mosaik Advanced Visualization Environment for Intelligent Power Grids

User Manual

11th March 2015

Erika Root, Gerrit Klasen, Hanno Günther,
Jerome Tammen, Marina Sartison, Marius Brinkmann,
Michael Falk, Rafael Burschik, Rouven Pajewski
Sascha Spengler, Andrianarisoa A. Johary Ny Aina und
Tobias Schwerdtfeger

E-Mail: pg-maverig@offis.de

Maverig is a graphical user interface to create and simulate smart grid simulations

Contents

1 User Manual

1.1 Introduction

Maverig is a graphical User Interface for creation and visualization of Smart-Grid simulations. Maverig is divided into the Composition Mode and the Simulation Mode. In Composition Mode a Smart-Grid scenario can be created and afterwards the user can run a simulation of this scenario in Simulation Mode while observing significant parameters. For this purpose the Mosaik simulators are used by Maverig.

1.2 Setup User Manual

This User Manual gives a general overview of the functionality and usability of Maverig. Therefore the User Manual is divided into to parts. First there is an explanation how to use the Composition Mode to create a scenario. Second there is a description how to use the Simulation Mode.

1.3 Installation

Maverig supports the operation systems Linux, OSX and Windows. In addition there is only a support for Python 3.4 or higher. For a Maverig installation the paketmanager „pip“ is required. Python 3.4 already includes pip. The command to install Maverig with the pip paketmanager is: “pip install maverig”

1.4 Componentmode

This chapter contains the setup of the Graphical User Interface (GUI). Below there is a detailled explanation for all GUI components and their functionality. Basically the GUI setup for Composition Mode and Simulation Mode is very similar. In Composition Mode the GUI is divided into a Menubar (1), a Toolbar (2), a Modepanel (3), a Propertypanel (4), a Statusbar (5), a Scenariopanel (6) and a Console (7).

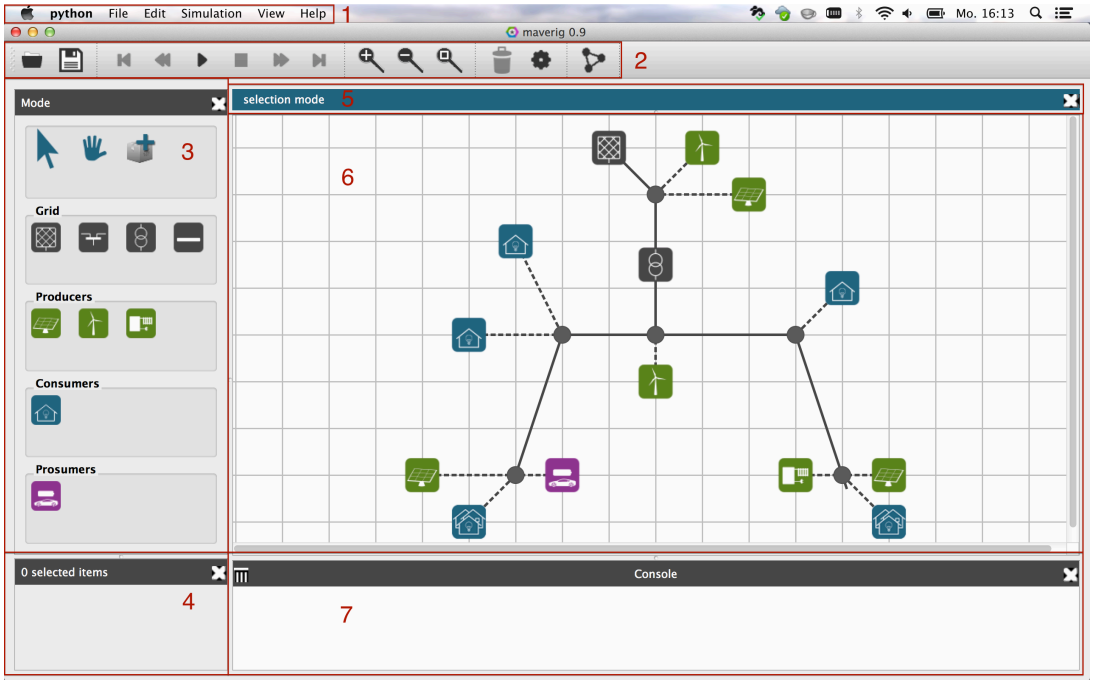


Figure 1.1: Overview GUI Maverig Composition

1.4.1 Menubar

Via the Menubar there are different features and settings for Maverig available. Many features in the Menubar are also in the Toolbar.

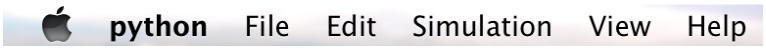


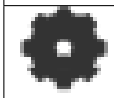
Figure 1.2: Maverig Menubar

File	New	Creates an empty scenario
	Open	Opens an existing Maverig scenario
	Save	Saves the scenario
	Save as	Saves the scenario in chosen path
	Preferences	General settings and specific simulation settings in Maverig
	Quit	Closes Maverig
Edit	Undo	Undoes the last step performed in the scenario
	Redo	Reverts the last step performed in the scenario
	Auto Layout	Arranges elements in Scenariopanel clearly
	Cut	Cut-out selected elements and paste into clipboard
	Copy	Copy selected elements and paste into clipboard
	Paste	Inserts elements from clipboard into scenario
	Delete	Deletes selected elements from scenario
	Select All	Selects all elements from scenario
Simulation	Run	Start the simulation
	Stop	Stop the simulation
	Pause	Pause the simulation
	Back to start	Skip to starting time of simulation
	Reduce Speed	Reduce playback speed of simulation
	Increase Speed	Increase playback speed of simulation
	Forward to end	Skip to end time of simulation
	Set time	Adjustment of simulation start and end time
	Go to	Skip to declared time of simulation
View	Shift Mode	Enable the Shift Mode
	Selection Mode	Enable the Selection mode
	Raster	Enable or Disable automatic docking of elements at Raster
	Zoom In	Increase the view of the scenario
	Zoom Out	Decrease the view of the scenario
	Zoom Fit	Adjust the view of the scenario automatically
	Fading out GUI components	Fade GUI components in or out.
Help	Maverig Help	Opens Maverig Help
	About Maverig	Informationen about Maverig e.g. involved developers

1.4.2 Toolbar

Via buttons in the Toolbar different features in Maverig are available. All features in the Toolbar are part of the Menubar.

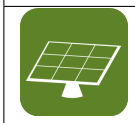
Figure 1.3: Maverig Toolbar

	Open	Open an existing Maverig scenario
	Save	Save the scenario
	Back to start	Skip to start time of simulation
	Reduce Speed	Reduce playback speed of simulation
	Run	Start the simulation
	Stop	Stop the simulation
	Increase Speed	Increase playback speed of simulation
	Forward to end	Skip to end time of simulation
	Zoom In	Increase the view of the scenario
	Zoom Out	Decrease the view of the scenario
	Zoom Fit	Adjust the view of the scenario automatically
	Delete	Deletes selected elements from scenario
	Settings	General settings and specific simulation settings in Maverig
	Auto Layout	Arranges elements in Scenariopanel clearly q.v. chapter Operation, Auto Layout

1.4.3 Modepanel

The Modepanel contains every usable component in Maverig. These components can be used to create a scenario.

Mode		Description
	Selection Mode	Enable the Selection Mode
	Shift Mode	Enable the Shift Mode
	Add Component	Start the wizard to add new components

Grid		Description
	Reference Bus	The Reference Bus is a voltage source and access point to a superior power grid and provides electric power for the scenario.
	PQBus Node	The PQBus is a connection point for lines, producers, consumers and prosumers.
	Transformer	The Transformer converts electric power from one voltage level into another voltage level.
	Line	The Line is a link between PqBus elements or a connection between producers, consumers, prosumers and PQBus elements.
Producer		
	Photovoltaic	A Photovoltaic facility to produce electric power.
	Wind Energy Conversion System	A Wind Energy Conversion System to produce electric power.
	Cogeneration of Heat and Power	Using Cogeneration of Heat and Power to produce electric power.
Consumer		
	Household	Consumer of electric power. The Consumption depends on the quantity of apartments and the number of residents per apartment.
Prosumer		
	Electronic Vehicle	An Electronic Vehicle produces and consumes electric power.

1.4.4 Propertypanel

Depending on the selected component the Propertypanel provides a set of adjustable parameters for this element. If several congeneric components are selected, the properties can be adjusted simultaneously.

Component	**Property**
Reference Bus	Basic Stress Level in kV
PQBus Node	Basic Stress Level in kV
Transformer	Transformer Type Voltage Tap-Off Online Mode
Line	Length in km Online Mode
Photovoltaic	CSV-File
Wind Energy Conversion System	CSV-File
Cogeneration of Heat and Power	CSV-File
Household	CSV-File
Electronic Vehicle	CSV-File

1.4.5 Statusbar

The Statusbar provides several informations and supports the user of Maverig. Informations are divided in three categories. Blue status messages convey the current mode, green status messages give feedback about valid connections between elements and red status messages give feedback about invalid connections between elements (q.v. chapter Error messages and troubleshooting).

1.4.6 Scenariopanel

The Scenariopanel allows the user to create a specific scenerio by using all given kinds of components. The scenario size is dynamic and increases or decreases depending on its necessity simultaneously.

1.4.7 Console

The Console provides information about the process of the simulation. Including informations about the start of required simulators as well as the simulation progress.

1.5 Simulation

As soon as the simulation starts there is a correspondent GUI change. Major operating elements as the Menubar, Toolbar, Statusbar and Console remain in the GUI. The Componentpanel and Propertypanel are disabled during simulation. The process of the simulation is displayed in the Scenariopanel (2). If any component is selected, the corresponding parameters are displayed in the Attributepanel (1). The Progressbar (3) shows the chronological process of the simulation.

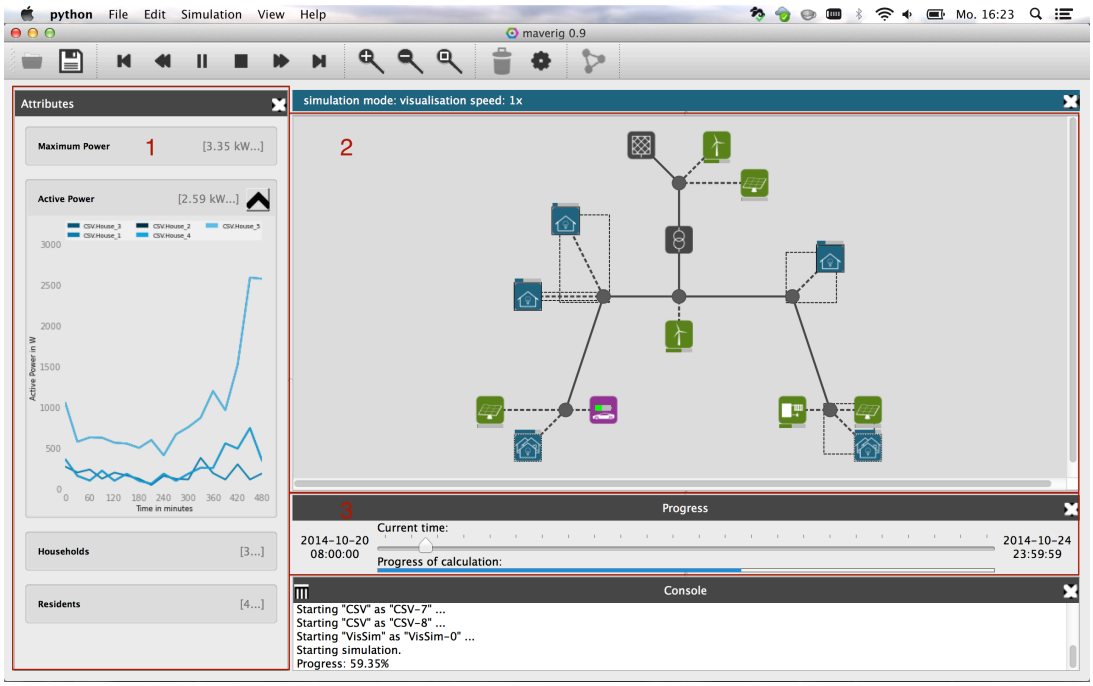


Figure 1.4: Overview GUI Maverig Simulation

1.5.1 Attributepanel

The Attributepanel is one of the essential elements during the simulation. It shows all attributes of the selected component(s). Any variable attribute, whose value changes during the simulation, is visualized in corresponding graphs. Depending on the user, graphs can be faded in or out. A double click on an element in the Scenariopanel selects any elements of these kind. Furthermore the variable attributes of these elements are summarized in one graph if they have the same measurement unit. Therefore it is possible to compare different attributes. It is also possible by selecting various elements within the Scenariopanel.

1.5.2 Scenariopanel

After starting the simulation the Scenariopanel is only in View Mode, thus the scenario cannot be changed temporarily. Single components can be selected by a left-hand click. Multiple components can be selected by tapping the CTRL button and selecting several components by a left-hand click. Alternatively multiple components can be selected by a tapping left-hand click and by drawing a frame around several components.

The current status of single components within the Scenariopanel is displayed in diverse types. Maverig provides special settings for the visualization of these types. The following are available:

Category	**Type**
Grid Components	- Shadow Effect - Color Effect
Producer, Consumer und Prosumer	- Bar Effect - Shadow Effect - Transparency Effect

1.5.3 Progressbar

The Progressbar has the start time (1) of the simulation on the left side and the end time (2) of the simulation on the right side. The Scrollbar (3) moves depending on the chosen speed, which can be changed in the simulation settings. The Scrollbar also displays the current progress of the simulation. Below there is a blue bar (4), which displays the current calculated simulation progress. By using the Scrollbar the user can skip to any already calculated point of the simulation.

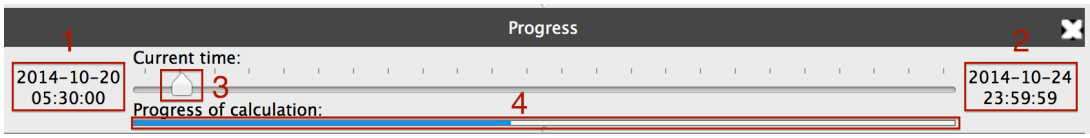


Figure 1.5: Progressbar

1.6 Operation

The chapter operation describes how to use Maverig in detail. This will be explained on the basis of various operating processes. In general Maverig contains four different modes, the Selection Mode, the Shift Mode, the Component Mode and the Simulation Mode. In Selection Mode any element in the scenario can be selected and moved. If a component of the Modepanel is selected the mode switches into Component Mode automatically. In this mode components can be placed into the scenario. In addition the user can switch into the Shift Mode by the corresponding button in the Toolbar or Menubar. In Shift Mode the user can overview and move through the whole scenario. In this mode components cannot be placed, moved or selected. If the simulation has been started, Maverig switsches into Simulation Mode simultaneously.

1.6.1 Place element

To place an element into the scenario the user has to select any component in the Modepanel by a left-hand click. The selected component is displayed through an enlarged icon in the Modepanel. If a component of the Modepanel is selected Maverig switches the mode into Component Mode automatically. In this mode components can be placed into the scenario. In addition there is also a message in the Statusbar. Afterwards the user can click on the required position, to create an instance of the selected component on this position. Alternatively the component can also be placed by Drag & Drop. For Some components there is a need to create a line, after they have been placed into the scenario. In this case Maverig creates a line automatically, which can be put to the required position using the mouse. Another left-hand click draws the line into the scenario. A direct connection to other elements is possible as well.

1.6.2 Change element position

In Component Mode or in Selection Mode the position of one or several elements in the Scenariopanel can be changed. Therefore select the required elements and move them by Drag &Drop to their new position. A Selection of an element via doubleclick, selects any element of this type in the current scenario. So several elements can change their position at once. Secondary a multiple selection is possible in Selection Mode. The elements can be selected by a tapping left-hand click and by drawing a frame around several elements. The selected elements can be moved by Drag & Drop to their new position in the scenario.

1.6.3 Change element properties

To change the properties of an element, the element needs to be selected in the Scenariopanel. In the Propertypanel the user can see the adjustable properties of the selected element. In addition it is possible to adjust properties of several elements of the same type simultaneously.

1.6.4 Connect components

In Maverig there are two alternatives to establish a connection between elements. On the one hand by using the Line component and on the other hand after placing an element automatically. To establish a Line between two elements, the user has to select the component Line in the Modepanel. The first left-hand click in the scenario sets the start point. Another left-hand click in the scenario sets the end point. Maverig displays information about valid or invalid connections in the Statusbar simultaneously. If the end point creates a valid connection the Line or rather connection between both elements will be created.

1.6.5 Delete elements

To delete one element or several components the user has to select the required elements in the scenario. Afterwards the element(s) can be deleted by using the Delete-Key of the keyboard or the Delete-Icon of the Toolbar.

1.6.6 Copy/Cut/Paste elements

To copy or cut elements select the required element in the scenario. Thereafter use the corresponding keyboard shortcut or the Menubar shortcut. In the same manner elements from clipboard can be inserted into the scenario by using the paste shortcuts (q.v. chapter Shortcuts).

1.6.7 Zoom and Zoom Fit

If the created scenario is too big for the Scenariopanel the user can Zoom In or Zoom Out to adjust the view of the Scenariopanel. For that purpose the mouse wheel as well as the corresponding buttons in the Toolbar and Menubar can be used. Maverig also provides a Zoom Fit feature to adjust the zoom level to display the whole scenario in viewing range. So the user has an overview of the entire scenario. The Zoom Fit feature can be used by the corresponding button in the Toolbar or the Menubar.

1.6.8 Auto Layout

Maverig provides a feature named “Auto Layout”, which arranges elements in the Scenariopanel clearly. Auto Layout can be used by the corresponding button in the Toolbar or the Menubar. Afterwards the optimization process in the scenario will be displayed for the user.

1.6.9 Set simulation time

Before the start of the simulation there are some settings to determine. Such as the start and end time, the simulation speed and also the simulation range. This occurs in the Menubar by the item Set Time. Maverig saves the settings until the user changes them again. The simulation speed determines the playback speed of the simulation.

1.6.10 Run simulation

If the creation of the scenario is completed or the current state should be simulated, the simulation can be started by the corresponding start button in the Toolbar or Menubar.

1.6.11 Show element attributes during simulation

While the simulation runs the Componentpanel is replaced by the Attributepanel. If any element in the Scenariopanel is selected, the Attributepanel displays all attributes of this element. Any variable attribute, whose value changes during the simulation, is visualized in corresponding graphs.

1.6.12 Increase/Decrease simulation speed

With the buttons “Increase Speed” and “Decrease Speed” in the Toolbar and Menubar the playback speed of the simulation can be increased or decreased. Thereby the simulation playback increases only as far as the calculation of the simulation proceeded. Alternatively the user can skip to any already calculated point of time by using the Scrollbar of the Progressbar.

1.6.13 Stop simulation

The simulation can be stopped by the stop button in the Toolbar or Menubar. Afterwards Maverig switches from Simulation Mode into Composition Mode. In Composition Mode the user can adjust the scenario.

1.7 Component Wizard

With the Component Wizard the user can create new components in Maverig and use them in further scenarios. There is a step by step creation process whose operation will be described below. The Component Wizard starts in a new window by clicking at the corresponding button in the Modepanel.

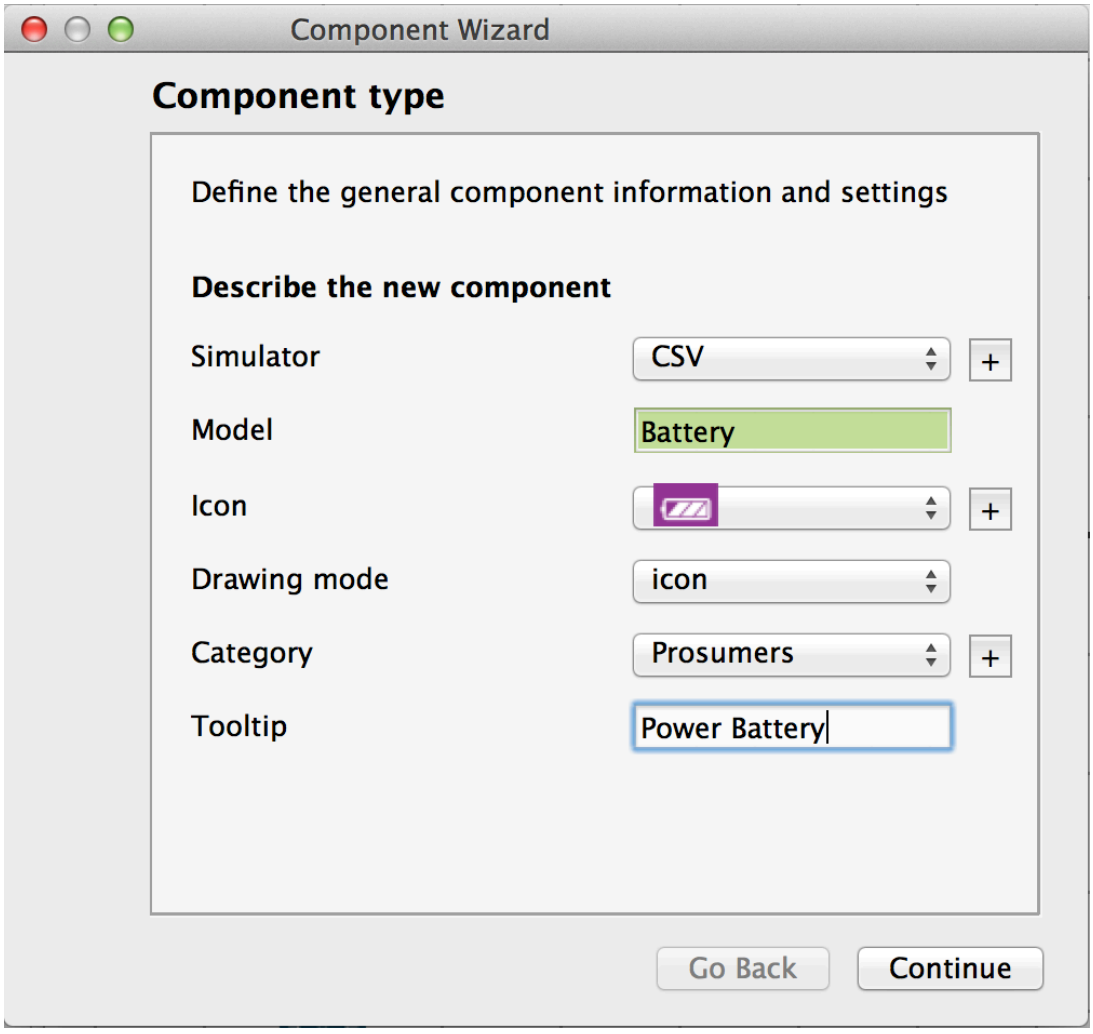


Figure 1.6: Component Wizard

In the beginning the user chooses the simulator type, for instance, PyPower or CSV. Alternatively the "+"-button can be used to add a new simulator. Then the new component gets a name and a representative icon. By default there are several symbols available. Here again with the "+"-button a new symbol can be added.

For the Drawing Mode there are four options as “line”, “line-icon-line”, “icon” and “node” available. The Drawing Mode depends on the type of application. Concluding the user defines the Category, in which the new component will be listed in the Modepanel in Maverig. If necessary, a new Category can be added. An optional Tooltip for the component can be assigned. The user reaches the next step by clicking on Next.

1.7.1 Add new Simulator

If the user wants to add a new simulator, a new window for detailled information opens.

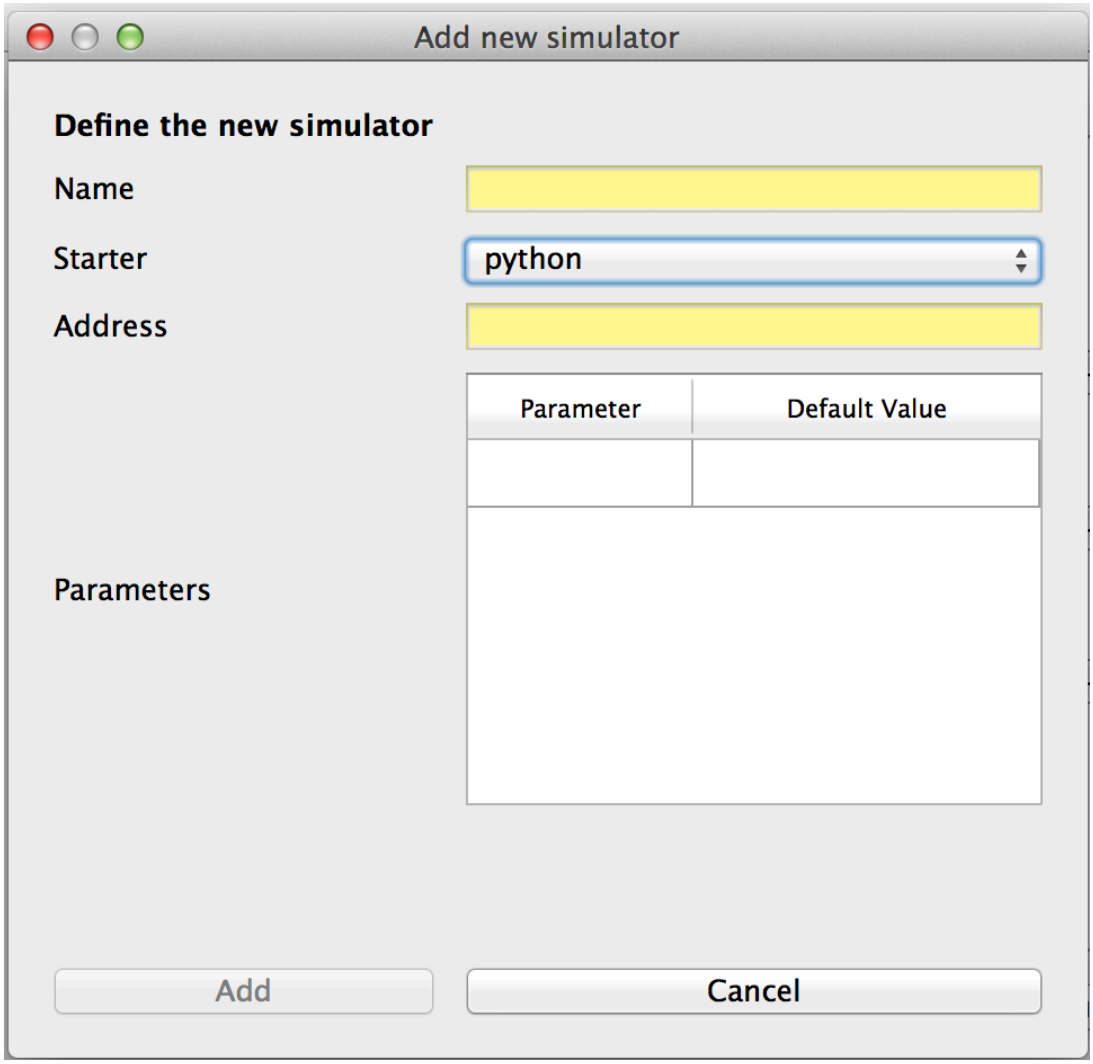


Figure 1.7: Add new Simulator

The yellow areas show the required information for a new simlator as the name, the starter and the path for the new simulator. Furthermore parameters and their default values can be defined. A click on “Add”, adds the new simulator to the new component and brings the user back to the previous window.

1.7.2 Determine Parameters and Attributes

In the next step of the Component Wizard parameters, attributes and their description will be determined.

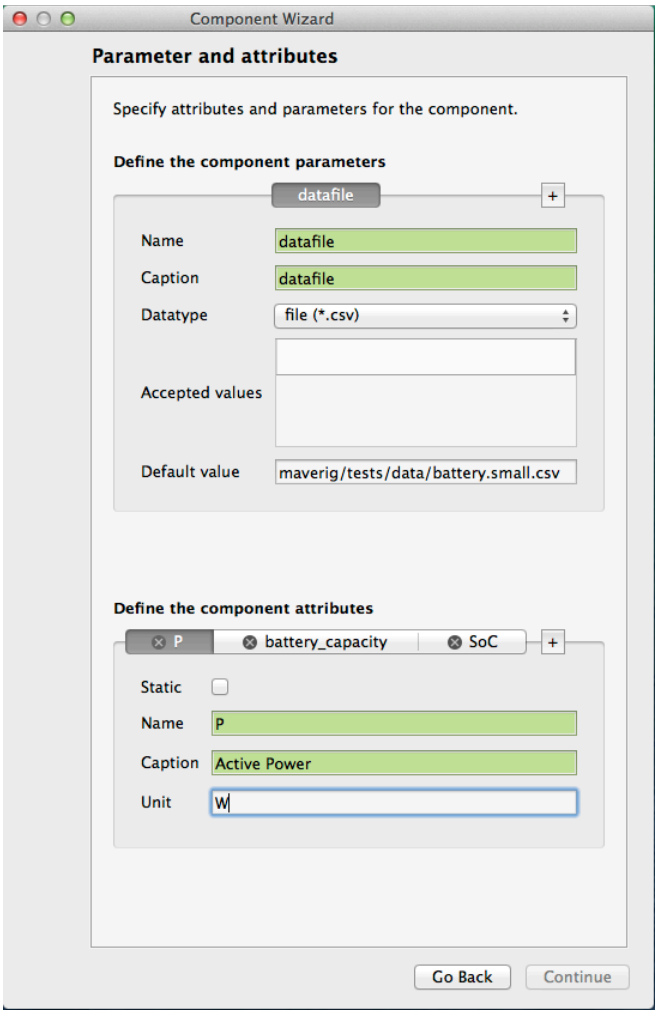


Figure 1.8: Determine Parameters and Attributes

Parameters and attributes need a name and a description. Additional for parame-

ters a datatype with a default value has to be specified. For attributes a declaration of a unit is required. If the option “static” is enabled, this parameter is not displayed in a graph during simulation. Static in this context means unchanged attribute values during simulation. With the “+”-button arbitrary parameters and attributes can be added. Finally a click on Next closes the Component Wizard and creates the new component.
After the completion of the Component Wizard the new component is listed in the Modepanel in the corresponding category and can be used in a scenario.

1.8 Error messages and troubleshooting

Error messages	Description
Component couldn't be created - invalid connection	You tried to place the element above another element or connection. Please place the element into a free area in the scenario.
No elements to connect	No elements for a connection have been found.
Line length must be longer than 0 km	You defined a Line length of 0 km.
Invalid connection	You tried to create an invalid connection.
Start time before end time	The simulation start time has to be before the simulation end time.
Simulation range less than simulation time and greater than 0	You chose a simulation range, which is greater than the simulation time
Length of selected Line is too long	Due to the Line length and the electric power to transfer the simulation canceled. Please adjust the Line length or the Line type.

1.8.1 Shortcuts

Control key Windows/Linux: Ctrl; Control key Mac: cmd	
Shortcut	**Feature**
Control key + ,	Settings
Control key + H	Maverig fade-out
Control key + N	New File
Control key + O	Open File
Control key + S	Save File
Control key + Shift + S	Save File as
Control key + Q	Close Maverig
Control key + Z	Undo
Control key + Y	Redo
Control key + X	Cut
Control key + Z	Copy
Control key + V	Paste
Control key + A	Select All
F1	Help
F4	Auto Layout
F5	Run Simulation
F6	Stop Simulation
F7	Pause Simulation
F8	Back to start
F9	Decrease simulation speed
F10	Increase simulation speed
F11	Forward to end
Control key + T	Set time
Control key + G	Go to
Control key + Alt + S	Selection Mode
Control key + Alt + R	Enable/Disable Raster
Control key + +	Zoom In
Control key + -	Zoom Out
Control key + .	Zoom Fit
Control key + 1	Enable/Disable Modepanel
Control key + 2	Enable/Disable Propertypanel
Control key + 3	Enable/Disable Console
Control key + 4	Enable/Disable Statusbar
Control key + 5	Enable/Disable Progressbar
Control key + 6	Enable/Disable Attributepanel