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PowerSim Modeling – Microgrid Example Problem

Fundamentals of Advanced Microgrid Evaluation, Analysis, and Conceptual Design (Consequence Modeling Module)

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PowerSim Modeling – Microgrid Example Problem



Outline of Presentation

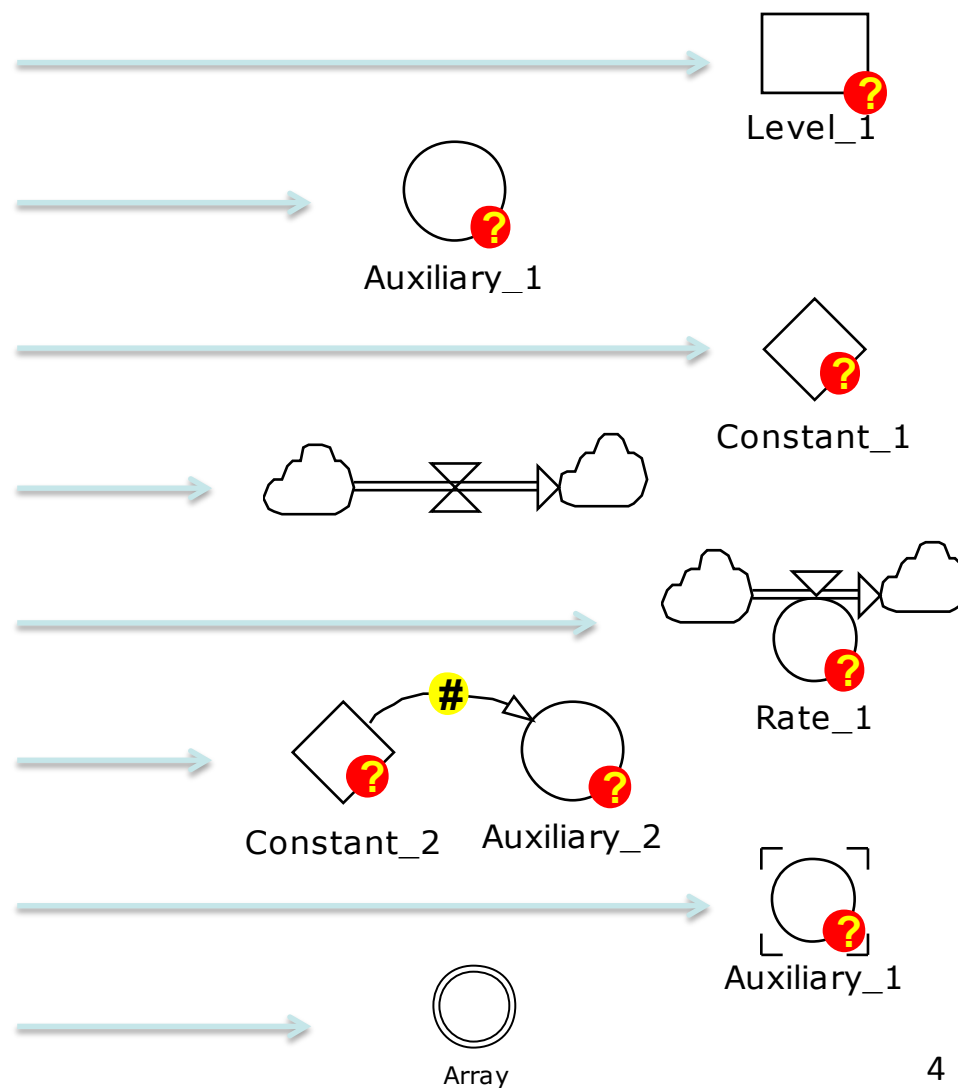
- Simple basics
- Accessing Data Files – Connections
- Managing Input
 - Creating Switches
 - Creating Sliders
 - Creating Figures and Charts
- Model Creation
- Summary
- Question & Answer Session

Basics

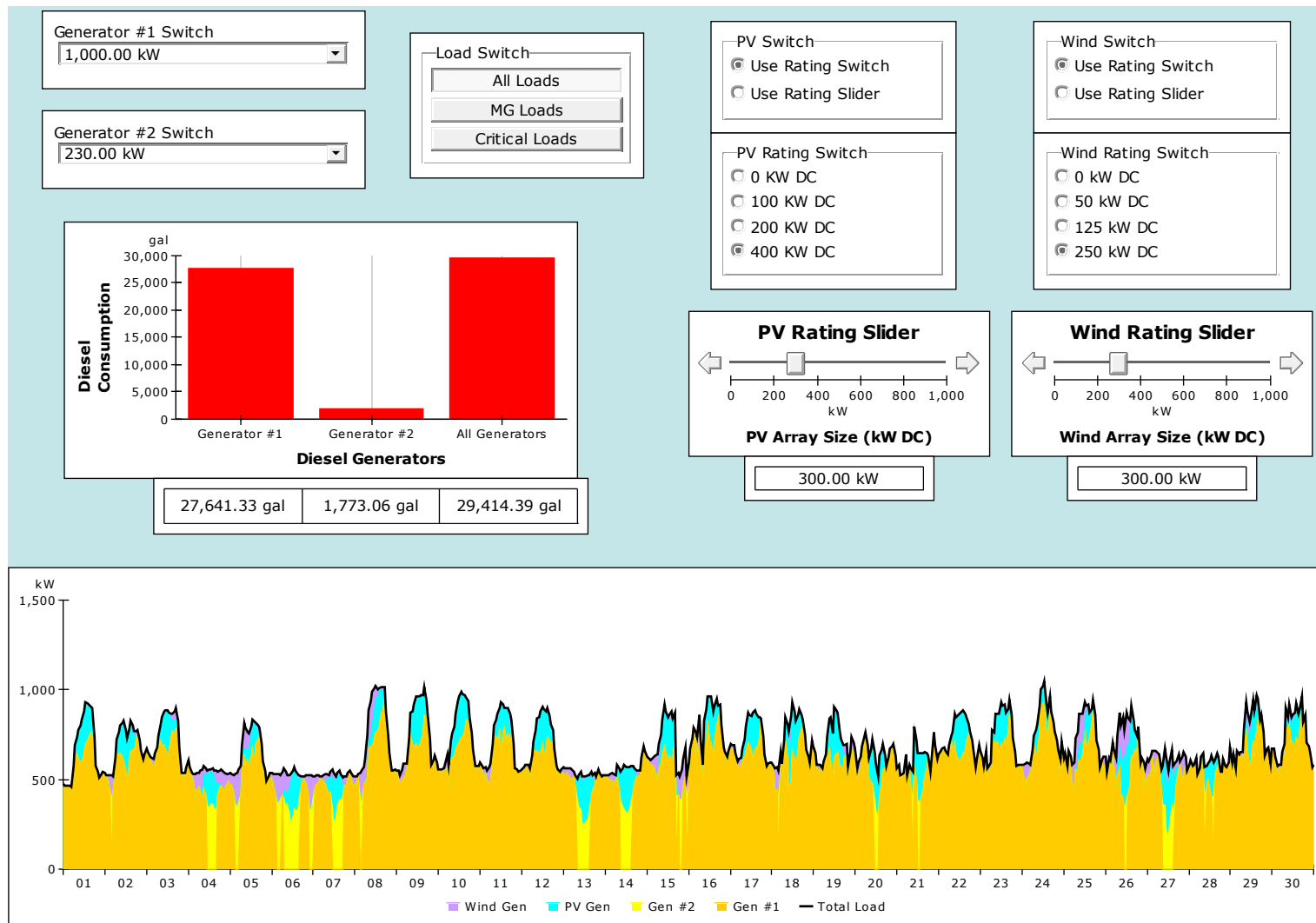
- PowerSim Studio
- Systems Dynamics Code
- Basic Building Blocks
 - Stocks - A stock is a generic symbol for anything that accumulates or drains. For example, water accumulates in your bathtub. At any point in time, the amount of water in the bathtub reflects the accumulation of what has flowed in from the faucet, minus what has flowed out down the drain. The amount of water in the bathtub is the stock of water.
 - Flows – A flow is the rate of change of a stock. In the bathtub example, the flows are the water coming into the bathtub through the faucet and the water leaving the bathtub through the drain.
 - Variables – Constants or auxiliaries are used to: calculate, make a model readable, prepare an interface.
 - Information Links – Connections/relationship between stocks, flows, and variables.

Basic Building Blocks

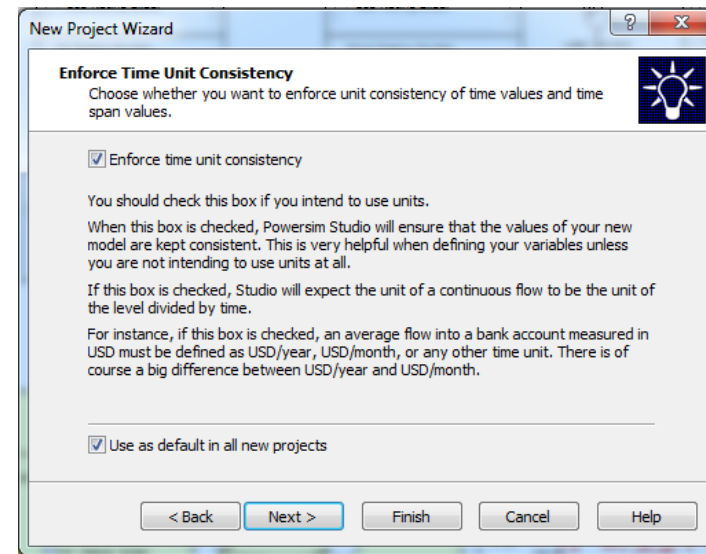
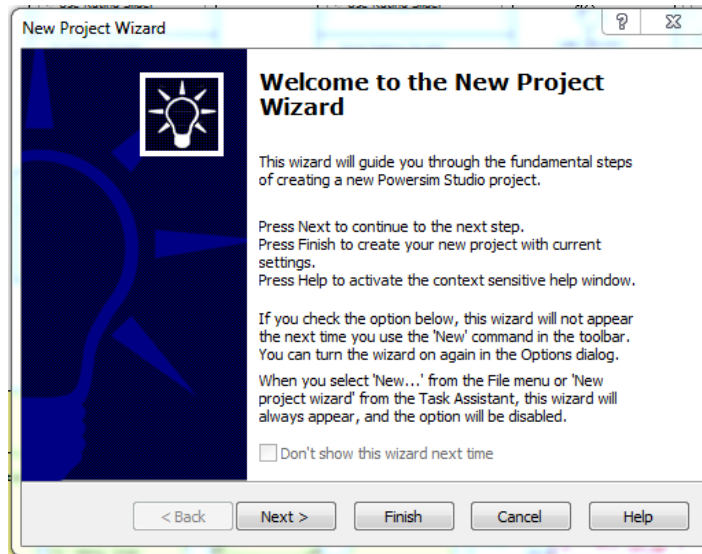
- Level (Stock)
- Auxiliary (Variable)
- Constant (Variable)
- Flow
- Flow w/ Rate
- Link
- Shortcut (“Alias”)
- Arrays



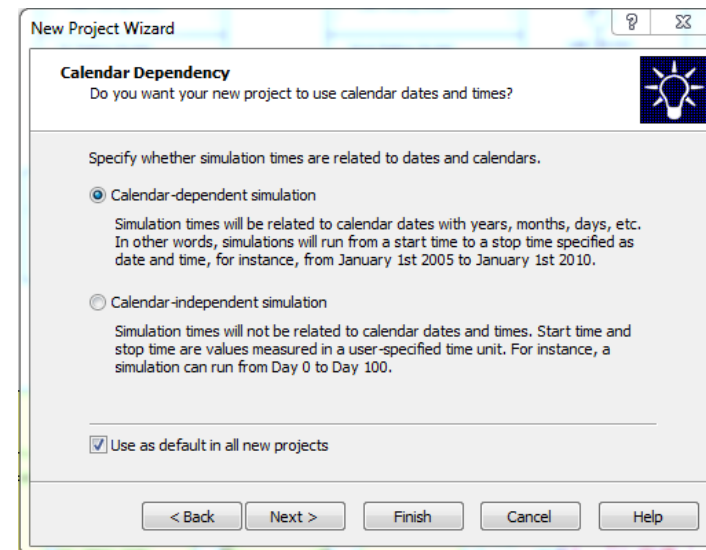
Example MG Model Output



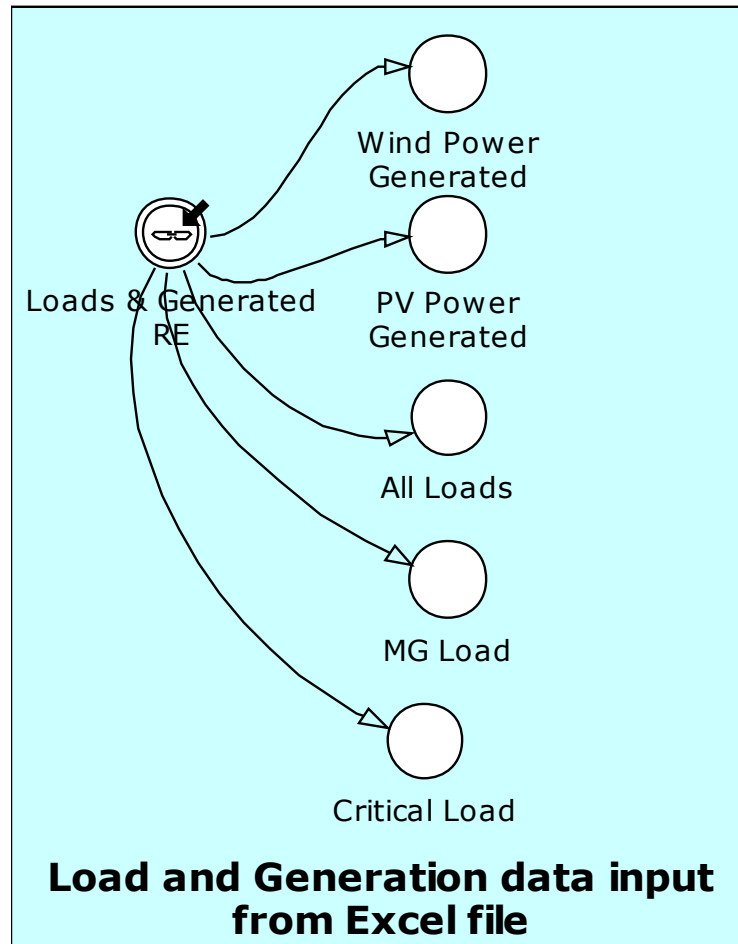
Begin Model Building



- New Model Wizard
- Step through Wizard



Accessing Data Files – Connections



- Create global dataset
- Add dataset
- Create auxiliary
- Create connection
- Create simple reports/figures

Dataset Creation

Spreadsheet Connection Wizard

Data Location
Specify where the spreadsheet data is located.

Workbook:
Example_Load_Data.xlsx

Worksheet: **Load Data (kW)** Cell origin: A1

☒ Connect to the specified workbook
☐ Connect to a temporary copy of the specified workbook (template)
☐ Connect to a persistent copy of the specified workbook (template)
Name of persistent copy:

< Back Next > Finish Cancel Help >>

Spreadsheet Connection Wizard

Misc
Specify how to exchange data with the spreadsheet and sampling times in case of time-dependent data.

Transfer
☐ To spreadsheet
☒ From spreadsheet
☐ Calculator (bi-directional)
☐ Bi-directional

Misc
☐ Represent time spans as days

Spreadsheet language
Language for headers, formats, etc:
English (United States)

Sampling times
☒ Load times from dataset
☐ Transfer at regular intervals

< Back Next > Finish Cancel Help >>

Spreadsheet Connection Wizard

Common Dimensions
Specify whether all variables in the dataset have the same dimensions, and if so, their common dimensions

☒ Use common dimensions for all variables
With this option selected, the dimensions are specified for the dataset as a whole. Otherwise, each variable will have its own dimension specification.

Common dimensions:
1..5

Dimensions next to name:
1 ☒ Automatic

< Back Next > Finish Cancel Help >>

Spreadsheet Connection Wizard

Layout
Specify the layout of the spreadsheet data and headers relative to the origin cell specified in the Data Location step.

Orientation:
Variable names across

Update in dataset
☐ Headers
☐ Number formats
☐ Time formats

Dataset includes
Variable names:
Name
☐ Subscripts in separate cells
☐ Units in separate cells
☒ Times in separate cells

☐ Clear cells beyond simulation end time

< Back Next > Finish Cancel Help >>

Spreadsheet Connection Wizard

Dataset Variables
Specify the dataset variables to be created. A dataset variable is Studio's representation of external data.

Dataset variables:

Name	Cells	Direction	Unit	Type	Summa
Variable 1	B2:F#	out (from XL)		Real	First

Note that the list contains dataset variables. Push the Help button for information about the relationship between model variables and dataset variables.

< Back Next > Finish Cancel Help >>

Spreadsheet Connection Wizard

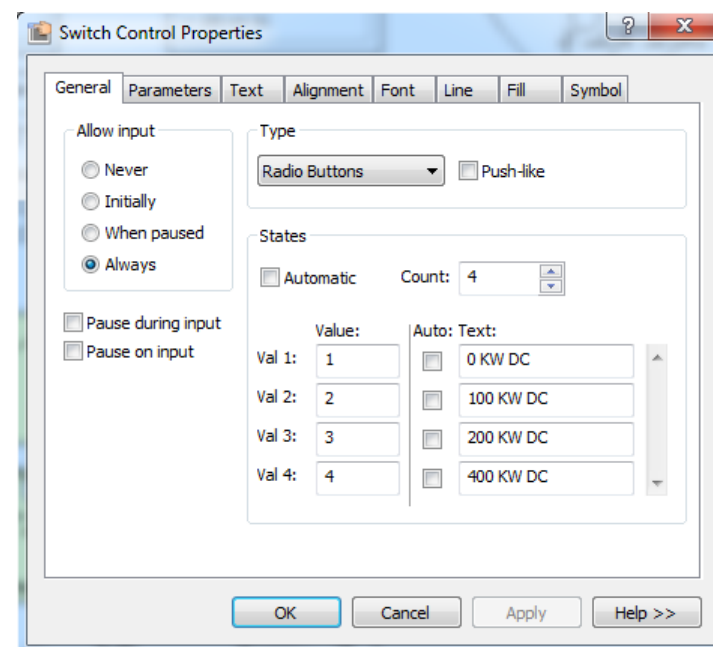
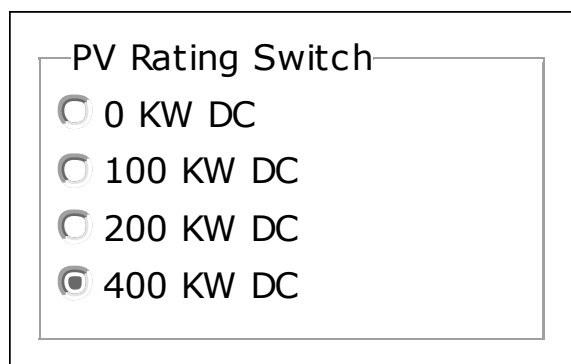
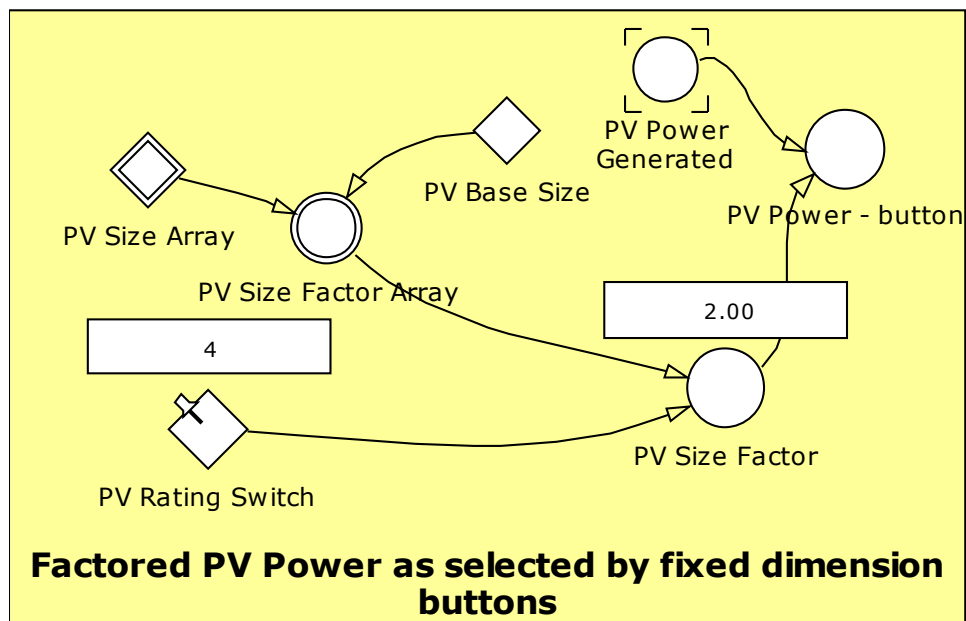
Transfer Options
Specify additional options regarding transfer of data

Transfer mode
☐ Manual transfer
Users control when to transfer data using 'Load/Save External Data'.
☒ Automatic transfer
Data is automatically transferred at simulation start and stop time.
☐ Continuous transfer
Data is continuously transferred during the simulation.

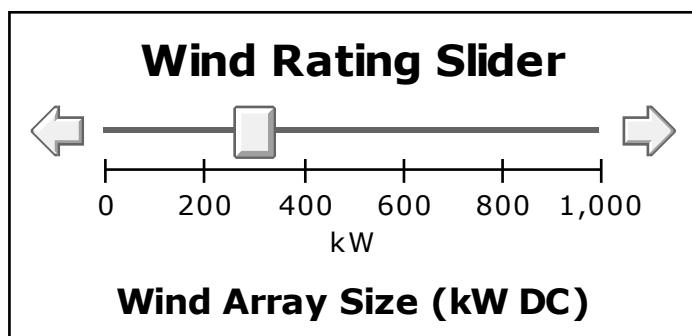
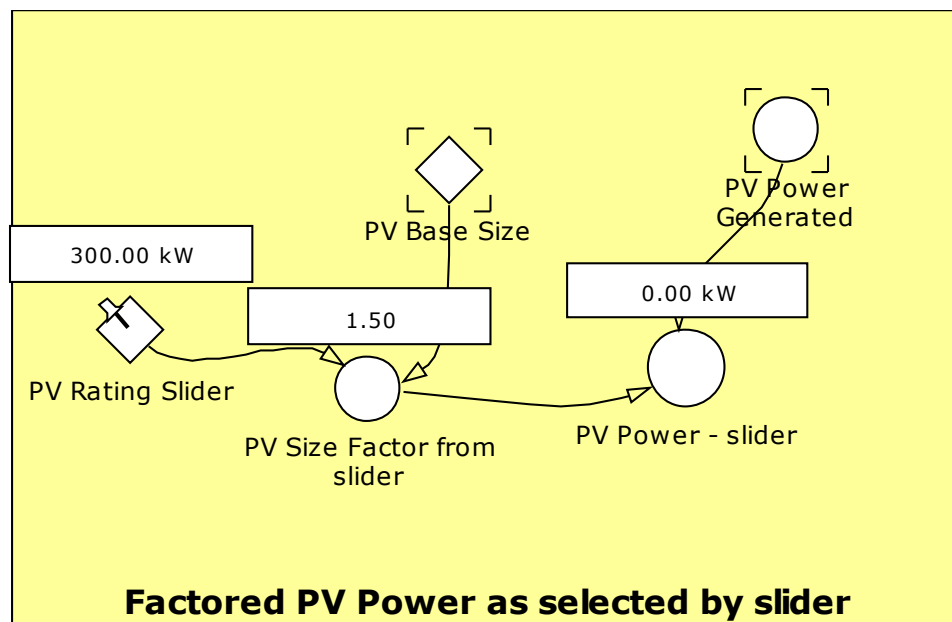
Manual edit and "write-back"
☒ Deny manual edit
Don't allow users to modify data loaded into simulations from this source.
☐ Allow manual edit
Allow users to temporarily modify data loaded into simulations from this source. (These changes will be discarded on next 'Load External Data'.)
☐ Allow manual edit and "write-back"
Allow users to modify data loaded into simulations from this source, and save these changes along with the simulated values on next 'Save External Data'.

< Back Next > Finish Cancel Help >>

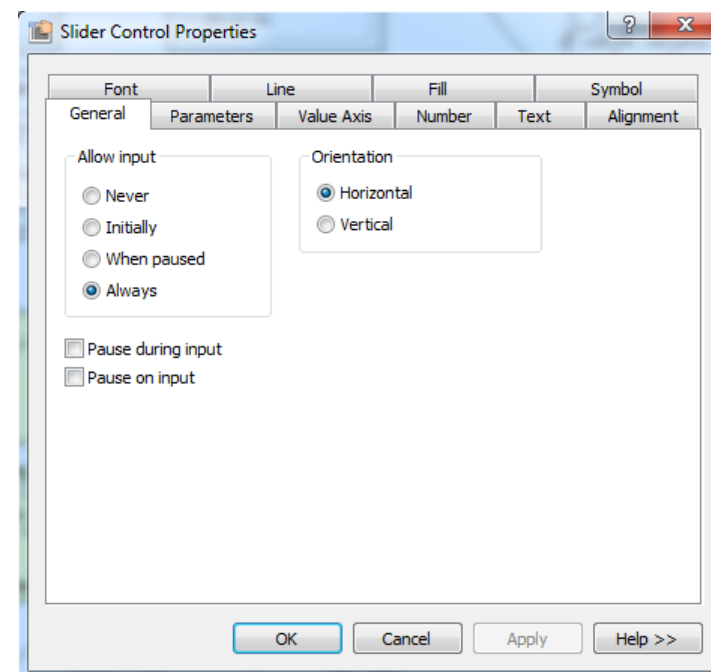
Creating Switches



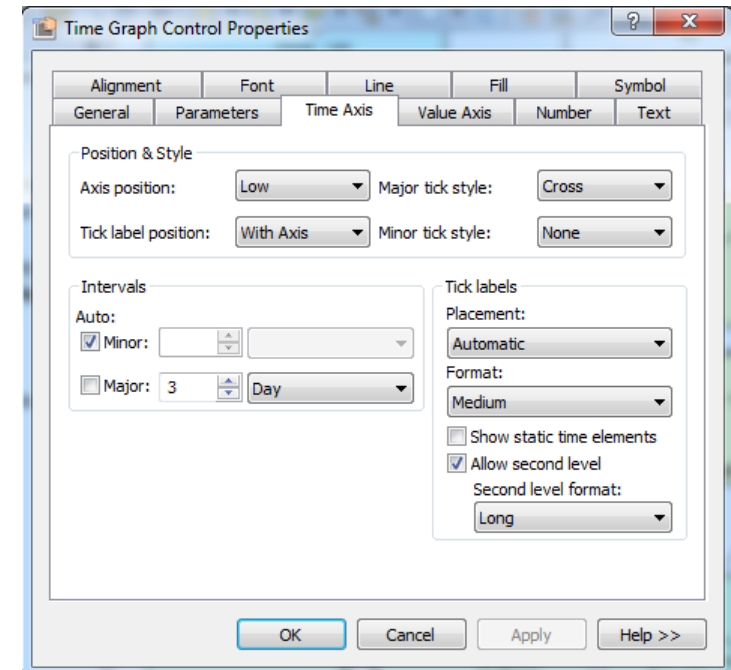
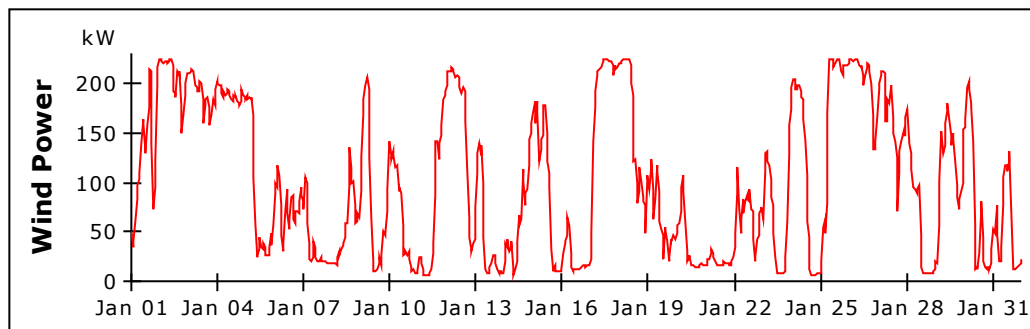
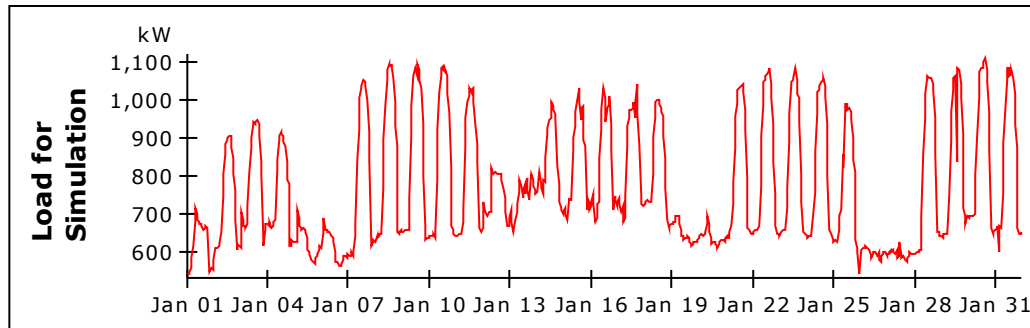
Creating Sliders



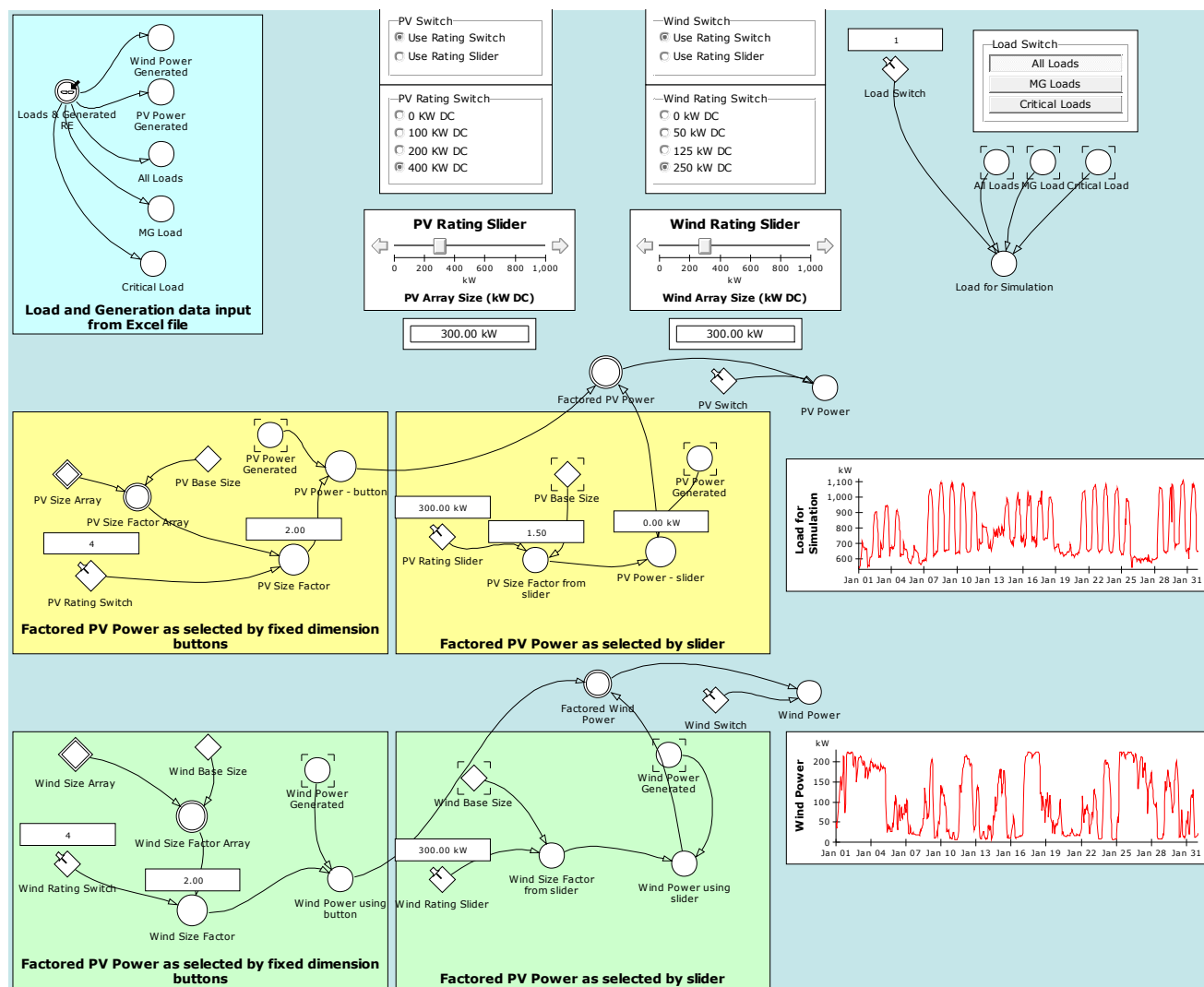
300.00 kW



Creating Figures and Charts

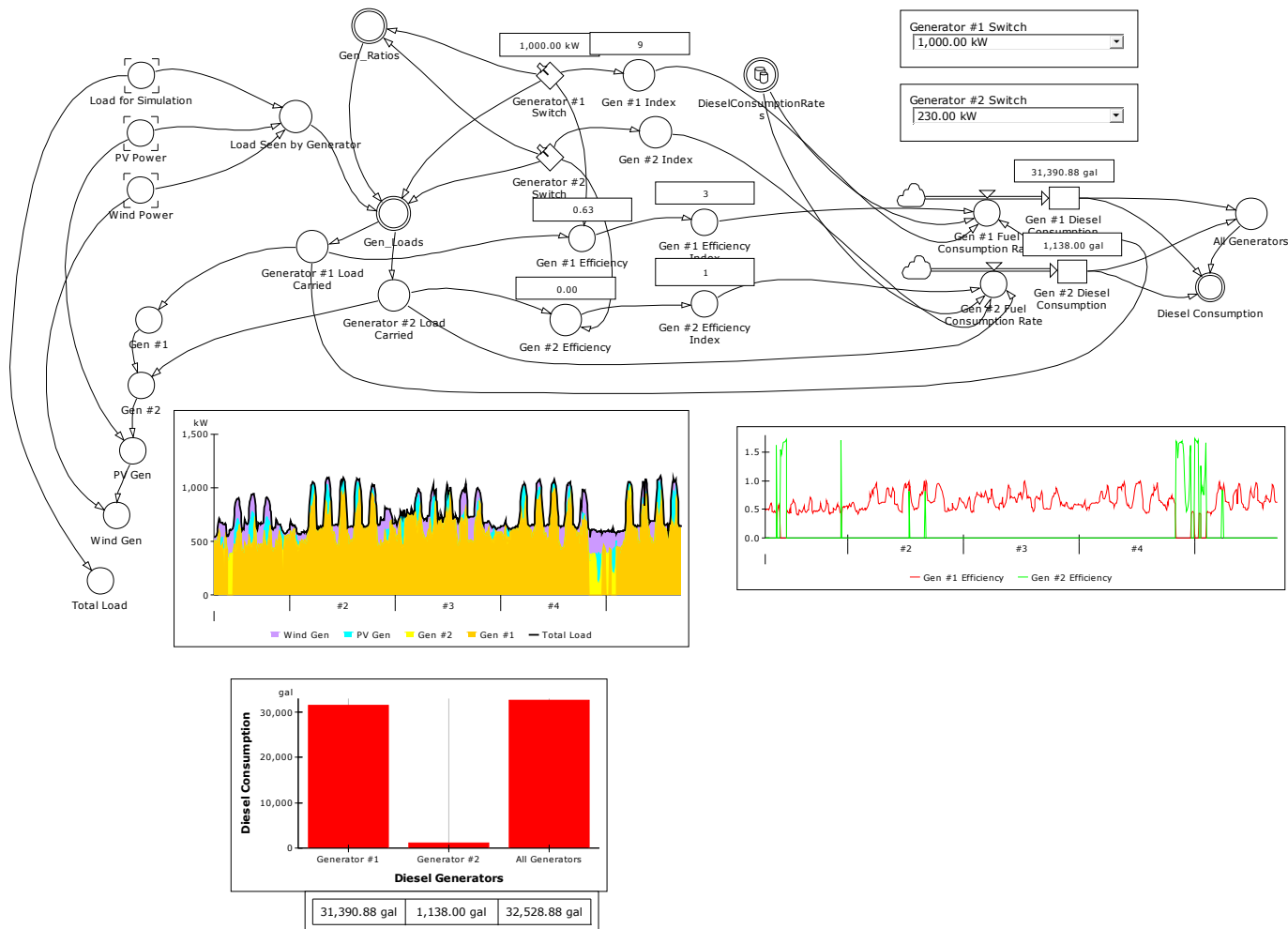


Model Creation



- Create input switches and slider for wind generation
- Create input switch for loads

MG Model

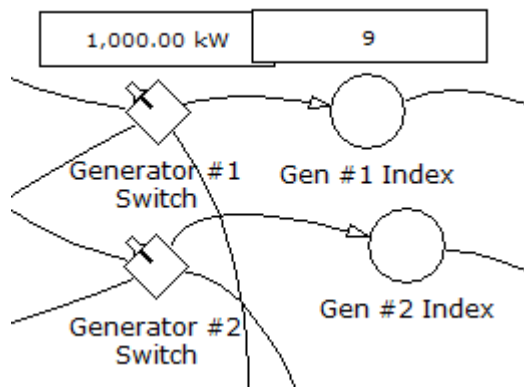


Generator Lists and Switches

- Include pull-down list

Generator #1 Switch
1,000.00 kW

Generator #2 Switch
230.00 kW



Switch Control Properties

General Parameters Text Alignment Font Line Fill Symbol

Allow input
☐ Never
☐ Initially
☐ When paused
☒ Always

Type
Combo Box

States
☐ Automatic Count: 10

Value: Val 4: 150 kW Val 5: 230 kW Val 6: 400 kW Val 7: 500 kW

Auto: Text: ☒ ☒ ☒ ☒

OK Cancel Apply Help >>

Switch Control Properties

General Parameters Text Alignment Font Line Fill Symbol

Allow input
☐ Never
☐ Initially
☐ When paused
☒ Always

Type
Combo Box

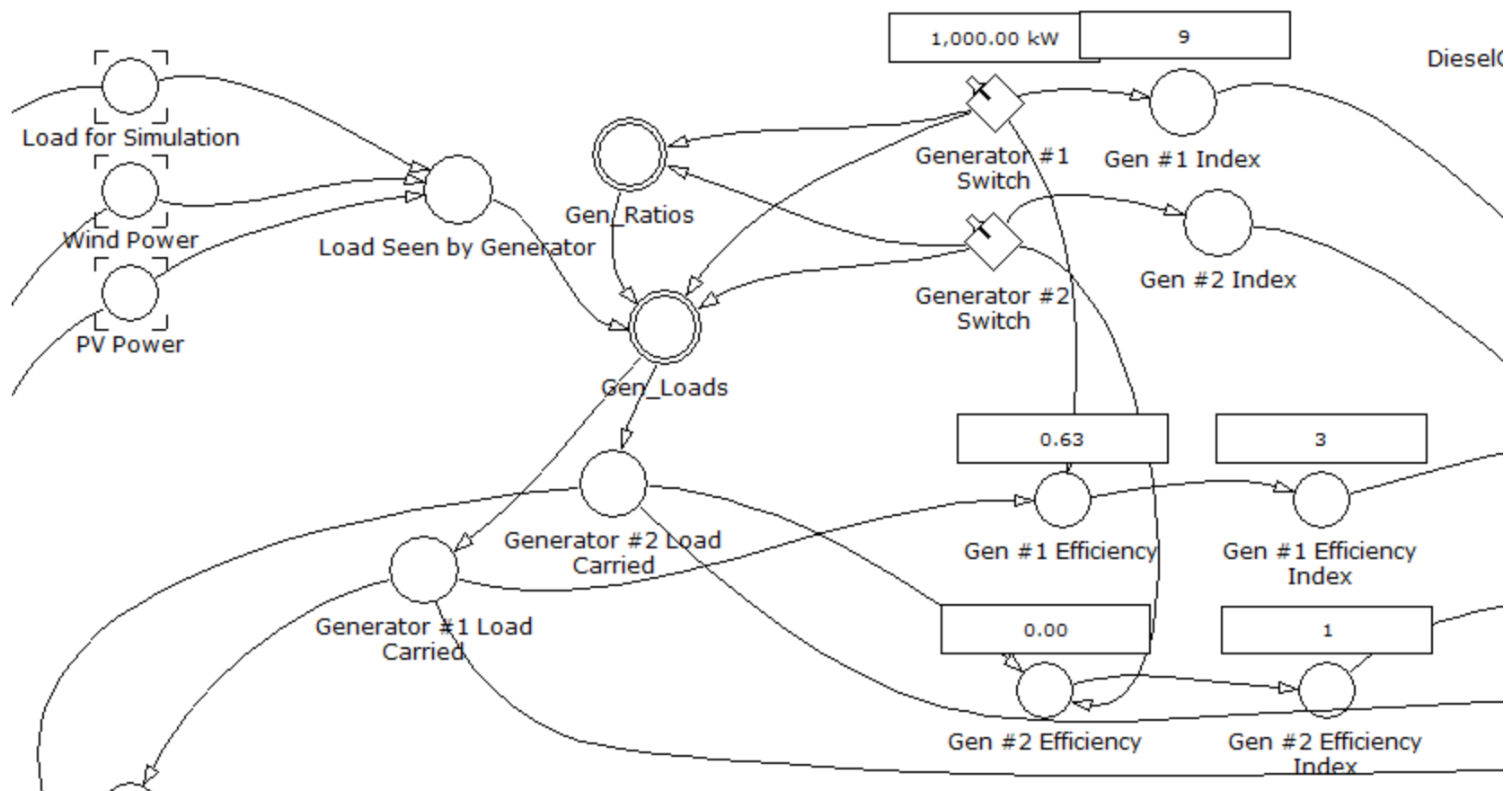
States
☐ Automatic Count: 11

Value: Val 8: 750 kW Val 9: 1,000 kW Val 10: 1,250 kW Val 11: 0 kW

Auto: Text: ☒ ☒ ☒ ☐ No Generator

OK Cancel Apply Help >>

Load Model



Generator Loads

Gen_Ratios Variable Properties

Definition Documentation Advanced Scale Value Line Fill Symbol

Type: ☒ Real Unit: ☐ Start-up

Dimensions: ☐ Series type: ☐ None

Definition

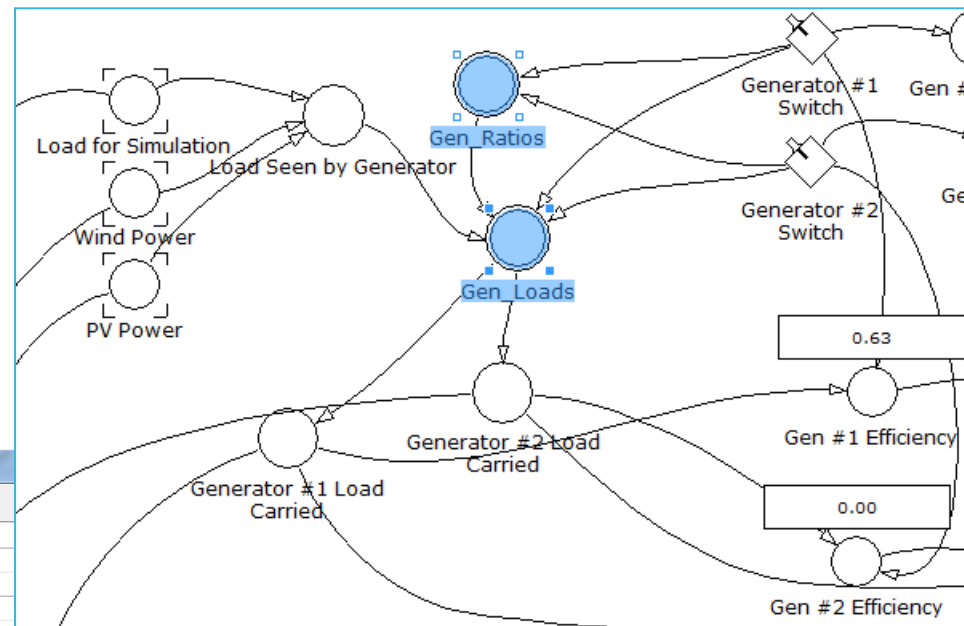
```
{'Generator #1 Switch'/'('Generator #1 Switch'+ 'Generator #2 Switch'),  
'Generator #2 Switch'/'('Generator #1 Switch'+ 'Generator #2 Switch')}
```

= {0.8130081300813, 0.1869918699187}

Generator #1 Switch
Generator #2 Switch

☒ 1 Linked variables
☐ 2 All variables
☐ 3 Ranges
☐ 4 Units
☐ 5 Functions

OK Cancel Apply Help >>



Gen_Loads Variable Properties

Definition Documentation Advanced Scale Value Line Fill Symbol

Type: ☐ Real Unit: ☒ kW

Dimensions: ☐ Series type: ☐ None

Definition

```
IF ('Generator #1 Switch'>0<<kW>> AND 'Generator #2 Switch'>0<<kW>>,  
  
  IF ('Load Seen by Generator'<=0<<kW>>, {0<<kW>>,0<<kW>>},  
    IF ('Load Seen by Generator'<0.4*'Generator #1 Switch',{0<<kW>>,'Load Seen by Generator'},  
      IF ('Load Seen by Generator'<'Generator #1 Switch',{0<<kW>>,'Load Seen by Generator'},  
        {Gen_Ratios[1]*'Load Seen by Generator',Gen_Ratios[2]*'Load Seen by Generator'})),  
  
  IF ('Generator #1 Switch'=0<<kW>> AND 'Generator #2 Switch'>0<<kW>>,{0<<kW>>,'Load Seen by Generator'},  
    IF ('Generator #1 Switch'>0<<kW>> AND 'Generator #2 Switch'=0<<kW>>,{0<<kW>>,'Load Seen by Generator'},  
    IF ('Generator #1 Switch'>0<<kW>> AND 'Generator #2 Switch'>0<<kW>>,{0<<kW>>,'Load Seen by Generator'},  
    IF ('Generator #1 Switch'>0<<kW>> AND 'Generator #2 Switch'>0<<kW>>,{0<<kW>>,'Load Seen by Generator'},  
    IF ('Generator #1 Switch'>0<<kW>> AND 'Generator #2 Switch'>0<<kW>>,{0<<kW>>,'Load Seen by Generator'}))
```

= {627.6866666667, 0} kW

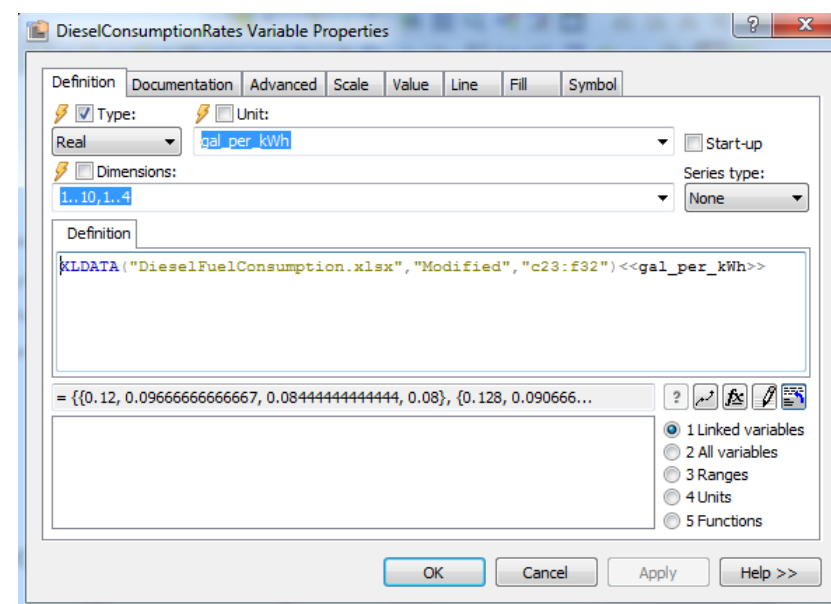
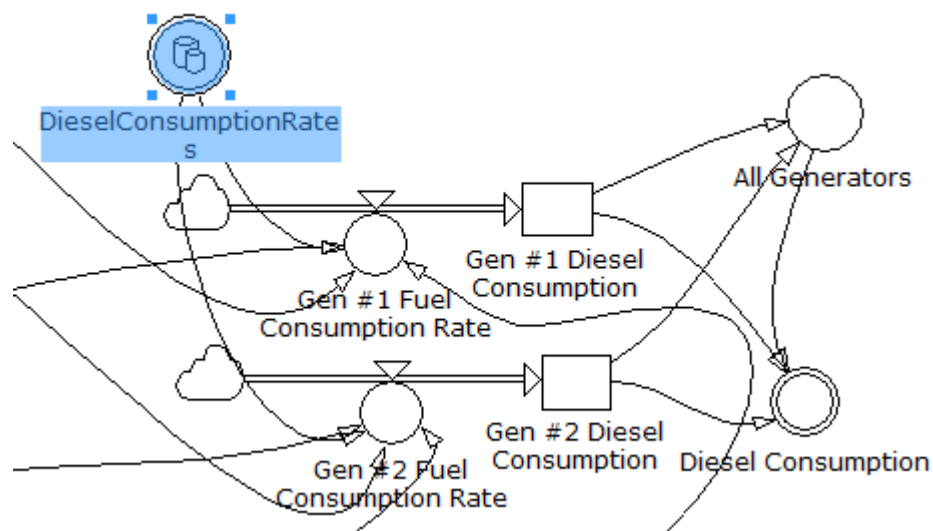
Gen_Ratios
Generator #1 Switch
Generator #2 Switch
Load Seen by Generator

☒ 1 Linked variables
☐ 2 All variables
☐ 3 Ranges
☐ 4 Units
☐ 5 Functions

OK Cancel Apply Help >>

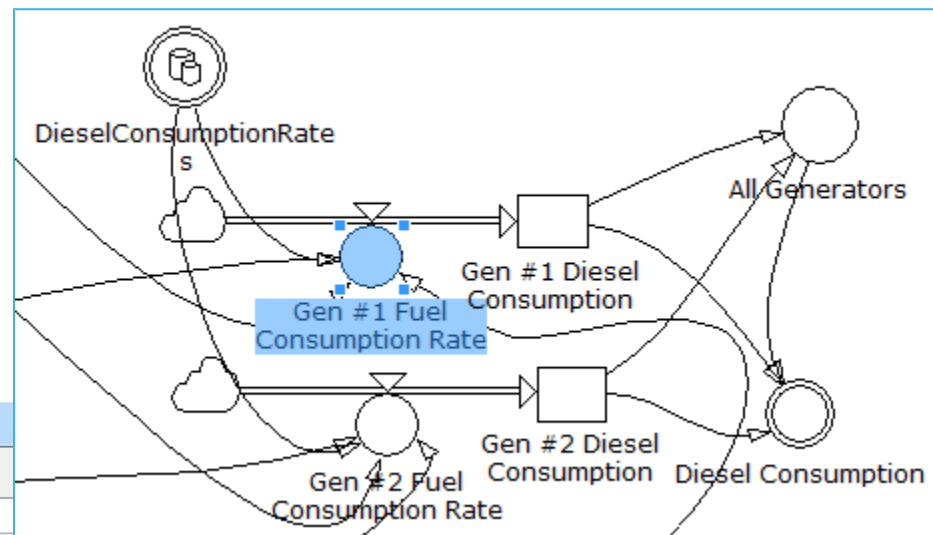
Diesel Consumption Rate

- Adding time independent dataset using direct call to EXCEL file
- Create array variable



Diesel Consumption

- Link diesel consumption rate to a flow w/ rate to calculate total consumption



Gen #1 Fuel Consumption Rate Variable Properties

Definition Documentation Advanced Scale Value Line Fill Symbol

Type: ☒ Real Unit: ☒ gal/hr

Dimensions: ☒

Definition

'Generator #1 Load Carried'*DieselConsumptionRates[INDEX ('Gen #1 Index'),INDEX ('Gen #1 Efficiency Index')]

= 43.60330044444 gal/hr

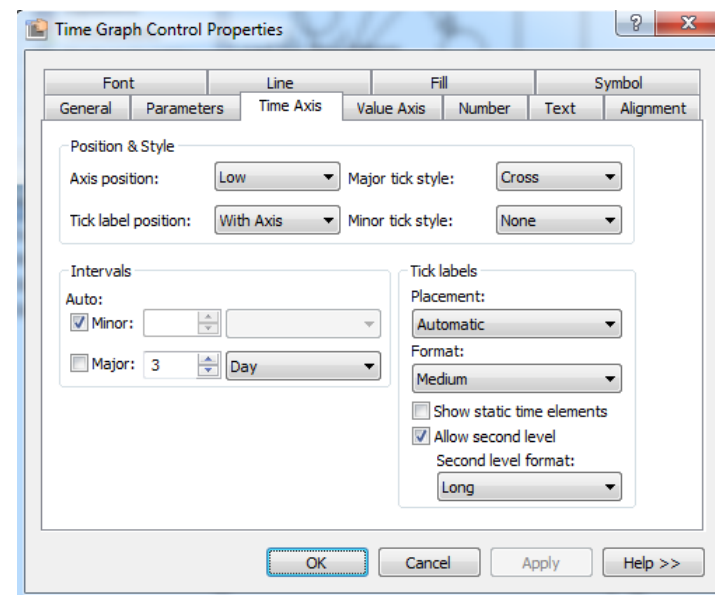
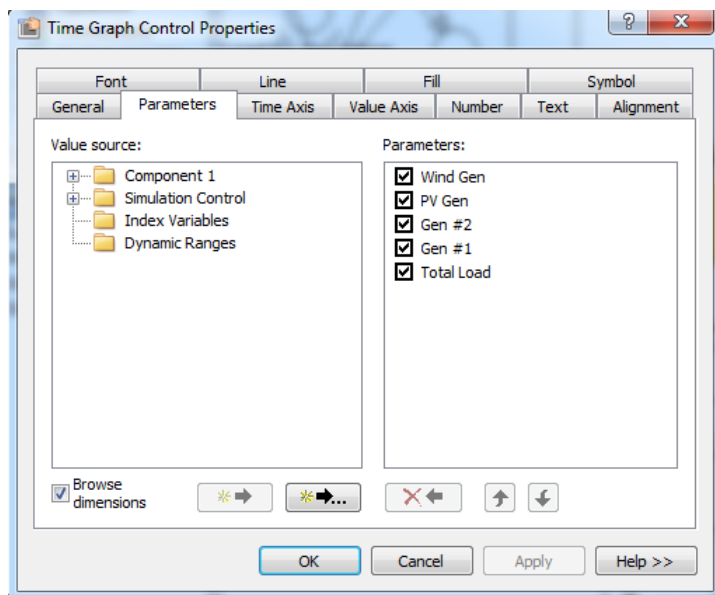
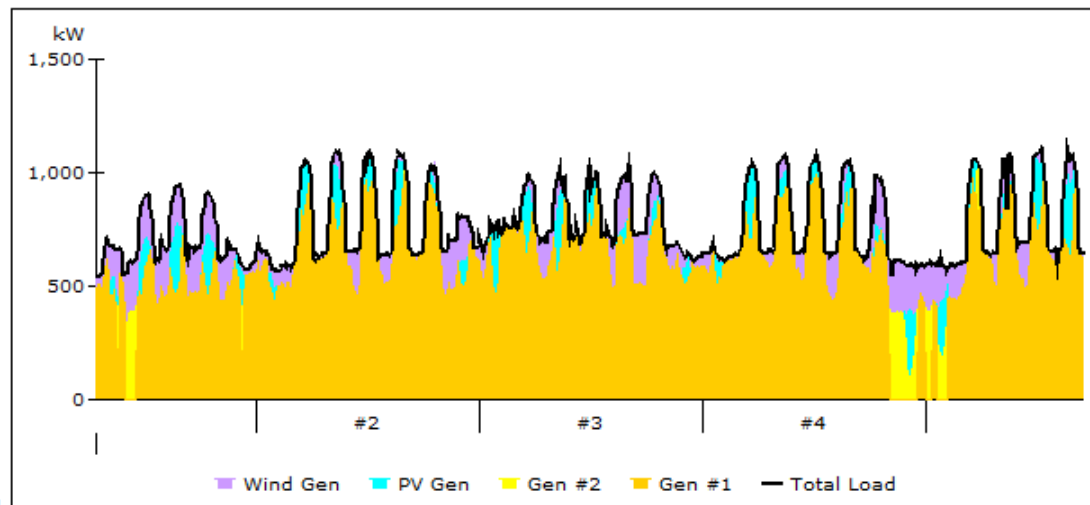
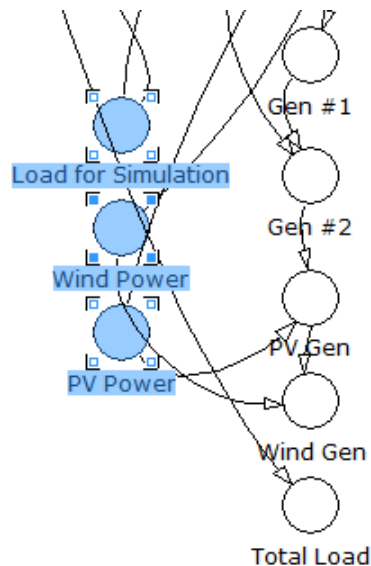
DieselConsumptionRates
Gen #1 Efficiency Index
Gen #1 Index
Generator #1 Load Carried

Start-up ☐ Series type:

1 Linked variables
2 All variables
3 Ranges
4 Units
5 Functions

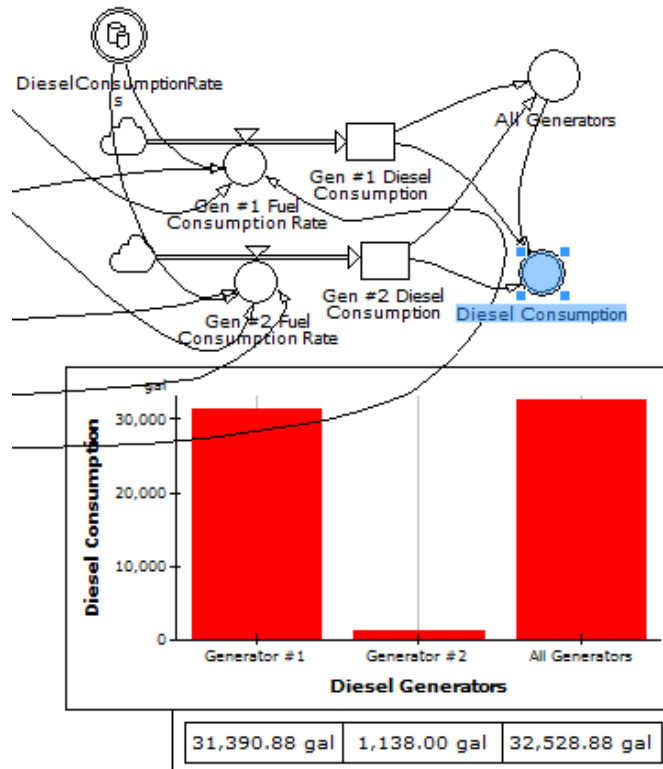
OK Cancel Apply Help >>

Create Output Figure



Create Bar Graph

- Create array of “Diesel Consumption”
- Create bar graph of array



Diesel Consumption Variable Properties

Definition Documentation Advanced Scale Value Line Fill Symbol

Type: ☒ Real Unit: gal ☐ Start-up

Dimensions: 'Diesel Generators' Series type: None

Definition

```
{'Gen #1 Diesel Consumption',  
'Gen #2 Diesel Consumption',  
'All Generators'}
```

= {31,390.88049191, 1,138.003674832, 32,528.88416674} gal

All Generators
Gen #1 Diesel Consumption
Gen #2 Diesel Consumption

☒ 1 Linked variables
☐ 2 All variables
☐ 3 Ranges
☐ 4 Units
☐ 5 Functions

OK Cancel Apply Help >>

Chart Control Properties

Number Text Alignment Font Line Fill Symbol

General Parameters Chart Graph Element Axis Value Axis

Properties:

Parameters(Diesel Consum

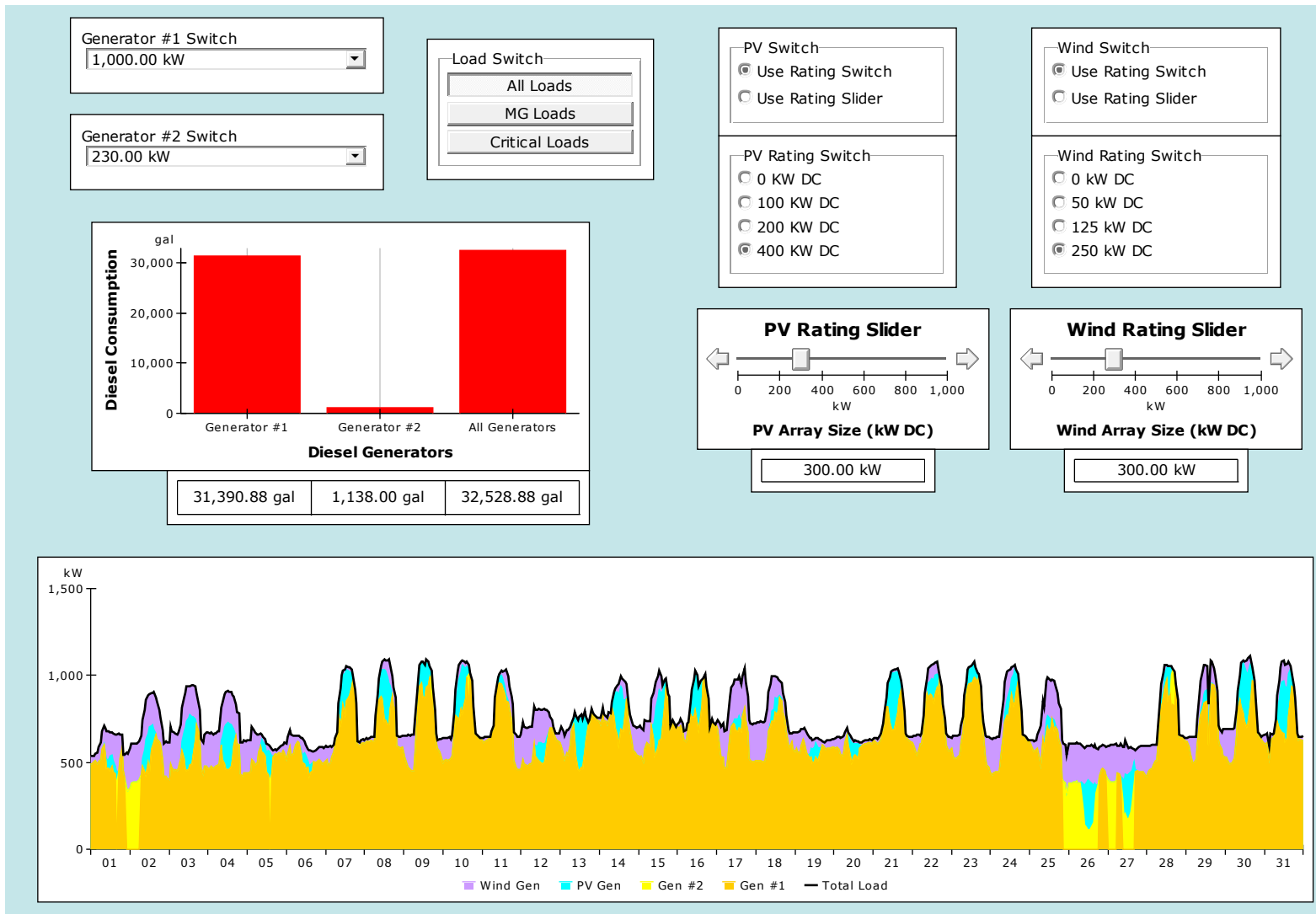
Graph type

☐ Line
☐ Step
☒ Bar

☐ Smoothed line

OK Cancel Apply Help >>

Create Input/Output Diagram



PowerSim Modeling – Microgrid Example Problem



QUESTIONS & ANSWERS

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