Controls and Displays

This section covers the controls and displays of the Simplex Nodal app.

Data Display common controls

Double-tap a component to access its Data Display. The controls indicated in Figure 147 are common to a number of the Data Displays. These controls are described in the following sections.

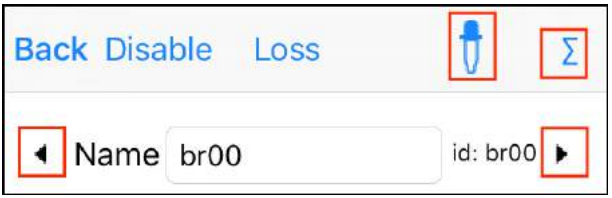


Figure 147: Controls common to a number of Data Displays

Navigation between displays

Common to all components:

◀ and ▶	Navigate to the Data Display for the previous/next component of the same type, e.g., for a branch navigate to the previous/next branch

Setting default parameters

Common to the Data Displays for Branch, Gen and Load components:

	Set the parameter values currently displayed as the default values for all new components of this type. Default values can be reset to the original defaults via Settings – Reset Default Values

Viewing variables and constraints

Common to the Data Displays for Branch, Gen and Load components:

	Displays the component's variables and constraints, as created by the latest solve. Variables and constraints can also be viewed via the Results display.

Naming a component

When components are added they are automatically assigned an i.d. and a name. The name is used for display purposes and is initially the same as the i.d. The i.d. cannot be changed, but the name can be changed via the Name field on the Data Display, as shown in Figure 148.

Figure 148: Name data entry for bus

Note that for the branch component there is also an auto-naming option available, this is described in the Settings section below.

Data Display for a Bus component

Shows whether or not the bus is the reference bus for the island. Includes the option to "Set as reference bus" by tapping the button indicated in Figure 149.

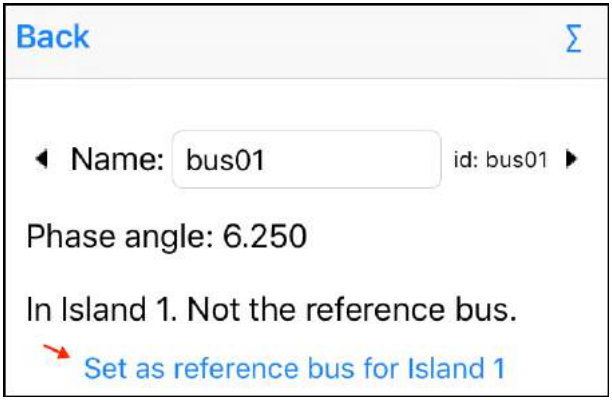


Figure 149: Button to make this bus the reference bus

Also shows the phase angle from the latest solve, useful if you choose to not show the phase angle on the main display.

Data Display for a Gen component

Energy Offers

Figure 150 shows the Data Display for a Gen component, where you can edit the name of the component and enter its energy offers. The lower half of the display shows the cleared offer quantities from the latest solve.

Figure 150: Data Display for Gen component

The toolbar has the "Reserve" button that leads to the Reserve display and the "Ramp" button for the Ramp Rate display.

Figure 151: Reserve Data Display for Gen component

Reserve display

The Reserve display shown in Figure 151 is where you enter the reserve offers, the generator capacity, the PLSR%, enable/disable the PLSR% constraint,

and define the generator as a risk unit. Note that reserves are only included in the model if Reserve is enabled via the Solve Settings display.

The interaction between Risk, Reserve Offers, Capacity and PLSR% are described in Tutorial 5: Risk and Reserve.

The lower half of the display shows the cleared reserve quantities from the latest solve.

Figure 152: Non-zero reserve offers and zero Capacity

The "∑" button sets the Capacity value to the sum of the energy offers. The button is only displayed if the Capacity is not already equal to the sum of the energy offers.

The capacity constraint is only applied if the generator has non-zero reserve offers and the solve

settings has Reserve enabled. When applied, the capacity constraint will limit the sum of cleared energy and reserve offers to be no more than the capacity of the generator.

If there are non-zero reserve offers but the capacity limit is zero then the Capacity will be highlighted red as shown in Figure 152, to alert that if the value is not changed and Reserve is enabled then the sum of the cleared energy and reserves will be limited to zero.

If you leave the Reserves display with non-zero reserve offers but a capacity of zero, then the warning shown in Figure 153 is displayed.

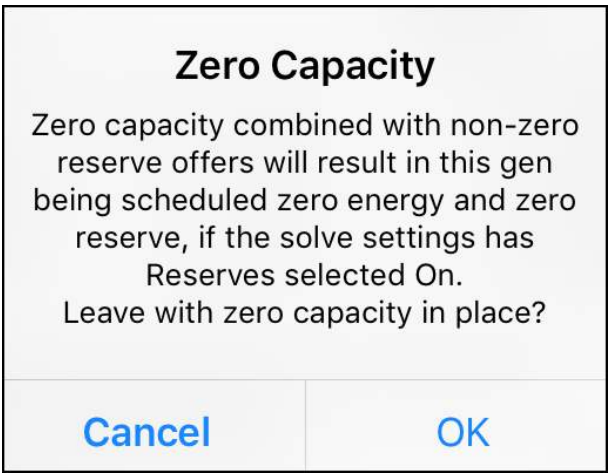


Figure 153: Warning when leaving Reserves display

Ramp Rate display

The ramp rate constraint restricts the generation based on how far the Ramp Rate Up value allows the generation to move from the Initial MW, as explained in Tutorial 6: Ramp Rates.

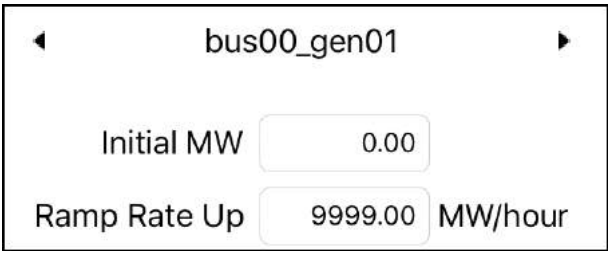


Figure 154: Ramp Rate Data Display

The Initial MW and the Ramp Rate Up are entered via the Ramp Rate display shown in Figure 154. The Ramp Rate Up has a default value of 9999, which ensures that for any realistically sized generator the ramp rate constraint will not bind unless the default value is edited.

Ramp rate constraints are only included in the model if Ramp Rate is enabled on the Solve Settings display. Ramp Rate constraints are not created if the ramp rate limit exceeds the sum of the offers (because the ramp rate limit would have no impact).

Data Display for a Load component

The Data Display for a Load component is shown in Figure 155. This is where you can change the load's name and enter the energy bids.

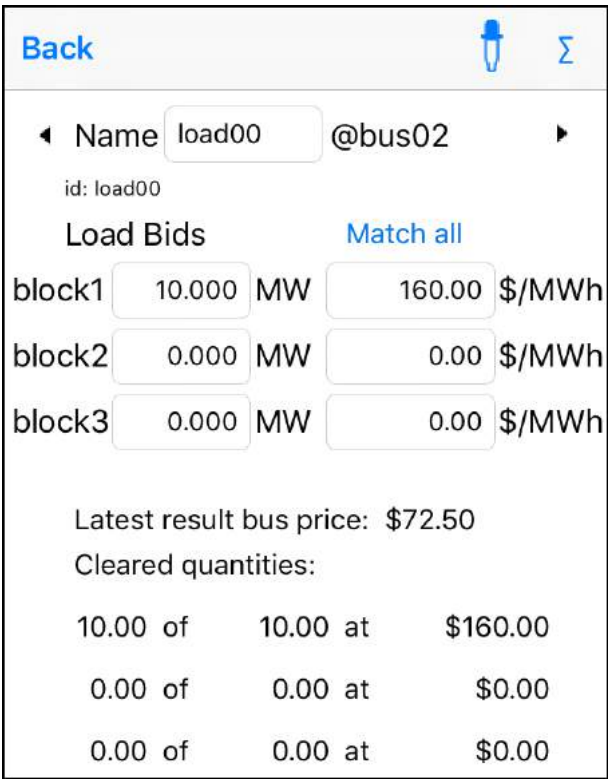


Figure 155: Data Display for Load component

The "Match all" button will update the block 1 bid price for all existing Load components to match the block 1 bid price of the currently displayed Load. This is useful if you want to treat the block 1 bid

quantity as a required load and use the block 1 bid price as the penalty cost for all required loads. Before "match-all" is applied the alert shown in Figure 156 is raised.

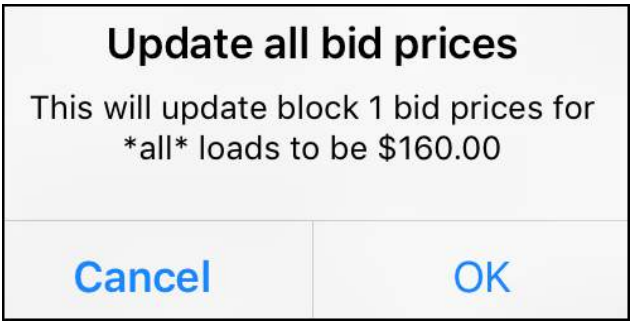


Figure 156: Alert raised after "Match all" button is tapped

Data Display for a Branch component

Branch parameters

Figure 157 shows the Data Display for a branch component. This is where you enter the branch parameters of maximum flow, resistance, and reactance. There is also the option to enter the susceptance instead of the reactance, by tapping the "View Susceptance" button. The relationship between resistance, reactance and susceptance is described in Tutorial 2: Modelling Transmission.

The display includes a switch to mark the branch as a transformer; the only thing that this changes is how the branch appears on the display.

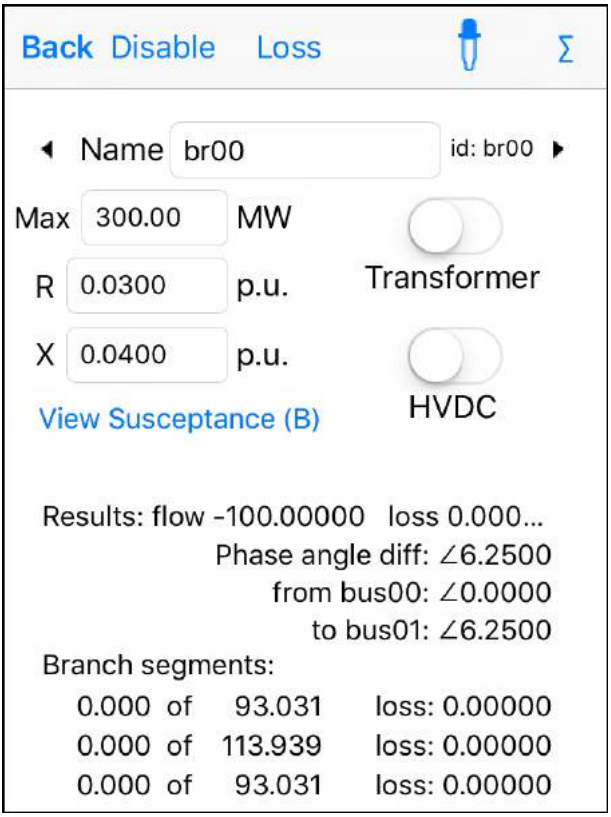


Figure 157: Data Display for a Branch component

The Data Display also includes a switch to define a branch as an HVDC link. The functional differences between an HVDC link and a normal branch are covered in Tutorial 7: HVDC Link.

The toolbar includes the Disable button, which removes the branch from the model without deleting the branch. After a branch is disabled the

Disable button changes to Enable as shown in Figure 158.

Figure 158: Disabled branch has an Enable button

Figure 159 shows the display differences for the various branch options.

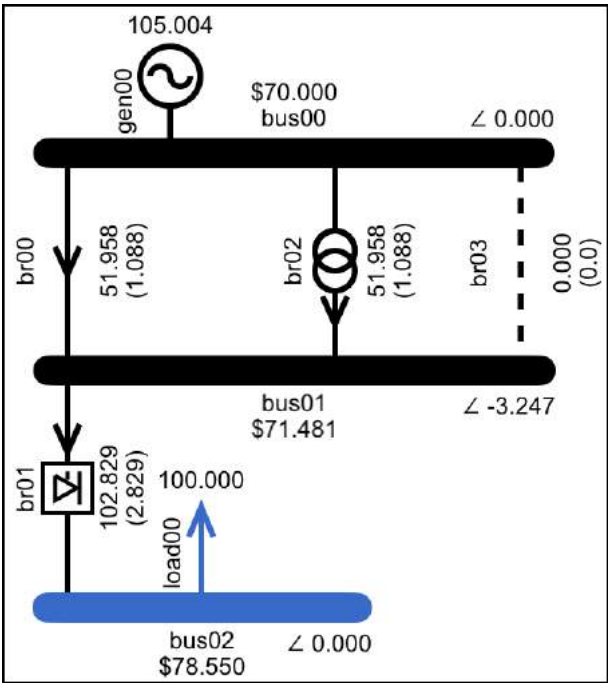


Figure 159: br00 is the default (a circuit), br01 is an HVDC link, br02 is a transformer, br03 is removed from the model

Branch losses

The Losses button on the Branch Data Display links to the Br Segments display shown in Figure 160, which shows the data for the individual segments that model the flow-loss parabola.

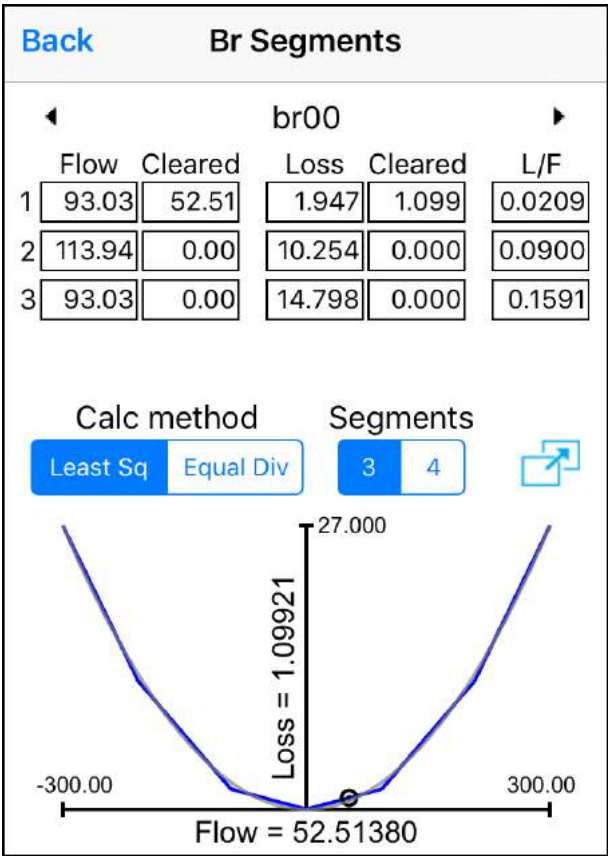


Figure 160: Branch segments display, i.e., branch flow-loss

The branch segments display includes options to change the number of segments, and to change the way that the segments are calculated. For a full discussion of these settings see Tutorial 4: Transmission Losses.

When a change is made to the settings, the segment data is re-calculated and the display is updated. Altered settings are highlighted red as shown in Figure 161. For the altered settings to be saved they must be applied to all branches in the model, which will happen automatically when you leave the display. Before this automatic update occurs, you will be prompted to confirm the update via the alert shown in Figure 162.

Figure 161: Altered loss segment settings are highlighted red

Figure 162: Segment changes will be applied to all branches

If you don't want to apply the change then select the Cancel option and undo the methodology change before leaving the display.

Full screen plot of flow-loss

The flow-loss plot is superimposed over the curve that represents the actual flow-loss parabola. You can use the pinch gesture to zoom in for a closer look at the flow-loss curve, as shown in Figure 163.

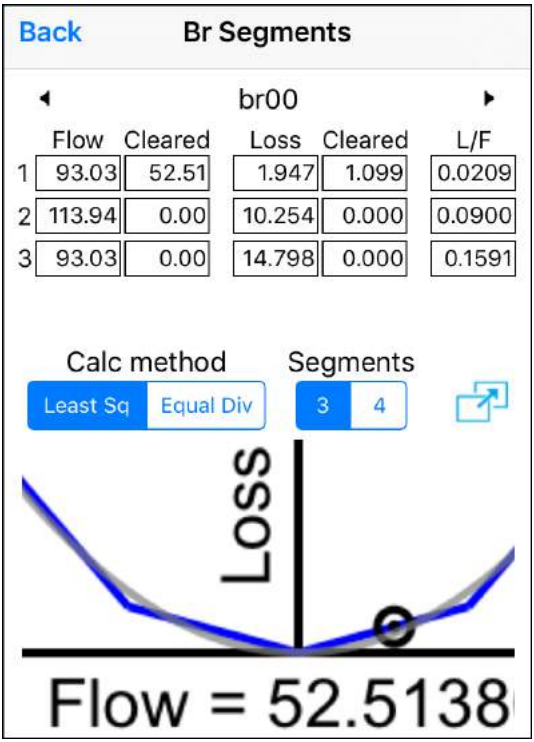


Figure 163: Flow-loss plot zoomed in

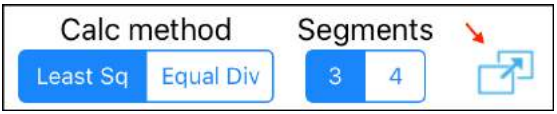


Figure 164: Button to view flow-loss curve full screen

The button indicated in Figure 164 leads to a full-screen plot of the flow-loss curve, as shown in Figure 165.

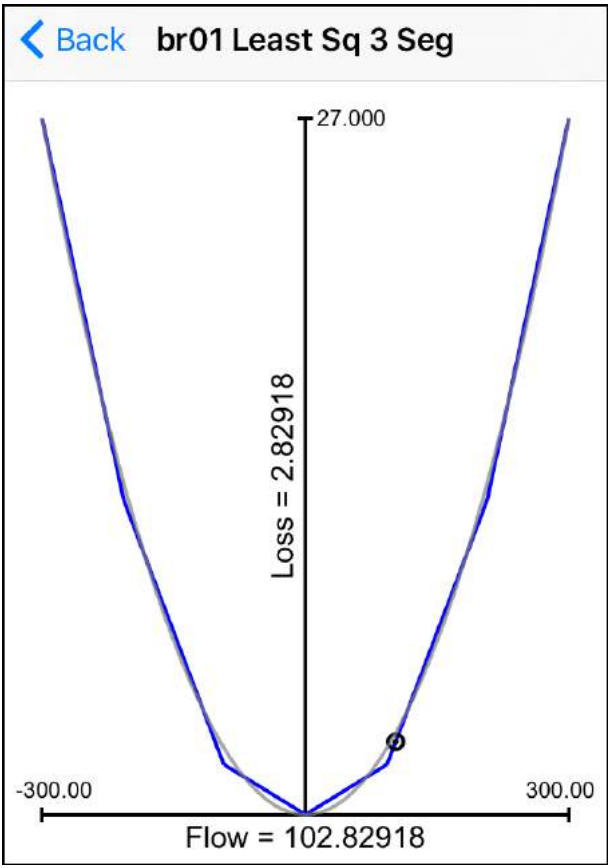


Figure 165: Full-screen view of flow-loss curve

Layout of bus labels

A bus's name label and phase angle label are situated in locations where they can get in the way, as shown in Figure 166. For this reason, every time a component is moved an automatic check takes place to see whether it would be better if the name and phase angle labels were positioned above or below the bus.

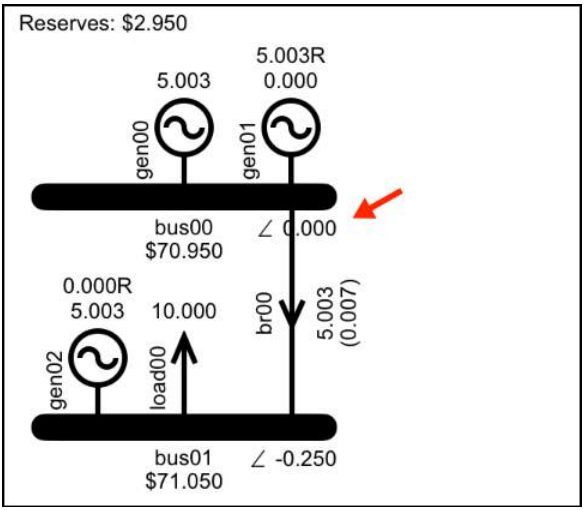


Figure 166: Phase angle label can get in the way

Figure 167 shows that if gen01 is moved then the location of the phase angle label for bus00 will be automatically adjusted.

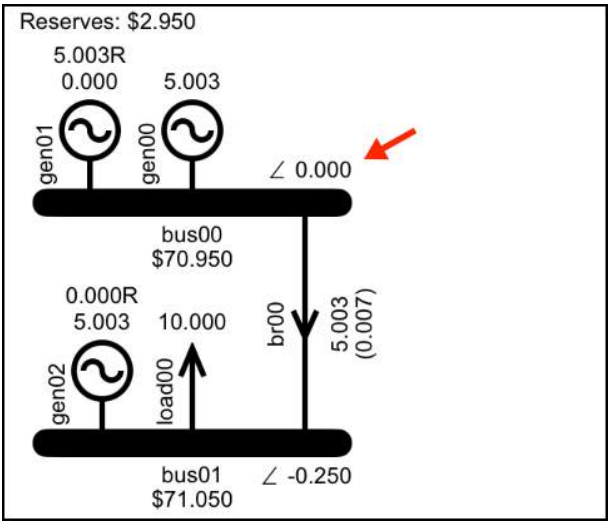


Figure 167: Automatic check moves label to better location

The automatic placement is not perfect because it is the size of the text box that determines whether or not there is an overlap, regardless of whether the text box is full. On the odd occasion when this is a problem you can get the placement to do what you want by disconnecting and re-connecting the troublesome component. If and when you save the model, the final placement of the labels is saved with the model.

Zoom and scroll

The tutorial examples can all be viewed full size on an iPhone screen, with the exception of the large sample model in Tutorial 8: Actual Market Data,

which can be viewed full size on an iPad screen as shown in Figure 168.

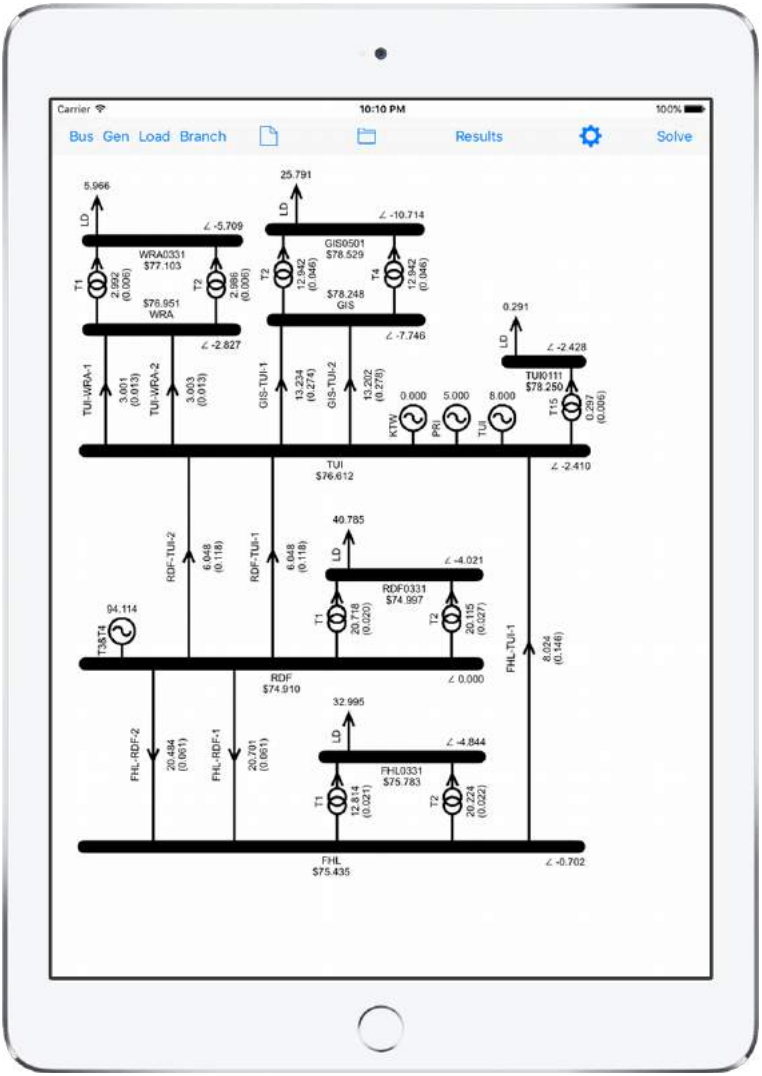


Figure 168: Large sample model on an iPad screen

The large model can be viewed on an iPhone screen by using zoom and scroll. When this model is first loaded onto the iPhone you will only be able to see part of it, as shown in Figure 169.

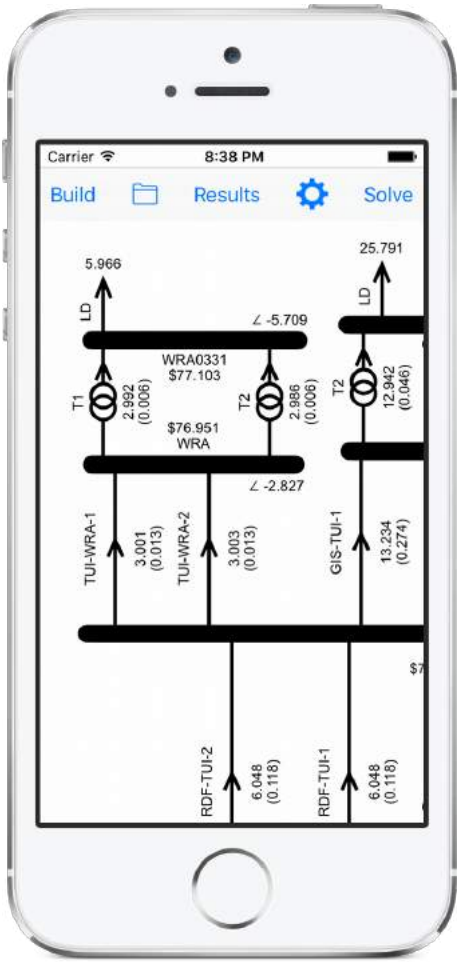


Figure 169: Large sample model at full size on an iPhone

With zoom/scroll enabled you can drag the background to scroll or use the pinch gesture to zoom out and view the full model as in Figure 170.

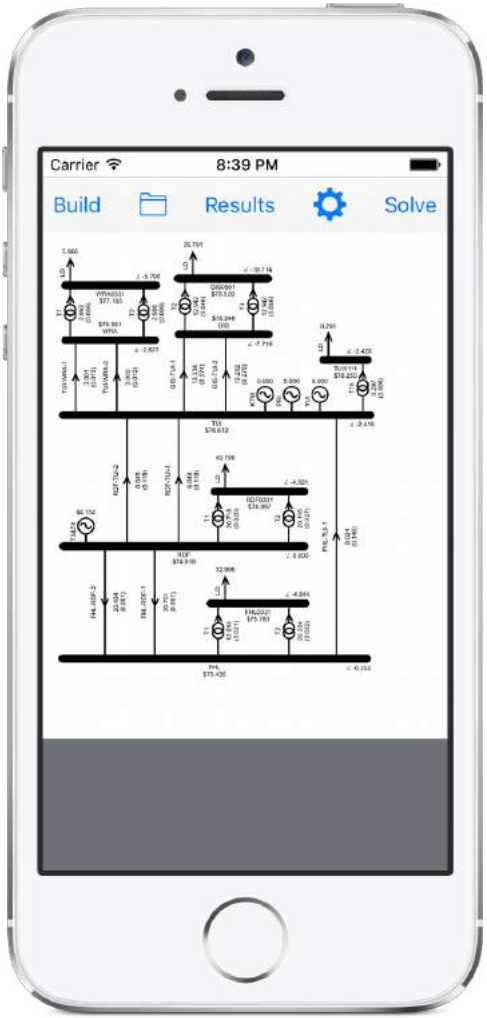


Figure 170: Large sample model zoomed out on iPhone

The iPad does not need zoom because the full size of the model is the size of the iPad screen. Scroll is available on the iPad because you may need to scroll if you operate in landscape mode.

Zoom and scroll for the iPhone is enabled/disabled via the Settings display.

Settings

The Settings display is accessed via the Settings button indicated in Figure 171.

Figure 171: The Settings button

The Settings display is shown in Figure 172, the individual options are described in the following subsections.

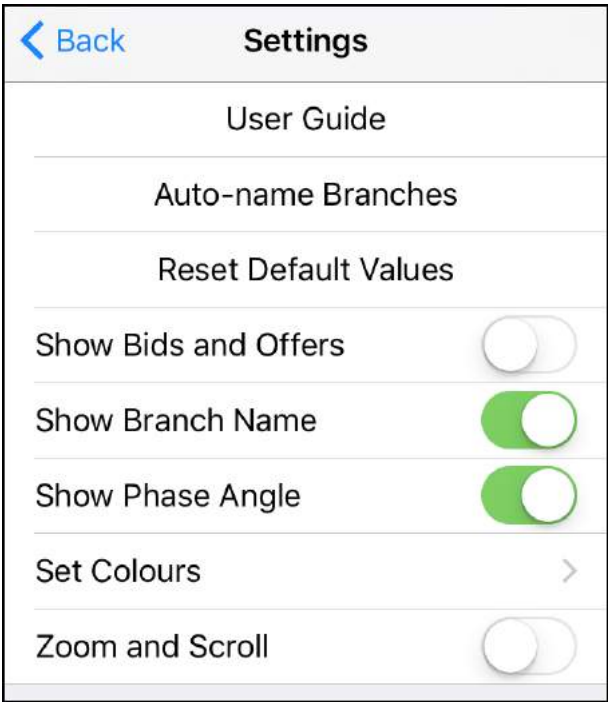


Figure 172: The Settings display

Settings: User Guide

The user guide display, shown in Figure 173, provides a brief guide to user actions that are not immediately obvious. It also provides a link to the location of this document, and an email link for the user to provide suggestions, feedback, or bug reporting.

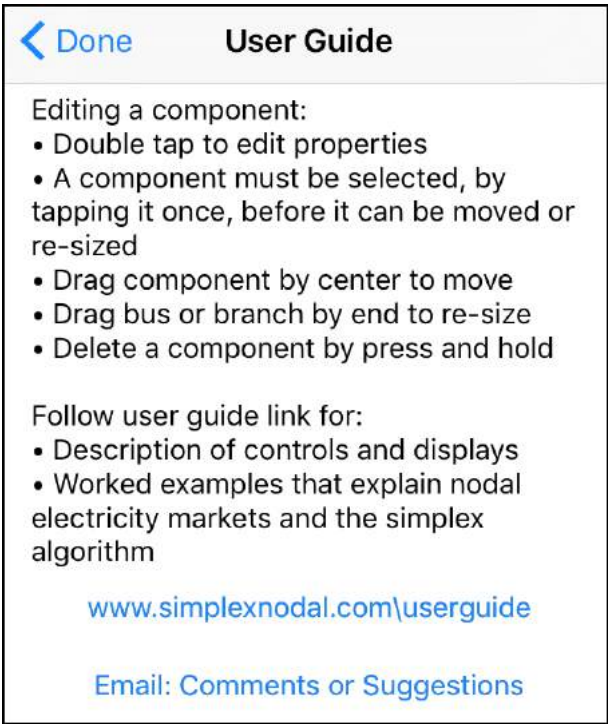


Figure 173: User Guide display

Settings: Auto-name Branches

Branches can be auto-named, following the convention of "fromBus-toBus-*number*", where:

- fromBus and toBus are the buses at either end of the branch, and fromBus is the bus whose name is alphabetically before the name of toBus

- *number* is used to differentiate between branches when more than one branch connects the same two buses
- the delimiter can be selected to be either a dash or an underscore

After tapping the "Auto-name Branches" button the alert shown in Figure 174 is raised to let you know that any existing branch names will be over-written. The prompt provides the option of delimiting the names using either underscores or dashes.

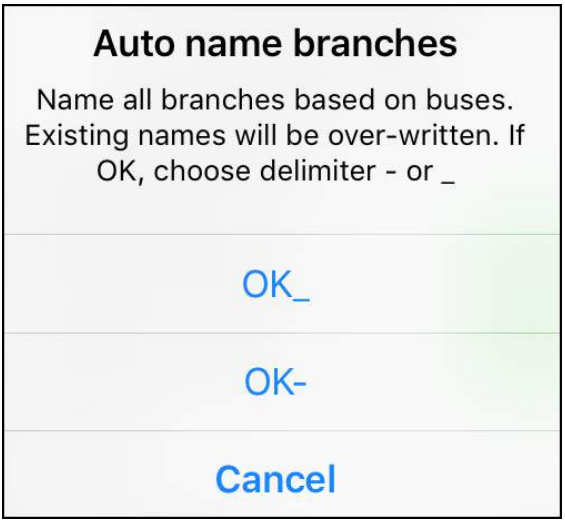


Figure 174: Alert to confirm auto-naming of branches

Settings: Reset Default Values

When a component is added to the model its parameters are populated using default values. As

described previously, some of these defaults can be updated using the eye-dropper button on the Data Displays.

The worked examples in this document mostly use the default values that were in place when the app was run for the very first time. If you have changed the default values and you want to reset them to the original default values (to make it easier to follow the worked examples) then use the "Reset Default Values" button.

Settings: Show bids and offers

The details of the bids and offers (price, quantity and cleared quantity) are viewed via the Data Displays of the Gen and Load components. The details can also be displayed on the network model, as demonstrated in Figure 175, by selecting the "Show Bids and Offers" option to ON.

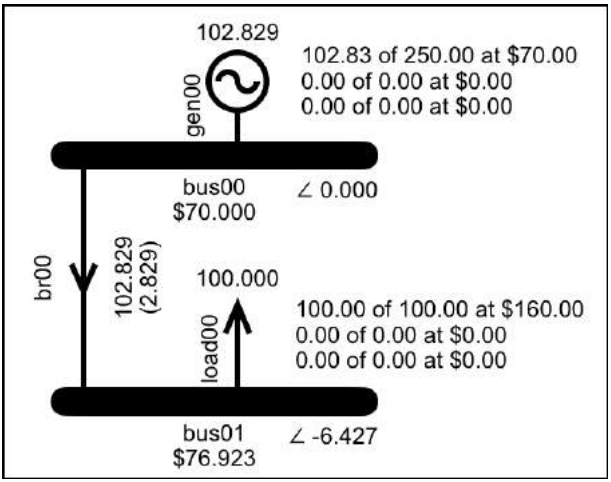


Figure 175: The model with bid and offer details displayed

The advantage of this is that it makes it easy to explain the results without needing to go to other displays, the disadvantage is that it takes up a lot of screen space.

Settings: Show Branch Name

You can save screen space by hiding the branch name, see Figure 176 (branch name displayed) compared with Figure 177 (branch name hidden).

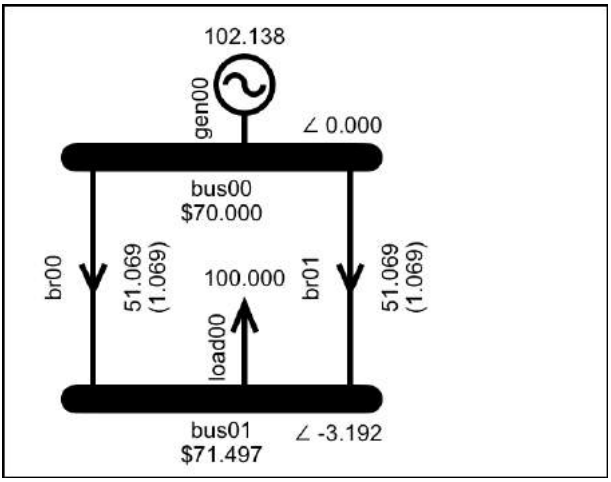


Figure 176: Branch name shown

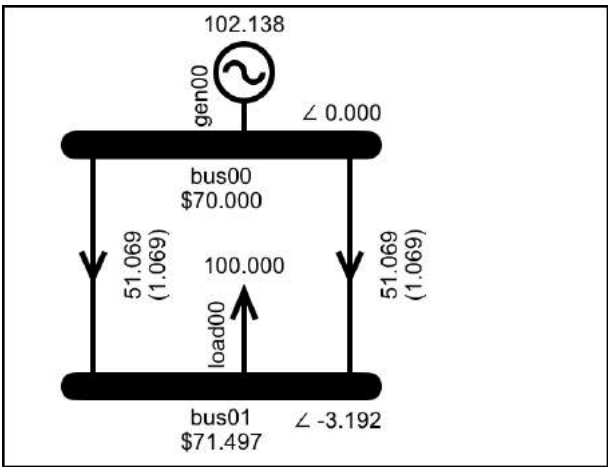


Figure 177: Branch name not shown

Settings: Show Phase Angle

Another way of freeing up screen real-estate is by removing the bus phase angle from the display, see Figure 178 compared with Figure 179.

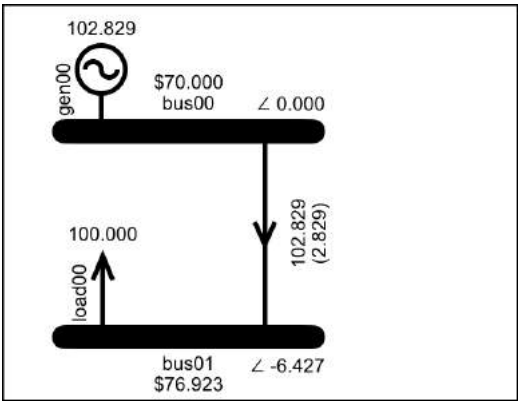


Figure 178: Show bus phase angle = ON

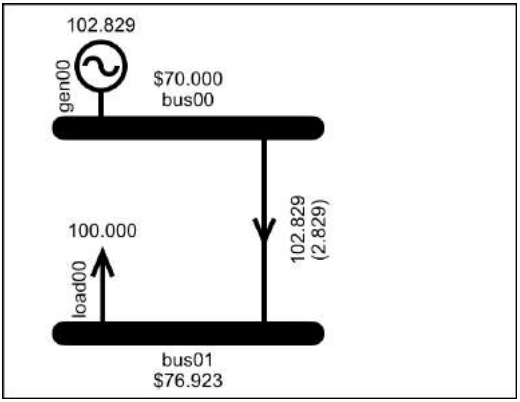


Figure 179: Show bus phase angle = OFF

The bus phase angle can still be viewed on the bus Data Display, and on the branch Data Display which shows the phase angle of the branch's from-bus and to-bus.

Settings: Set Colours

The Settings display also includes the Set Colours option that leads to the Set Colours display shown in Figure 180 where you can set the background colour and the island colours.

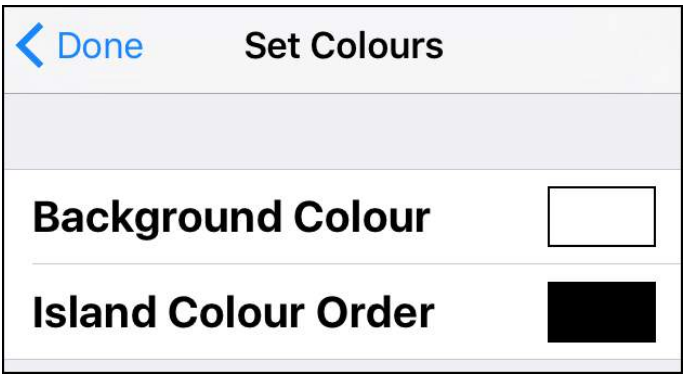


Figure 180: The Set Colours display

The "Background Colour" option leads to the display shown in Figure 181. An example of what happens if you change the background colour is shown in Figure 182.

Figure 181: Background Colour options

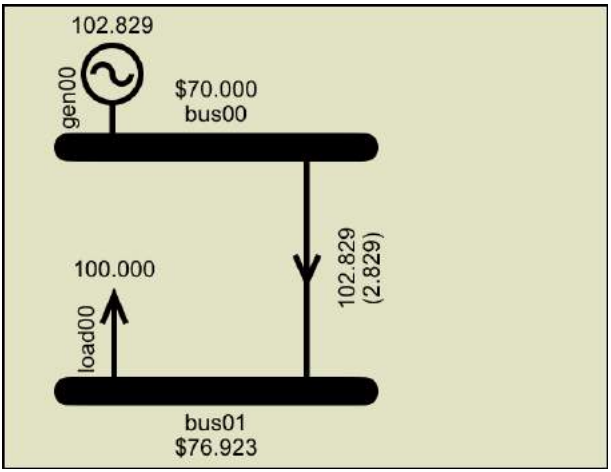


Figure 182: Example of changing the background colour

The "Island Colour Order" option takes you to the display shown in Figure 183 where you can drag the rows by their right hand edge to set the order in which the island colours are assigned. Note that the colour for Island 0 cannot be re-ordered.

Figure 183: Drag the row by its RHS to re-order the island colours. Note that Island 0 cannot be re-ordered.

Settings: Zoom and Scroll

On the iPad the model is always full size so there is no zoom, while scroll is available in landscape mode. Hence, the iPad does not have "Zoom and Scroll" as an option.

On the *iPhone* if "Zoom and Scroll" is on then you can zoom using the pinch gesture, and scroll by dragging the background. If a model will fit on the screen without zooming then it is easier to work with "Zoom and Scroll" selected off.

Saving and Loading a Model

Figure 184: The Save/Load button

The display for saving and loading models is accessed via the folder button indicated in Figure 184. This links to the Models display shown in Figure 185, which lists the names of the models that you have saved. It also has a link to the Save models display (to save the current model) and, in the lower toolbar, a link to the Sample models display (to view and load sample models).

The list of models can be sorted by either by name or by date, using the sort-order button in the lower toolbar.

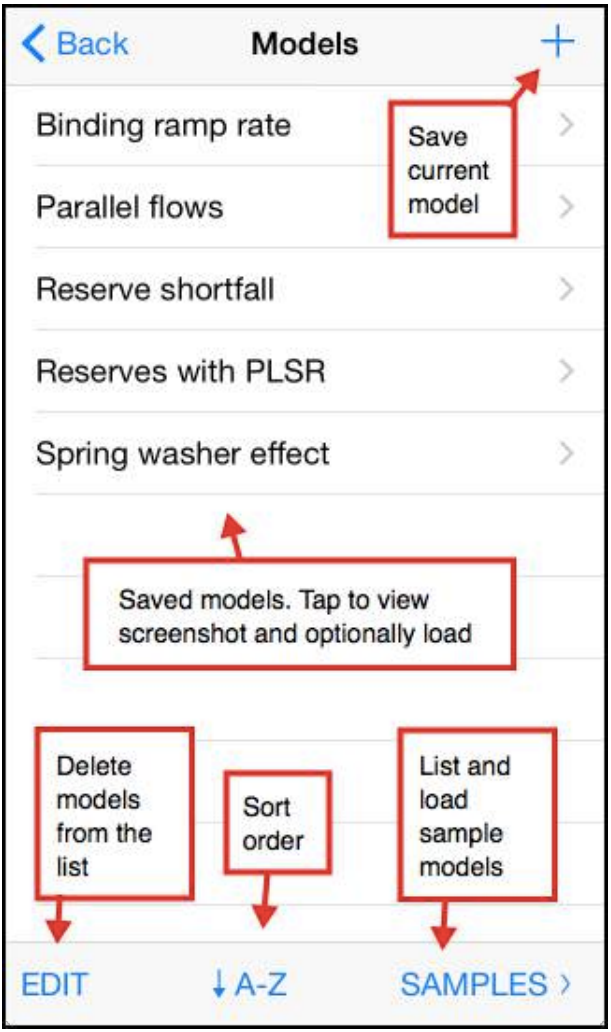


Figure 185: The save/load Models display

Load a model

Tapping a model's name on the Models display takes you to the model details display in Figure 186.

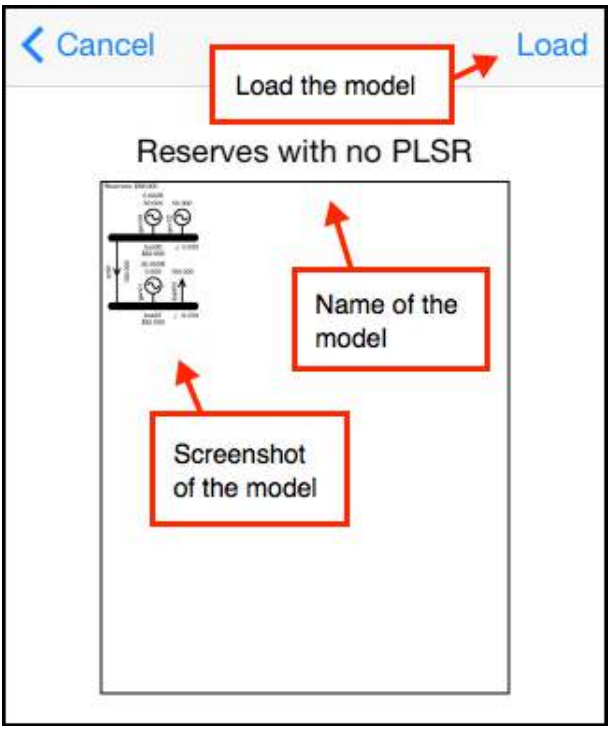


Figure 186: View and Load a model

Tapping the "Load" button will load the model as the current model. If there is an existing current model then the alert shown in Figure 187 will be raised to warn you that loading the model will over-write the existing current model.

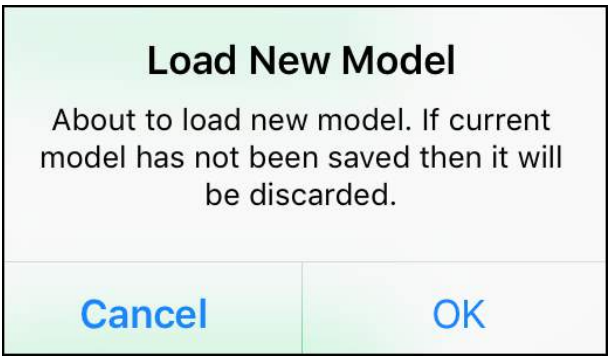


Figure 187: Alert raised if current model exists

Save a model

To save the current model, tap the "+" button on the Models display. This will take you to the Save display shown in Figure 188 where you name and save the model.

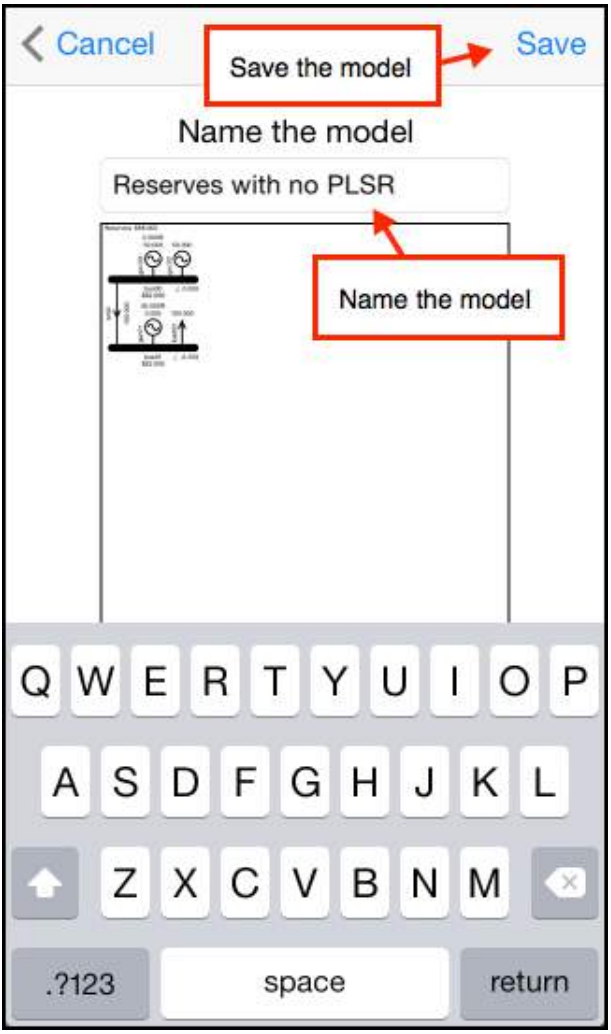


Figure 188: Name and save the model

Delete a model

To delete a model, tap the Edit button on the bottom toolbar of the Models display. This will provide the option of deleting any of the saved models.

Load a sample model

The app includes pre-built sample models. The samples are accessed via the Samples button on the lower toolbar.

The Import Export display

The current model can be exported as a text file. This text file representation of the model can also be imported into the app either as an email attachment or via iTunes.

The Import Export display is accessed via the Import Export button on the Results toolbar, as indicated in Figure 189.

Figure 189: The "Import Export" button on the Results toolbar

The Import Export display is shown in Figure 190. The available options are described in the following sections.

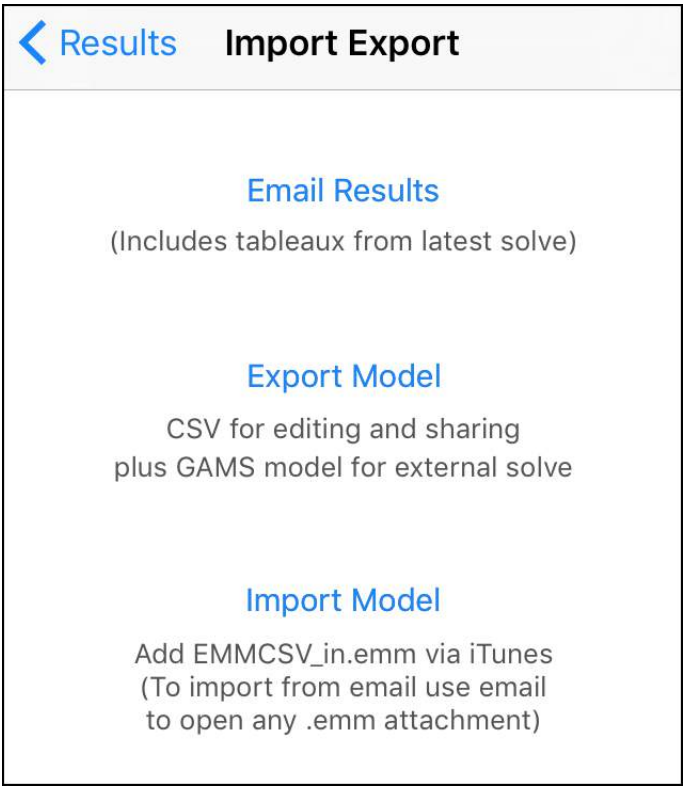


Figure 190: The "Import Export" display

Email Results

Creates an email with the following attachments:

- A screenshot of the current model
- The results of the latest solve, in csv format
- The simplex tableaux from the latest solve, in csv format

Note that the tableaux are only saved if the option to "Save Tableaux" was selected at solve time. If no tableaux were saved then the Email Results button will include the caption "Latest solve did not save tableaux".

As you build bigger models, the associated simplex tableaux get larger quite quickly. If the tableaux are saved then this will slow the solve and strain the memory, so it is best not to save tableaux unless you want to study the simplex solve in detail.

The simplex tableaux are explained in Tutorial 9: Simplex Explained.

Export Model

Creates an email with the following attachments:

- A screenshot of the current model
- A csv representation of the model. This file has a ".emm" extension (electricity market model), and can be imported back into the app (see below for details)
- A GAMS representation of the model. This file has a ".gms" extension and can be solved using the GAMS solver

Solving the model using GAMS

You can download GAMS from…

http://www.gams.com/download/

…install it on your computer and then use it to solve the GAMS model that you exported.

At the time of writing, the free version of GAMS will allow you to solve a model that has up to 300 constraints and variables. This is enough to recreate the results from any of the worked examples in the tutorials, except for the sample models of an actual market which are too large.

Note that HVDC links were added in version 2 of the app and have not yet been added to the GAMS model (if there is any interest in this then it can be suggested as an enhancement).

Confirming the GAMS result

Confirm the GAMS result by loading and solving the sample model "Losses Reserves Ramp". This model exercises most of the market system features implemented by the app.

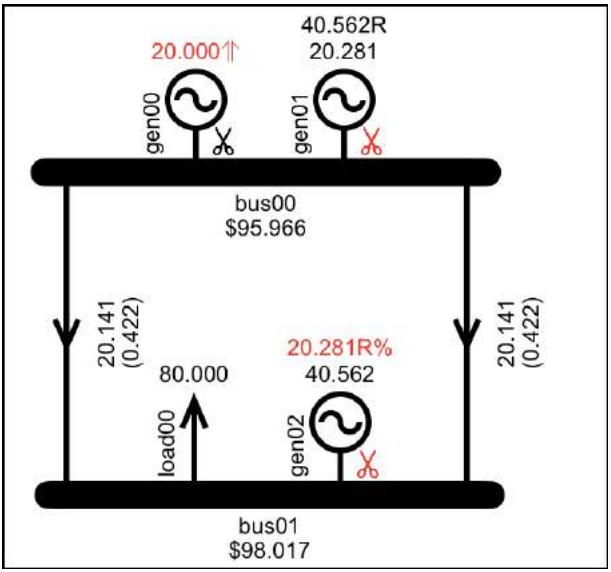


Figure 191: Sample model "Losses Reserves Ramp"

Use the Results - Export Model option to email a copy of the gms file to your computer. Solve the gms file in GAMS.

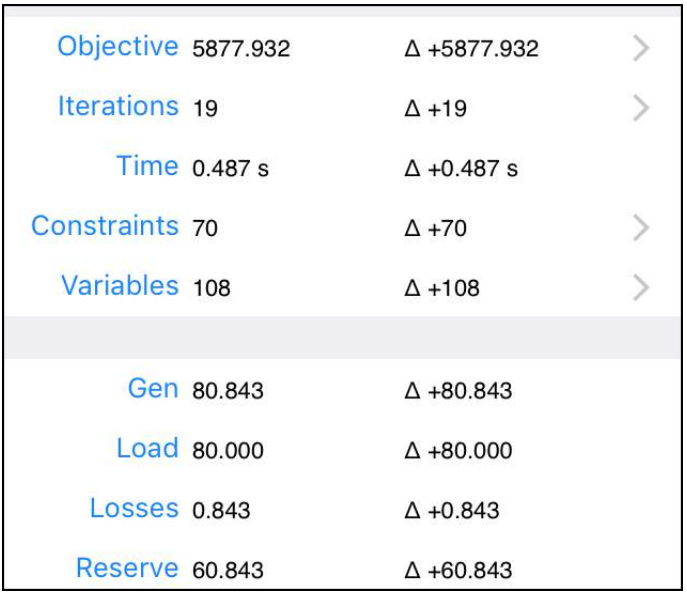
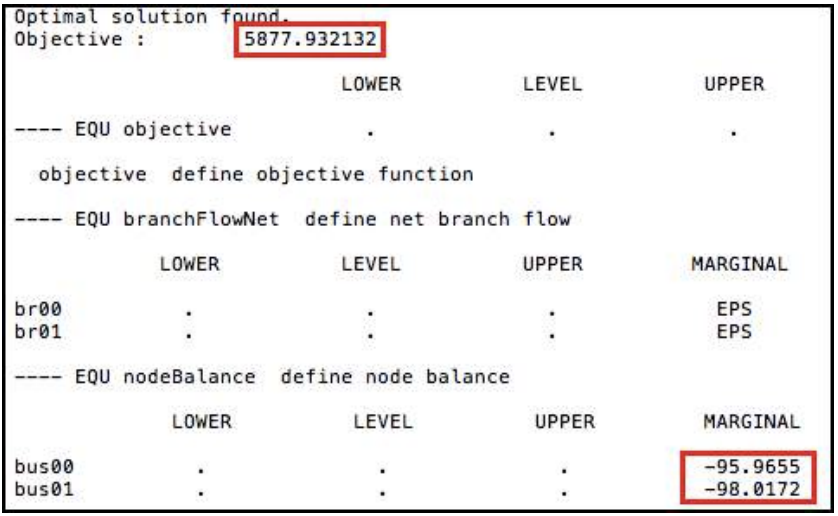


Figure 192: Results for "Losses Reserves Ramp" model

Confirm that the GAMS output, a snippet of which is shown in Figure 193, matches the app results in Figure 191 and Figure 192.



```
Optimal solution found.
Objective :        5877.932132

                            LOWER          LEVEL          UPPER

---- EQU objective             .              .              .

  objective  define objective function

---- EQU branchFlowNet  define net branch flow

            LOWER          LEVEL          UPPER         MARGINAL

br00            .              .              .             EPS
br01            .              .              .             EPS

---- EQU nodeBalance  define node balance

            LOWER          LEVEL          UPPER         MARGINAL

bus00           .              .              .          -95.9655
bus01           .              .              .          -98.0172
```

Figure 193: Snippet of GAMS result for "Losses Reserves Ramp"

Importing a model

Once the model has been exported as a csv file, you can edit the model via the csv, e.g., to easily update multiple inputs, or share it with someone else who has the app. The csv model file can be re-imported by the following two methods.

If the model is sent as an email attachment with the ".emm" extension then the email app on the iPhone/iPod/iPad will recognize the file type and provide the option of loading the model into the Simplex Nodal app.

The model can also be imported using iTunes. In iTunes, select your iPhone/iPod/iPad. In the

Settings side panel select Apps, then in the right-hand side panel scroll down to the File Sharing section, shown in Figure 194

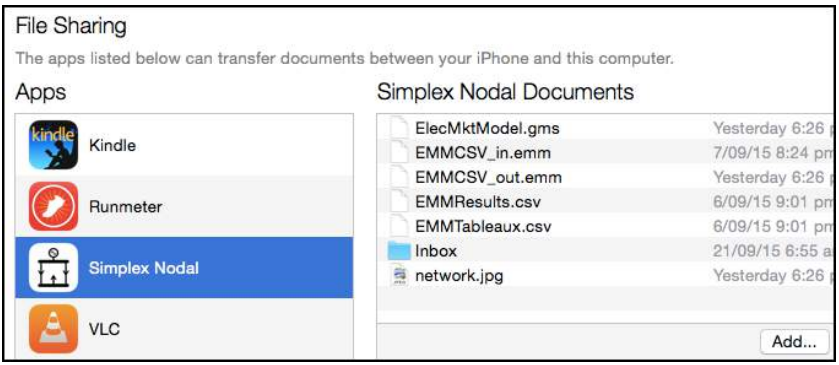


Figure 194: Importing a model using iTunes

Select the "Simplex Nodal" app and click the "Add" button then select the model file from your computer's file system. The file must be named *EMMCSV_in.emm* This file name is also specified on the Import Export display.

Once the file has been added via iTunes, it can be imported to the app via the "Import Model" button on the Import/Export display.

When a model is imported, if the app has a model currently loaded then an alert will be raised.

Solve Settings

The Solve Settings display shown in Figure 196 is accessed via the Solve button indicated in Figure 195.

Figure 195: The Solve button accesses the Solve Settings display

The Solve Settings display is where the solve settings are selected and also where the solve is initiated, via the "Solve Now" button.

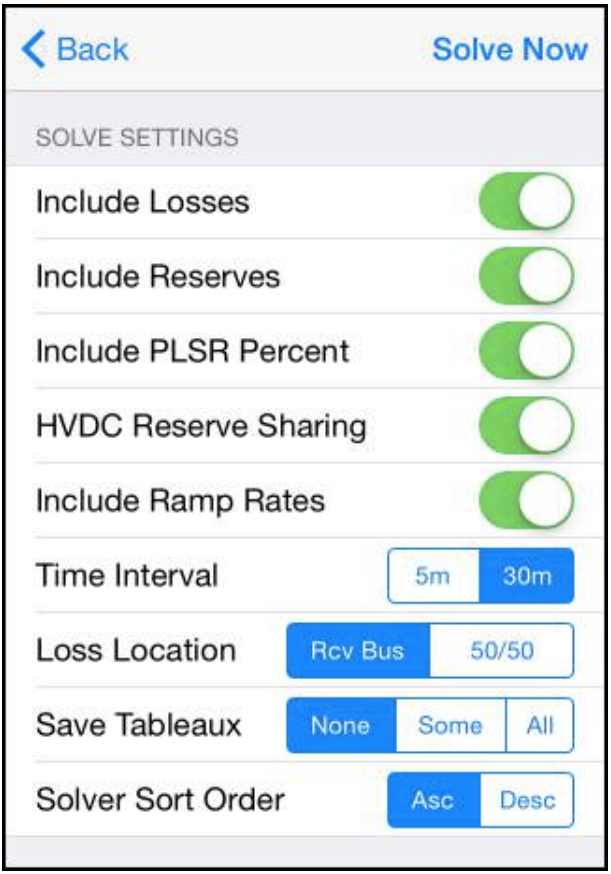


Figure 196: The Solve Settings display

The Solve Settings are as follows:

Setting	Determines
Include Losses	Whether or not the model includes branch loss constraints. See Tutorial 4: Transmission Losses.

Include Reserves	Whether or not the model includes reserve constraints. See Tutorial 5: Risk and Reserve.
Include PLSR%	Whether or not the model includes PLSR% constraints. Only available if the model includes reserves. See Tutorial 5: Risk and Reserve.
HVDC Reserve Sharing	Whether or not HVDC links are capable of sharing reserve between islands. Only available if the model includes reserves. See Tutorial 7: HVDC Link
Include Ramp Rates	Whether or not the model includes ramp rate constraints. See Tutorial 6: Ramp Rates.
Time Interval	The time interval used by the ramp rate constraints. Only available if the model includes ramp rate constraints. See Tutorial 6: Ramp Rates.
Loss Location	Determines whether dynamic line losses are assigned to the bus at the receiving end of the branch, or half of the losses are assigned to the buses at each end of the branch. Only available if the model includes line losses. The New Zealand electricity market assigns dynamic losses to the receiving end of the branch, while

	the Singapore electricity market assigns them half at each end. The receiving end option is the value assumed by the tutorial models, if the 50/50 option is selected then the selection is highlighted orange to indicate it is not the usual option.
Save Tableaux	Whether or not the solver saves the simplex tableaux. Options are "None", "Some" or "All". The "Some" option will save the first, second, and last tableaux. If the model is anything other than very small then the "Some" or "All" options will cause a warning to be raised due to the potential size of the tableaux (and its impact on memory and CPU), and the selection will be highlighted orange. See Tutorial 9: Simplex Explained for an explanation of the simplex tableaux.
Solver Sort Order	Determines the sort order of the constraints and variables in the solver's initial tableau. The initial tableau is explained in Tutorial 9: Simplex Explained. There is a demonstration of the impact of the sort order in Tutorial 8: Actual Market Data.

The Results display

The Results display, shown in Figure 198, is accessed via the Results button shown in Figure 197.

Figure 197: The Results button accesses the Results display

The toolbar on the Results display includes the Import Export button, for importing and exporting model data and results, as described in the Import Export section.

The Results display itself was described in the Using the Simplex Nodal App section. Here we will briefly describe the displays that are accessed via the Results display.

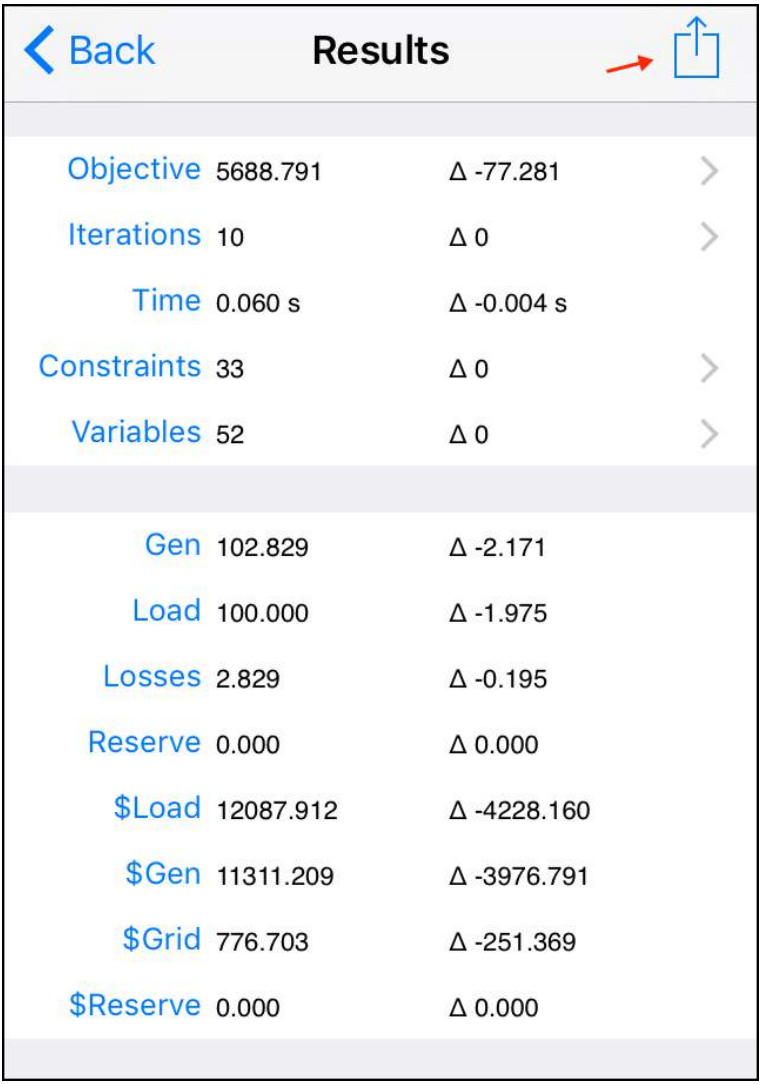


Figure 198: The Results display, with Import/Export button indicated

Objective display

The Objective display in Figure 199 is accessed via the Objective row of the Results display.

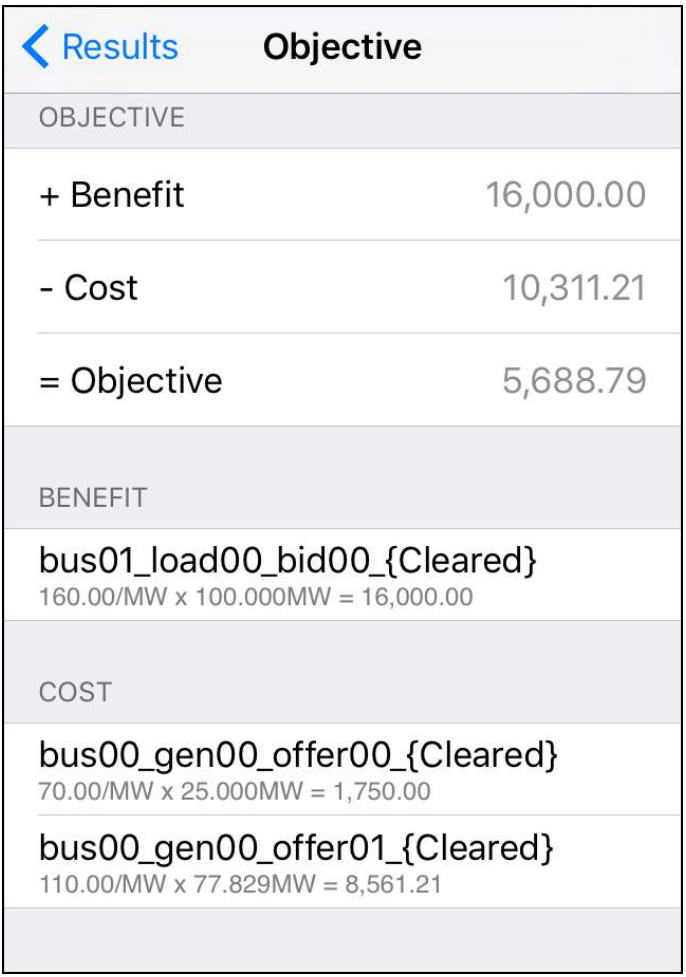


Figure 199: The Objective display

The Objective display shows the objective value calculation, i.e., Benefit – Cost, followed by the details of the individual benefits (cleared bids) and costs (cleared offers).

Iterations display

The Iterations display, shown in Figure 200, is accessed via the Iterations row of the Results display. It provides details of each of the iterations that the simplex algorithm performed.

The details of how and why the simplex algorithm iterates are explained in Tutorial 9: Simplex Explained.

In the list of iterations, iteration 1 describes the step from the first simplex tableau to the second, and so on. Hence, if the simplex algorithm uses three tableaux there will be two iterations. The tableaux themselves can be exported as a csv file, as described in the Import Export section.

The toolbar of the iterations display includes a Chart button which links to the iterations chart described below.

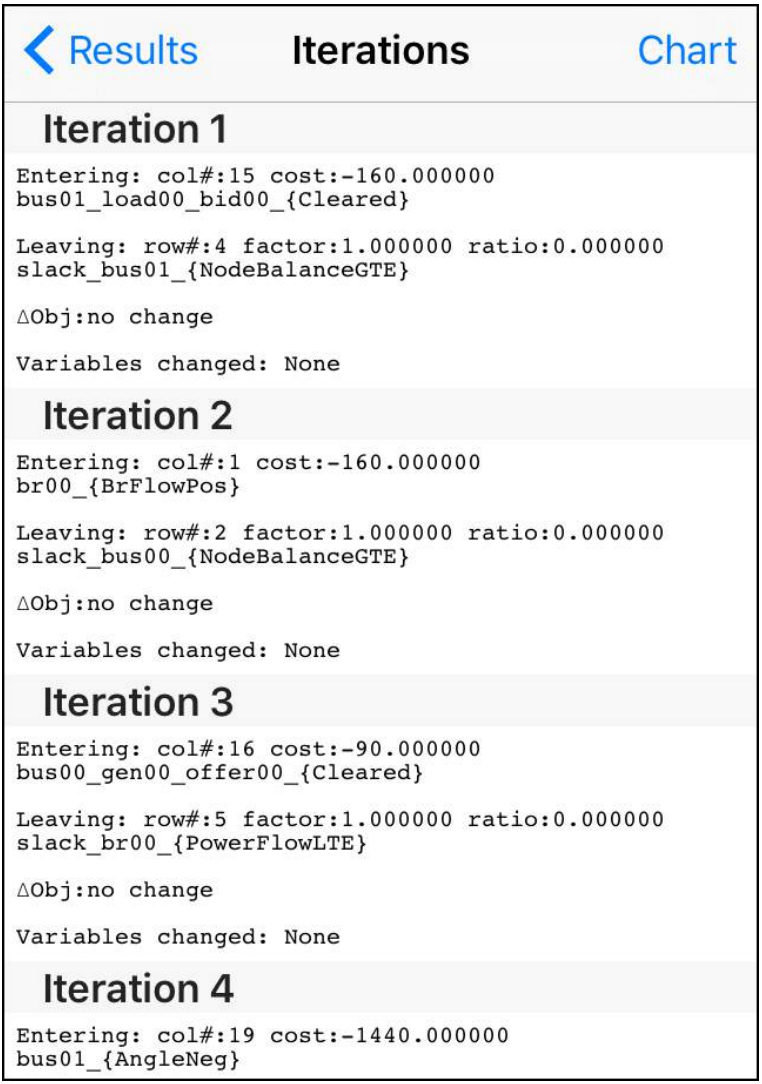


Figure 200: The iterations display

Iterations Chart

The Iterations Chart shown in Figure 201 is accessed via the Chart button on the Iterations display. The chart displays the individual objective values that the simplex algorithm passed through as it iterated towards the optimal objective value.

You can zoom in on the chart using the pinch gesture to see the points that represent the individual iterations, as shown in Figure 202. Tapping on a point will display the details of the iteration, as shown in Figure 203.

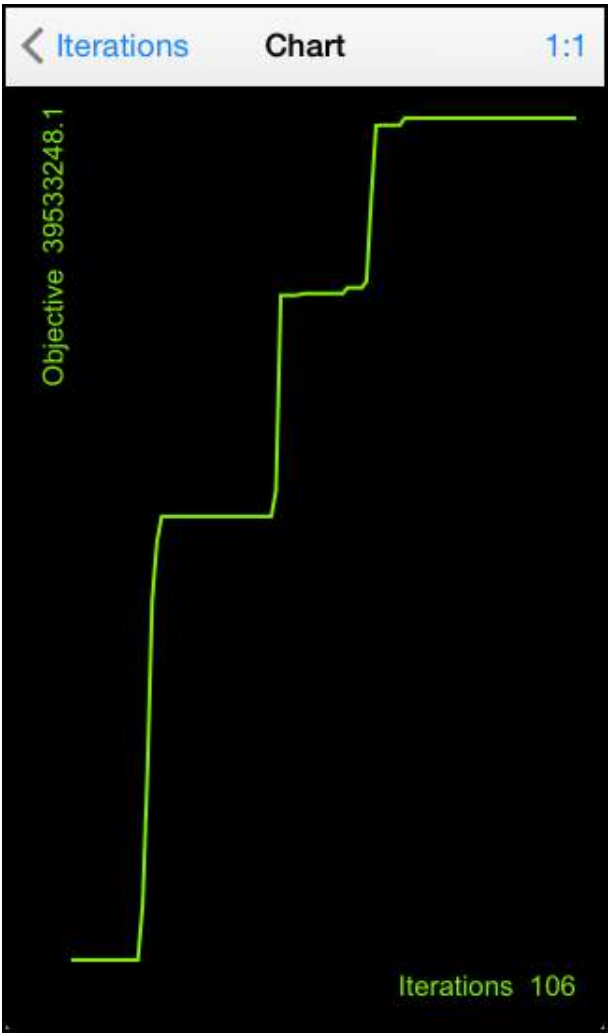


Figure 201: The iterations chart at 1:1 zoom

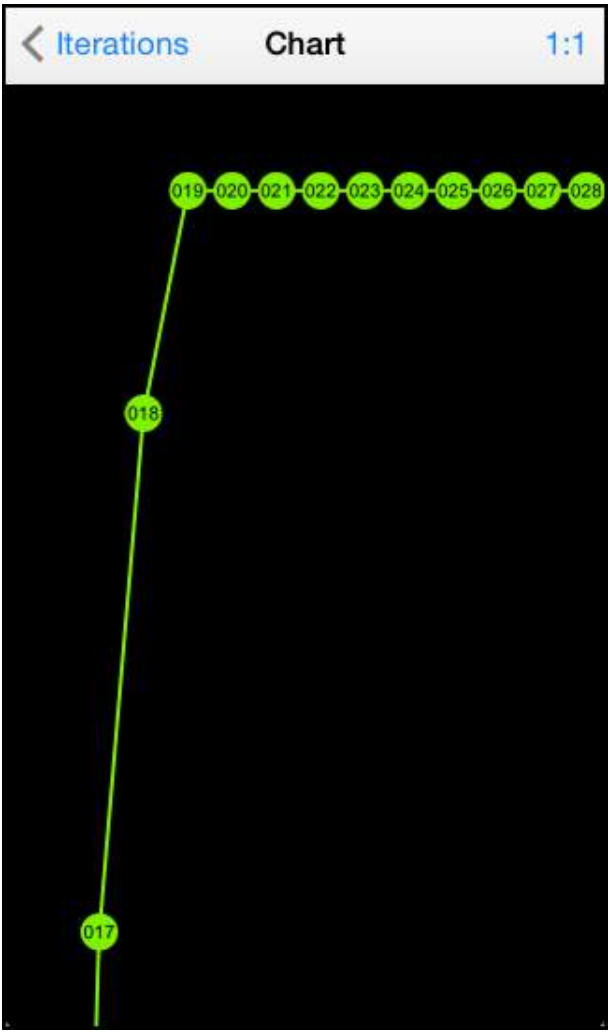


Figure 202: Zoom in to see individual points

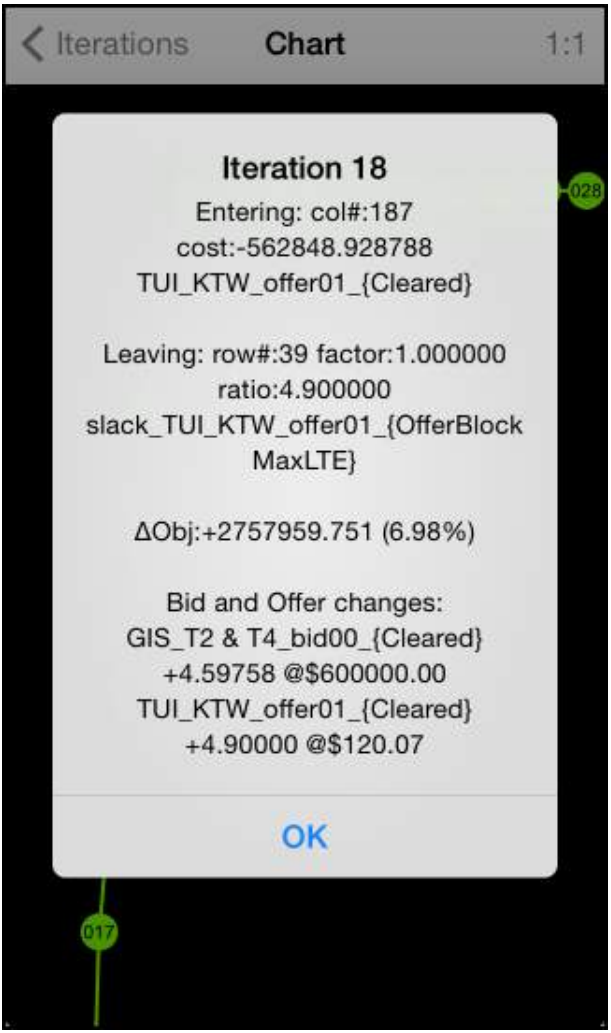


Figure 203: Tap an individual point to view the iteration details

Constraints display

The Constraints display in Figure 204 is accessed via the Constraints row of the Results display.

Figure 204: The Constraints display

The Constraints display lists the constraints for all the components in the model, together with the associated shadow price.

The shadow price is introduced in Tutorial 1: Explaining Prices and explained in detail in Tutorial 9: Simplex Explained.

(The constraints for an individual component can also be viewed via the ∑ button on the component's Data Display).

Variables display

The Variables display, shown in Figure 205, is accessed via the Variables row of the Results display. The Variables display lists all the variables from the latest solve and their associated values. It also displays whether the variable is basic or non-basic. The difference between basic and non-basic variables is explained in Tutorial 9: Simplex Explained.

(The variables for an individual component can also be viewed via the ∑ button on the component's Data Display).

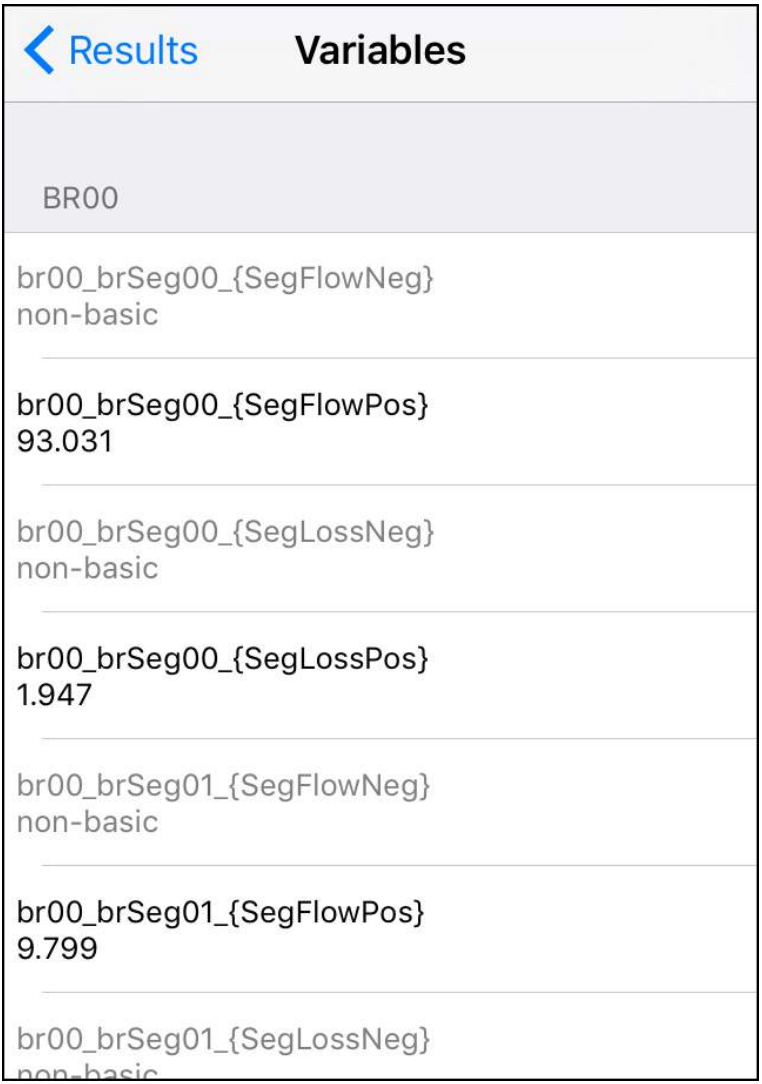


Figure 205: The Variables display