for Generator 1

---

[1] Note that these points are disabled by setting P and L to zero.

2. Copy the data to generators 2 and 3.

4.4 Configure Station Parameters

Station parameters such as spinning reserve and change down hysteresis can be configured in the StationStats tab (see Figure 19).
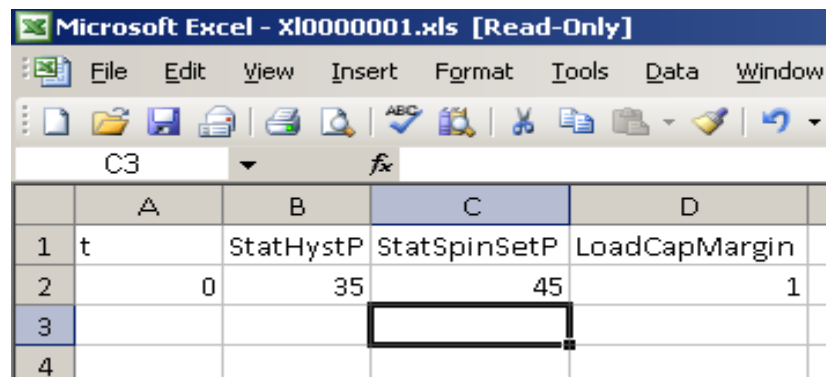
Figure 19 Station Stats tab

StatHystP and StatSpinP are the station's hysteresis and spinning reserve respectively. The LoadCapMargin is used for the redundancy alarm and is discussed in greater detail in Chapter 4 under the section Redundancy Alarm.

Use the example spreadsheet to configure the station's hysteresis to 35kW and spinning reserve to 45kW.

1. Select the cell below StatHystP and enter 35
2. Select the cell below StatSpinP but enter 45
3. Leave LoadCapMargin as 1
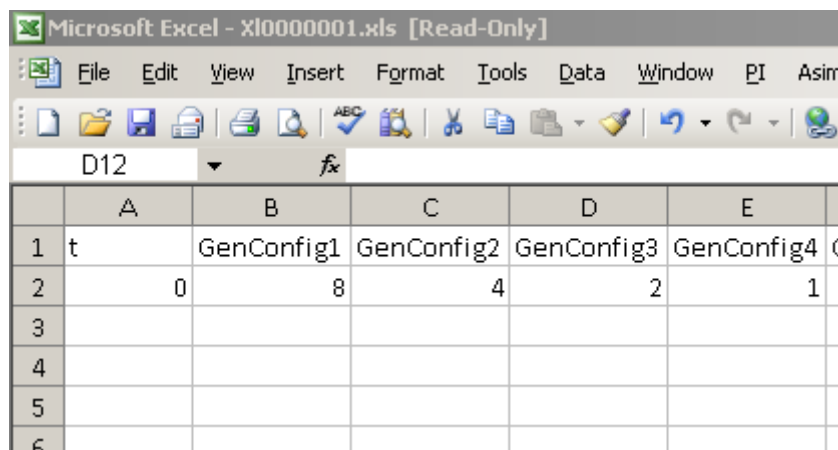
Figure 20: StationStats with data entered

4.5 Configure Generator Start Order

The GenConfiguration tab determines which generators to call up and in what order. GenConfig1 takes precedence over GenConfig2 and so on. Figure 21 shows what the GenConfiguration tab looks like when first opened.

Figure 21: GenConfiguration tab

Use the example spreadsheet to configure the generator start order.

1. Open the GenConfiguration tab
2. Select the cell under GenConfig1 and a pop up box will appear
3. Tick the box to determine which generators to call up for that configuration
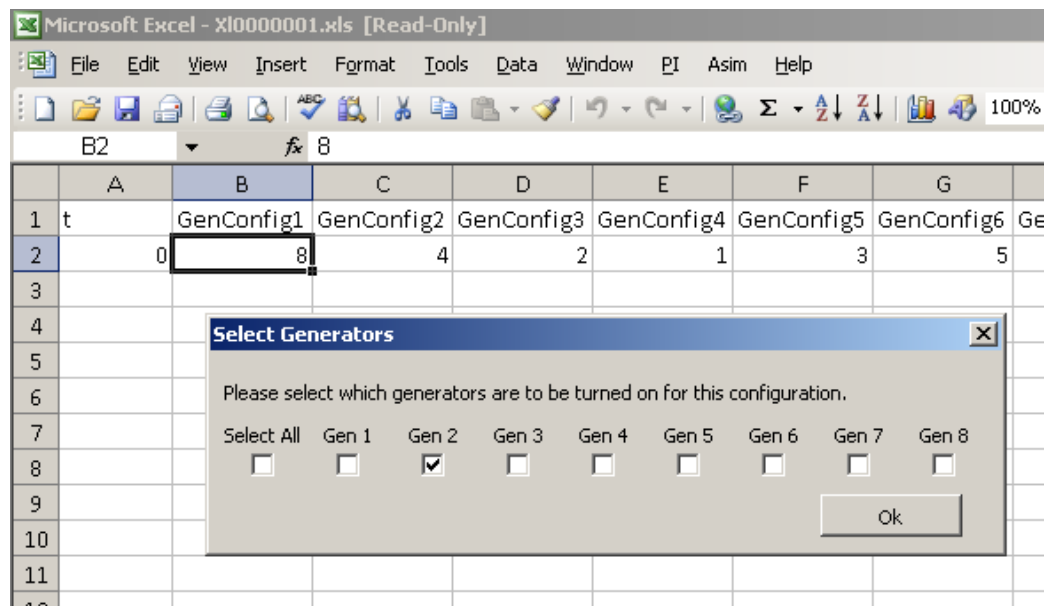
Figure 22: Generator Configuration pop up box

4. Keep repeating for GenConfig2 → GenConfig 19 or until sufficient generator configurations are scheduled. In Asim, up to 256 configs are possible (2^8) for an 8-generator station.

In this example, the smallest engine is used when possible therefore the order in which generators are called up is from smallest total capacity to largest total capacity. I.e. the first configuration is Gen 2 only, the second is Gen 1 only, the third is Gen 3 only. A fourth configuration can be added where sets 1 and 2 operate in parallel, however the load profile never exceeds Gen 3's capacity, so this configuration is never used.

4.6   Configure Photovoltaic parameters

The Solar tab is where you set the maximum ramp up and ramp down rates (in kW/s) for the PV array (see Figure 23).
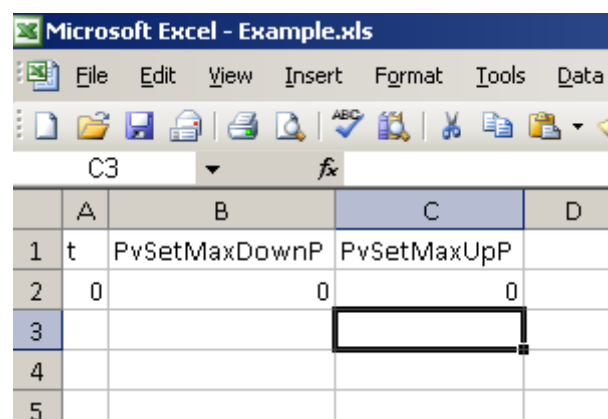
Figure 23: Solar Tab

For this example PvSetMaxDownP and PvSetMaxUpP are both 0.

The Ramp rates are used to control the rate in which solar is increased or decreased per second.

- The ramp up rate is applied to limit the amount power output by the solar so that it smoothly transitions from off or low power to full/almost full power.
- The ramp down rate is applied to limit how fast the power drops from a larger output to a smaller output.

A large ramp down rate is only possible if the power system includes a storage device. It is possible to model the effects of a storage device but this does not model the storage system itself.

4.7 Configure Outputs

After all the tabs are filled out and configured to match the power station, the next step is to set up the output files. The config worksheet should look similar to Figure 13.

Use the example spreadsheet to configure two output files:
- Specify a file for daily statistics called operations.csv
- Specify a file for monthly statistics to assist with economic calculations over a 20 year period called econ_analysis.csv

1. Open the config tab of the example spreadsheet
2. Create a new row
3. Select the empty cell and pick *output* from dropdown menu. The worksheet should now look like Figure 24
4. In the adjacent cell type in the name of the output file (operations.csv or econ_analysis.csv). The file does not have to exist as the simulator creates the output file.
5. Column C, which is adjacent to the output file name, is where you specify the time resolution of the output (how often a new line will be written to that file)
    a. In this example operations.csv will use 10 minute resolution and econ_analysis.csv will use monthly resolution.
    b. Click on Column C to set time resolution
    c. A popup box appears which allows you to select the resolution.
    d. The simulator will automatically convert the time back into seconds.
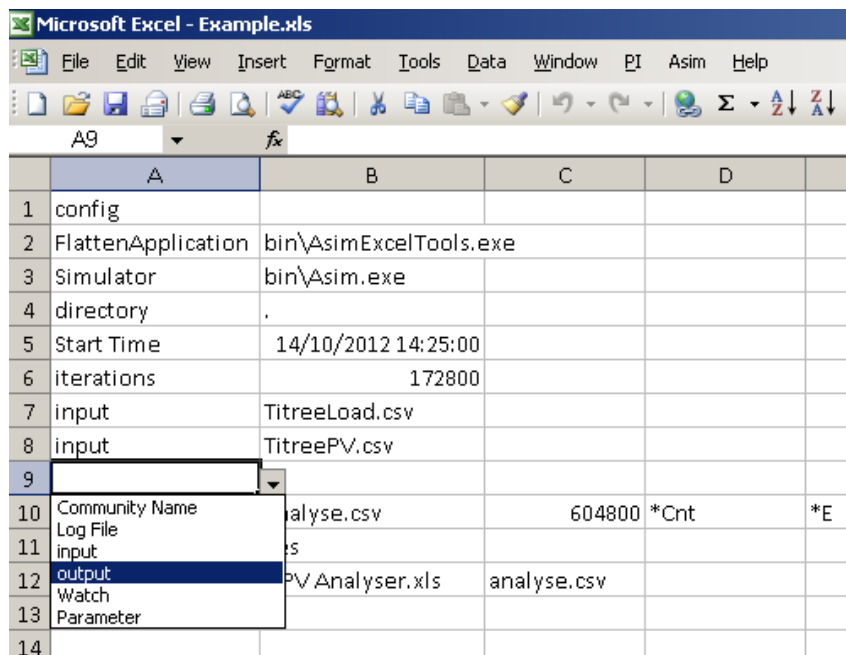
Figure 24: Creating a new output field
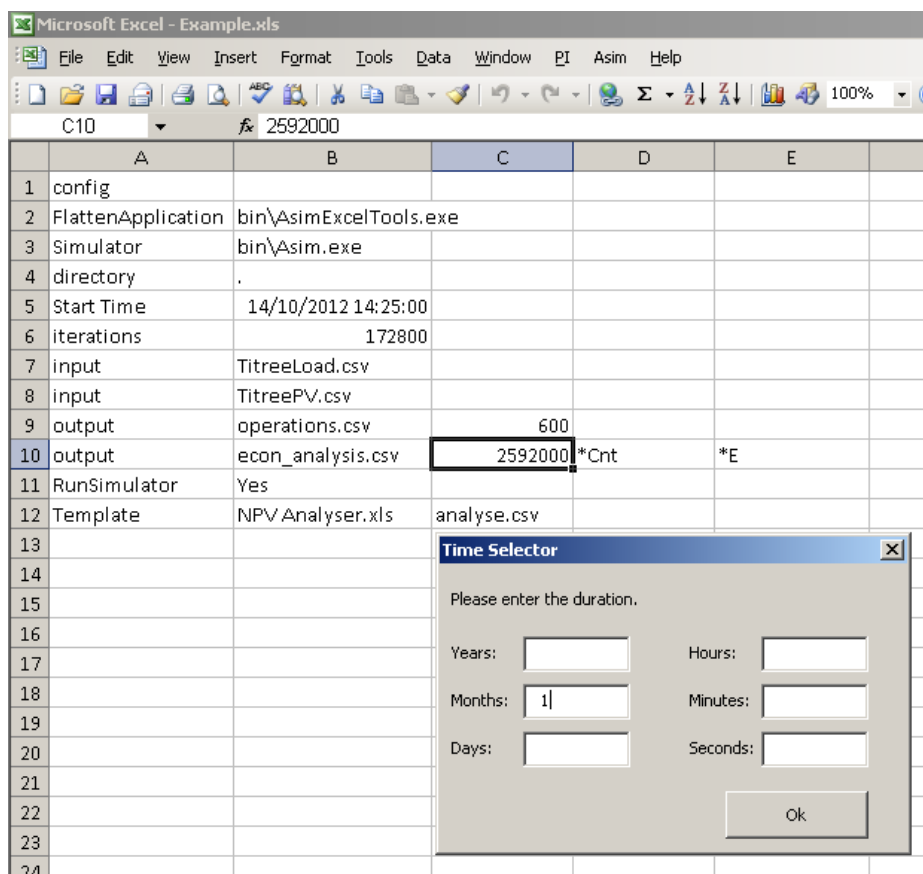
Figure 25: Setting the time resolution for the outputs

6. Now we will specify which output statistics are required. Table 2 shows which output statistics are specified for the two different outputs. For more
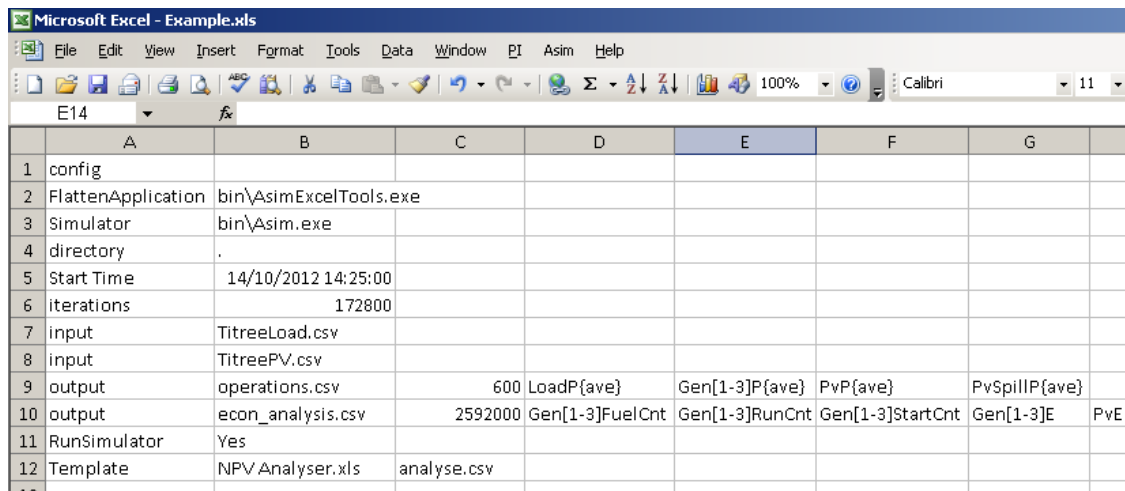
information on variable names refer to Chapter 4 'Output Statistic Nomenclature'.

Operations.csv	*Econ_analysis.csv*
LoadP{ave}	Gen[1-3]FuelCnt
Gen[1-3]P{ave}	Gen[1-3]RunCnt
PvP{ave}	Gen[1-3]StartCnt
PvSpillP{ave}	Gen[1-3]E
	PvE

Table 2: Output statistics specified in config tab

7. To enter the desired output statistics select the cell next to the output resolution for operations.csv and enter the output statistic in each subsequent cell

8. Repeat step 6 but for econ_analysis.csv with the output statistics shown in column 2 in Table 2.

Figure 26 Example config tab with sample output options

9. The output rows should now look like Figure 26.

The statistics nomenclature is discussed in further detail in Section 7.8 Output Variable Nomenclature.

4.8 Creating Templates

Templates are user-created Excel spreadsheets which can represent the output statistics in any way the user wants.

Create two templates:
- A user-defined template to plot the operations of a station for 1 day
- A preconfigured template called *NPV analyser* which calculates economics of the system (including service requirements, O&M and capital costs for new sets) based on run hours, fuel consumption and number of starts of each generator.

1. Create a new blank spread sheet and rename sheet 3 to "autofill". The simulator will look for "autofill" and place all output data into this worksheet.
2. Save this new Excel spreadsheet under the name "operationschart.xls" (for this example) making sure it is saved in the same directory as the inputs files.
3. The operationschart.xls template will be blank for now until we fill the "autofill" tab with some raw data.
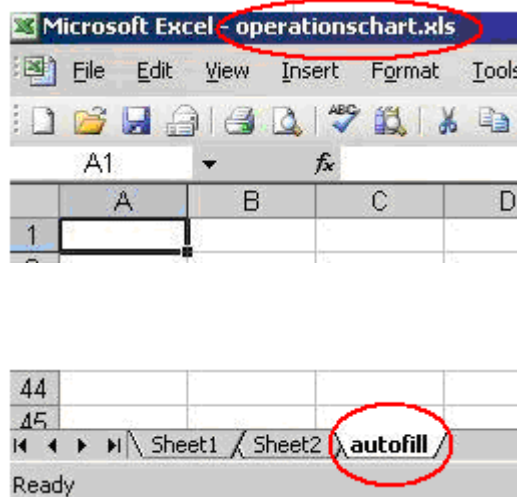
Figure 27: Empty template

Templates must be either Excel spreadsheet file format not CSV. For example .xlsx for 2007 and above and .xls for 2003

4. The *NPV analyser.xls* template can be found in the *Samples* directory of your installation.
5. In the config spreadsheet, insert a new template field by typing the text "Template" below the existing template entry (see Figure 26).
6. Adjacent to the template fields write the file names of the templates "NPV analyser.xls" and "operationschart.xls". It doesn't matter which order the templates are specified as long as the correct output files are linked to them.

7. The field next to the template file names, in column C, is where output files are specified. These entries determine which output file is placed into which template.
    a. For "NPV analyser.xls" enter "econ_analysis.csv" in the adjacent cell.
    b. For "operationschart.xls" enter "operations.csv" in the adjacent cell.

We will run the simulation once to populate the autofill tabs of our templates. This allows us to customise the template with real data.

8. The config tab is now complete and should look similar to Figure 28
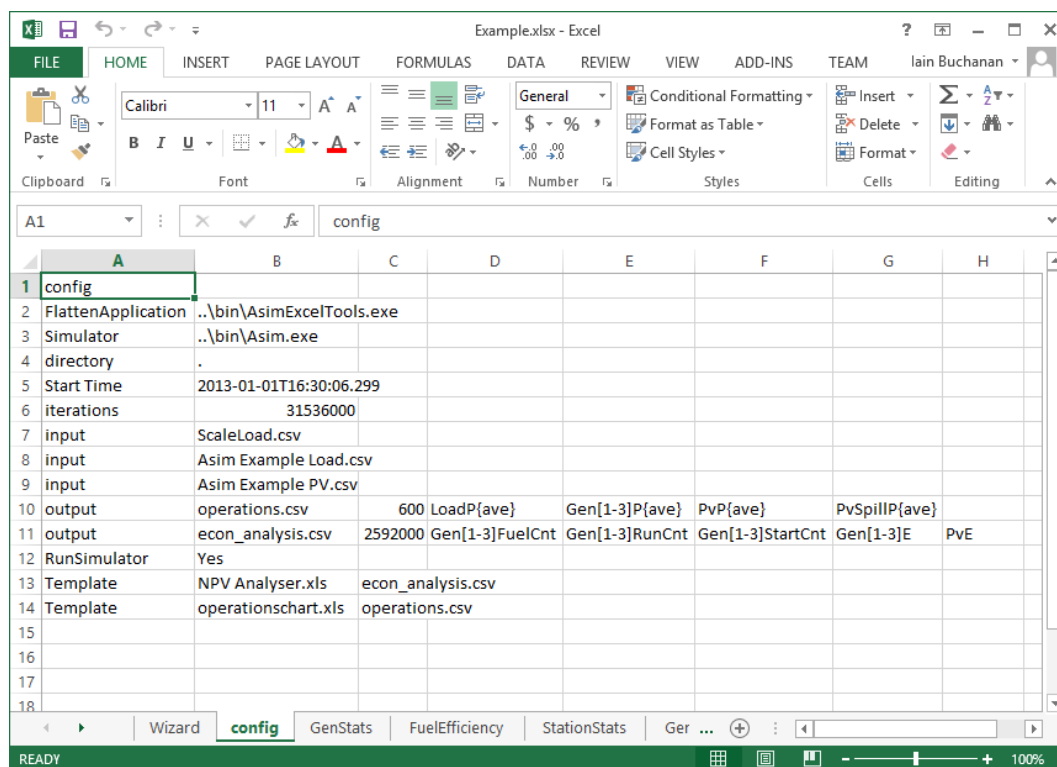
Figure 28 Config tab after templates have been entered

9. Before the simulation is run the time period and start time must be set. The start time used in this example is the first time stamp found in the input file *Asim Example Load.csv*.
    a. Enter a start time of 2013-01-01T16:30:06.299.
    b. Click on column B after the iterations option and enter 1 year

10. Now that config tab is ready for simulation we will run the simulation once so that the operationschart.xls template will contain some output data.

11. Select Run Application from the Asim menu.

The simulation will run for some time and both template files should open in Excel. Ignore the NPV analyser for now as we will reproduce it again after operationschart.xls has been modified.

In this example, the two output files produced are:

- 2013-06-12-15-29-20 NPV analyser.xls
- 2013-06-12-15-29-20 operationschart.xls

When a simulation is run the outputs are named by the date and time at which the simulation was run, prefixed to the specified template name.

Opening "*2013-06-12-15-29-20 operationschart.xls*" will bring up an empty spreadsheet with the "autofill" tab filled with output data. Now the data can be manipulated within spreadsheet to report day to day operations.

12. Create 2 charts as in Figure 29:
    a. One to show load, generator outputs and PV output
    b. One to show actual PV output compared with PV spill.

This example assumes that the user knows how to use Excel and create charts.

13. Once the charts have been completed, save the file as "operationschart.xls" and not "2013-06-12-15-29-20 operationschart.xls". This will overwrite the previous "empty" operationschart.xls template.

Now both templates are ready for use in a real simulation.
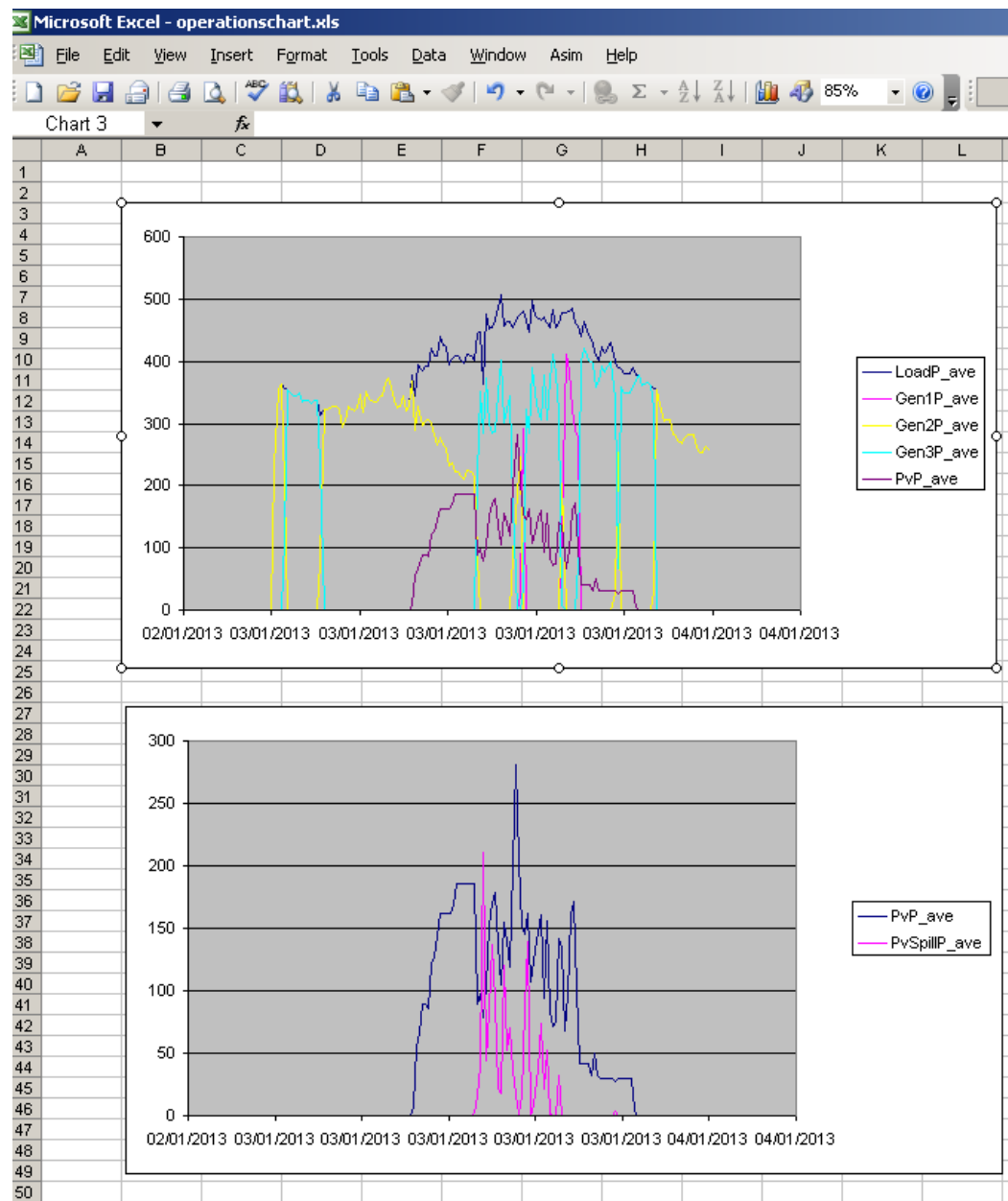
Figure 29: Report from opertionschart.xls

4.9   Running the simulation

Run a simulation and analyse the results (A simulation has already been run to prepare the operationschart.xls template)

1.   Before running the simulation change the start time to 03/01/2013 00:00:00 or 2013-01-03T00:00:00.

Changing the start time and will produce different results from the first simulation. This simple step allows different simulation periods to be executed while re-using graphs and other calculations, showing the power and flexibility of Asim

2. Select Run Application from the Asim menu, and wait for templates to be populated.

Figure 30 shows the contents of *NPV analyser.xls*. Over the 12 month and 4 day simulation period, costs have been tallied for O&M and Diesel. The energy produced in kWh is also tallied allowing a cost of electricity to be calculated and a PV % contribution to be determined.

Figure 30: NPV analyser results

5 Input Files

Before running a simulation, all input data must be collected.

There is only one format for input files: CSV.

Input files may contain any data:

- Load
- Solar
- Sheddable load
- Station parameters

5.1 Single inputs

Use Excel to create two input files with one input in each:
- One file with a relative time series for Consumer demand (LoadP)
- One file with a date/time series for available solar power (PvAvailP)

1. Open two blank workbooks and place the letter 't' in cell A1. The content of the column under "t" is the time values for your input. There is some flexibility in the choice of time values. The different time values compatible with Asim are:
   a. Human readable time such as ISO8601 and formats like "29-march-20110 00:30:03.740"
   b. POSIX time (the number of seconds since the Epoch, or 00:00:00 Coordinated Universal Time (UTC), Thursday, 1 January 1970)
   c. Relative time (the number of seconds since the start of the simulation)
2. Fill in column A in one workbook with a whole-number series starting at zero and incrementing by one (see Figure 31)
3. Fill in column A in the other workbook with a time series, starting at 26/05/2013 00:00:00 and incrementing by one hour (see Figure 32)
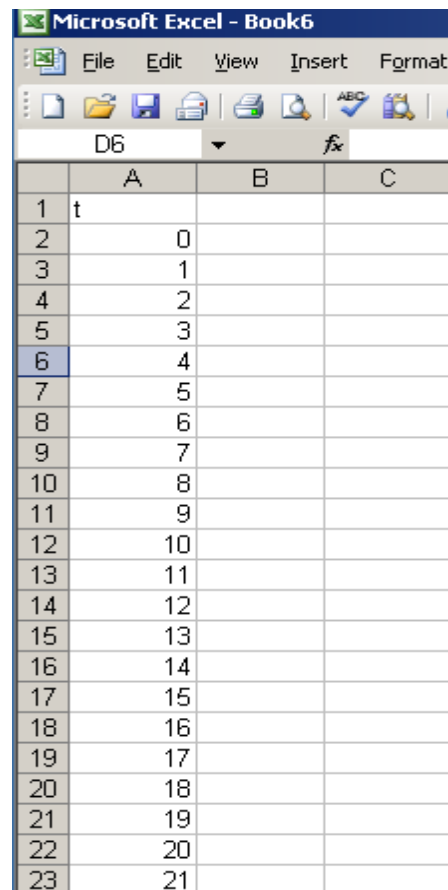
Figure 31: Time series in seconds since simulation start
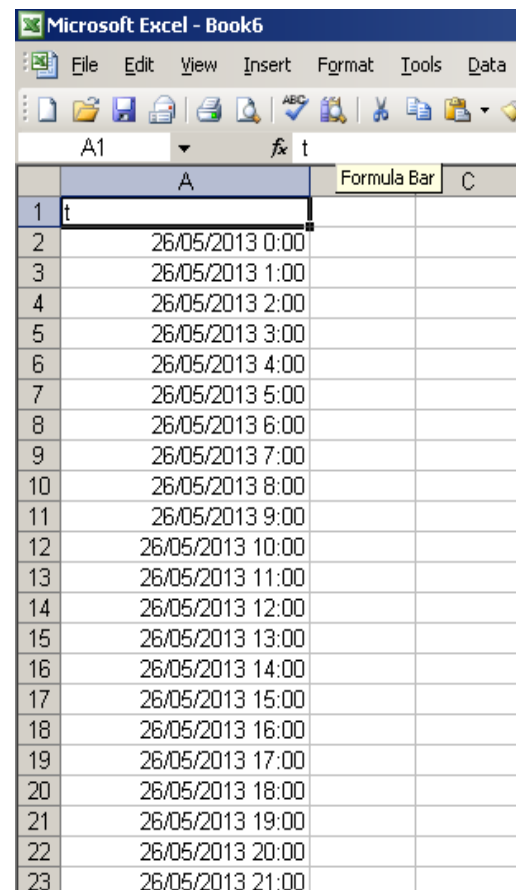
Figure 32: time series in human readable time

- Figure 31 is in seconds since simulation start, which means that for each second of "simulation time" (which is one iteration) a value is read from the input file.
- Figure 32 is hourly time stamps, which means that after one hour of simulation time, a value is read from the input file.

4. Insert the input name in cell B1.
   a. In the relative-time file, enter LoadP in cell B1
   b. In the date-time file, enter PvAvailP in cell B1

   A list of available inputs is in the Reference Manual, section 11.

5. Fill Column B with data from these inputs. The Input files should now look like Figure 33 and Figure 34.

6. Save and export the files in CSV format. They are now ready to be used in a simulation.

- The input files must be saved as CSV file format.
- If data is imported rather than created, you may need to rename the variable headings to the appropriate input name.

- In Excel 2003, the maximum number of rows is 65536, enough for approximately 18.2 hours of 1 second data.
- In Excel 2007 and 2010, the maximum number of rows is 1048576, approximately 12.1 days of 1 second data.

	A	B	C
1	t	LoadP	
2	0	406	
3	1	416	
4	2	507	
5	3	500	
6	4	496	
7	5	475	
8	6	467	
9	7	447	
10	8	471	
11	9	434	
12	10	463	
13	11	440	
14	12	458	
15	13	444	
16	14	454	
17	15	418	
18	16	424	
19	17	400	
20	18	423	
21	19	380	
22	20	385	
23	21	374	

Figure 33: Station load input

	A	B	C
1	t	PvAvailP	
2	26/05/2013 0:00	0	
3	26/05/2013 1:00	0	
4	26/05/2013 2:00	0	
5	26/05/2013 3:00	0	
6	26/05/2013 4:00	0	
7	26/05/2013 5:00	0	
8	26/05/2013 6:00	2	
9	26/05/2013 7:00	15	
10	26/05/2013 8:00	16	
11	26/05/2013 9:00	17	
12	26/05/2013 10:00	18	
13	26/05/2013 11:00	24	
14	26/05/2013 12:00	26	
15	26/05/2013 13:00	29	
16	26/05/2013 14:00	26	
17	26/05/2013 15:00	24	
18	26/05/2013 16:00	18	
19	26/05/2013 17:00	17	
20	26/05/2013 18:00	12	
21	26/05/2013 19:00	8	
22	26/05/2013 20:00	0	
23	26/05/2013 21:00	0	

Figure 34: Solar farm output

- Whilst using Excel is convenient, it is not an ideal tool for generating large 1 second time series data. However, the multi input file flexibility of Asim would allow many 12-day CSV files to be specified as long as the time stamps were continuous. See Figure 35 for an example.

loadp_1.csv	loadp_2.csv	loadp_3.csv
•start: 01/01/2000 00:00:00	•start: 10/01/2000 00:00:00	•start: 20/01/2000 00:00:00
•end: 09/01/2000 23:59:59	•end: 19/01/2000 23:59:59	•end: 29/01/2000 23:59:59
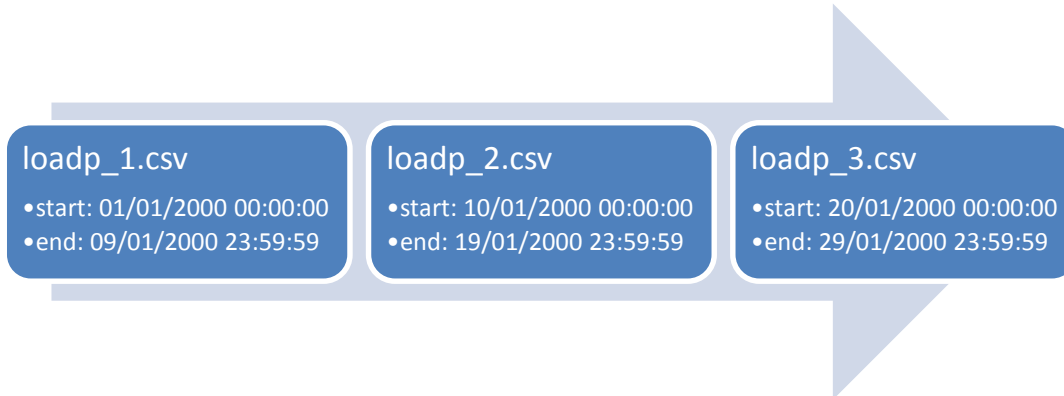
Figure 35 Chaining multiple CSV files

- This limitation is imposed by Excel, not by Asim. Asim can efficiently handle input files with millions of rows!

5.2   Multiple inputs

The user has great flexibility with input files; any number of input files can used.

If the user specifies a time and value, then that input will change at that specified simulation time. For example, to change the capacities of several generators mid simulation, specify the time at which the change occurs and the new value of Gen#MaxP.

Figure 36 shows that after 1 year of simulation the capacities of generators 1 and 2 are changed from their initial capacity to 500kW and 750kW respectively.

Figure 36: Capacities being changed mid simulation

5.3   Input tabs

In the example spreadsheet, the tabs from GenStats to Solar are all considered input files.

- The simulator generates CSV files for each tab in the example worksheet that contains "t" in cell A1.

Therefore users have the ability to:

- add in extra parameters, selected from the input variable list,
- change values at certain times in the simulation
- create new tabs to add information into the simulation (for example generator service schedule; see below)

Limit the maximum solar production to 500kW, even though your available solar input file has values greater than 500kW.
- The variable PvMaxLimP sets a maximum PV capacity produced by the system

1. Open the example spreadsheet from your Asim installation
2. Open the Solar tab
3. Add the variable PvMaxLimP into row 1 in a new column
4. Enter 500 below PvMaxLimP

Figure 37 shows the updated Solar tab.

Figure 37: Solar tab with extra variable added.
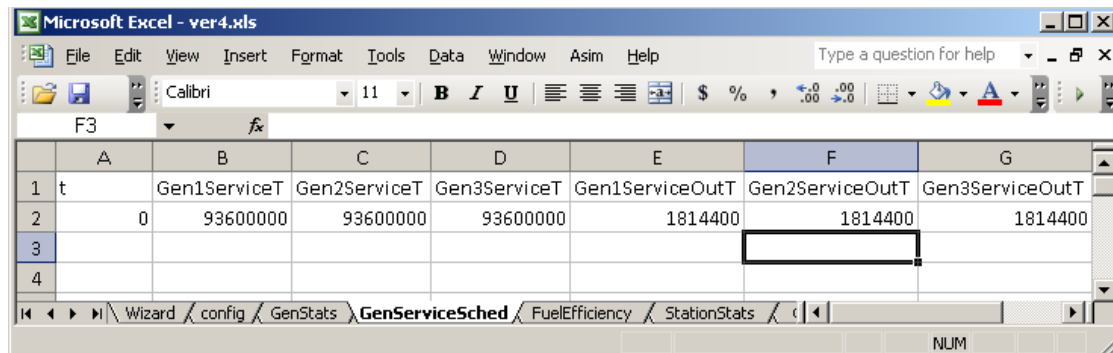
Create a new tab with additional service schedule information to bring generators offline for certain time periods.

1. Open the example spreadsheet from your Asim installation
2. Create a new tab and name it GenServiceSched

3. Put the letter t in cell A1, and 0 in cell A2
4. Add some parameters for configuring the service outage periods and times for generators in row 1 (see Figure 38)

Figure 38: New tab created with service schedule example

- Gen1ServiceT is the amount of run hours (Gen#RunCnt) that may elapse before the generator is taken offline for a service.
- The value 93600000 is 26000 hours converted into seconds.
- Gen1ServiceOutT is the amount of time the generator is offline for servicing

6 Output Files

Output files are used to display the output of specified parameters in a CSV file. The user has the ability to specify multiple outputs. For each output variable, its resolution can be specified e.g. from 2 second statistics to annual statistics of each variable, such as a maximum, minimum and average.

6.1 Creating output files
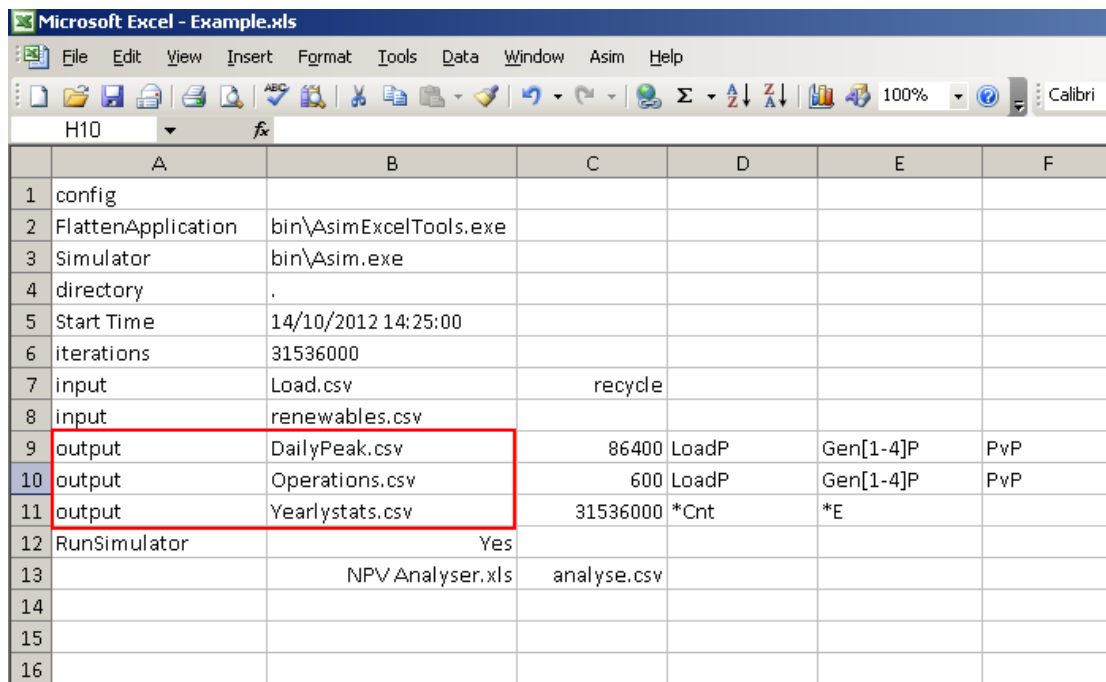
Create three new output files in the example spreadsheet:
- DailyPeak.csv (1 day statistics)
- Operations.csv (10 minute statistics)
- Yearlystats.csv (yearly statistics)
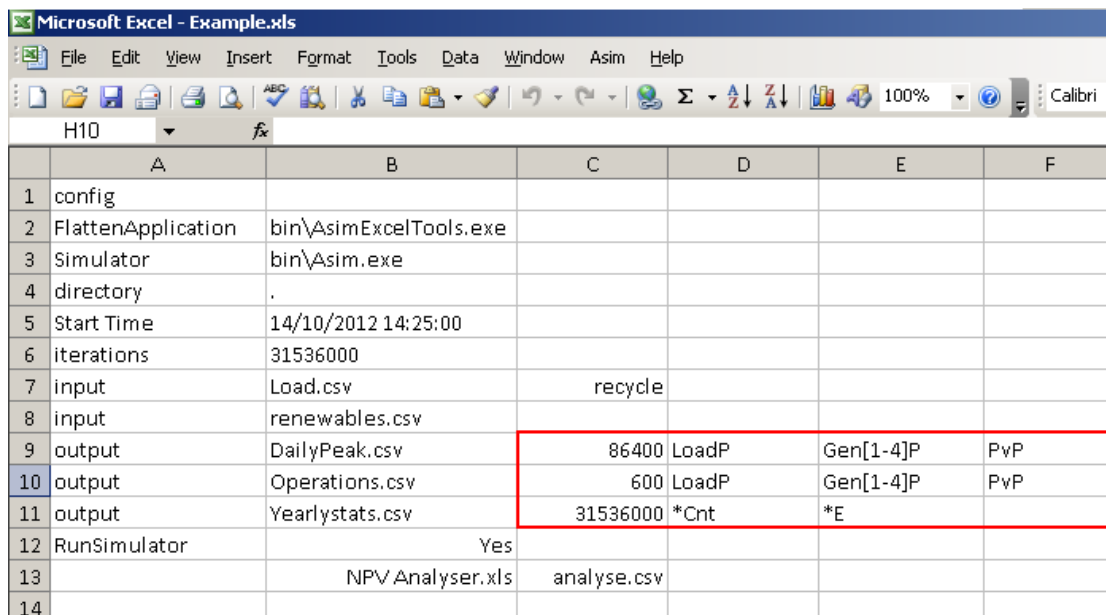
1. Open the example spreadsheet
2. Insert or edit the existing output rows. Select output from the dropdown menu in column A
3. Enter the file name into column B for each output file above (see Figure 39)
4. Select column C and enter the period into the popup window for each output file
5. Enter the variables as shown in D9 – F11 in Figure 40.

Figure 39: Output fields

Figure 40: Output time resolution and output parameters

After the simulation is finished, the three files will contain the following data:

- DailyPeak.csv will contain one row of data for every day of the simulation (for a one year simulation, that is 365 rows). The output parameters will be consumer load statistics, Generator output statistics, and solar output statistics.

- Operations.csv will contain one row of data for every 10 minutes of the simulation (for a one year simulation, that is 52560 rows). The output parameters will be consumer load statistics, Generator output statistics, and solar output statistics.
- YearlyStats.csv will contain one row of data for every year of the simulation (for a one year simulation, that is one row). The output parameters will be the final yearly value of all counters and energy totals. This will allow the user to see the fuel consumption, energy produced in kWh and run hours of each generator for the year.

- There is no limit to the number of output fields however more variables will slow the total simulation run time.
- See the Asim Reference Manual, section 8.3 Output Statistics for more information on statistics generation.

6.2 Creating output templates

Templates are user created worksheets that summarise or analyse the data from the simulation.

A template is set up by the user before running a simulation.
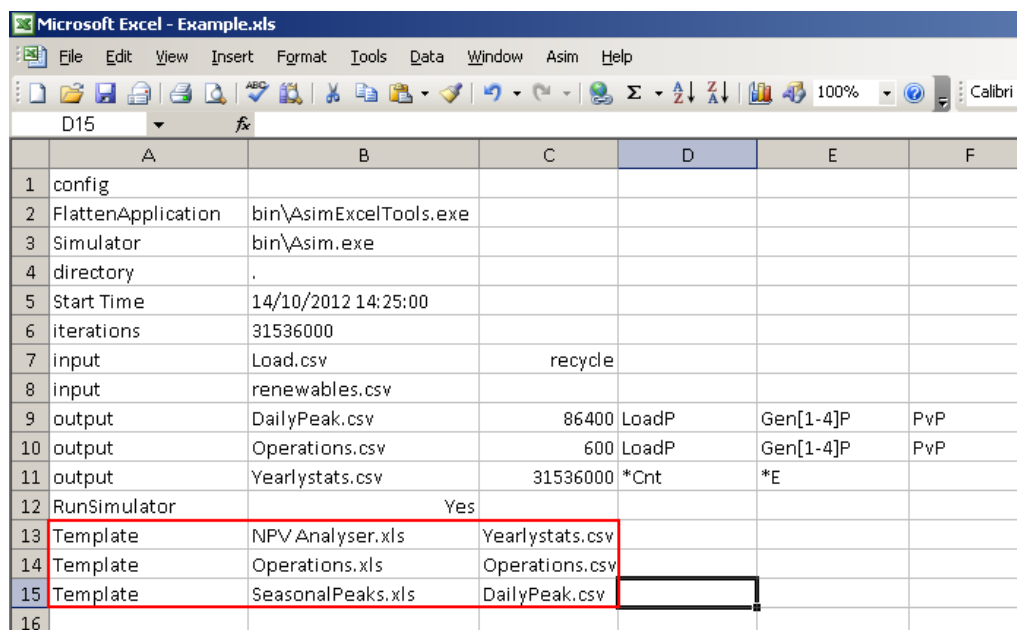
Templates give assistance to higher-level analysis of the data from a simulation, including:

- System performance
- Economic analysis
- Project plans
- Asset Management
- Station optimisation
- And many more

- Instructions for creating a template are in Section 4.8 Creating Templates.
- The more templates in the simulator the slower it takes to run.

Figure 41 shows the configuration of three templates.

Figure 41: Config tab showing multiple templates

7 Functional Notes

7.1 Consumer Demand

Asim reads consumer load data as kW values and records the load value for each date stamp specified. For example if the load data supplied has data every 10 min then Asim will record the value for the first instance of the data point then keep that value for 600 samples (Asim is based on a one second cycle therefore 10 minutes is 600 seconds, or 600 samples). When the next date stamp is reached the new data point will override the value of the previous one.

Load data can also be scaled using a scaling input. To find out more about scaling inputs, refer to the Asim Reference Manual, Chapter 8.4 Scaling.

Load data can also be recycled (repeated when the end of the file is reached) which is ideal for applying load growth for future years.

7.2 Solar

Asim reads solar data as kW values and records each solar value for each date stamp specified.

Asim only accepts one solar input representing the total available solar power. If your system has several PV farms then they need to be added and treated as one input.

The amount of solar power simulated by Asim is based on system load and generator minimum load requirements. For more information on solar control methods, see the Asim Reference Manual, section 8.5.2 Solar Control.

Solar input data can also be recycled and scaled.

7.3   Sheddable load

Sheddable load is a form of load management that allows the power system to shed low-priority customer loads in order to decrease the load demand in certain conditions.

Asim treats all sheddable load as a variable controllable load. That is, the load can be switched on or off by any value up to the total available sheddable load.

Asim allows users to set the latency of shedding the load. This will make the actually sheddable load track the sheddable load setpoint by the defined number of seconds.

Sheddable load can modify the spinning reserve calculation, since sheddable load can be considered an offset for a fixed minimum spinning reserve requirement. Depending on the *maintain spinning reserve (StatMaintainSpin)* parameter, generators may reach 100% load factor.

Load will be shed when generator load factor reaches the *ideal sheddable load factor (ShedIdealPct)*. Asim will only shed enough load to reduce the generator load factor back to ShedIdealPct.

The Sheddable load functions to improve system stability in the presence of solar energy. It allows time for generators to be called up when solar is cut out, due to cloud-over event, or when a load spike occurs. It can also improve renewable penetration by allowing a generator to stay online for longer by covering the spinning reserve set point.

7.4   Changing Variables Mid-Simulation

The variables used throughout this guide are interchangeable with any variables in the Asim Reference Manual. Any variable can be changed mid simulation.

Changing variables in a simulation is precisely the same as providing consumer load or available solar power. You may provide **any variable** in a time series format.

Inputs such as generator capacity, available generators, station spinning reserve and even generator configurations can all be changed. The format is the same as described in section 5.1 Single inputs.

This provides many options, such as

- Replacing generators due to end of life
- Changing generator scheduling due to increased capacity
- Service scheduling (bring generator offline for certain time periods)
- Increasing maximum available solar
- Changing spinning reserve due to increase in largest load

7.5 Redundancy Exceeded Alarm

Asim has a function to show when the peak load exceeds the rated capacity of the "N-1"th smallest generator sets:

$$PeakLoad > \sum_{n=1}^{n-1} GenMaxP_{Smallest\ Generators}$$

Equation 1 Redundancy Exceeded

It does this by checking the capacity of all generators except the largest, and compares this to the peak load up until that point. If peak load is greater than or equal to this capacity then the alarm is raised.

The variable LoadCapMargin allows the user to set what percentage of the peak load will trigger this alarm according to the equation:

$$PeakLoad \times LoadCapMargin > \sum_{n=1}^{n-1} GenMaxP_{Smallest\ Generators}$$

Equation 2 Redundancy Exceed with Scaling Factor

Configure the Redundancy Exceeded Alarm to raise when the sum of N-1 smallest sets is less that 125% of the peak load.

1. Open the example spreadsheet
2. Select the *StationStats* tab
3. Under *LoadCapMargin*, change the value from 1 to 1.25
4. Open the *config* tab
5. Add the variable *LoadCapAl* to the end of an output line
6. Run the simulation
7. Open the output file from instruction 5. You will see a column titled *LoadCapAl* that contains a 0 or 1. 0 represents off or low, and 1 represents on or raised.

7.6 Recycle

Recycle is a function that allows Asim to reuse input data. Once it reaches the last data point in the input file Asim will jump to the beginning of the input file and start again. Used in

conjunction with the scaling function (explained below), this will allow for load growth simulations using one year's worth of data.

To activate this function simply enter the text "recycle" in the cell adjacent to your input file name cell (see Figure 39 above).

7.7   Scaling

Scaling allows the user to scale input data by using an input scaling file. The scaling function contains a multiplier and offset constant which is applied to the variable before each iteration:

$$v_1 = v * m + k$$

Configure the simulator so that one year of consumer demand data is used for a 20 year simulation. Scale the consumer demand every year by 10% of the previous year.

1. Open the example spreadsheet
2. Open the config tab
3. Enter an input file name containing one year of consumer load data (LoadP). In column C, enter the word 'recycle'
4. Open a new blank spreadsheet
5. Enter the values from Table 3 below into the blank spreadsheet, so that the letter t is in cell A1
6. Save this new file in CSV format and name it ScaleLoad.csv
7. Return to your example spreadsheet and enter another input file, choosing ScaleLoad.csv for the file name
8. Select the iterations cell, and enter 20 years
9. Run the simulation

t	>StatP
31536000	*1.00+0
63072000	*1.10+0
94608000	*1.21+0
126144000	*1.33+0
157680000	*1.46+0
189216000	*1.61+0
220752000	*1.77+0
252288000	*1.95+0
283824000	*2.14+0
315360000	*2.36+0
346896000	*2.59+0
378432000	*2.85+0
409968000	*3.14+0

441504000	*3.45+0
473040000	*3.80+0
504576000	*4.18+0
536112000	*4.59+0
567648000	*5.05+0
599184000	*5.56+0

Table 3: scaling input file example

For more information on scaling refer to the Asim Reference Manual, Section 8.4 Scaling.

7.8 Output Variable Nomenclature

There are several ways of customising the output variables to assist with reporting.

Read the Asim Reference Manual, Section 8.3 Output Statistics, before continuing with this section.

These are some examples of the different variables and statistics you can produce for output files. The variable name can include wildcard characters, such as *, which allow you to match multiple variable names.

Table 4 assumes the output period is set to 1.

Variable	Output	Notes
Gen1P	Gen1P	To produce the simplest set of results, enter an exact variable name without any special characters
Gen[16]P	Gen1P Gen6P	Square brackets are used to specify *any* **single** *character from the group in the brackets*. In this example, [16] means "1 or 6"
Gen[1-8]P	Gen1P Gen2P Gen3P Gen4P Gen5P Gen6P Gen7P Gen8P	Square brackets with a hyphen are used to specify *any* **single** *character from the* **range** *in the brackets*. In this example, [1-8] means either 1, 2, 3, 4, 5, 6, 7 or 8.

Variable	Output	Notes
*Cnt	All variables that end in the characters 'Cnt'	A wildcard * will match anything (and nothing!). In this case, any variable that ends in Cnt will be written to this output file

Table 4 Output Variable wildcards

- Table 5 assumes the output period is greater than 1.
- In this case, a variable is replaced with five variables representing the minimum, maximum and average in the time period between two rows.

Variable	Output	Notes
Gen1P	Gen1P_min Gen1P_minT Gen1P_max Gen1P_maxT Gen1P_ave	To produce the simplest set of statistics, enter an exact variable name without any special characters. This is replaced with the minimum, maximum, and average over the period.
Gen1P{ave,max}	Gen1P_max Gen1P_ave	Braces can be used to limit the statistics for a given variable. Place the statistics you want inside the braces. In this example, {ave,max} is replaced with _ave and _max for Gen1P
Gen[1-8]P	Gen1P Gen2P Gen3P Gen4P Gen5P Gen6P Gen7P Gen8P	Square brackets with a hyphen are used to specify *any* **single** *character from the* **range** *in the brackets*. In this example, [1-8] means either 1, 2, 3, 4, 5, 6, 7 or 8.
Gen[1-3]P{ave}	Gen1P_ave Gen2P_ave Gen3P_ave	A mix of the wildcards and statistics can also be used. All statistics in the braces are matched with all variables from the wildcard.

Table 5 Output Statistic Wildcards

7.9   Use Asim to start another program

Asim can execute any other application that you have privileges to run manually. You could use this feature to:

- Archive all files related to the Asim simulation in a zip archive
- Log the results from a simulation
- Start a custom graphing program and graph the results

Sample batch files are included in your Samples directory of the Asim installation to perform these tasks. These files are samples only and should be customised to your requirements.

DO NOT RUN ANY EXECUTABLE UNLESS YOU KNOW THE SOURCE OF THE FILE AND TRUST IT. It is possible to install viruses, trojans, and perform malicious tasks by running unknown executables on your system.

Read section 7.2 Program Options of the Asim Reference Manual, regarding the Batch Command program option before continuing with this section.

To run start another program with Asim, first decide whether the application

- is aware of the Asim Environment (i.e. it has been compiled specifically to be run by Asim), or
- requires further manipulation or options to be run from Asim

7.9.1   Applications that are Asim-aware

Application that are Asim-aware can take advantage of the environment variables that Asim creates for executables to use.

Use Asim to run the application *myapp.exe* designed to integrate with Asim that performs some custom tasks.

1. Open the example spreadsheet
2. Open the config tab
3. In an empty row, click column A
4. Select "Batch Command" from the drop down menu
5. In column B, enter the path to myapp.exe
6. In column C onwards, enter any required arguments to run myapp.exe
7. Run the simulation

A	B	C
Batch Command	myapp.exe	/someOption

Table 6 Loading a Simple Executable

7.9.2   Applications that are not Asim-aware

Application that are not Asim-aware require an intermediate batch file or program format the Asim environment variables in a way that is suitable to the application.

Writing batch files is beyond the scope of this guide. This example uses a provided sample batch file called *tma.bat* to start a graphical analysis program *tma* which needs command-line arguments to specify files containing data to plot.

Use Asim to run the application *tma* with an intermediate batch file to prepare the options for *tma*.

1. Write a batch file that formats the Asim environment into options suitable for tma and name it *tma.bat*. (see the provided tma.bat, which is designed to accept one argument - the location of the tma executable)
2. Open the example spreadsheet
3. Open the config tab
4. In an empty row, click column A
5. Select "Batch Command" from the drop down menu
6. In column B, enter the path to your custom tma.bat
7. In column C, enter the location of the actual tma executable (note that this may be another batch file, even with the same name)
8. Run the simulation

A	B	C
Batch Command	tma.bat	C:\Program Files\tma\tma.bat

Table 7 Loading a Custom batch file

8   Validating Your Simulation

Asim has a built-in validation mode, which uses actual generator performance data to determine generator run time, number of starts, number of stops, and energy totals. This can then be compared to data collected from Asim in simulation mode, to validate the accuracy of your simulation.

Use pre-recorded generator data to determine if the simulated power station statistics produced by Asim are similar to the real-world system.

1. Open the example spreadsheet
2. Open the config tab
3. In an empty row, click in column A
4. Select "parameter" from the drop down menu
5. In the column B write the text "GeneratorStats" (without the quotes)
6. In column A, add or edit an input option and provide an input file with generator actual power data
7. In column A, add or edit an output option
    a. Name it *counters.csv* (column B)
    b. Column C (the output period) can be the same as the simulation run time
    c. In column D enter Gen*Cnt
8. Run the simulation
9. Copy the output file from step 7. to another directory
10. Remove the GeneratorStats parameter row
11. Remove the generator actual power data input file
12. Re-run the simulation
13. Compare the final counters.csv counters from step 9. with those created in step 12.

Validation mode will turn of the simulator and just calculate statistics such as generator run time, number of starts, number of stops, and energy totals.

Figure 42 shows a sample validation mode setup.
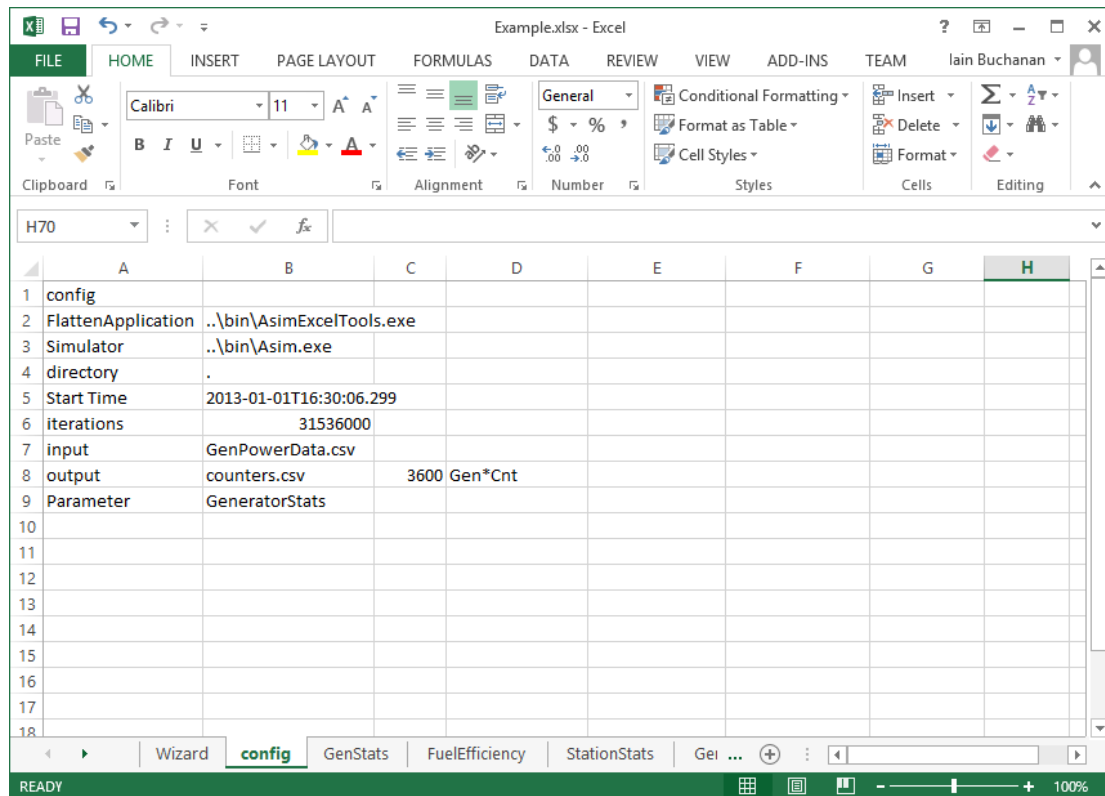
Figure 42: Generator Validation mode.

9 Troubleshooting

The simulation doesn't seem to run at all

→ Check the final tab in the Example spreadsheet called SimResults. Carefully read the output from the last simulation and see if there are any errors.

The sample spreadsheet wizard produces an error or pop up boxes don't appear

→ Make sure that macros are enabled and the Asim Add In is enabled. For more information about macro security and the Asim Add in refer to the Asim Quick Start Guide

The output file shows all zeros for each output statistic

→ Make sure that the start time is within the input data range.

Some of my output statistics are constant from halfway through to the end

→ Check to see if you have stated recycle next to the input or if the time period of simulation does not exceed the input data range in you don't want the data to be recycled.

→ Make sure to state the "recycle" option next to the input file in the example spreadsheet, especially if the time period of the simulation exceeds the input data range

My results doesn't seem right

→ Make sure that all your station parameters are set, this includes generator capacities, minimum run times, available generators, generator configurations, etc.

→ Check your spelling of variable names

The simulation doesn't complete and displays the error message:
Error running simulation: F:\: Cell 0,0 must contain 't' to be a valid input file

→ Asim was run with an input or scaling file in XLS format. All input files must be CSV formatted.

The simulation won't run and displays the error message:
Error: The process cannot access <a filename> since it is being used by another process

→ If Asim is run and stopped mid-way through the simulation, the program may still be running. Follow these steps to close Asim and Excel:

1. Close all Excel spreadsheets (whether or not they are related to Asim)
2. Press ctrl + alt + delete and select "Task Manager"
3. In the "processes" tab, look for Excel.exe and Asim.exe
4. Select each instance of these programs and press delete
5. Agree with any warnings about stopping processes
6. Re-run the Asim model from the start

The original load data was not scaled after running the Asim model with a scaling input.

→ Check that the second column used in the scaling input and the load data file should contain the same variable. Ex: ">LoadP" or ">StatP".
→ Ensure the scaling input file path is located above the load data file path in the list of inputs in the example spreadsheet

After running a simulation there is significant difference between each year's output statistics in the NPV analyser file

→ Before running the simulation, make sure the original NPV analyser template does not contain any data in the auto fill tab.

→ It is ideal to set the time resolution for the outputs to one day rather than setting it to one month, especially when the simulation run period is one month.

→ One month contains 2592000 seconds which is equivalent to 30 days, however after a year, an average month is 30.42 days. After a large number of months, the monthly output data will drift from the actual number of months. To overcome this, instead of selecting a number of months for the output time period, enter a number of seconds such as 2629800 (the number of seconds in 365.25 days / 12).

The salvage value cannot be found in NPV Analyser Template.

→ In the original NPV analyser template, the calculation for salvage value was not included. Including the salvage value makes a significant difference in the NPC value. A column has been created to include the salvage value in the "System Overview" tab and the NPV formula has been corrected.

How do I get appropriate PV input data from Homer?

→ In homer:
1. Open the "PV" tab in the simulation window
2. Right click on the PV output graph and select export data.
3. Re-edit the data so it contains date and time in column A (named 't') and the kW values in column B (named 'PvAvailP')

The simulation doesn't complete and displays the error message:
Error running simulation: Header row column 2 is empty:

→ This problem occurs when the input CSV files (load data, PV data, etc). are not in the correct format.
1. Open the original input file in notepad
2. Check if there are any empty ",," (commas) next to any values.
3. If so, open the original data file in excel and select all visible empty columns to the right of the data
4. Press delete
5. Resave the file as CSV