ENGERY VISION

User Guide

Contents

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1. About ENERGY VISION

The ENERGY VISION AX Dashboard is a professional energy display dashboard, and a simple tool for energy benchmarking and analysis, built on Niagara web graphics technology. It runs on any Niagara AX platform including a PC-based supervisor or HAWK controller requiring no additional plugins.

As well as providing an energy dashboard display for use in a building reception area, ENERGY VISION is the ideal system to help manage energy, analyse and optimise the operation of your facility and to measure performance across multiple levels within your building or estate. Using advanced tools to gather and aggregate data from energy and utility meters, along with graphically rich visualisation techniques, dynamic menus, and charts, dials and gauges.

2. Features

ENERGY VISION provides the following features and benefits:

- Visually stunning graphs, meters, and dials to create a fantastic user experience.
- Kiosk Mode shows a rotating sequence of energy dashboard pages ideal for use in a building foyer or reception area.
- Dynamic hover-over menu system creating powerful navigation between zones or pages.
- Energy Benchmarking graphs, with weekly, monthly, yearly view – for example comparing this week, last week and this week last year.
- Aggregation of meter data with the ability to compare energy profiles for different zones, buildings or time periods.
- Intelligent metering components with normalization of data, handling meter roll-over and periods of missing data.
- Visualisation and ranking of consumption between meters, zones, systems, buildings, sites etc.
- Attractively simple license model – one price, for one installation, with the ability to scale up to the size you need with no on-going or hidden charges.

3. Licensing

5.1 License Requirements

To use the ENERGY VISION AX Dashboard, you must have a target NiagaraAX host (HAWK, EAGLEHAWK or Supervisor) that is licensed with the “CentraLine License” file. An ENERGY VISION license can be obtained from your local sales representative.

The ENERGY VISION License is installed in the same way as any Niagara driver. It is recommended that the station and workbench be restarted after installing a licence.

5.2 Software Installation

From your PC, use the Niagara Workbench 3.7.xx or higher. Copy the ENERGY VISION.jar files to the modules directory folder where your Niagara workbench software is installed; restart your PC or platform services to complete the installation. It is recommended that the ENERGY VISION Demo station included with the ENERGY VISION software is copied into your Niagara/stations folder as this provides a simple starting point to creating and customising your ENERGY VISION dashboard.

4. ENERGY VISION Palette

Once the ENERGY VISION module, license files, and certificates have been installed in the host system, you are ready to start building your ENERGY VISION dashboard. A workbench palette called “ENERGY VISION ” gives access to the various components which make up the system. The Palette can be reached using the Palette side bar (in the Window menu, choose Sidebars->Palette to show the palette view). Click on the Open Palette button and search for the “ENERGY VISION ” palette.

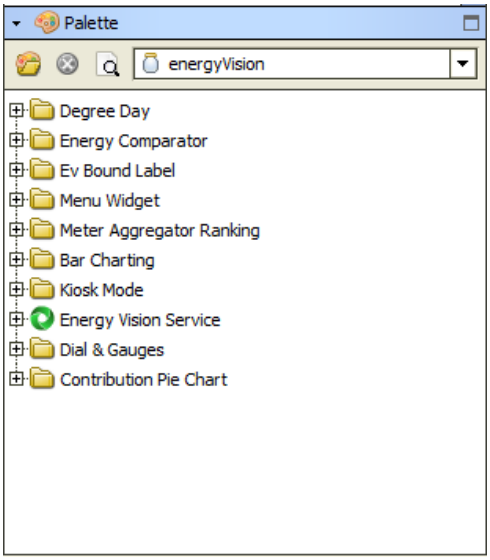


Figure 1 - Energy Vision palette overview

The palette side bar has a preview button which can be used to see a sample view of each of the dials.

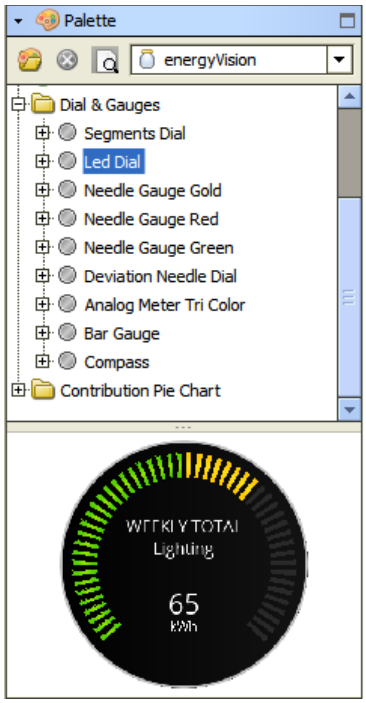


Figure 2 - Preview of Energy Vision Widgets within the palette sidebar

5. ENERGY VISION Components

The ENERGY VISION module contains a number of key components to manipulate and organise utility and energy metered data, as well as a collection of graphical widgets to visualise and compare energy consumption and trends.

Each component is described in detail as follows:

5.1 ENERGY VISION Service

The ENERGY VISION service can be added to a new station by dragging an instance of ENERGY VISION service from the palette into the ***services*** folder of a Niagara station.

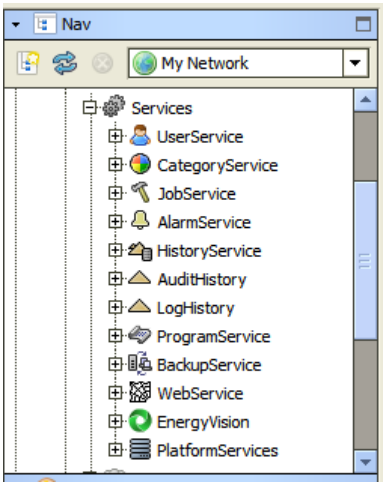


Figure 3 - Adding ENERGY VISION Service under the station's Services container

The ENERGY VISION Service contains Managers to license a particular ENERGY VISION instance, provide cost conversions of consumption, benchmarking and comparison data and a thread worker to queue all aggregator actions on a single thread by default.

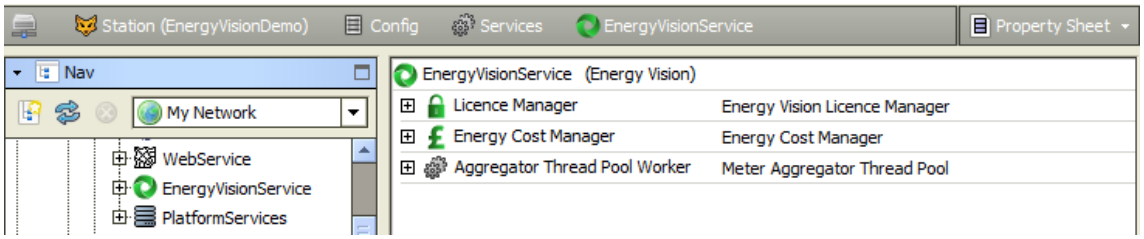


Figure 4 - Property sheet of the ENERGY VISION service

Features

The ENERGY VISION service consists of two Managers and a Thread Pool Worker:

1. **License Manager** – this part of the Service Handles licence validation for the product. Once the energy vision service has been added into to the services of the host station, and the required licence and certificates are present, the licence will be validated and the ***licence active*** and ***energy vision active*** properties will become set to true.
   The ***Active features*** property provides information about the type of licence installed.

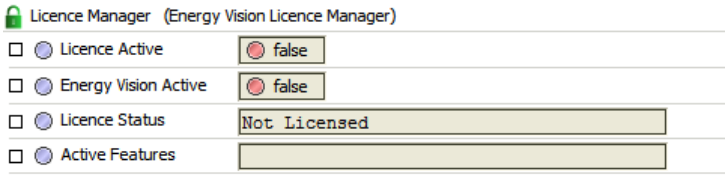


Figure 5 - Property sheet of the License Manger under the ENERGY VISION service

2. **Energy Cost Manager** – this serves cost/consumption information for other components where consumption or comparison data is to be displayed as the cost of the energy or resource consumed. The Default values are zero giving a consumption/cost ratio of 1-1.

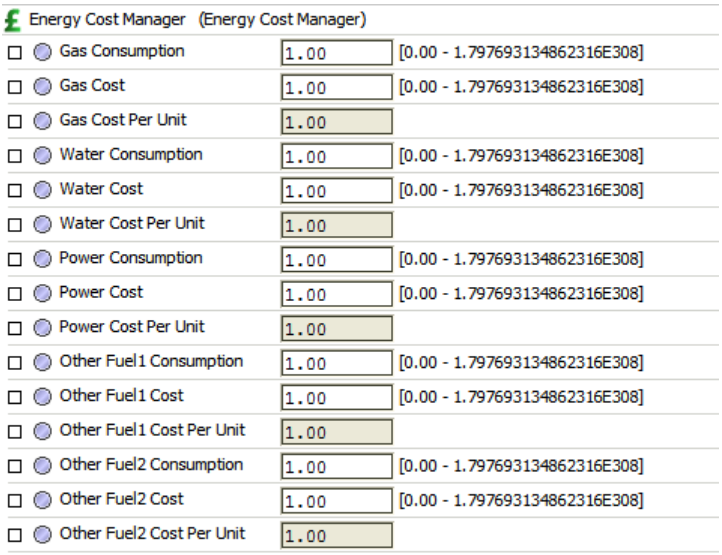


Figure 6 - Property Sheet of the Energy Cost Manger under the ENERGY VISION Service

To incorporate approximate resource costs for use in charts and dials, the properties of the cost manager should be set according to the approximate unit costs for each type of fuel or utility.

The cost manager provides only indicative costs and doesn't account for different tariffs. It is intended to provide an estimated cost, and cannot be used for bill verification or tenant billing applications.

To set the cost for a particular type of fuel, enter an amount of fuel, and the total cost for that amount of fuel. The intention here is to take the cost and number of units consumed from a recent utility bill for a particular site. The Cost manager will then calculate the Cost per Unit for that particular resource. Each of the gauges and charting components can be configured to present their data using this cost per unit, rather than displaying the raw unit costs.

3. **Aggregator Thread Pool Worker** – this worker thread is used to queue & execute all EvMeterAggregator actions. Defaults are set to 1 Thread and 10000 queue size.

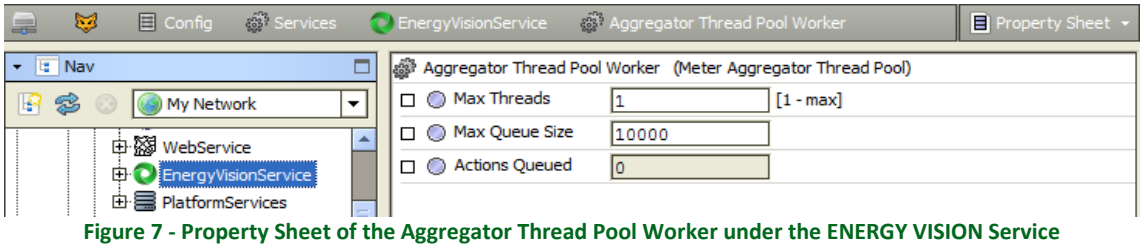


Figure 7 - Property Sheet of the Aggregator Thread Pool Worker under the ENERGY VISION Service

5.2 Pop-out Menu

Pop-out Menu also called as Dynamic Menu is a 3 Level configurable Hover Menu for Px pages. The Pop-out Menu can be directly added on to the Px page from the ENERGY VISION palette. Figure 8 shows the default view of the Dynamic Menu which has to be selected when adding a new Pop-out or Dynamic Menu.

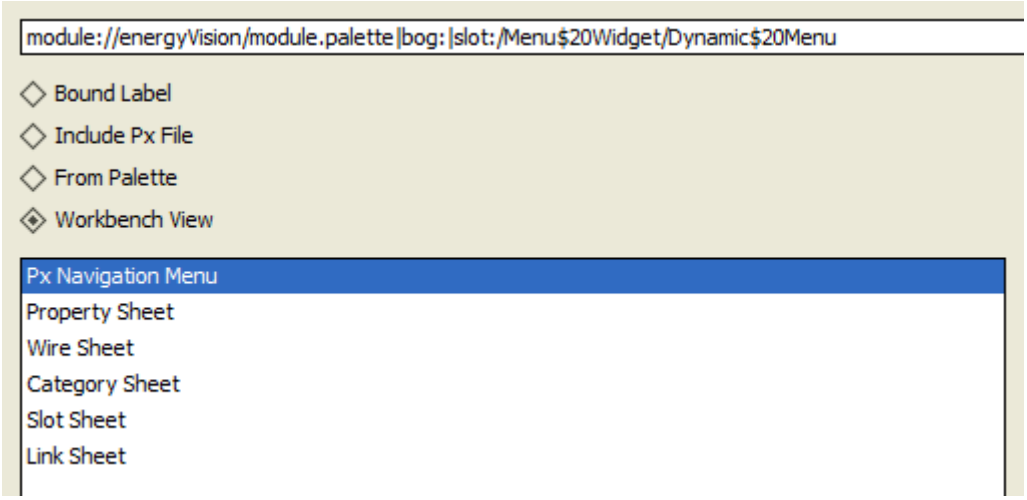


Figure 8 - Adding Pop-out Menu from palette

Each element on the menu can be configured as a hyperlink to an **Ord** or configured to serve as a pop out menu for sub elements. The Pop-out menu uses an easily configurable XML file to get the following properties related to the Menu:

- Structure of the Menu.
- Display Texts for each of the menu and the submenu items.
- Available Hyperlink ords for menu and submenu items.

User defined XML files can be created as per user requirements using the following section which explains the structure of the XML used within the Dynamic Pop-out Menu.

Typical XML Structure for Menu

A typical menu structure in the XML file can be similar to the structure as in Figure 9 and can be changed as per requirements. As in the screenshot of the example XML file, the XML structure directly resembles the structure of the Pop-out Menu. The menu can be structured as a single level structure to a maximum of 'n' level structures, provided the size of the page allows the 'n' levels to be viewed adjacently. The menu items are defined as **MenuItem**, and sub menu items under each menu item can be defined as **MenuItem** for any number of required levels. Each of these menu items has two main properties, which are the **displayText** and the **ord** for hyperlinking. If the **ord** on the menu item is removed, but has sub menu items then it is treated as another pop-out menu item without hyperlink.

```
<?xml version="1.0"?>
<nav>
  <MenuItem>
  <displayText>HOME</displayText>
  <ord>fox:|station:|slot:/Home</ord>
 </MenuItem>

 <MenuItem>
  <displayText>ENERGY RANKING</displayText>
  <ord>fox:|station:|slot:/Energy$20Ranking</ord>
 </MenuItem>

 <MenuItem>
  <displayText>ENERGY BENCHMARKING</displayText>
  <MenuItem>
   <displayText>CAMPUS</displayText>
   <ord>fox:|station:|slot:/Energy$20Benchmarking</ord>
  </MenuItem>
 </MenuItem>
 <MenuItem>
  <displayText>ENERGY CONSUMPTION</displayText>
  <MenuItem>
   <displayText>CAMPUS</displayText>
   <MenuItem>
    <displayText>POWER</displayText>
    <ord>local:|fox:|station:|slot:/Energy$20Consumption/Energy$20Consumption$20Campus$20Power</ord>
   </MenuItem>
  </MenuItem>
 </MenuItem>

 <MenuItem>
  <displayText>ENERGY CONTRIBUTION</displayText>
  <ord>fox:|station:|slot:/Energy$20Contribution</ord>
 </MenuItem>

 <MenuItem>
  <displayText>KIOSK MODE</displayText>
  <ord>fox:|station:|slot:/Kiosk$20Mode</ord>
 </MenuItem>

</nav>
```

Figure 9 - Typical XML Structure for Pop-out Menu

Configuring the Pop-out Menu

After adding a new Pop-out Menu on the Px page and creating a required XML file which provides the required structure for the custom menu, double click on the Pop-out Menu to bring up the properties, as in Figure 10. Change the **configPath** property which refers to the XML file for the Menu structure. The path can be changed to refer to the user defined XML file for a custom Menu Structure. Subsequently the **font styles**, **background colour**, **foreground colour**, **hover colour etc**. can be changed as per user requirements.

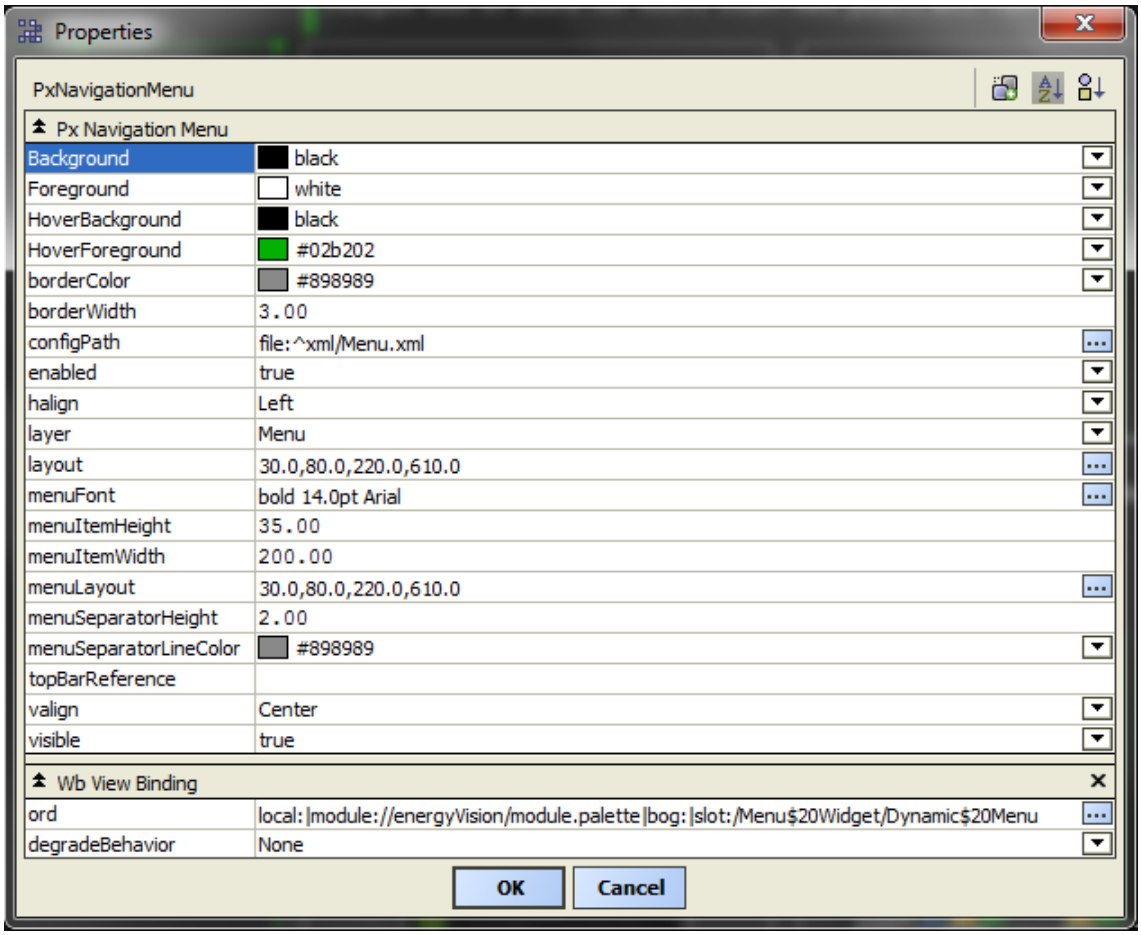


Figure 10 - Edit properties of a Pop-out Menu

Configuring the Pop-out menu, changing the configPath to the required XML file path and clicking OK completes the configuration of the Pop-out Menu. Save the Px page, by switching the mode from edit to view mode. Figure 11 also gives an example of the properties which are changed to suit the ENERGY VISION Demo station's Pop-out Menu.

Example screenshot of a custom configured Pop-out Menu

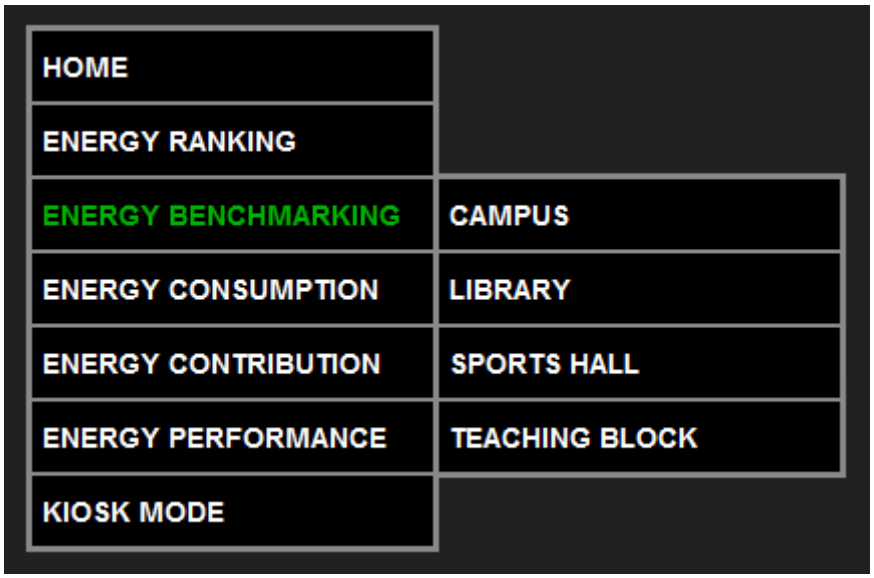


Figure 11 - Custom configured Pop-out Menu

5.3 Kiosk Mode

Kiosk mode is a mechanism to display a series of dashboard pages in a continually rotating sequence for use on a static display in a building reception or lobby area.

Kiosk mode is achieved using the ENERGY VISION Kiosk Mode custom PX panel. This is included in the ENERGY VISION palette.

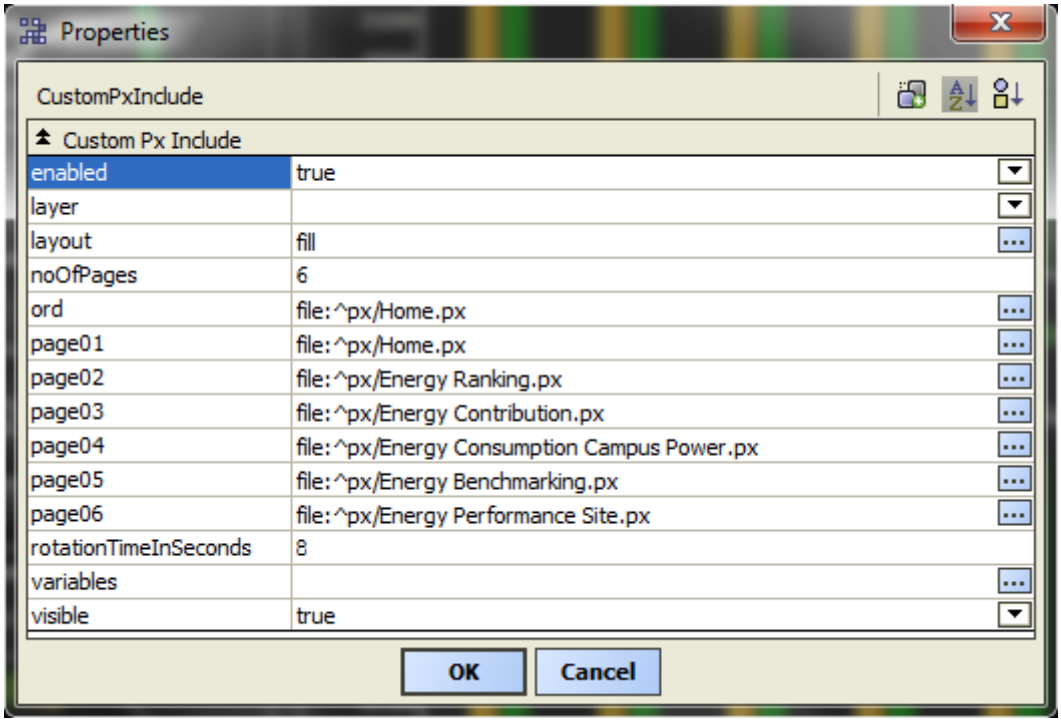


Figure 12 - Edit Properties of the Kiosk mode CustomPxInclude

The Kiosk mode **CustomPxInclude** component can be added onto a PX page. The **page01-page20** properties allow the engineer to configure up to 20 pages to be displayed in a rotating sequence with a pause determined by the **rotationTimeInSeconds** property.

Navigating to the px page which contains the Kiosk mode CustomPXInclude component starts the rotation sequence.

N.B: It is often a good idea to provide a button or link on each of the sequence pages, to take the user to another page, and therefore exit kiosk mode if desired.

Kiosk Mode Properties

- **noOfPages**: The number of pages to be shown in the sequence. The sequence always starts at Page01, and cycles up the pages until the NoOfPages limit has been reached.
- **page01 - page20**: The ords for each PX file to be shown in sequence.
- **rotationTimeInSeconds:** The length of time to dwell on each page before showing the next page.

5.4 Meter Aggregator

The ENERGY VISION Meter Aggregator Component is a wiresheet component used to group a collection of meters for a particular zone, building, site etc. This is a core component of the ENERGY VISION system as it provides valuable data for graphical representation of energy consumption for a range of different periods using a single meter, or a group of sub meters.

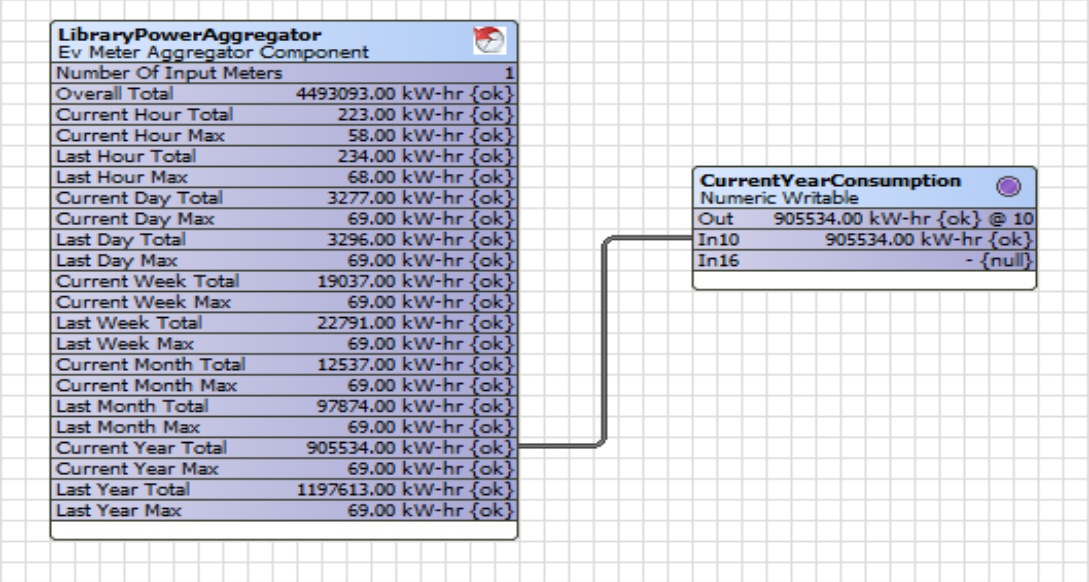


Figure 13 - Ev Meter Aggregator Component added on a Wiresheet

The component takes a number of Numeric Interval or Numeric COV (Change of Value) histories and aggregates these into a single component giving an overall Total of all values for all included histories, as well calculating totals, and max values for each of a range of specific time periods including:

- Overall Total
- Current Hour
- Last Hour
- Current Day
- Last Day
- Current Week
- Last Week
- Current Month
- Last Month
- Current Year
  - Last Year

Features

- **"Load Totals" Action**: This action loads all the values by querying all available records for each Meter ord in the widget. This action should be called on adding/deleting meters as the values need to get updated accordingly. This action can be invoked sparingly to sync the values. Repeated use of this action will have an inverse effect on performance of the widget since all available history records are queried during this action.
- **"Add Meters" Action**: Allows the user to add up to a maximum of 50 meters of instantaneous/accumulative type. On adding the meters each meter needs to be specified a valid history ord, meter type and roll over value (Optional - in case of accumulative meters).
- **"Create Summarised Histories" Action:** This action calculates the values for hourly, daily, monthly and yearly for the meter(s) under this component and adds these values as histories under the 4 points which are added as **Name_H**, **Name_D**, **Name_M** and **Name_Y**

(where **Name** = **Component Name**). These can then be used in-turn for various analysis and display.

- **"Add Slots" Action**: This action allows the user to dynamically create Numeric Writable components corresponding to the status numeric slots for the widget. Also links the numeric components to its respective slots.

Adding History Extensions and Alarms to the Meter Aggregators

Individual history extensions and alarms can be added on to Numeric components created underneath the component if required. The Add Slots action of the Meter Aggregator component creates child numeric writable object in the wiresheet of the Meter Aggregator component, linked to the slots of the Aggregator component itself. This allows alarms and histories to be added to these objects to enable events to be triggered based on consumption levels within a period, and to enable trend graphing of daily, weekly, monthly, and annual consumption levels.

Meter Aggregator Properties

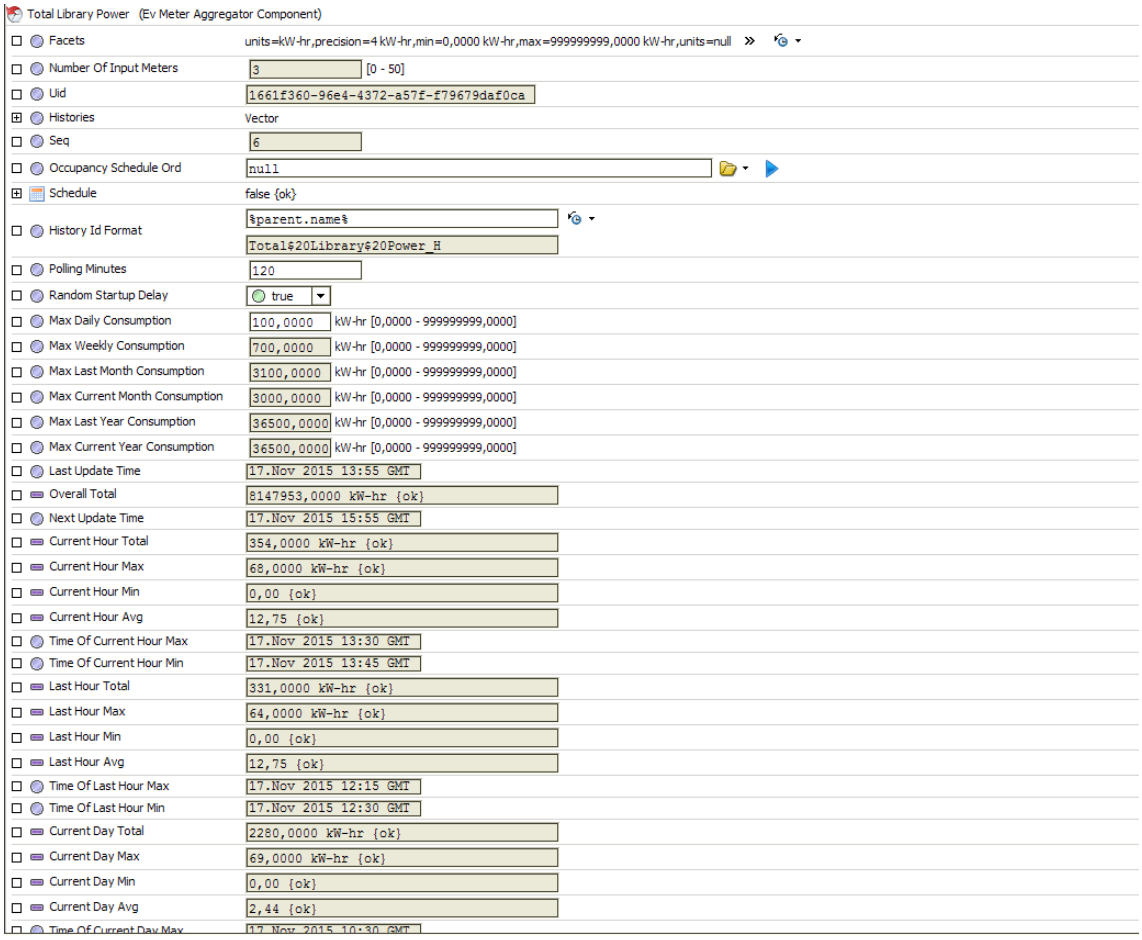


Figure 14 - Property sheet of Ev Meter Aggregator Component

- **Polling Minutes:** Determines the frequency with which the properties of the component are recalculated.

Number Of Input Meters: **Shows the number of meter histories which are combined in this particular Aggregator component.**

- **Random Start-up Delay:** Schedules the component to calculate the totals with a random start up delay between 10s – 5minutes. This ensures that the station is not overloaded with processes if hundreds of such aggregator component is used in a single station.

- **Facets:** Units and precision of values can be setup or changed based on type of meters being aggregated by the component. Eg: kWh, m^3 etc.
- **Last and Next Update Times:** Timestamps indicating last successful loading of totals and the next scheduled update timestamp.
- **Value Properties:** Various totals with corresponding max values within the respective time periods also providing the exact time-stamp of the max consumption.

Using the Meter Aggregator

After adding the Meter Aggregator Component to a folder or wiresheet the user can enter the desired polling frequency (minutes). This schedules the component to recalculate totals and max values at the specific frequency. Facets can be edited to user requirements.

Meters can be added to the aggregator using the add meters action, meters can be copied from another meter aggregator, duplicated, deleted manually, or renamed as required. For each Meter in a Meter Aggregator component an Ev Meter component is created under the parent aggregator block.

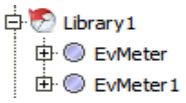


Figure 15 - Nav Pane view of Meter Aggregator with 2 meters added under it

Each Ev Meter component must be configured to include that particular Meter's History into the parent Meter Aggregator.

EvMeter Properties

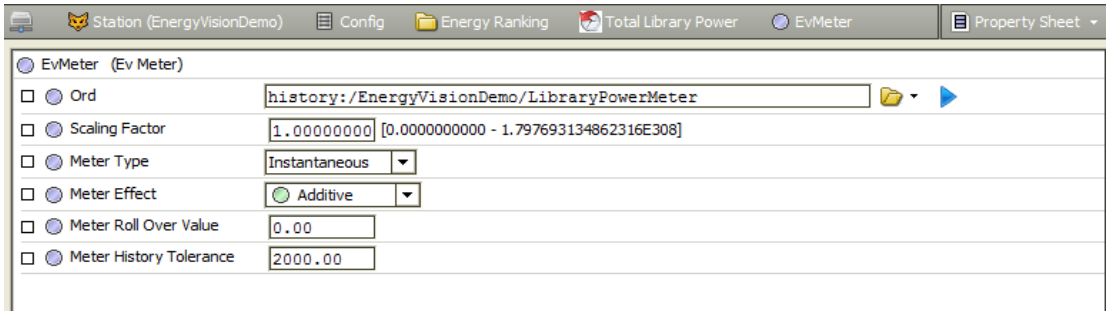


Figure 16 - Property sheet of individual meter components under the Ev Meter Aggregator

- **Ord:** Must be set the Numeric Interval/COV History for a Meter.
- **Scaling Factor:** This property can be used to scale the history values if meters have different logging units. For example: kWh is used as standard for logging, but if a meter has MWh logging then a scaling factor of 1000 can be used.
- **Meter Type:** Accumulative/Instantaneous. This determines whether the particular meter reading is a cumulative reading which continually increments, or an instantaneous value showing the consumption in the current period since the last reading.
- **Meter Effect:** Additive/Subtractive. This determines whether the meter increments over time, or decrements.
- **Meter Roll Over Value:** Meter Roll Over Value - Widget handles roll overs, provided correct roll over values for each meter is added. Default is 0.00 and if unchanged, would lead to loss of minor meter values.

  Ex: If two histories are recorded as 980kWh and 55kWh for a meter. Meter roll over value should be suitably entered as 999kWh. If this value is entered incorrectly as 99kWh or

9999kWh or unchanged at 0.00, the higher recorded value is assumed to be the roll-over value and the record value is taken as 0.00 for any calculations.

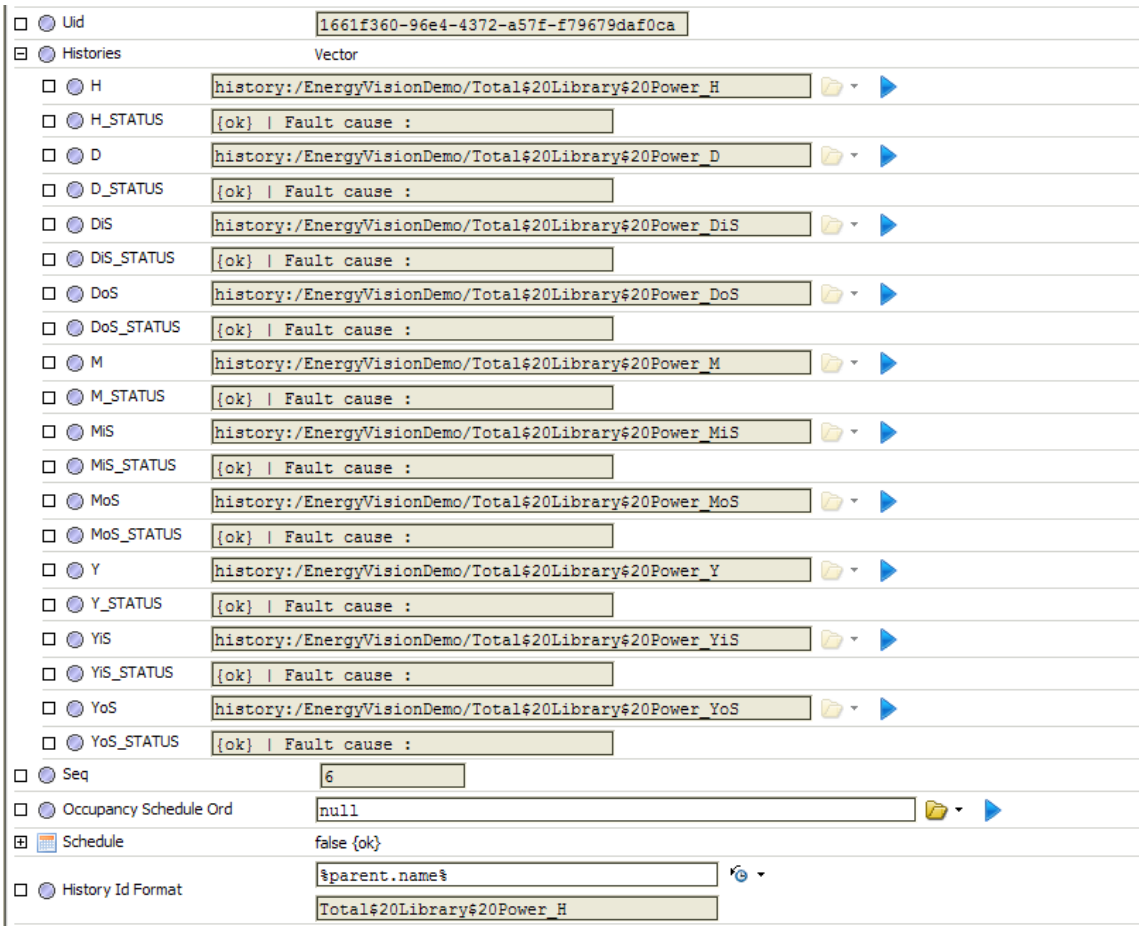


Figure 17 - Property sheet of the histories created under the Ev Meter Aggregator

5.5 Ranking Component and Ranking Graph

As the name suggests Ranking Component ranks a group of values in either descending or ascending order and presents these values on a Bar Graph. Ranking component has 20 status numeric properties, into which values that need to be ranked can be linked on the wiresheet or manually set values from the property sheet. Ranking Component can be directly added from the ENERGY VISION palette onto a station's folder or wiresheet, Refer Figure 19. Figure 18 shows the property sheet of a Ranking Component, each component can sort up to 20 **values**. Ranking Component by default ranks the values in Descending order, this can be changed in graphics view to rank the values in ascending order.

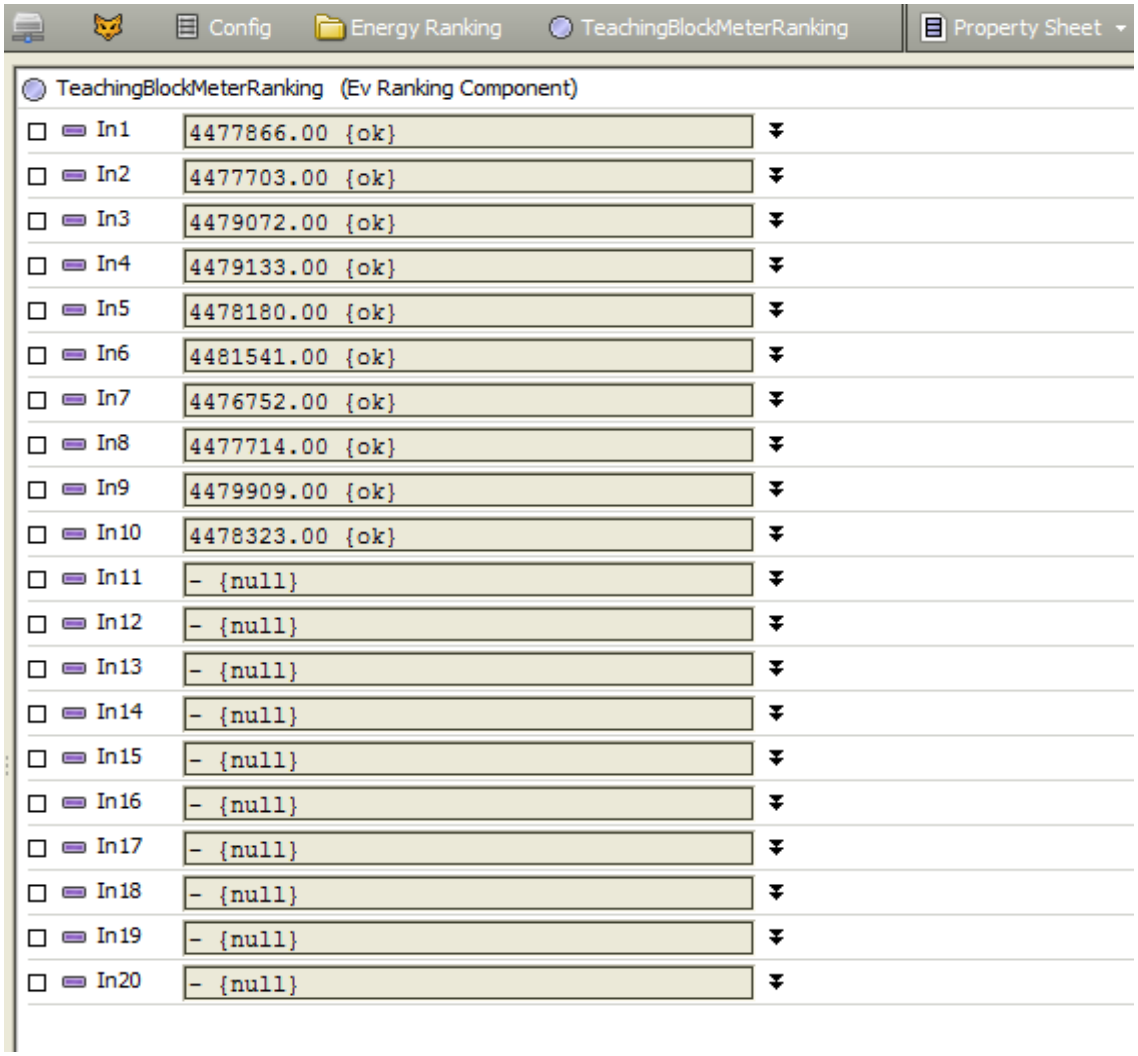


Figure 18 - Property sheet of a Ranking Component

A Ranking Graph can be added on the Px page by dragging the required Ranking Component from the nav pane of the station. Figure 20 shows the default Workbench View that has to be selected by default to display the Ranking Graph.

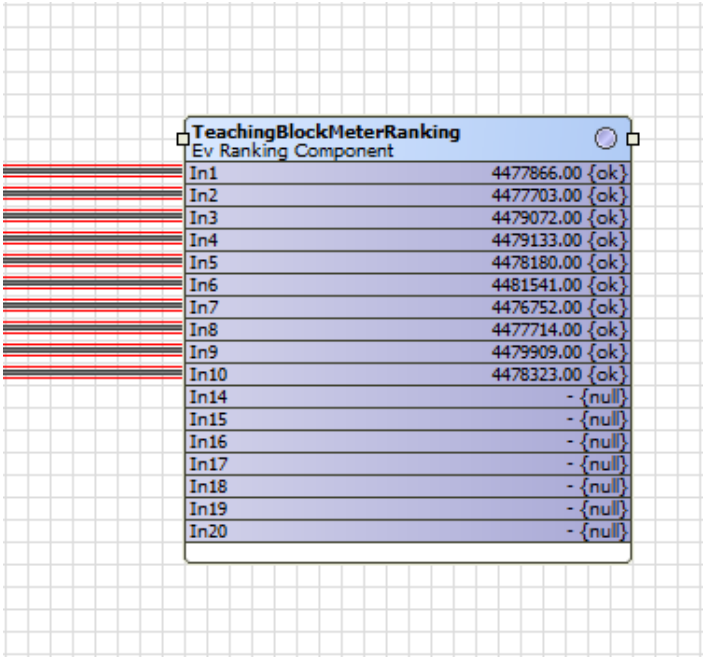


Figure 19 - Adding the Ranking Component on the wiresheet

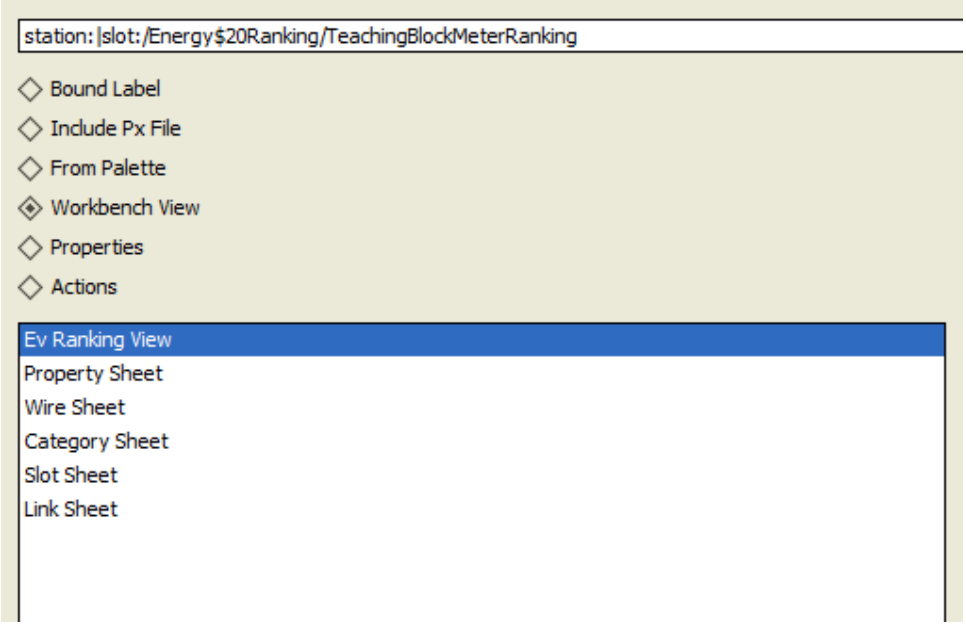


Figure 20 - Adding the Ranking graph on a Px page

Once the Ranking Component has been added on the Px page and size of the ranking graph can be suitably changed to user requirements. The properties of the ranking graph can be changed according to user requirements. Figure 20 shows an example screenshot of the edit properties of a Ranking graph while in edit mode of the Px page.

Properties of Ranking Graph

- **costConverter**: This works with the ENERGY VISION Cost Manager and selecting the appropriate unit will convert the consumptions to approx. costing. By default graph displays consumption.
- **displayMode**: This property specifies the quantity to be picked up from the Meter Aggregator component. By default the Overall Total is ranked from all the Meter Aggregator components. This can be changed to Current Hour Total, Current Week Total etc.

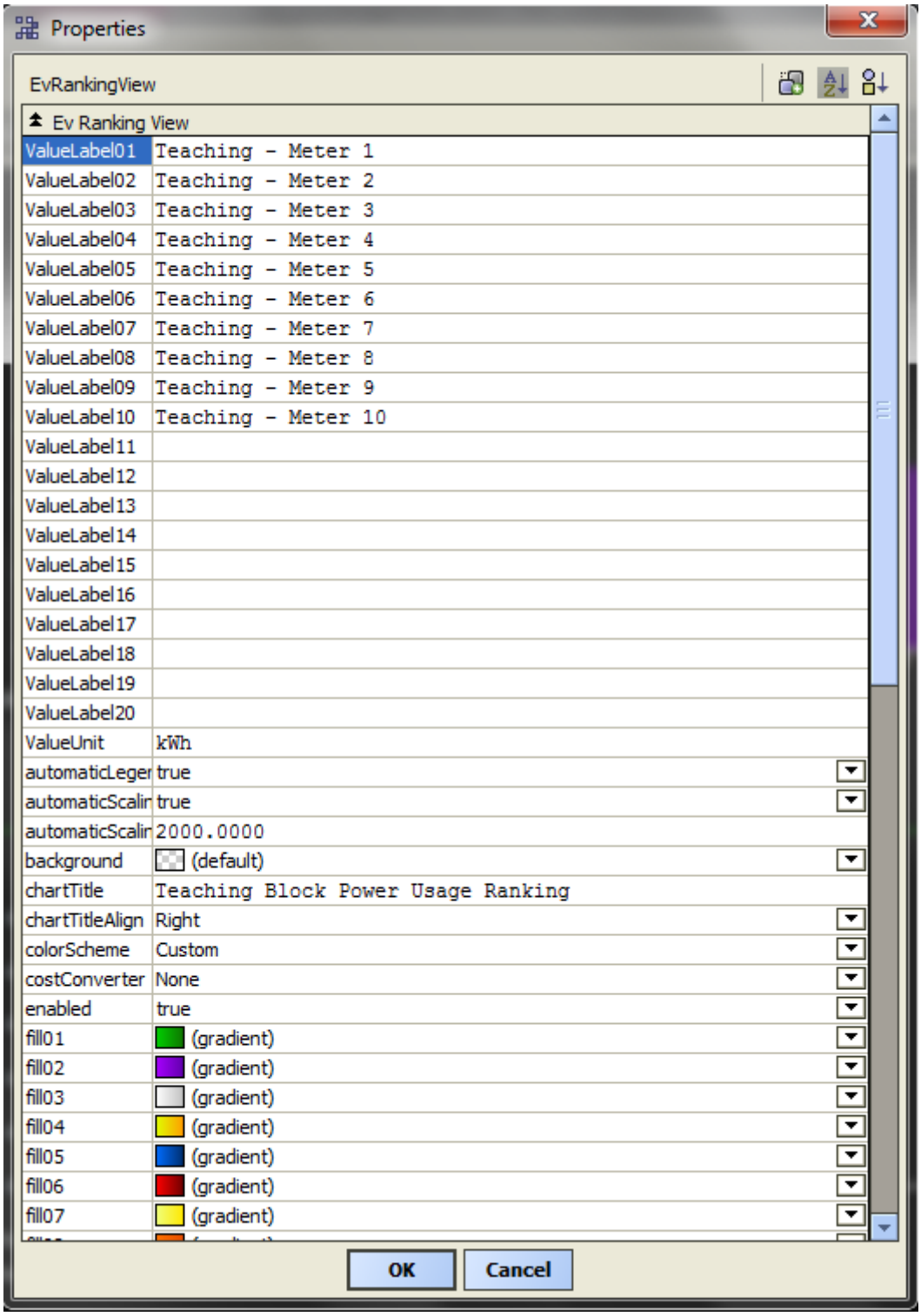


Figure 21 - Edit properties of Ranking View Graph – 1

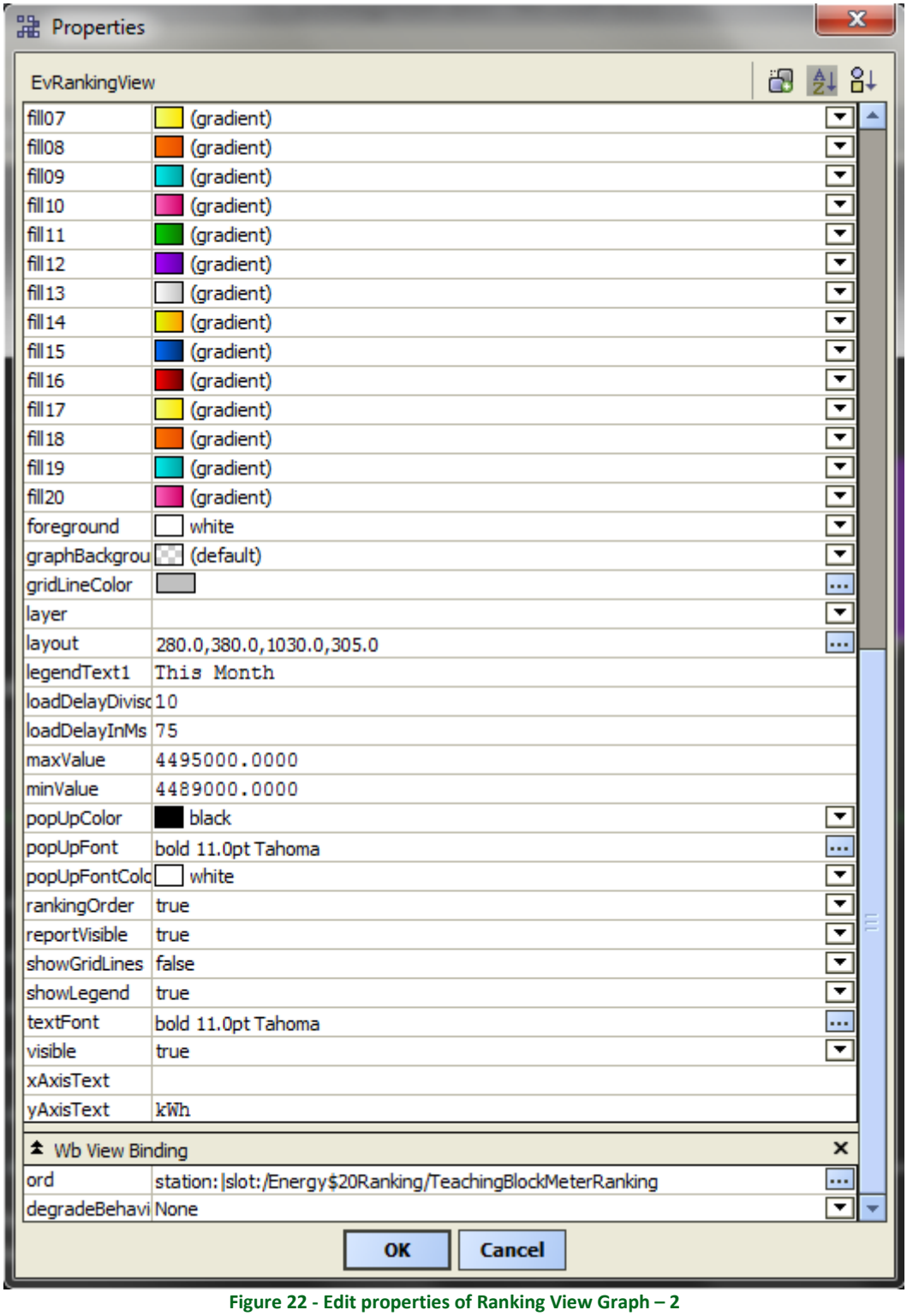


Figure 22 - Edit properties of Ranking View Graph – 2

User Interaction

Hovering over each bar on the graph gives exact value as a pop-up tooltip. Clicking the mouse on the blocks of colour in the legend toggles hide and show values within the graph and remaining values are reordered and the graph is redrawn to new scale.

Example Screenshots of Ranking graphs

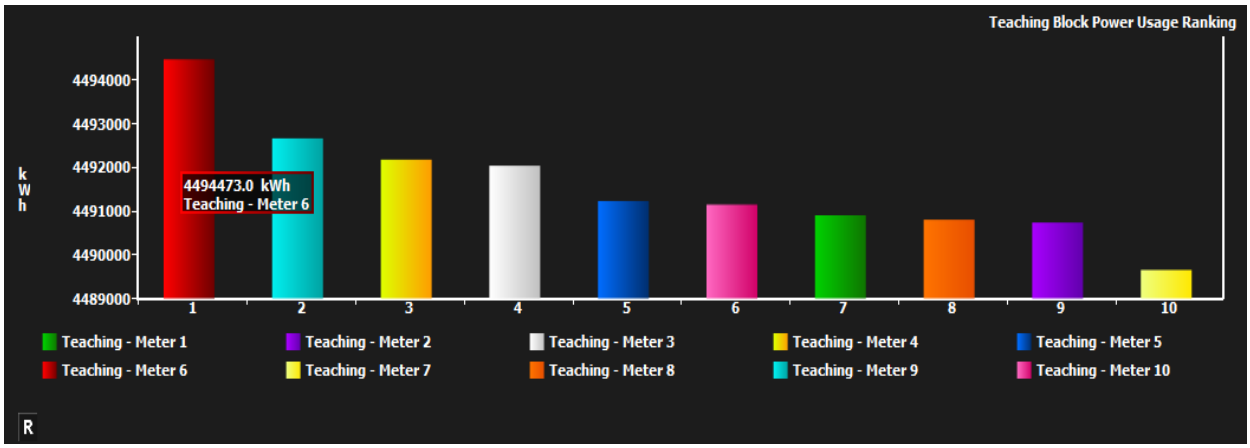


Figure 23 - Example screenshot of a single Ranking Graph

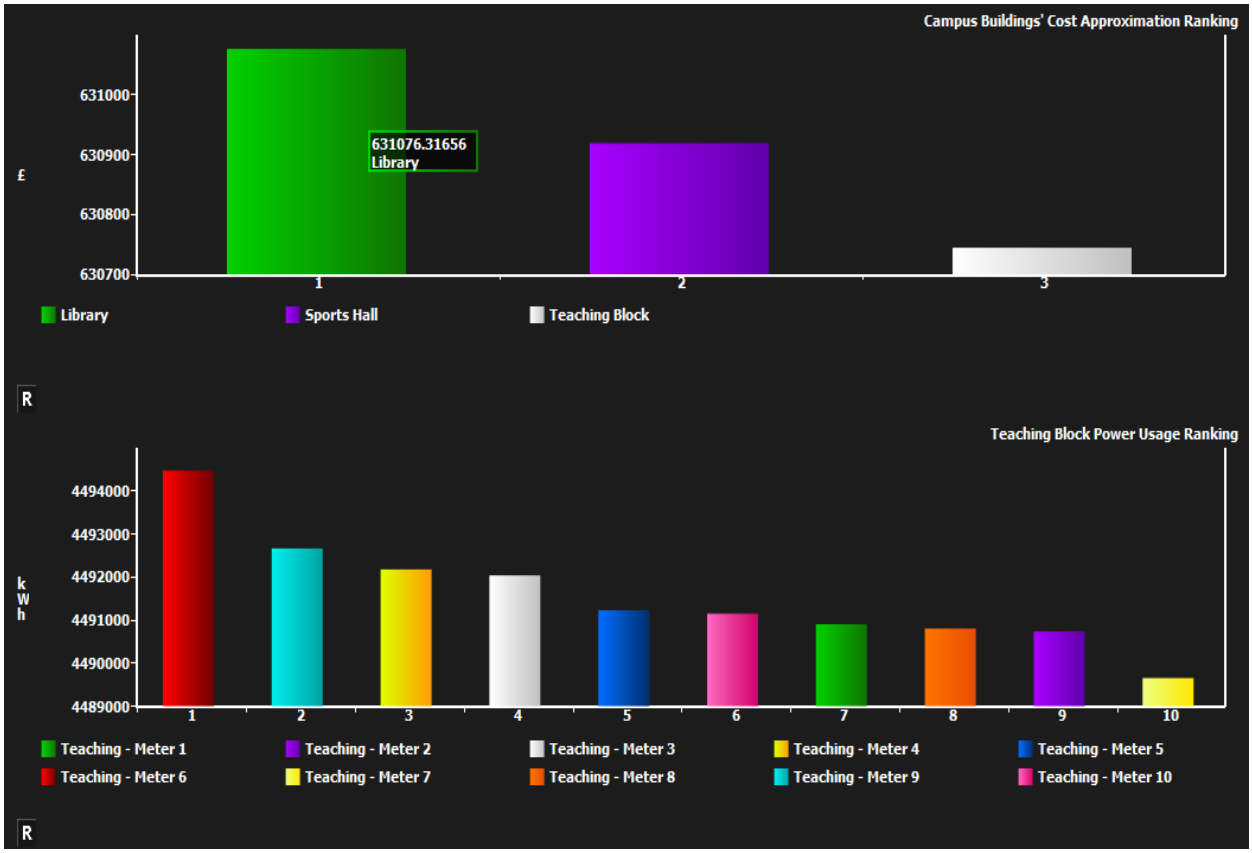


Figure 24 - Example Screenshot of Ranking graphs used to represent approx. costing and power usage

5.6 Benchmarking Chart

The Benchmarking charting component creates a Bar Graph which compares the daily values for either a weekly or monthly period, overlaying three different sets of bars, in three different colours representing daily values retrieved from within a standard Niagara AX numeric history. For a weekly period the three sets of bars represent daily totals for the current week, last week, and the same week last year.
For a monthly period the three sets of bars represent daily totals for the current month, last month, and this month last year.
In the case of a monthly benchmarking graph, the weekdays are aligned between this month, last month, and the same month last year, such that each of the 3 bars grouped together represent the same day of the week, this ensures that unfair comparisons between business and non-business days are never made (avoiding comparison of Sunday daily total with Monday for example). The number of values shown in a monthly benchmarking graph is always equal to the number of days in the current month. However the week-day alignment between the current and previous months means that the same day last month is actually the same weekday on or before the corresponding day in that previous month. Ex: The 12th of April 2013 (a Friday) would be grouped with the 8th of March 2013 (the nearest Friday before the 12th of March), and the 9th of March 2012 (the nearest Friday before the 12th of March 2012).

Features
The Benchmarking Chart consists of three elements:

1. **Numeric Interval Histories** – The histories from any required meter aggregator - Daily (xx_D) History and the Hourly (xx_H) can be used or these can be created from any numeric interval history extension on a Numeric object such as a meter kWh reading logging at 24hr intervals.
2. **BenchmarkingComponent** created in the Station:
    a. Drag a Benchmarking Component from the ENERGY VISION palette onto a folder or wiresheet.
    b. View the property sheet of the Benchmarking Component to set its history Ord property to the appropriate Numeric Interval History Ord.
    (The Load Delay In Ms, and Load Delay Divisor properties are used to configure the rate at which the bars of the graph rise from the X-Axis at the moment of page loading.)
3. **ChartingComponentView** on the BenchmarkingComponent created on a PX file:
    a. Create a Benchmarking ChartingComponentView by dragging a BenchmarkingComponent onto a Px file while the Px file is open in the editor mode.
    b. In the Make Widget Dialogue box click the Workbench View radio button, and select a ChartingComponetView.
    c. Set the appropriate properties E.g. Charting Range:Weekly/Monthly, colorScheme, Y-Axis label, WeekFormatInDisplay: SundayToSaturday etc. and click Save to create the ChartingComponentView for the benchmarking bar graph.

User Interaction
Hovering over each bar on the graph gives exact value as a pop-up tooltip along with the date. Each of these bars is a clickable element of the graph and on clicking a pop-up graph is brought up, displaying the line chart for hourly histories for that day. Clicking on the legend blocks of the legend bar, toggles the values to hide and show within the graph. The Report Icon '**R**' when clicked on brings up a report in a table format which can be exported. The toggled values are hidden in the report similar to the graph.

Charting Component Properties

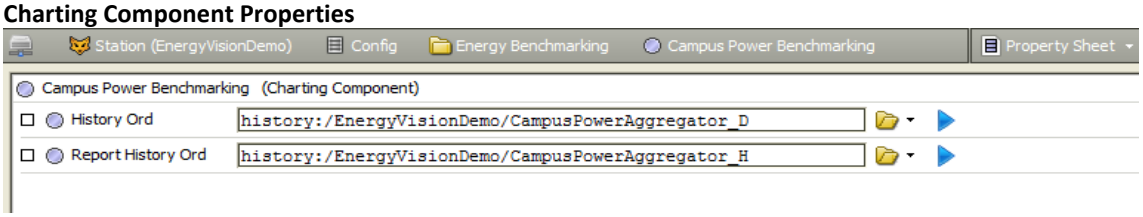


Figure 25 - Property sheet of a ChartingComponent

Charting Component View Properties

- **chartingRange:** Determines whether the chart shows a weekly or monthly chart.

- **colorScheme:** Determines whether the pie segments are coloured automatically using one of the pre-set colour schemes, or whether custom colours can be specified for each segment.
- **costConverter:** Determines whether chart shows a utility cost or raw consumption data.
- **weekFormatInDisplay:** Determines whether a weekly chart starts on a Sunday, or Monday.

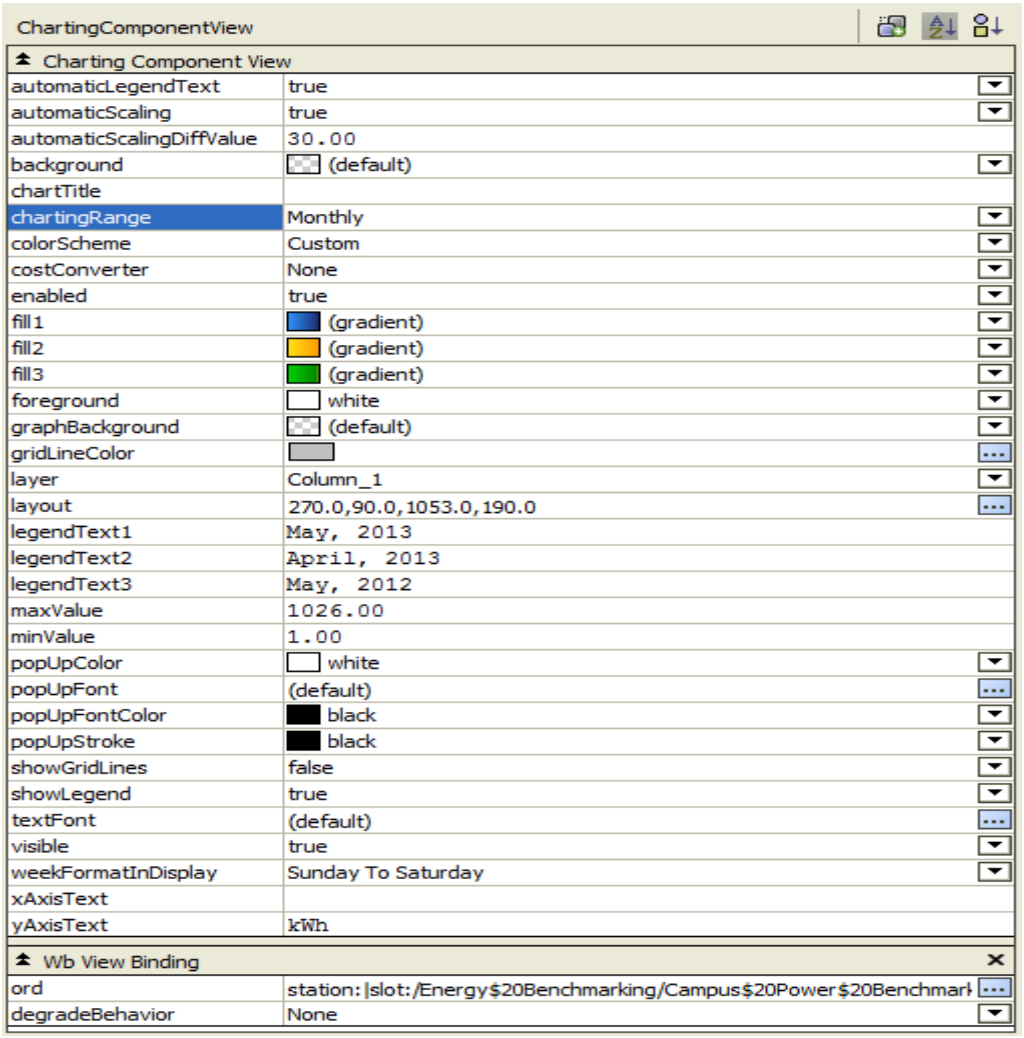


Figure 26 - Edit properties of Charting Component View

Figure 26 shows an example screenshot of a weekly benchmarking graph where a single bar representing the first day in the current period (shown in blue) is grouped closely with the first day in the previous period (shown in yellow), and the first day in the same period last year (shown in green).

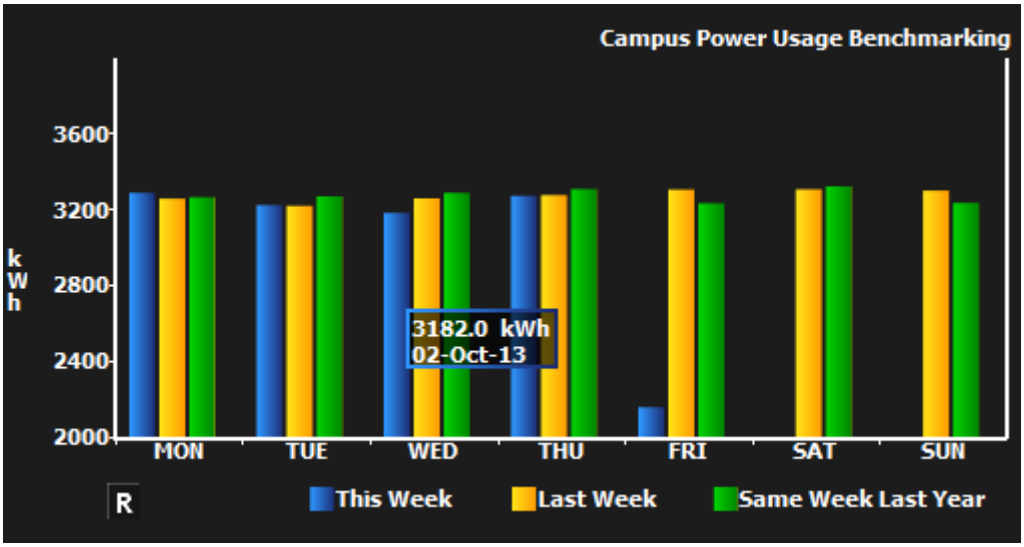


Figure 27 - Example Screenshot of a Weekly Benchmarking graph

5.7 Contribution Pie Charts

The ENERGY VISION contribution Pie Charts can be used to visualise the proportion of consumption that a particular building/floor/area contributes to the total consumption.

Pie charts can be used to show the contribution of different areas for a particular resource.
Ex: Proportion of water used by each building, or proportion of power consumed by each floor in an office block etc.

Contribution charts can be represented as either a traditional circular pie chart, or as a doughnut chart (ring shaped), with the option of displaying a legend below the chart.

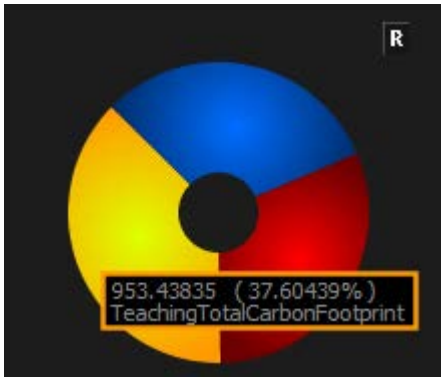


Figure 28 - Example Doughnut chart

User Interaction

Clicking the mouse on the blocks of colour in the legend either hide or show the segments relating to that segment on the chart.

Each segment of the pie chart has a tooltip which indicates the name of the segment, the value which the segment represents, and the percentage each segment contributes to the total. The tool tip is displayed when the mouse hovers over a segment. The border colour of the segment indicates which segment the tool tip refers to.

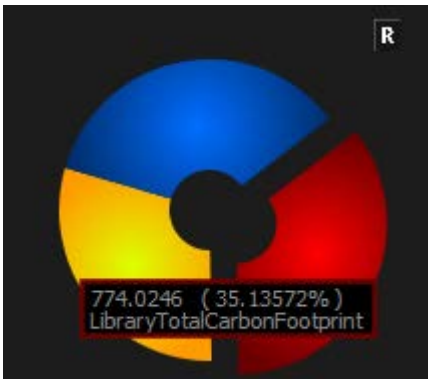


Figure 29 - Hover over tooltip on Doughnut or Pie Chart

Clicking the mouse pointer over a particular segment pops that segment out from the circle, or pops the segment back in again.

Holding down the mouse button and dragging the mouse spins the chart around in rotation.

Properties of a Pie Chart

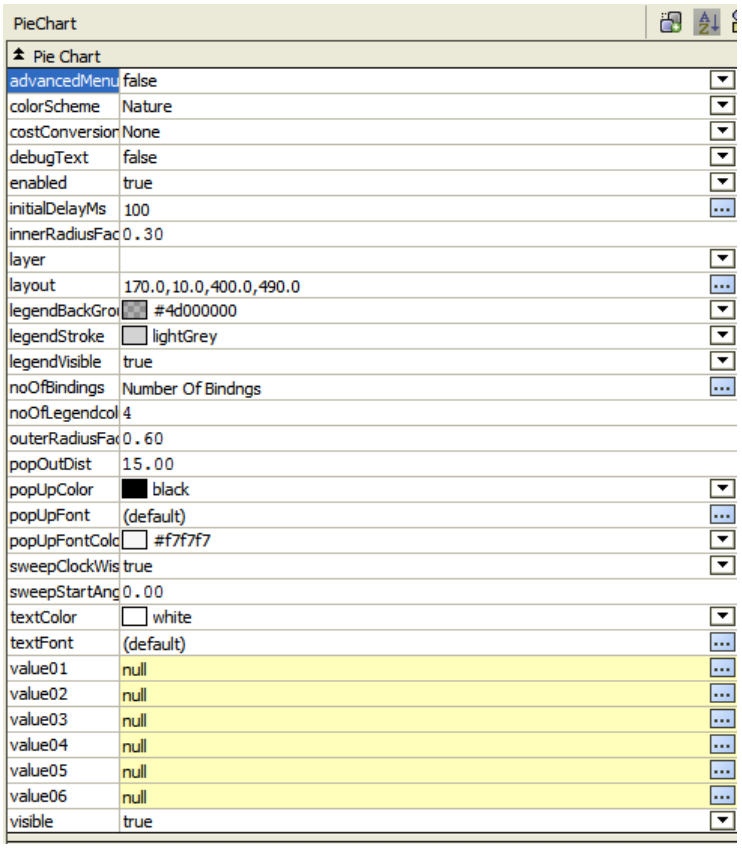


Figure 30 - Edit properties of a Pie Chart

The key properties used to configure the look and feel of the contribution charts are as follows:

- **noOfBindings:** Change the number of bindings as per the number of segments desired. Once the noOfBindings property has been changed, click the refresh button to display the bindings which will automatically be created.

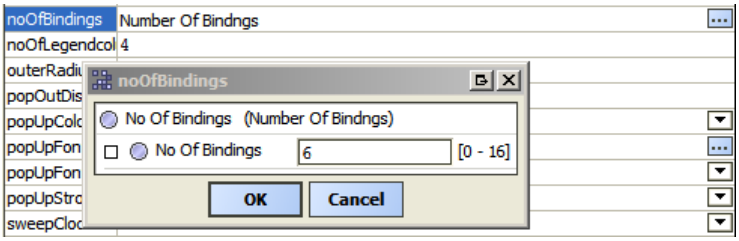


Figure 31 - Changing the No. of Bindings property

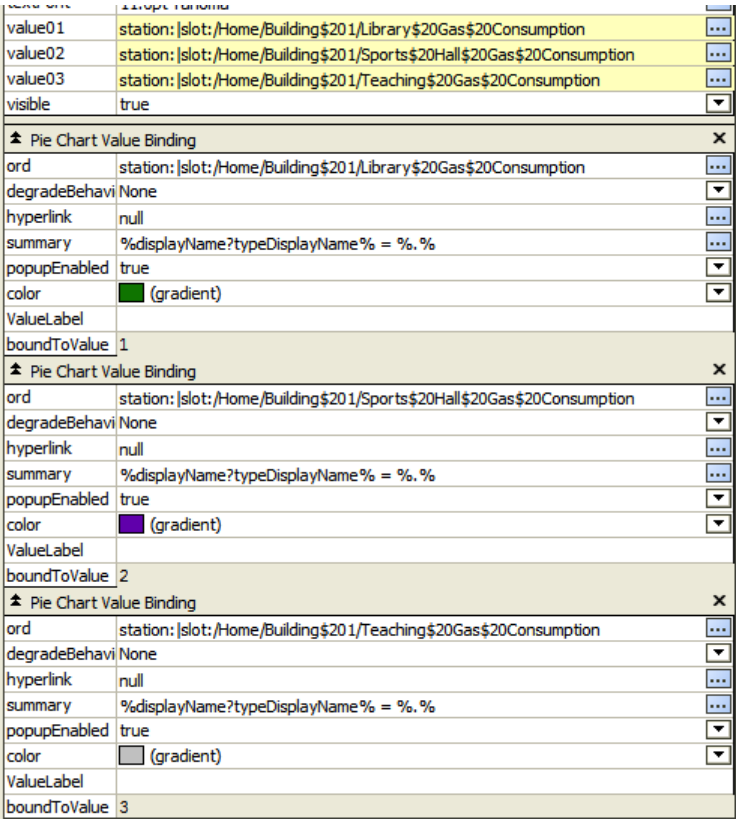


Figure 32 - Editing properties on Value bindings

The name used in the tool tip, and legend can be automatically chosen based on the type of input which the value binding is bound to. For control points the control points name will be chosen, for properties the name of the property will be chosen. Alternatively the ValueLabel property in the Pie Chart Value Binding can be configured to override the automatic name selection.

- **legendVisible:** Determines whether a legend is displayed beneath the chart.
- **colorScheme:** Determines whether the pie segments are coloured automatically using one of the preset colour schemes, or whether custom colours can be specified for each segment.

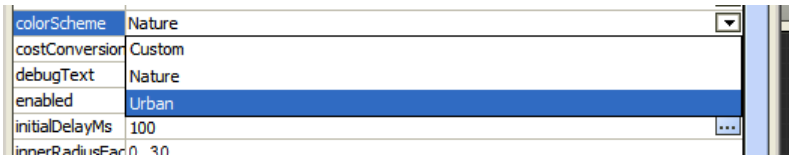


Figure 33 - Changing colour schemes

- **initialDelayMs:** allows each pie chart to be loaded after a specific delay when the page is opened. This feature gives a visually appealing effect by staggering the loading of different pie charts on a single page.

- **startAngle**: Determines the angle on the circle to start the loading of segments when the page is opened.
- **noOfLegendColumns:** The number of legend columns (1 – 4), the number of rows will be calculated automatically.
- **sweepClockwise**: Load animation can be clockwise or in anti-clock wise.
- **costConversion**: Converts the displayed values using the cost per unit taken from the energy vision cost manager.

5.8 Consumption Dials/Gauges

The ENERGY VISION palette includes a number of dials and gauges used to show current consumption values for single meters, areas, buildings etc. The different dials are styled to suit a variety of applications.

Each type of dials have specific properties, however the key properties for all dials are detailed below.

Key Properties

- **Min Value:** minimum value in the range
- **Max Value:** maximum value in the range
- **Input Value:** bound to a point by default
- **Medium per cent:** input values greater than this % of the range between min and max values are considered as medium range values. This medium range is shown as a yellow segment in the gauge
- **High per cent:** input values greater than this % of the range between min and max values are considered as High range values. This high range is shown as a red segment in the gauge.
- **advancedMenu:** This properties determines whether advanced properties relating to start and stop angles of dials are shown or hidden from the properties sheet.
- **Rounding:** This is a Boolean property which by default is set to FALSE. When in False, the value bound to the widget will be rounded to the nearest whole number value without any precision. If the widget needs to display float values then this property should be set to TRUE and number of precision digits can be set/changed using the "**Rounding Decision**" property
- **Rounding Precision:** This integer property will be enabled to be edited by the user when the Rounding property is set to TRUE. The Rounding Precision is by default set to 2 and can be changed according to user requirements.

1.1.1. Bar Gauge

The bar gauge is used to show a horizontal bar similar to a progress bar. This can be useful for showing a level of consumption for one particular period. E.g: CO2 consumption for last week.

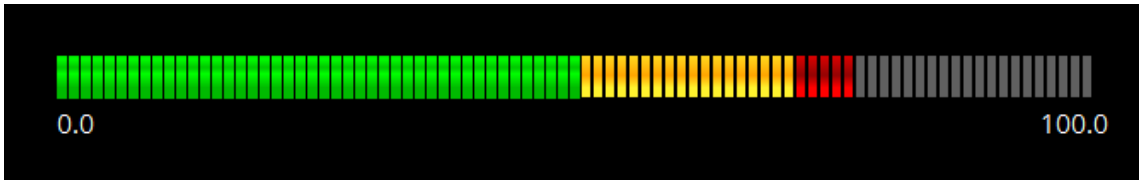


Figure 34 - Screenshot of an example Bar Gauge

Bar Gauge Properties

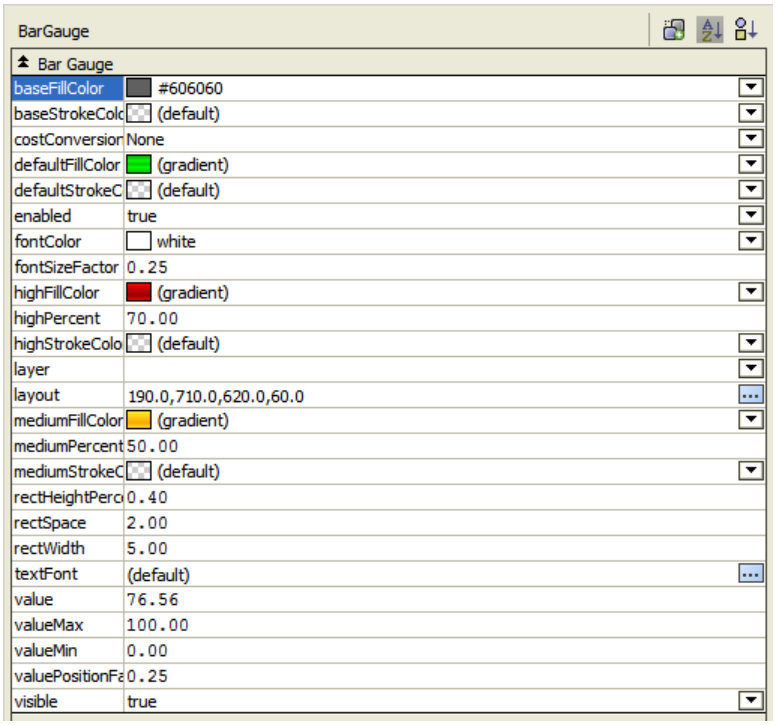


Figure 35 - Edit properties

1.1.2. Compass

The compass dial is used to show a compass bearing/direction and is useful for displaying wind direction when using a weather station or weather service to obtain the current prevailing wind direction.

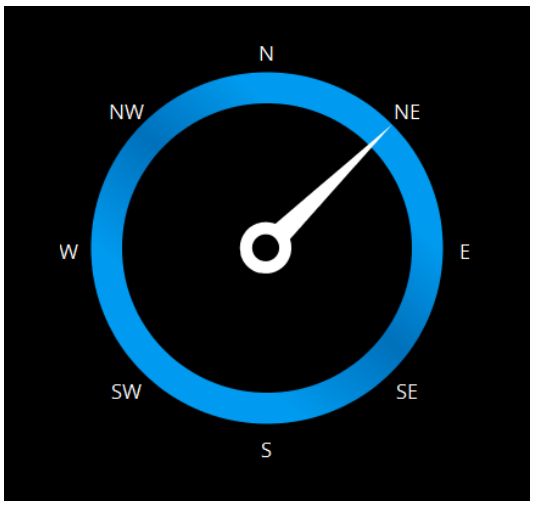


Figure 36 - Example screenshot of a Needle Compass

Compass Properties

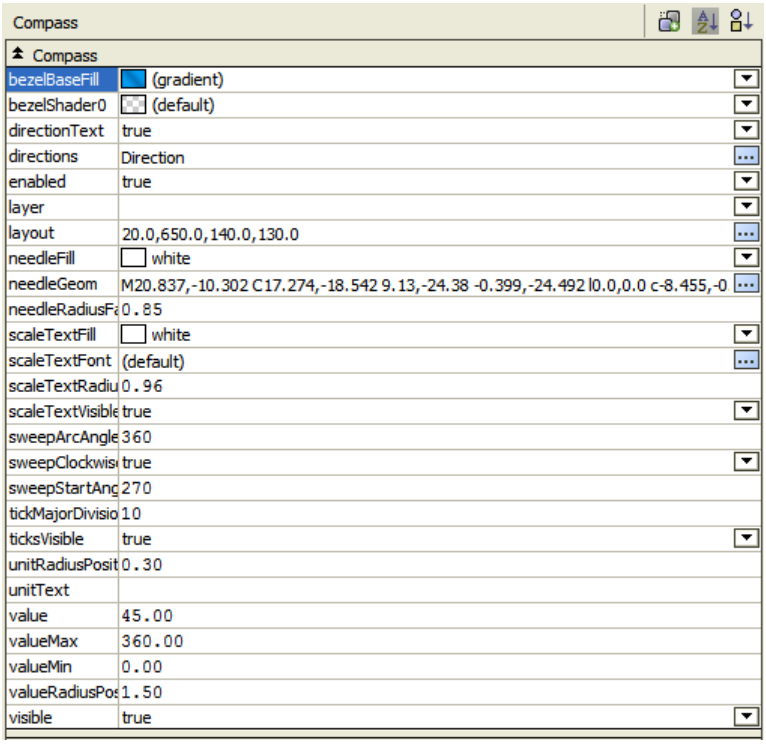


Figure 37 - Edit properties of a Compass

Deviation Needle Dial

The Deviation Needle Dial is used to represent the size of deviation away from a desired set point.

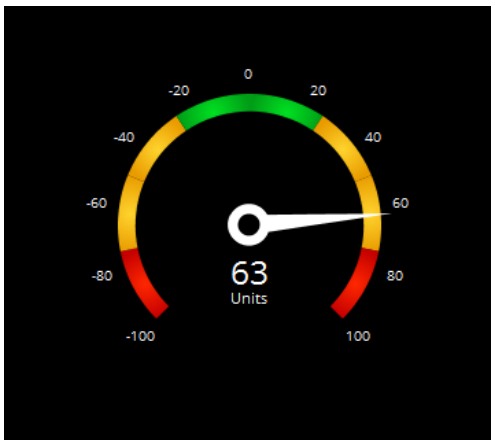


Figure 38 - Example Screenshot of a Deviation Needle Dial

Deviation Needle Dial Properties

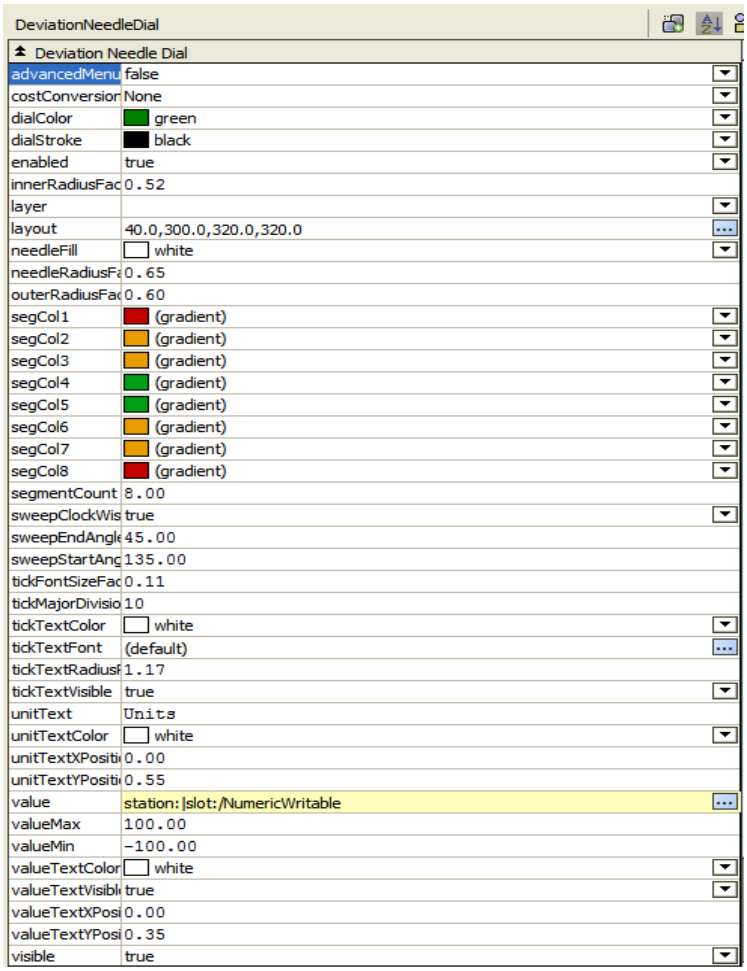


Figure 39 - Edit properties of a Needle Dial

- **unitText:** the text label to display the units of measurement

LED Dial

The LED Dial is used to represent a current analog value such as total Power consumed this week (kWh). The current value is displayed graphically as a ring of LEDs as well as a textual value label with the units shown beneath. Above textual value a text label can be used to give an explanation of what analogue input this dial represents.

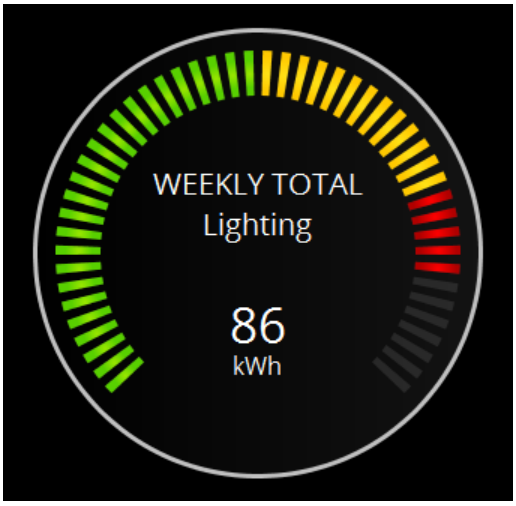


Figure 40 - Example screenshot of a LED Dial

LED Dial Properties

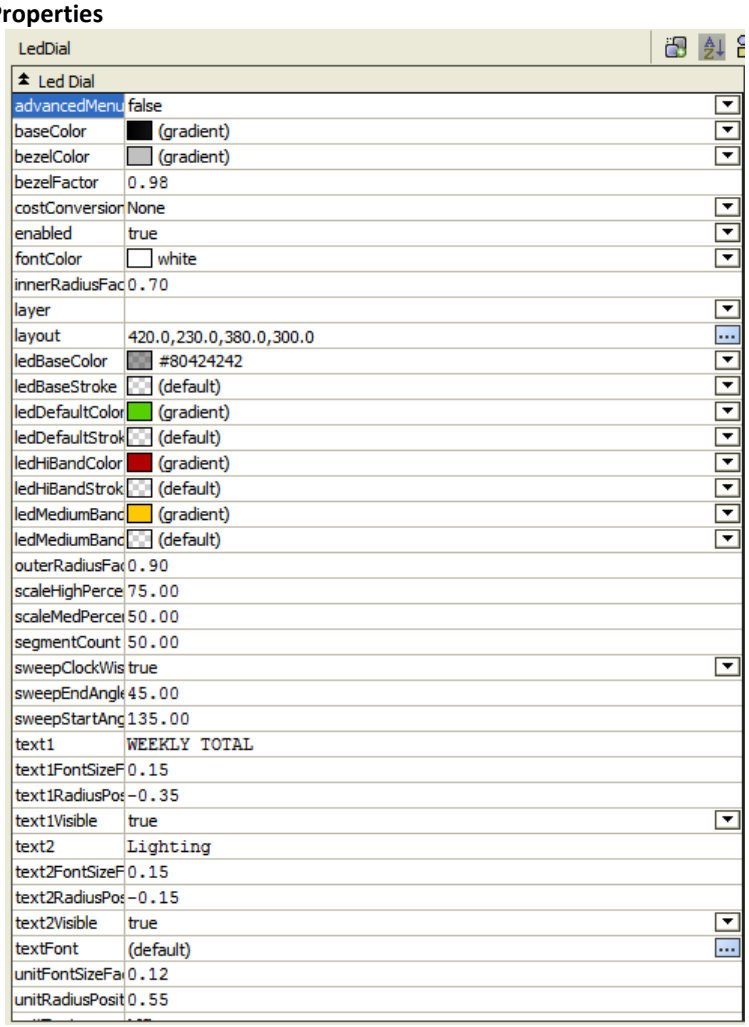
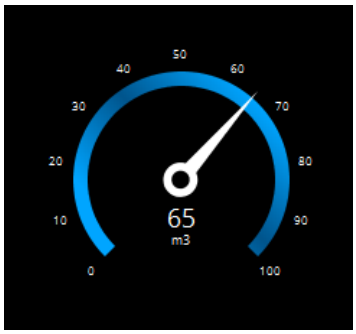


Figure 41 - Edit properties tab for LED Dial

- **text1:** the first line of text label to be shown in the centre of the dial
- **text2:** the second line of text label to be shown in the centre of the dial
- **unitText:** the text label to display the units of measurement
- **unitVisible:** determines whether the units are shown

Needle Gauge

The Needle gauge is used to represent a current analogue value such as current power, gas, water consumption etc. The palette contains needle gauges in 4 commonly used colours for representing utility consumption.



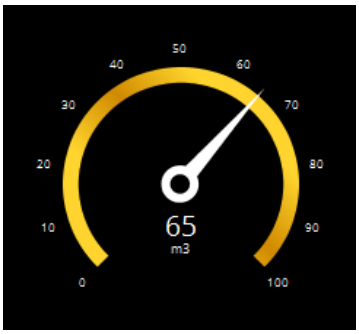


Figure 42 - Example screenshots of Needle Gauges with varying templates

Needle Gauge Properties

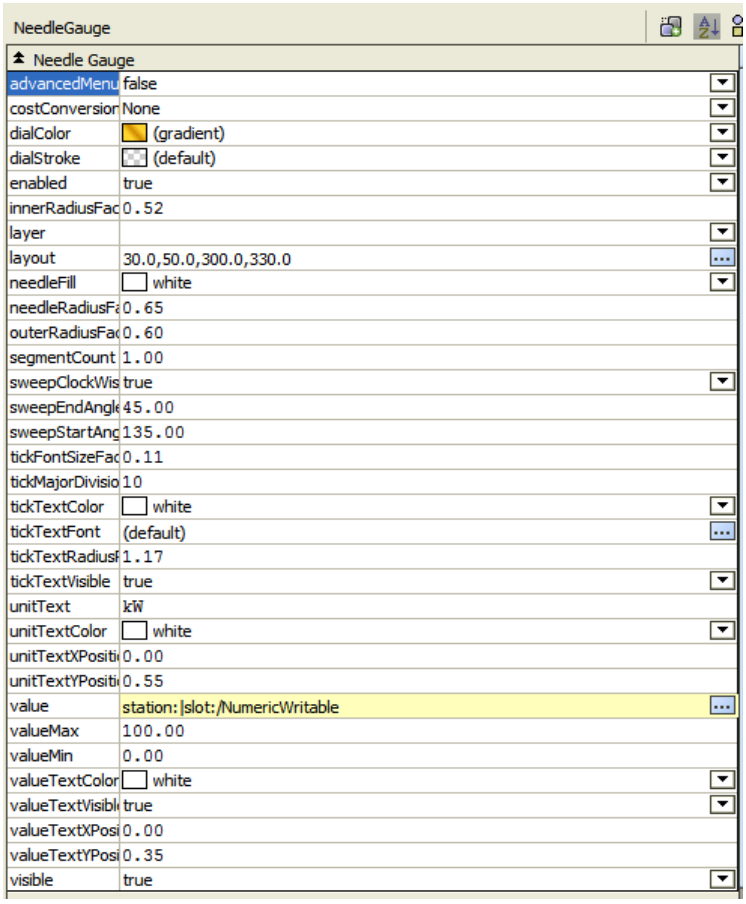


Figure 43 - Edit properties of a Needle Gauge

- **sweepClockWise:** determines whether the lowest value needle position is at the bottom left or bottom right of the gauge.

Segments Dial

The Segments Dial provides an alternative representation of an analogue dial which includes optional icons for power and temperature. The colour of these icons changes in accordance with the colour band that the current value falls within.

Figure 44 - Example screenshots of Segments Dials displaying values for Temperature and Power

Segments Dial Properties

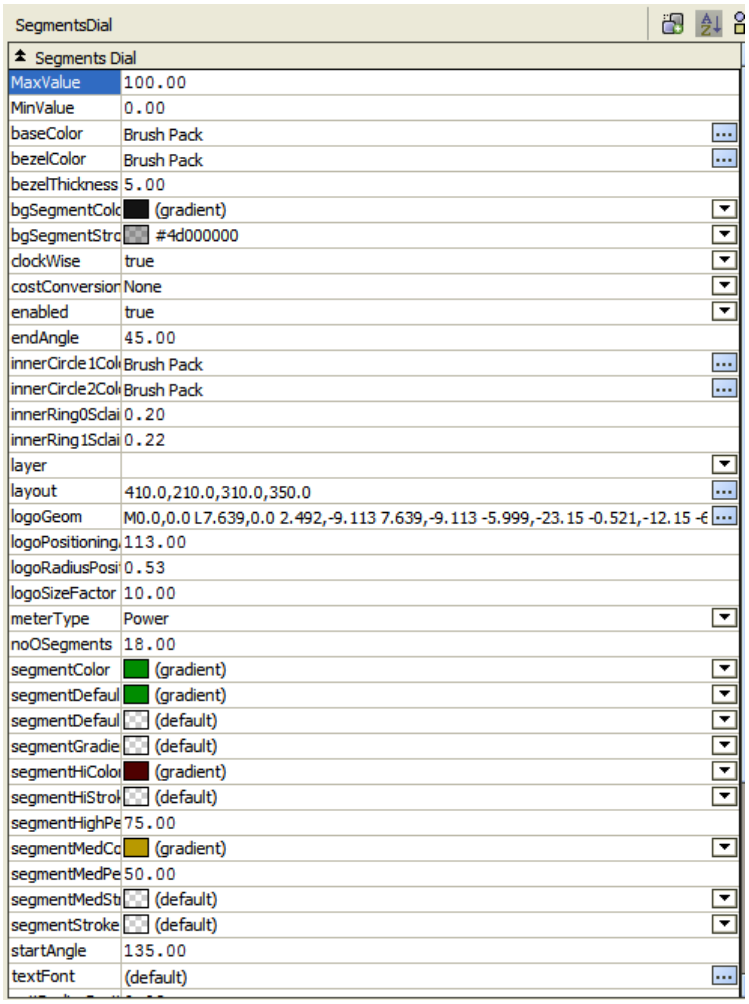


Figure 45 - Edit properties of Segments Dial

- **meterType:** this determines whether an icon is displayed at the bottom of the gauge to represent the type of utility being measured second line of text label to be shown in the centre of the dial
- **unitText:** the text label to display the units of measurement
- **unitVisible:** determines whether the units are shown

5.9 Line Chart and Comparison Line Chart on Histories

Line charts are custom graphic views on Niagara Histories. The line chart view resembles the standard Niagara history line chart view with similar properties of x-axis time, y-axis facet and value display etc. But the EV Chart view gives the user a rich look and feel experience in viewing the line chart on a history. The values are plotted as a circle fills, slightly larger than the line itself for a small number of values. The hover feature pops up a text box with the value and timestamp for that particular history value. Similar to the Niagara history chart view, the drop down list allows the user to view different time ranges on the line chart. The line chart view also supports the zoom feature, where the user can click and drag on the graph to select and zoom into a particular section of the graph. And using the 4 arrows the graph can be navigated – up, down, left or right in this zoomed state.

The Line charts can be added on to a Px page as a widget by dragging a history from the pane and choosing Ev Chart View in the make widget dialog box. On adding this as a widget on the px page the display colour of the line chart can be changed to User requirement.

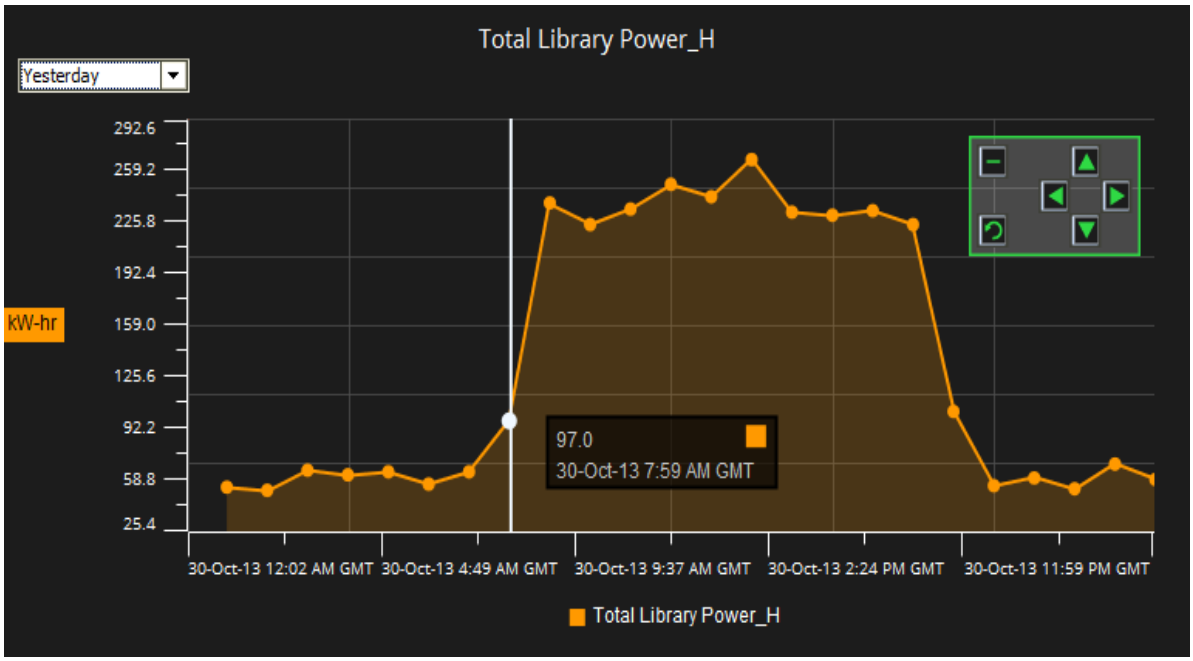


Figure 46 – Line Chart View on a History

Comparison Line Chart on a history is particularly useful on the hourly histories created by the meter aggregators for a set of meters. This line chart can be used to benchmark or compare a particular day's energy consumption against a target day's energy consumption.

This comparison line chart by default compares today's history values with yesterday's values as target values. The comparison time range is 24 hours.

On loading of the comparison chart, the user can pick and choose the dates for monitored and target values. This gives the flexibility to the user to set a particular day of ideal consumption as a default target date and start comparing other days around this date.

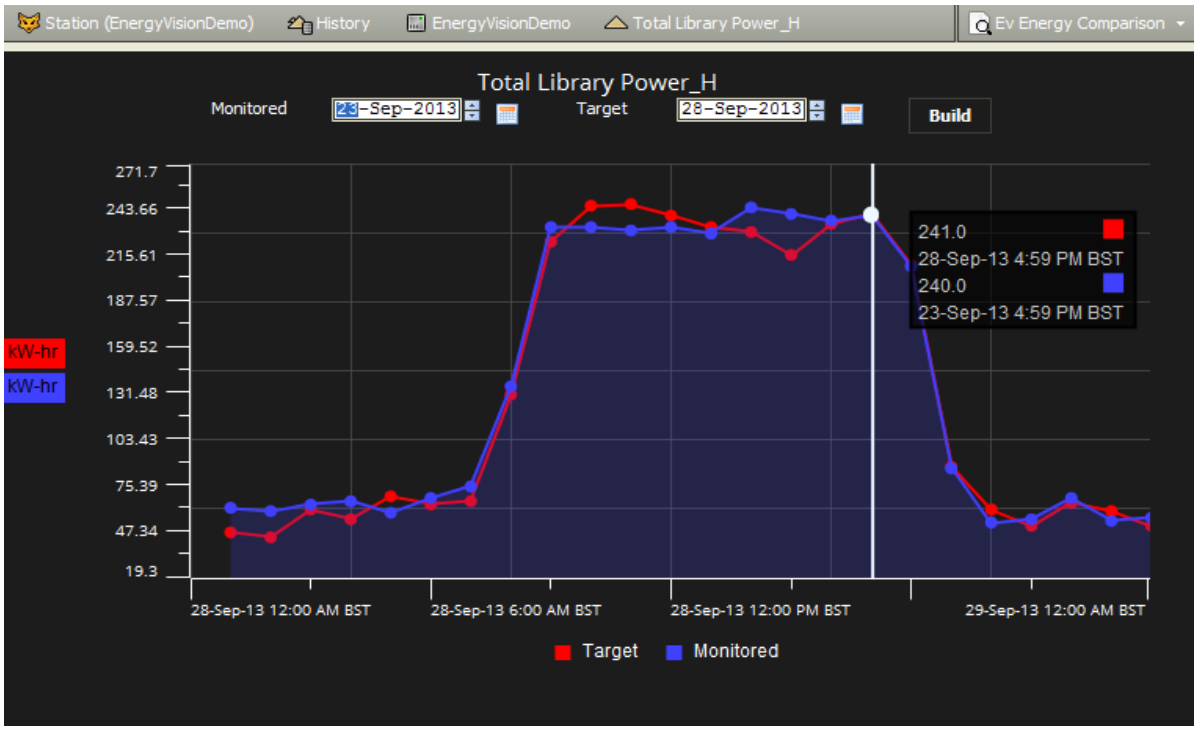


Figure 47 – Comparison Line chart view on history

5.10 Degree Day Component & Graphic Views

Degree day component within the Energy Vision calculates the Heating Degree Days (HDD) and Cooling Degree Days (Cooling Degree Days). This Degree Day component has three user actions to calculate the degree days and estimate the energy consumption of a particular building using the heat loss rate input by the user.

The degree day component by default has two graphic views on it – Chart View and Comparison view. The chart view compares the daily totals of the model cumulative energy against the actual cumulative energy consumed for that building. This chart view displays values only for the current month. Whereas the Comparison View contains the line charts for both model cumulative energy and Actual consumed energy along with the Performance straight lines for model and actual energies. The comparison view is cumulative curve plot for the entire year and hovering over any part of the graph will give a pop-up displaying the relevant values and times at that point.

On adding the Degree days component within the station the graphic views will be null since the values required by the graphs are not calculated yet. To get the component working, firstly the required properties of the component should be changed from the "**Property Sheet**" and the necessary actions need to be invoked. The next section gives a more detailed explanation about the actions available on the component. In the Property sheet the following properties can be set as per requirement:

- **OAT history ORD**: This should be set to reference the history ord of Outside Air temperature if available. This is required when invoking the action "**Calculate Estimated Energy From History**".

- **Hourly Energy, Daily Energy and Monthly Energy History Ords**: These history ords should be set to reference the history ords from a required EV Meter aggregator and this is mandatory because these histories will be aggregated, sorted and filtered for a set of meters or a single meter. All these properties should be set to the correct history ords for the graphic views to display proper graphs and charts.

- **Cumulative Energy history Ord**: This property should be changed/set to the history of the Actual Cumulative history. The point holding this history will be created under the same component once the "**Calculate Model Energy**" is invoked and executed.

- **Degree Days Csv File Ord**: This property should hold the file Ord to the CSV file which contains the date and degree day values.

- **Estimated Heating and Cooling Energy ORDs**: These ORD properties should reference to the required Estimated Heating and Cooling energy history ORDs which will be displayed in the graphic views.

The degree days are calculated using the methods described in the document TM41:2006 Degree-days: Theory and application, CIBSE. The two methods adopted from this document, which are available for calculating HDD and CDD are Mean Degree-hours equations and MET equations. The Mean Degree-hours method is the most accurate method and can be used when the Outside Air Temperature values are available for hourly intervals or less (every 15 min or 30 min). The MET Equations method gives the HDD and CDD as published by the MET offices, UK.

Using any of these two methods the HDD and CDD can be computed by one of the three actions:

1. **Calculate Model Energy**: This action takes a CSV file, time of the first model Outside Air Temperature value and the interval of temperature values as inputs. Reference to the CSV file must be made by setting the ORD of the CSV file in property "**Model Hourly Oat Csv File Ord**". This CSV file must contain the modelled Outside Air Temperatures for the entire year, and these temperatures must be values spaced at regular/equal intervals of time. The time of the first value in the CSV file and the interval for the modelled temperatures can be set in the pop-up dialog box which appears when the action call is made. On providing the appropriate inputs

to this action, history points are created under this component for model OAT, model HDD, and model CDD along with the model daily and monthly energies. All the calculated values are stored as history records under the respective points.

2. **Calculate Estimated Energy From Csv**: This user action calculates the estimated energy using the Degree Days CSV file. The reference to this file is held in the property "**Degree Days Csv File Ord**". The CSV file must contain the values in each of the row as Date (as YYYY-MM-DD), HDD (Positive Float value), CDD (Positive Float value). The estimated energy is then calculated using the Heat loss rate constant and the total degree day for that particular day. Similar to the previous action a history point is created under this component with the name as **ComponentName+"EstimatedCsvDegreeDayEnergy"** and the values are stored as history records under this point.

3. **Calculate Estimated Energy From History**: Similar to the above user action, this action also calculates the estimated energy for a particular building using the heat loss rate and the Total degree day. But in this case the Heating and Cooling degree days are calculated using the Outside Air Temperature history. The Outside Air Temperature history ORD must be specified in the property "**O A T History Ord**". Once this action has completed its execution, the historical degree days are stored as history records under the Historical heating, cooling and total degree days. These can be viewed or compared with the estimated energy which is also stored as history records under the history point named as **Component Name+ "EstimatedHistDegreeDayEnergy"**.

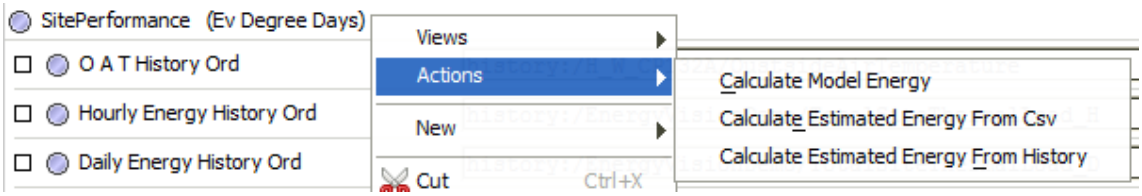


Figure 48 – Available User actions on Degree Days Component

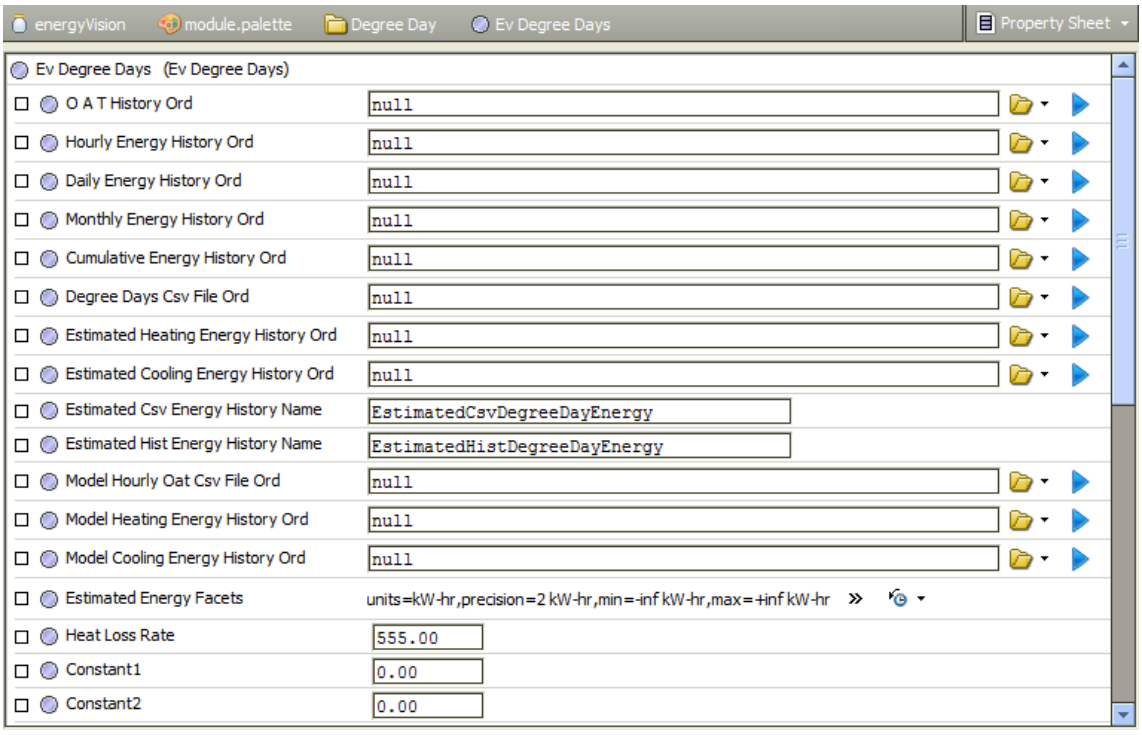


Figure 49 – Property sheet of Degree Days Component

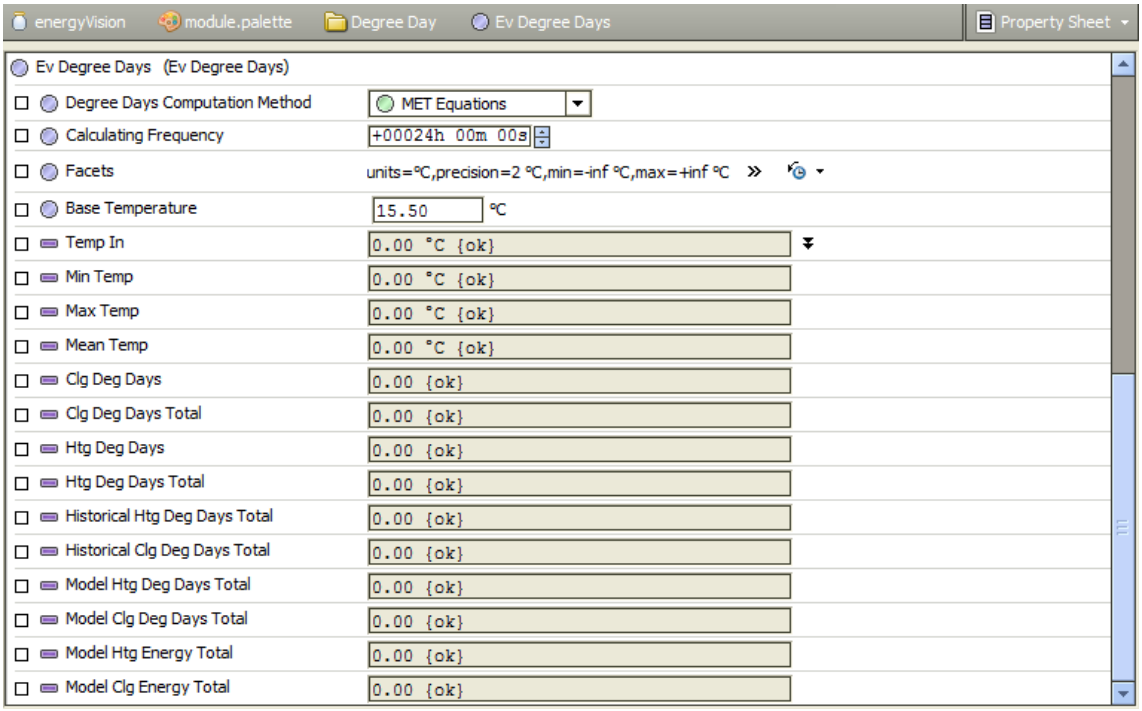


Figure 50 – Property Sheet of Degree Days Component, Continued

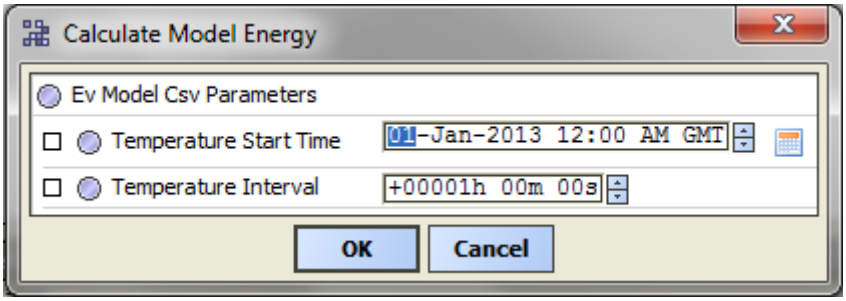


Figure 51 – Input Parameters for "Calculate Model Energy" User Action

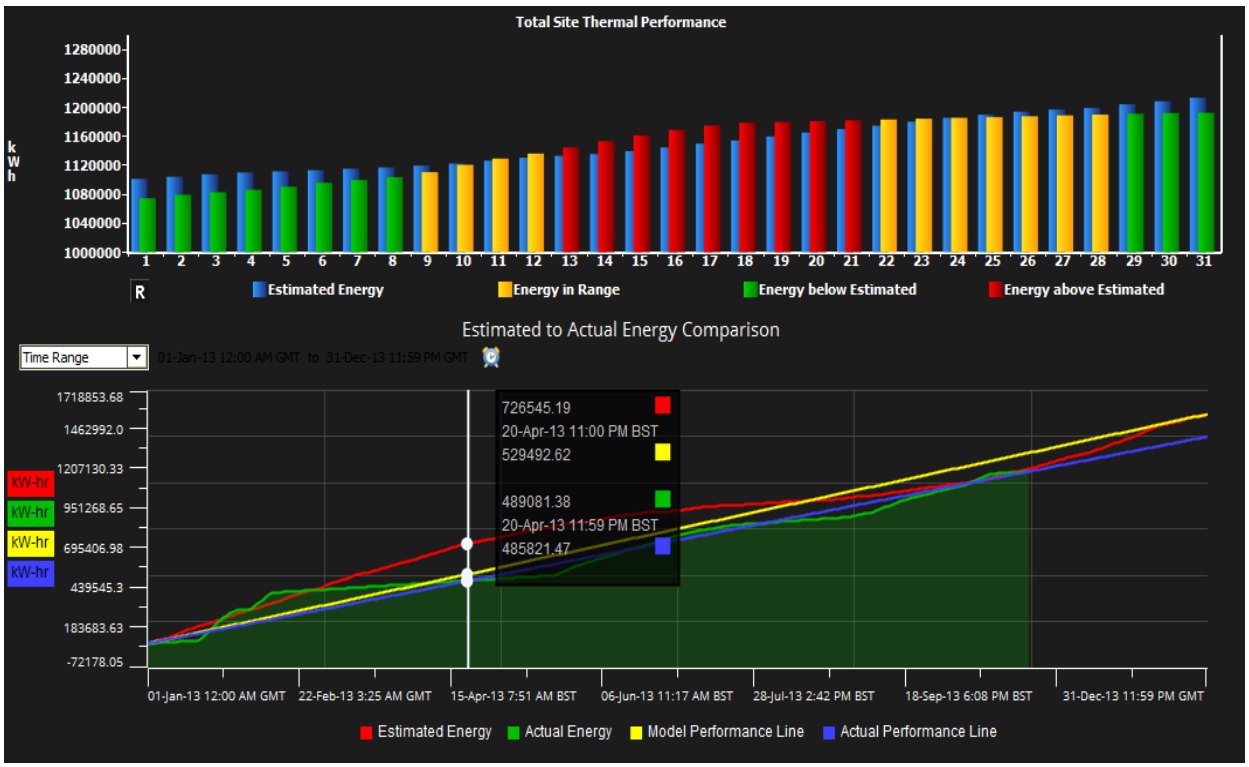


Figure 52 – Bar Graph and Line Graph Views of Degree day component

5.11 Energy Comparator Component

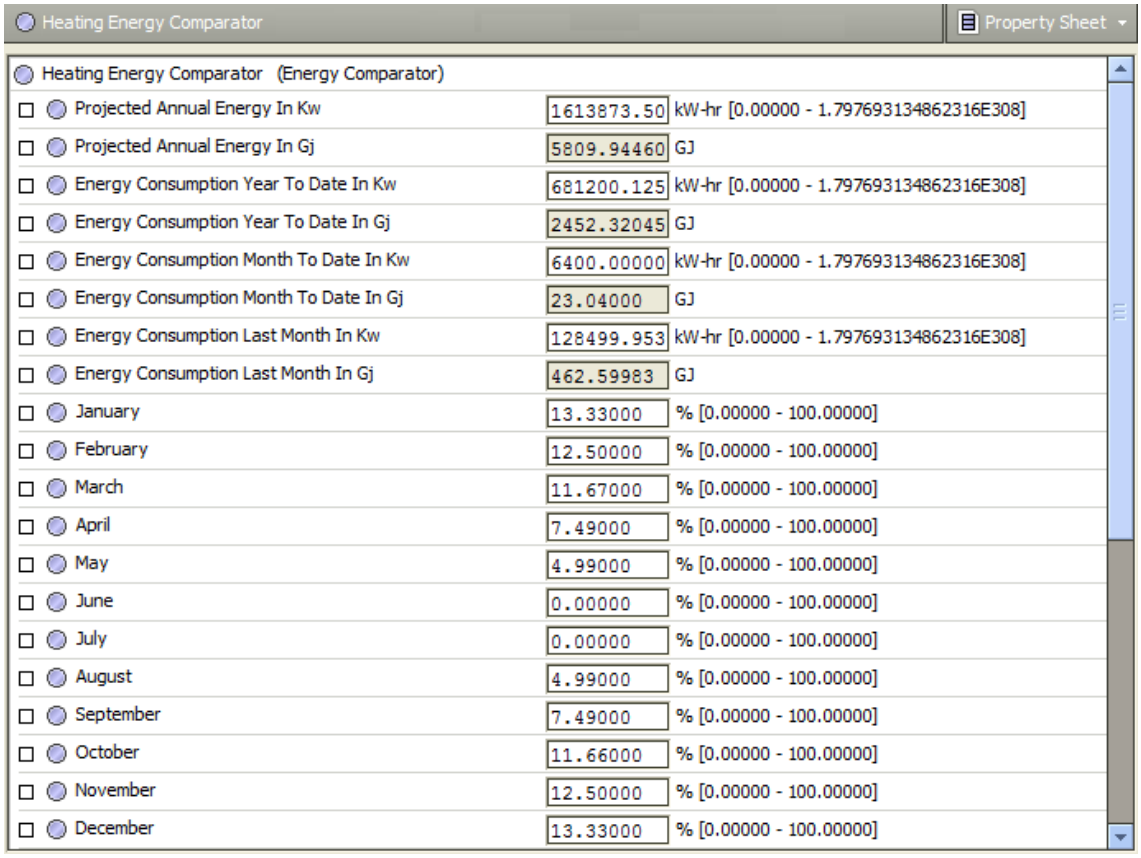


Figure 53 – Property Sheet of Energy Comparator

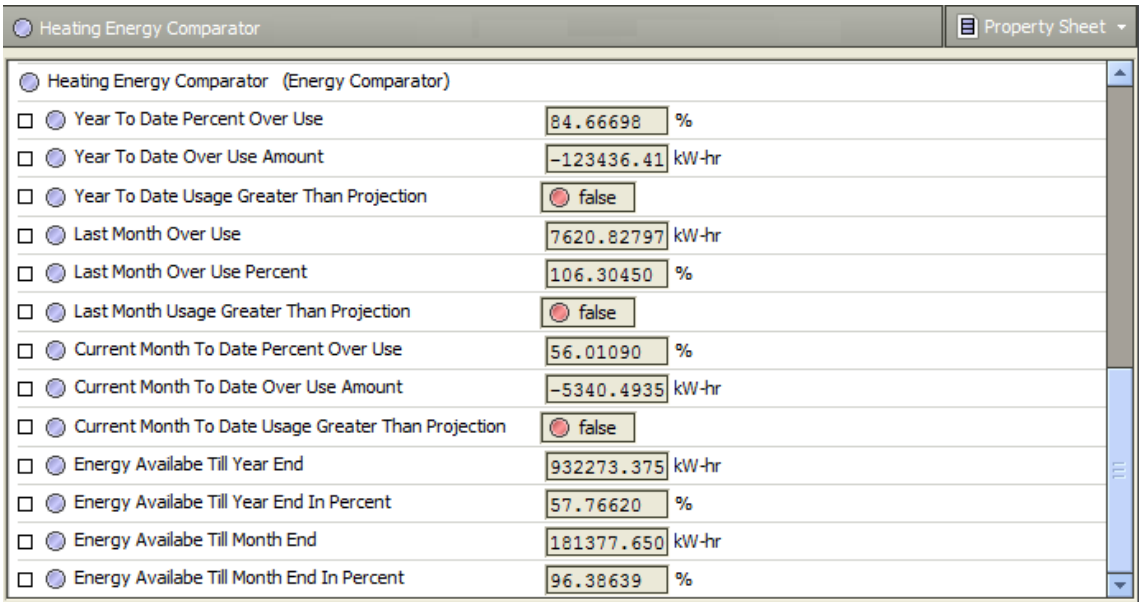


Figure 54 – Property Sheet of Energy Comparator, Continued

5.12 Regression Analysis & Multi Period Regression Analysis

Regression Analysis

The Regression Analysis component in Energy Vision performs linear regression analysis on two sets of data gathered from two Niagara Histories. These two histories need to be configured on the widget property sheet as X Axis and Y Axis history ords. The regression analysis component from the palette should be added under the Config of the station and the component can then be dragged onto a PX page in edit mode.

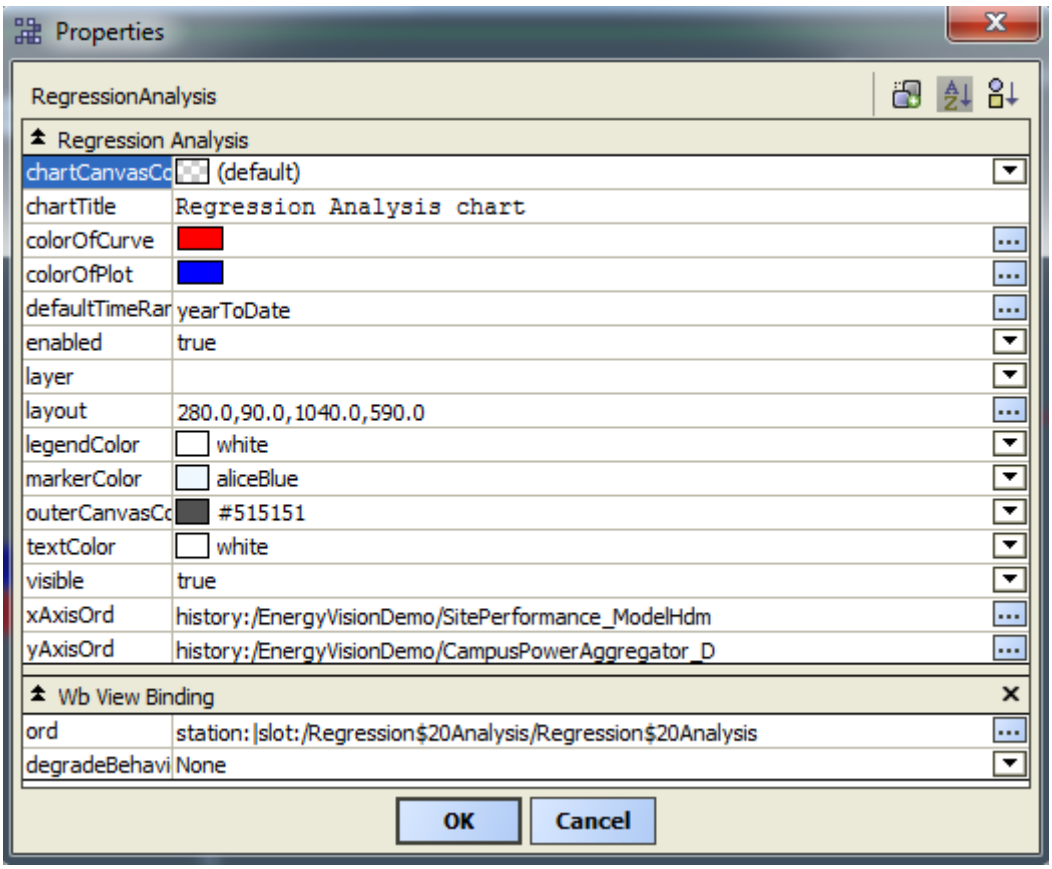


Figure 55 – Property Sheet of Regression Analysis widget

Once the X Axis and Y Axis histories are properly configured then the component will perform the linear regression analysis and calculate various parameters such as Y intercept, RSS (Residual sum of squares), linear parameters Beta0, Beta1, standard errors of Beta0 and Beta1.

The calculated values are then plotted as the regression line and the actual X-Y value pairs are plotted as dots. An example of the regression analysis chart for the Heating degree days vs Site Energy Consumption can be seen in figure 56

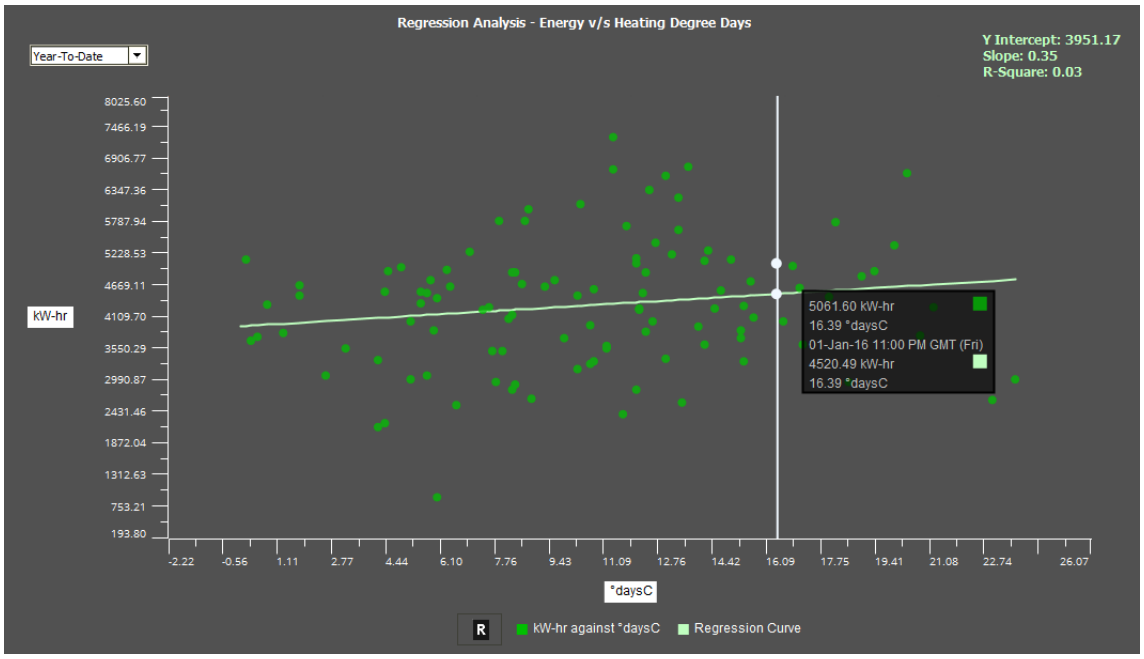


Figure 56 – Example regression plot for Heating degree days vs Site Energy consumption

Multi Period Regression

Multi Regression Chart is similar to the above Regression chart with an additional feature of defining discrete periods. The number of periods that can be defined or set by the user can range from 1 to 3. Number of time range properties to edit the time periods on the chart can be set using the property "**noOfPeriods**" from the property sheet of the "**Multi Regression Analysis**" widget as in Fig 57. The default time ranges for the three periods can also be set from this property sheet which will load the chart with the default time ranges.

Based on the "**No of Periods**" set on the property sheet of the widget, Regression Analysis will be performed on the History set (i.e. Y Axis History and X Axis History) to produce 1 to 3 discrete linear regression lines and scatter plots.

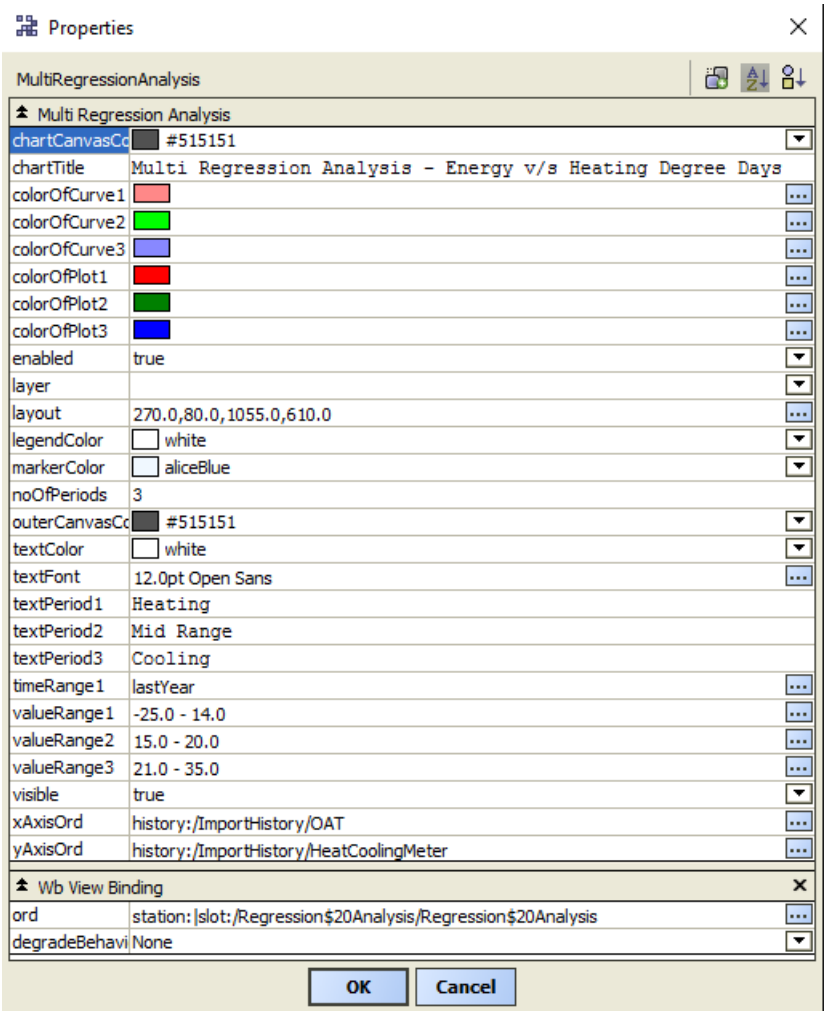


Figure 57 – Property Sheet of Multi Regression Analysis widget

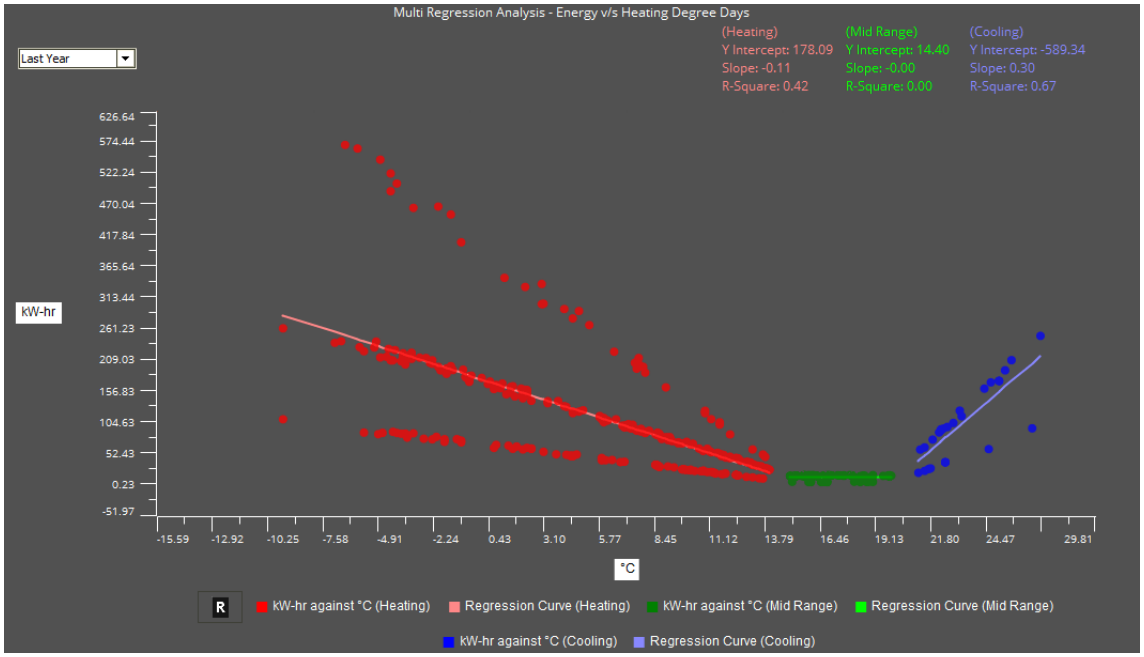


Figure 58 – Example multi regression plot for Heating degree days & Site Energy consumption

5.13 Meter Tree and Site Architect

Meter Tree component is a powerful tool which helps in visualising and comparing all the meter aggregators in a site via a simple Px view. This meter tree can be found within a station under "**Config/Services/ENERGY VISION Service/Meter Tree**". On selecting this meter tree component a default view for the meter tree component will appear as in Figure 59. The entire site's tree structure will appear in the left top pane from where various meter aggregators can be selected by double clicking on them for daily, weekly, monthly and yearly comparisons. The selected aggregators will appear on the left bottom pane in the order or selection and the dials will be populated with slot values from the first aggregator.

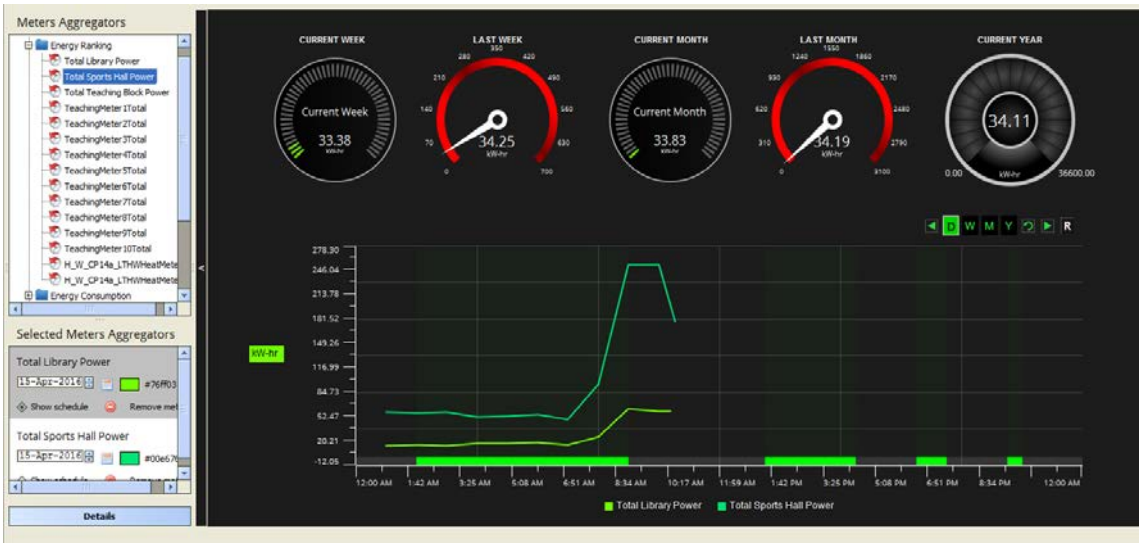


Figure 59 – Default view of the Meter Tree with two selected Meter Aggregators

Site Architect is a second view on the Meter Tree component which is a really useful tool to engineer Meter Aggregators within a station. Figure 58 shows the default view of a Site Architecture for a station (In this case the ENERGY VISION Demo station). The left hand side pane shows the entire station in a tree structure view for the Config part of the station. The two tables on the right shows the Learn Table (Top) of all the histories within a station and the Folder Database view (Bottom) for any folder within the station. By default the bottom right table is the database view for the Config under the station which will only display Folders and Meter Aggregators. There are couple of options to create meter aggregators, i.e. using individual histories or using group of histories. Refer figures 59 and 60 which shows options to create meter aggregators with individual or group histories.

The data can be visualised for following time periods using the buttons on the top right of the chart.

- Hourly – 24 Hours for the current day. (D)
- Weekly – last seven days. (W)
- Monthly – a complete month (28 – 31 days). (M)
- Yearly - 12 months

Energy baseload analysis:

The meter tree can be used to perform base load analysis of one or more meters. Energy consumption profile for multiple days can be overlaid over each other on the the chart along with the occupancy schedule. This provides a detailed view of the how the energy consumption has changed with respect to the operation schedule.

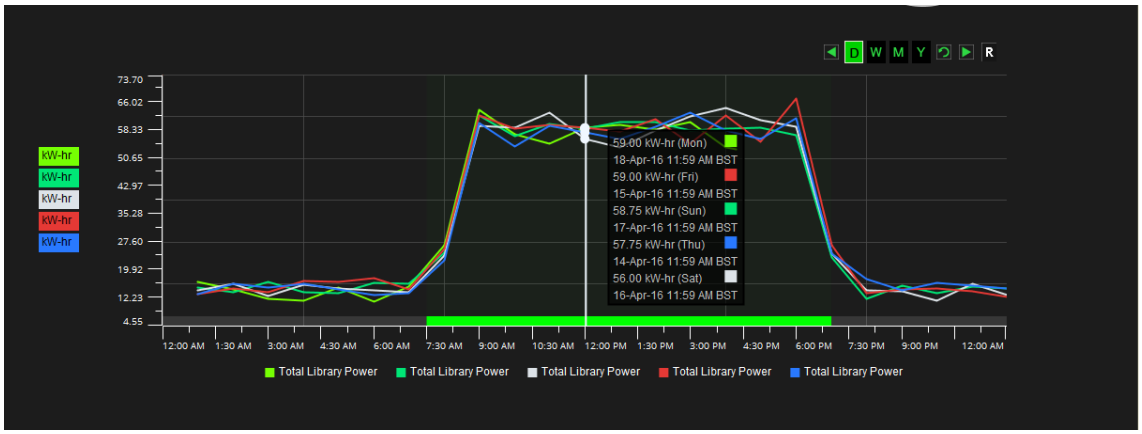


Figure 60 24-hour Energy profile

The above chart dispalys the the 24 hour profile for five different days for the same meter. The pop up also displays the weekday corresponding to the chosen date. This type of analysis can be done for all the meter listed in the meter tree. The analysis can also be performed for weekly,monthly and yearly time periods using the buttons on the top right of the chart.

A meter aggregator is associated with an occupancy schedule using the **“Occupancy Schedule Ord”** property. The schedule associated with a meter aggregator will be displayed on the chart. The green bands near the x-axis represent the schedule ON periods and the faint grey bands represents the schedule OFF periods. The chart can only display only one schedule at a time. When multiple aggregators are chosen the schedule to be displayed on the chart can be controlled using the **“Show schedule”** radio button on the selected meters pane.

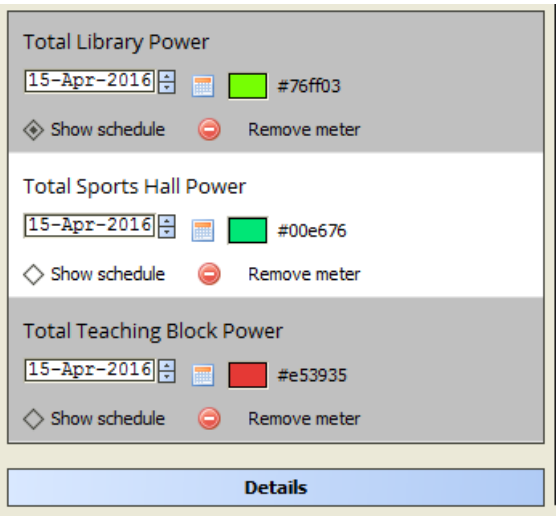


Figure 61 Selected Meters Pane

The details button brings up the following popup wich contins more detailed information about the chosen meters. New meters can be added or removed while the details popup is open and the pop upn will update dynamically.

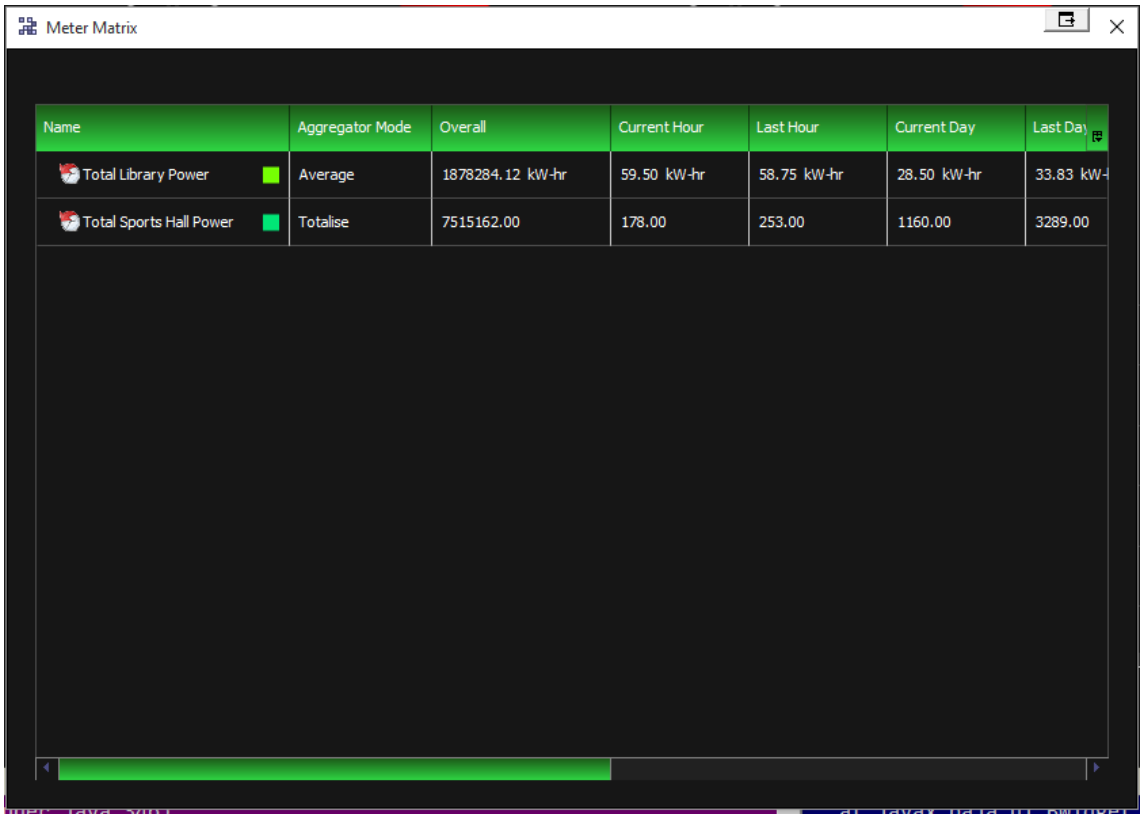


Figure 62 Meter details popup

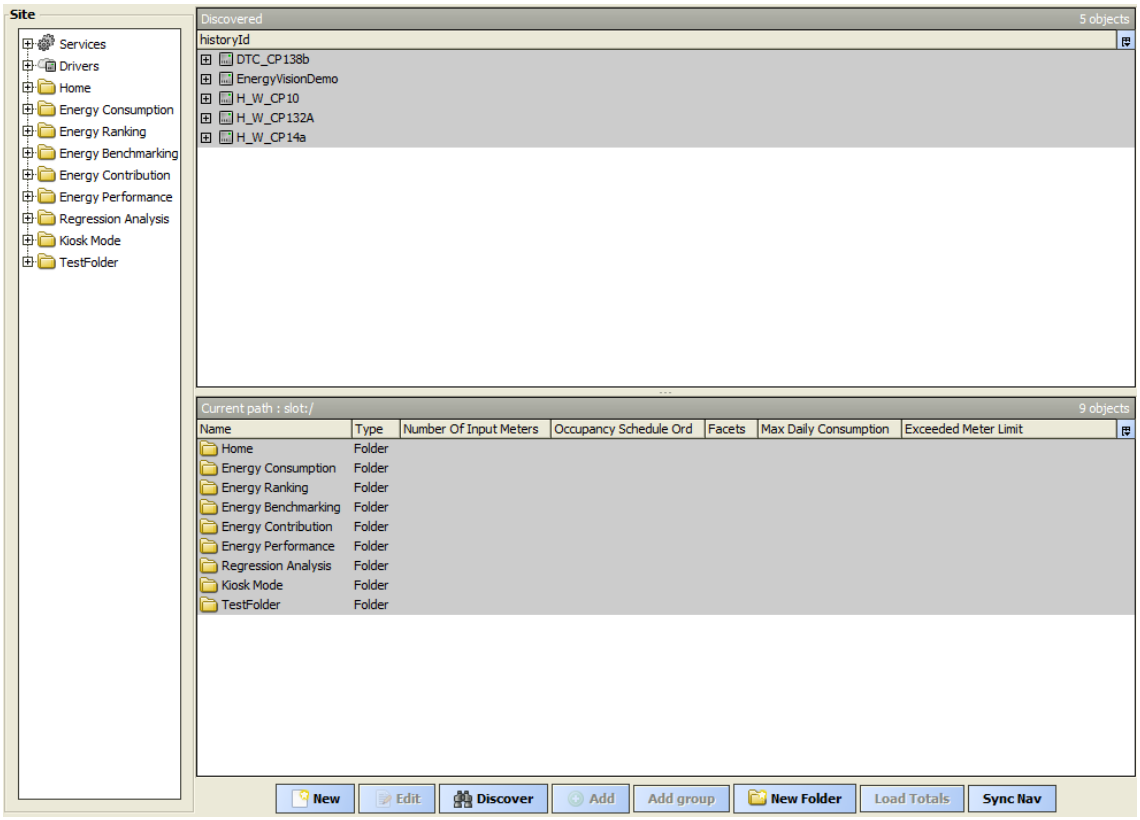


Figure 63 – Site Architect view of the meter tree component

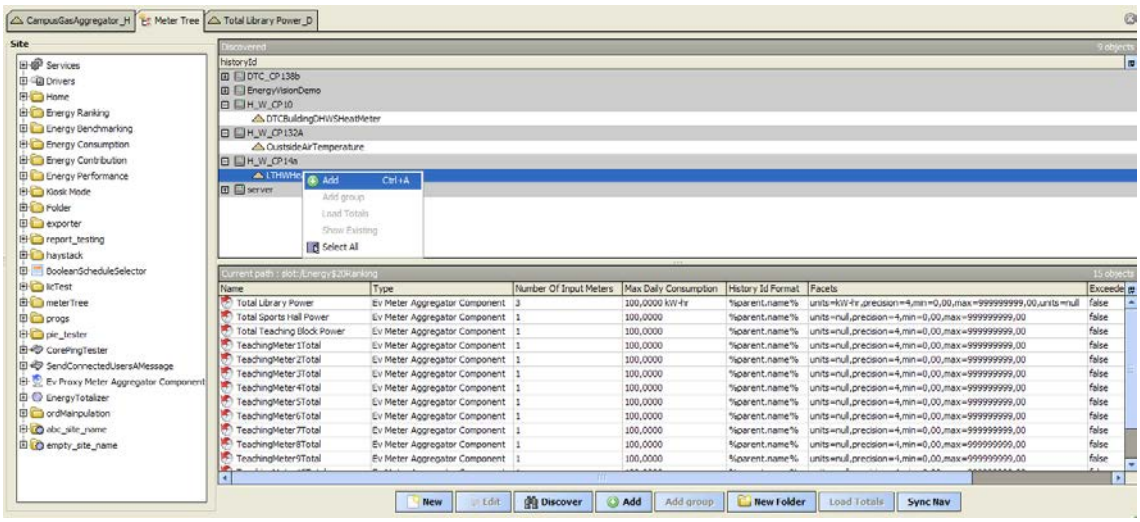


Figure 64 – Add a meter aggregator with individual history under Site Architect view

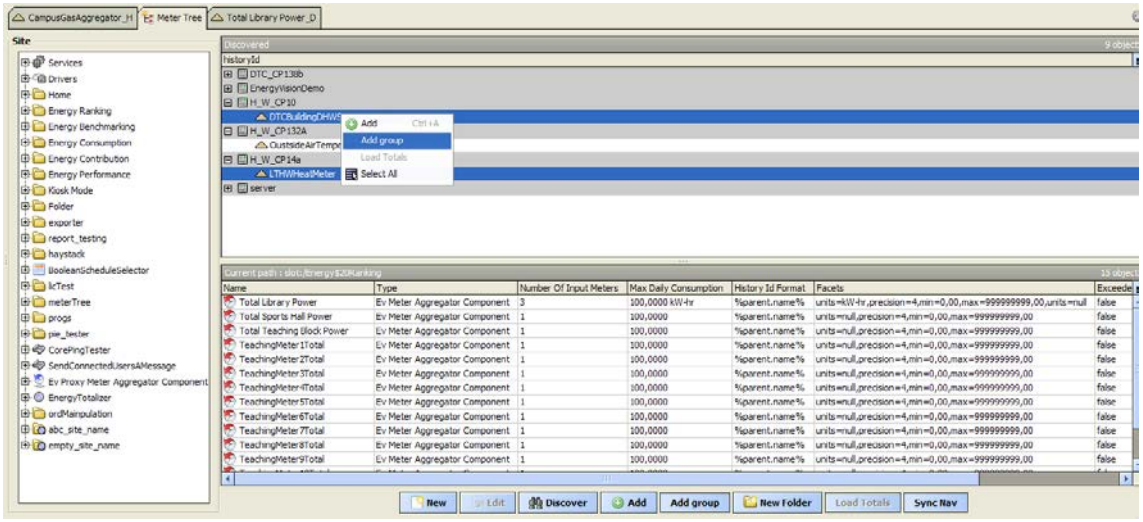


Figure 65 – Add a meter aggregator with a group of histories under Site Architect view

5.14 Stacked Bar Chart

The stacked bar chart allows the user to visualise the usage of one or more aggregators. The user can set a target consumption level and visualise how the system is performing against the set target. The data can be visualised for following time periods.

- Hourly – 24 Hours for the current day. (D)
- Weekly – last seven days. (W)
- Monthly – a complete month (28 – 31 days). (M)
- Annual by week – 52 Weeks. (A^{12})
- Annual by month– 12 Months (A^{52})
- Yearly - 5 Years (Y)

Figure 66 List of available chart profiles.

A stacked bar chart can be created by following the steps,

- Drag and drop the **Stacked Bar Chart** widget form the palette into the PX page.
- To add meter aggregators to the chart add an **Ev Stacked Bar Aggregator Binding** to the widget and point the ORD to a meter aggregator in the station.
- Targets can be set individually for daily, weekly, monthly and annual modes using the **dailyTarget**, **weeklyTarget**, **monthlyTarget** and **yearlyTarget** respectively.
- The styling for meter aggregator can be set on the binding.

The left and right arrows can be used to move forward or backward a step based on the time period currently chosen (i.e. if monthly is chosen the arrows can be used to go to next month or previous month).

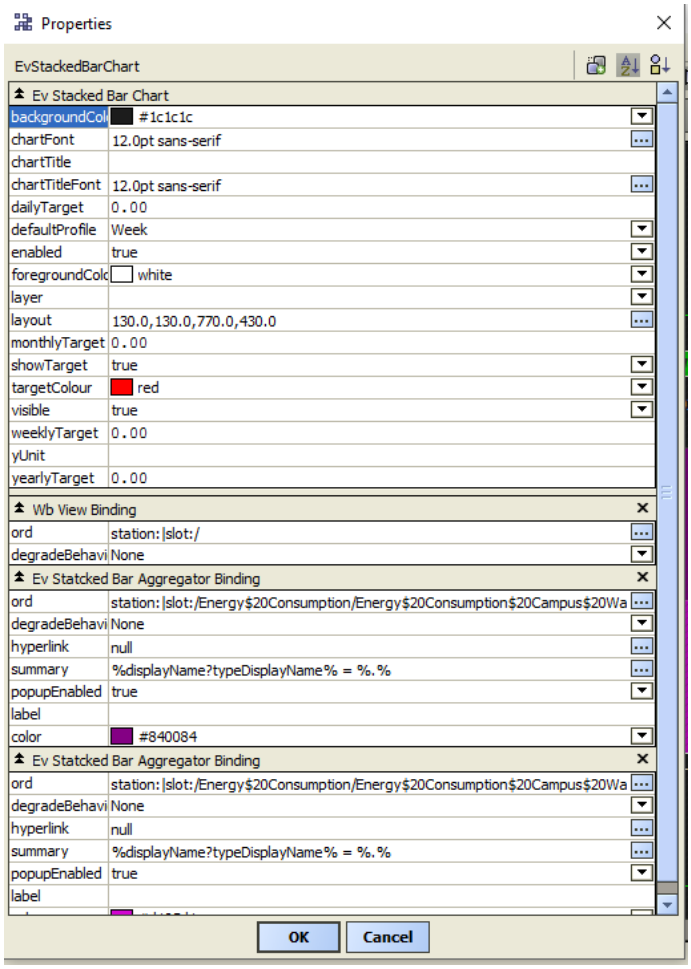


Figure 67: Stacked chart properties

Configurable properties:

- **backgroundColour**: The background colour of the chart.
- **dailyTarget, weeklyTarget, monthlyTarget, yearlyTarget:** These properties are used to set the target lines for their respective profiles. The values can also be bound to a point using a vale binding.
- **yUnit:** The unit to be displayed in the y axis.
- **chartTitle:** A title/ header for the chart.

By default the name of the aggregator is chosen as the name to be displayed on the legend. The name of the legend can be customised by setting a value in the **"label"** property in the binding. The legend can be clicked to toggle the visibility of an aggregator.

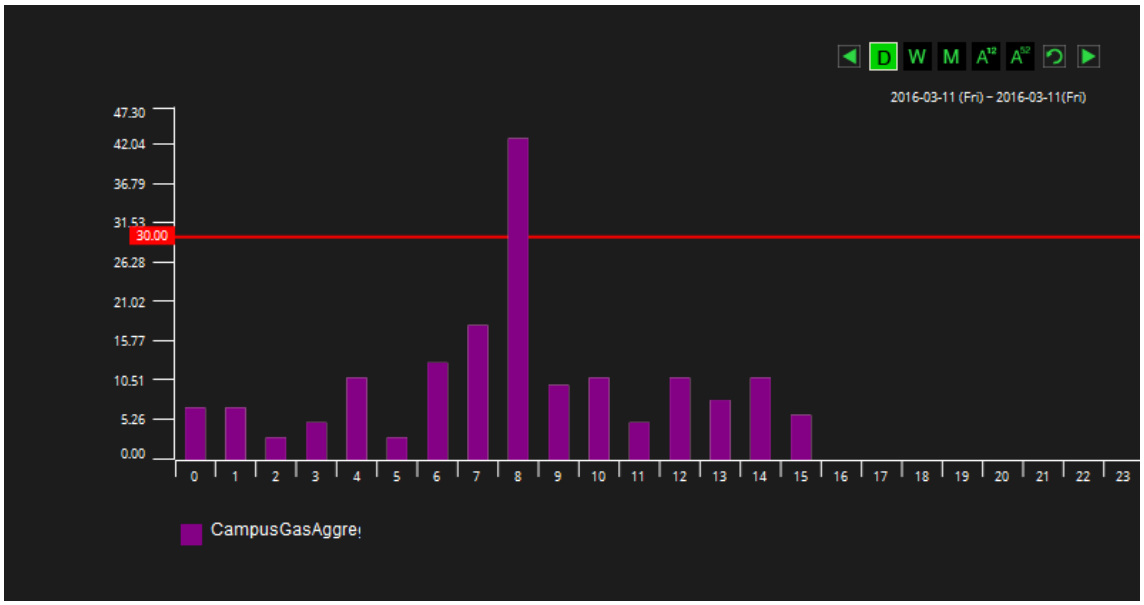


Figure 68: Stacked bar chart displaying 24 hour profile of a single meter with a target line.

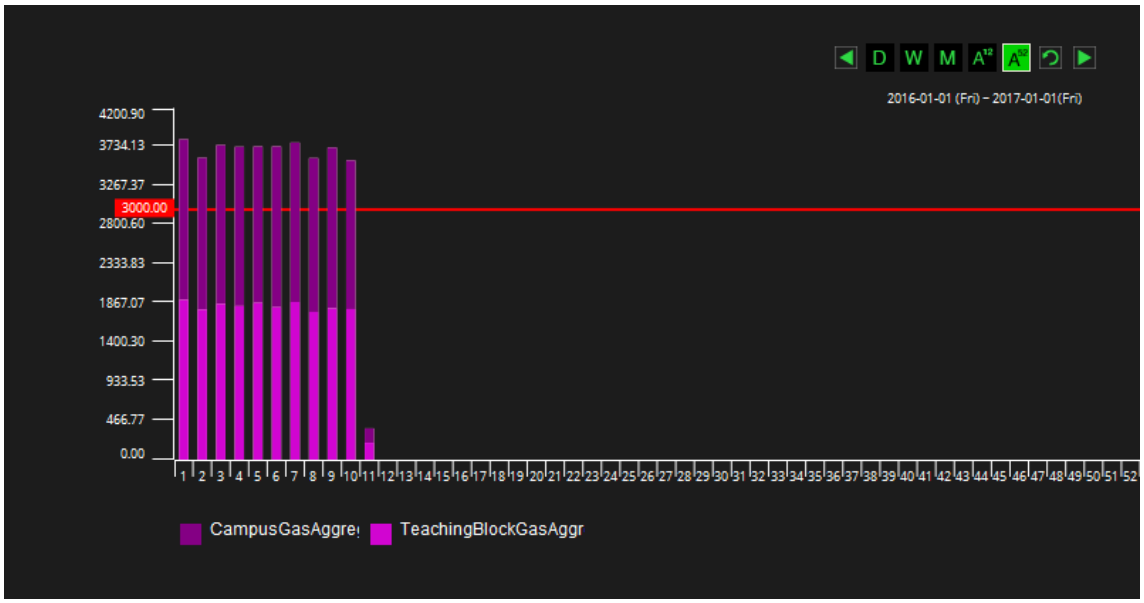


Figure 69: Stacked bar chart displaying an annual 52 week profile of two aggregators with a target line.

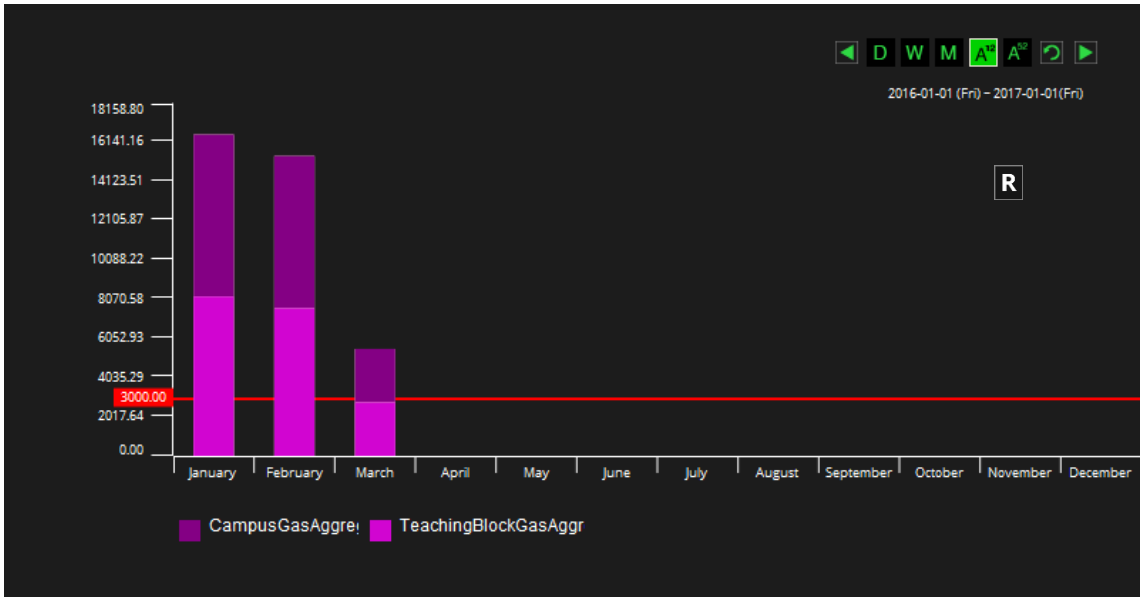


Figure 70: Stacked bar chart displaying a 12 month profile of two aggregators with a target line.

5.15 Reporting

All the energy vision widgets have built in ability to export data associated with it to pdf. The reports can be pulled up straight from any energy vision widget in a px page by clicking the button on the widget. Generating reports can also be automated and the resulting pdf can be saved to file or sent to email accounts.

Viewing and save a report:

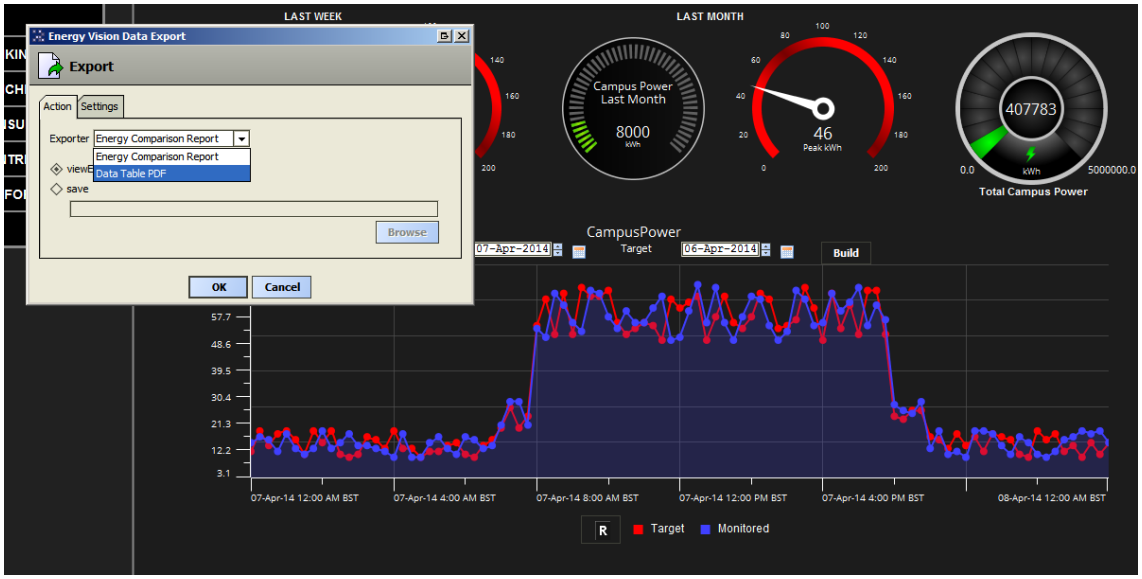


Figure 71 – view and save report

- Click on the **"R"** button.

- Choose the type of report from the drop down.
- The report can either be viewed with a pdf reader or saved to a location on the file system.
- To save the report, choose the “save to file” option and choose a desired path using the browse button.
- Click *OK* to save or view the report.

Automated report:

Any report associated with the energy vision can be compiled into a single pdf report. This process can be automated on a schedule. The automated report generation depends on Niagara AX reports module.

- Drag and drop the report service from reports module into services.
- Drag and drop the report generator component from energy vision palette.
- Copy the desired widgets from the PX page for which the report needs to generated and paste it under the report generator component.

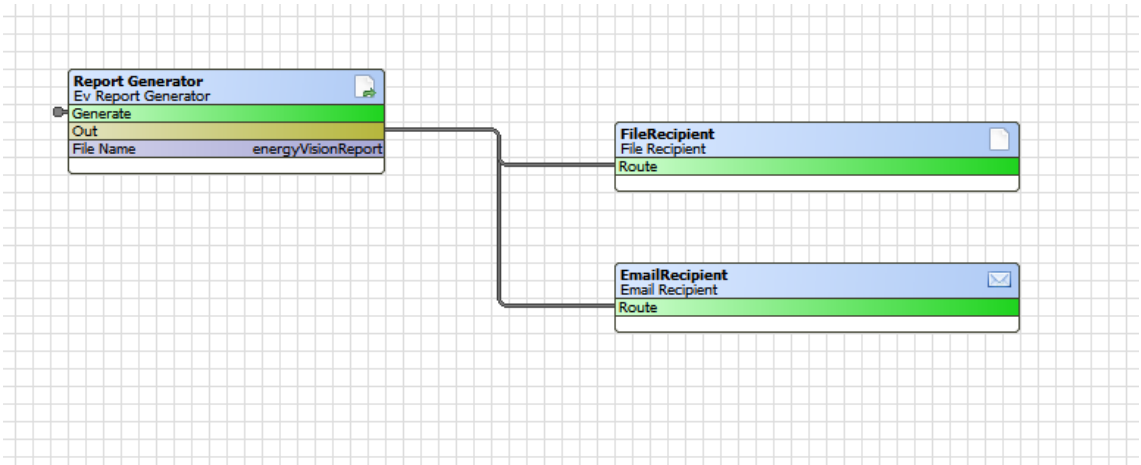


Figure 72 – Report recipients

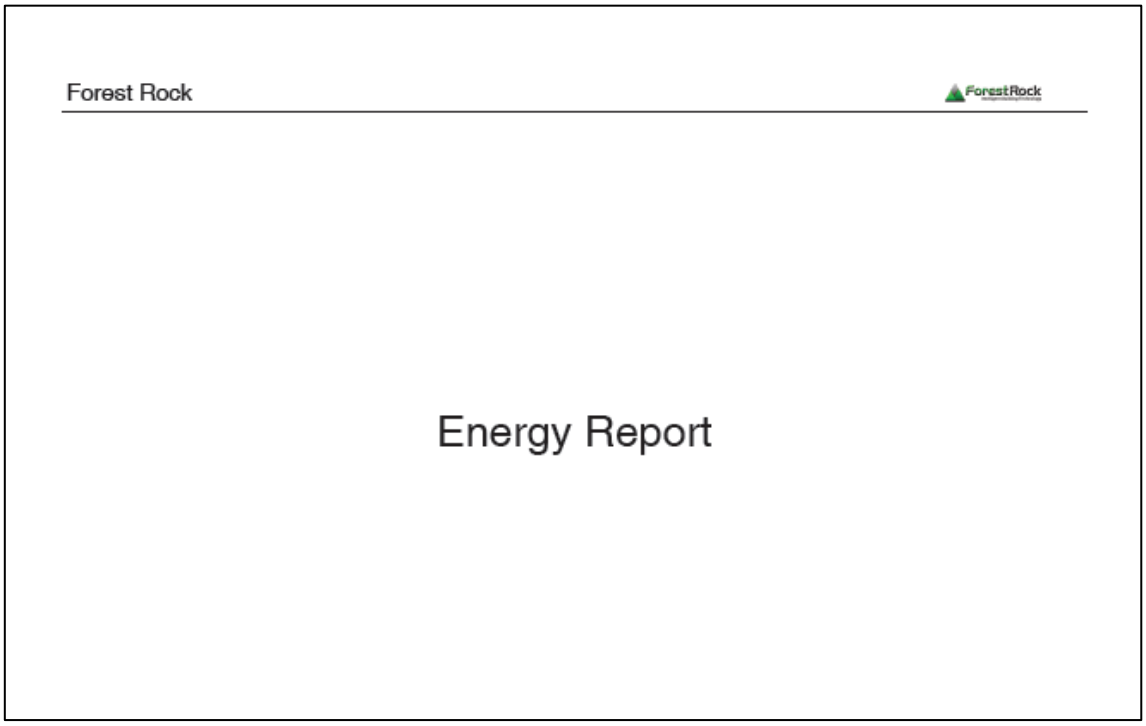


Figure 73 – Sample Report

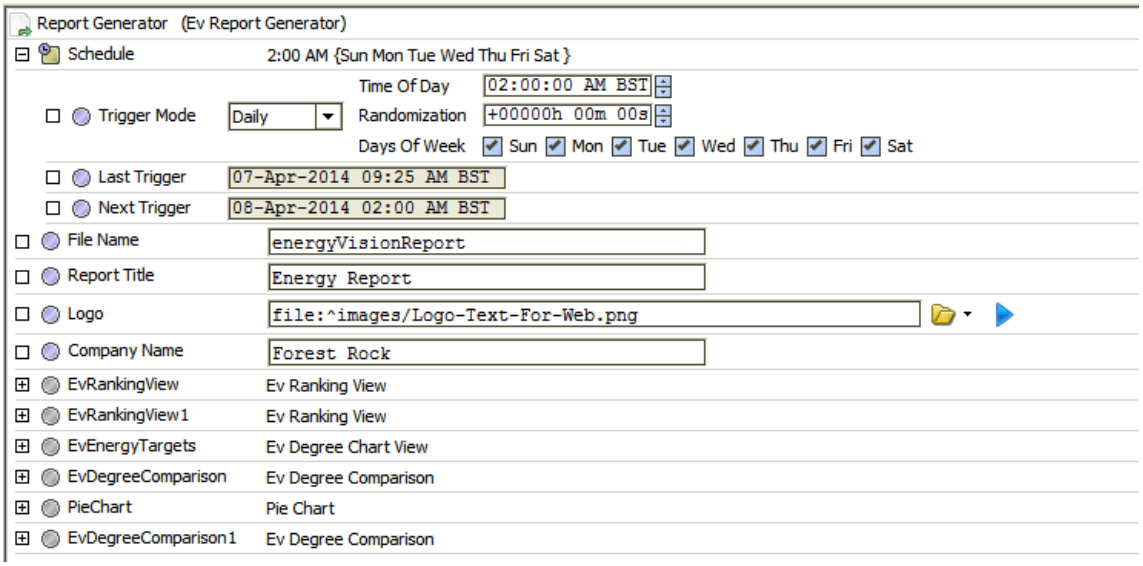


Figure 74 – Report Generator

- Configure the interval at which the report needs to be generated.
- File Name – file name for the generated report.
- Company Name – The company name to be displayed in the header.
- Report Tile – Title of the report.
- Logo – The company logo in to be displayed in the header.

5.16 ET Analysis

ET Analysis allows you to determine how the energy consumption of a site varies with temperature. For a given period, the kWh/m^2 of a site vs. temperature can be superimposed onto a graph showing the ideal consumption for the period. Please refer the figure 75 for the properties of the ET Analysis chart. The key user configurable properties are:

1. **defaultTimeRange**: This is the time range property which can be set/changed to show the default period of the chart when the chart is first loaded.
2. **etChartMode**: Mode property can be modified to view the Daily or Monthly values. Based on this property the ideal curve values will be taken from the "**idealCurveProperties**".
3. **idealCurveProperties**: This component will allow the user to set the ideal properties for the ET Analysis curve/profile. Ref fig for the properties where the user can specify the Start, End and 3 change values for temperature and consumption (daily and monthly), along with the tolerance band as a value of positive and negative percentage values. Based on the values set and the Chart mode, appropriate Ideal curve with the positive and negative percent curves will be plotted.
4. **xAxisOrd**: This property is usually set pointing to the Temperature history ORD.
5. **yAxisOrd**: This property is set pointing to the Energy Consumption ORD as per user's requirement.

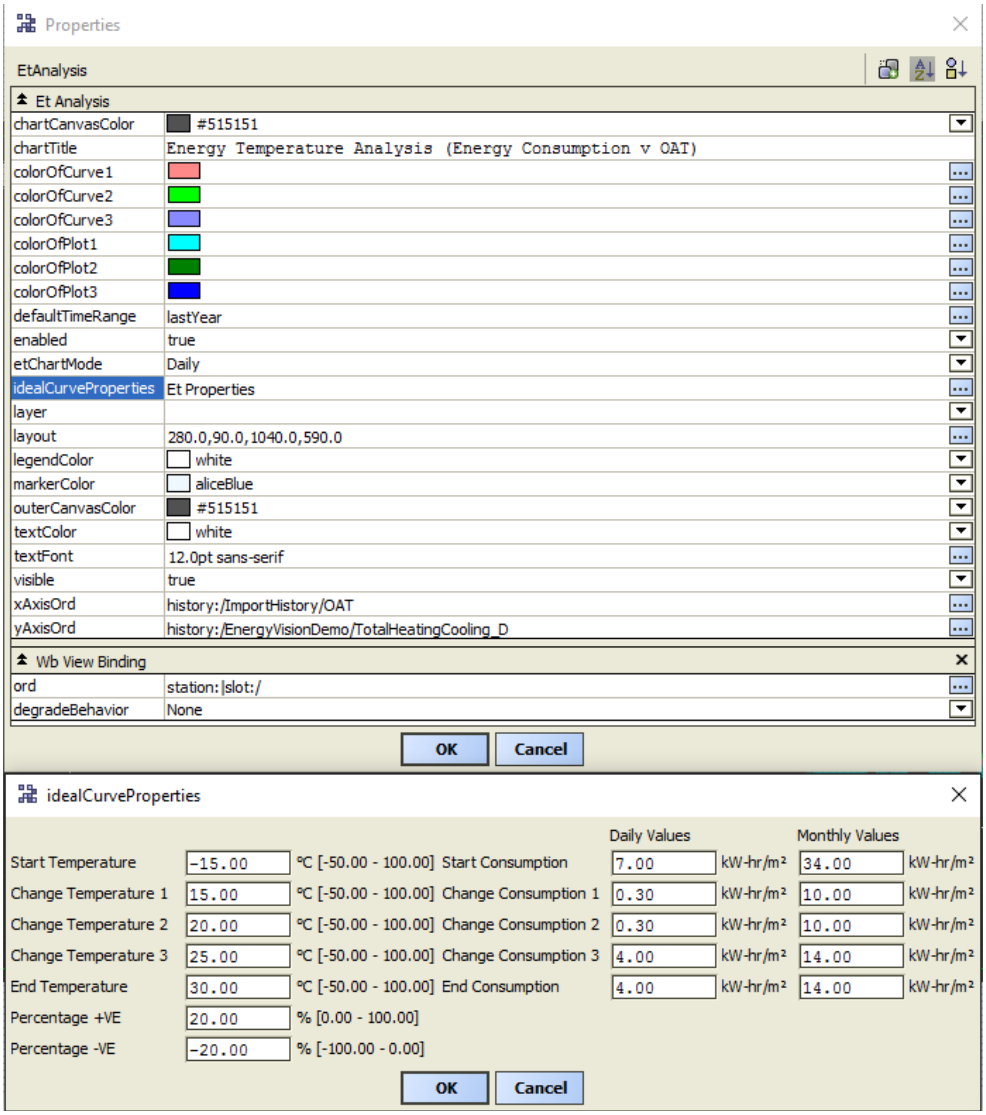


Figure 75 ET Analysis property sheet

Once the appropriate properties have been configured, the widget will load a chart as shown in figure 76. Hovering over the points will provide summary details of the hovered data points in a pop-up box. The time range for the chart can be temporarily change to view different time period from the drop down on the top of the chart and the chart will redraw accordingly.

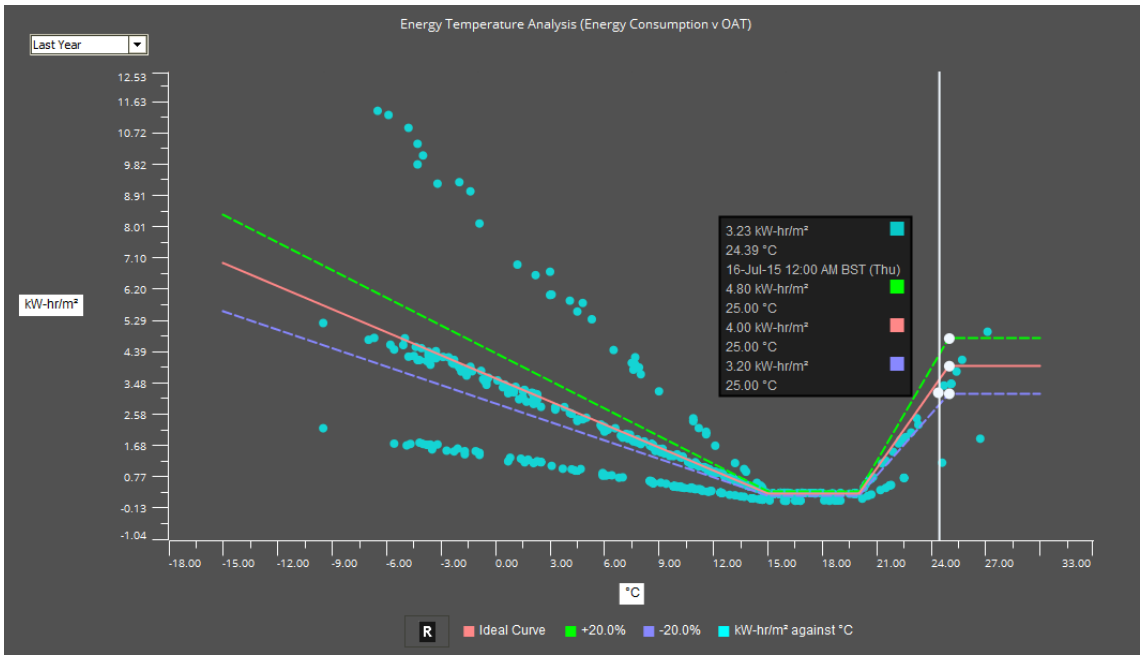


Figure 76 Energy Temperature Analysis

5.17 Example Pages

Home Page

Figure 77 - Example Home Page

Energy Ranking

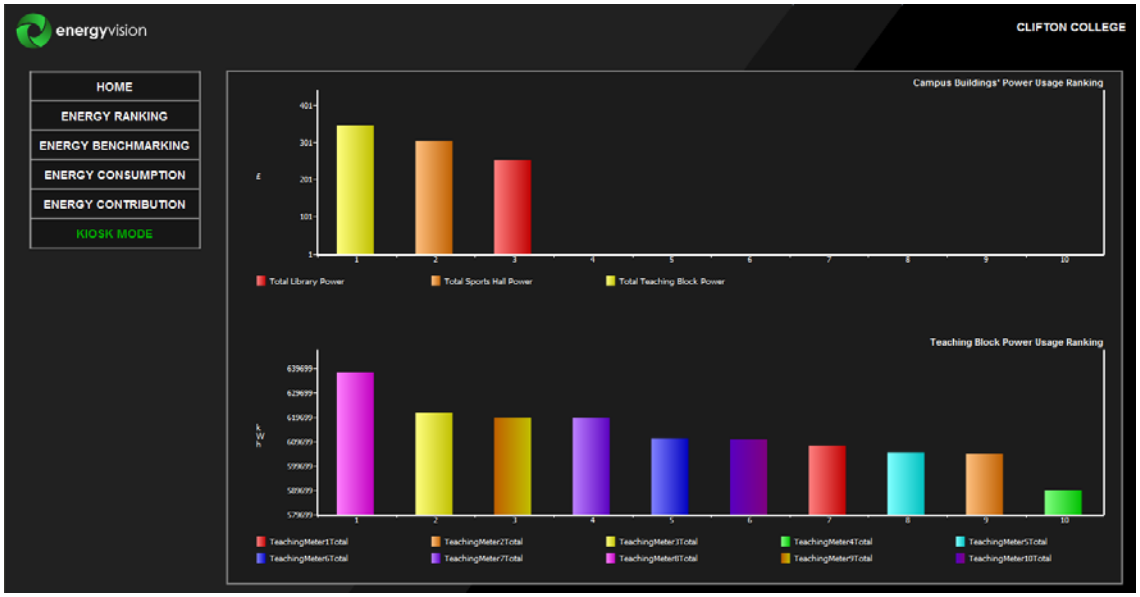


Figure 78 - Example Ranking Page

Energy Benchmarking

Figure 79 - Example Benchmarking Page

Energy Consumption

Figure 80 - Example Energy Consumption page showcasing various types of dials

Energy Contribution

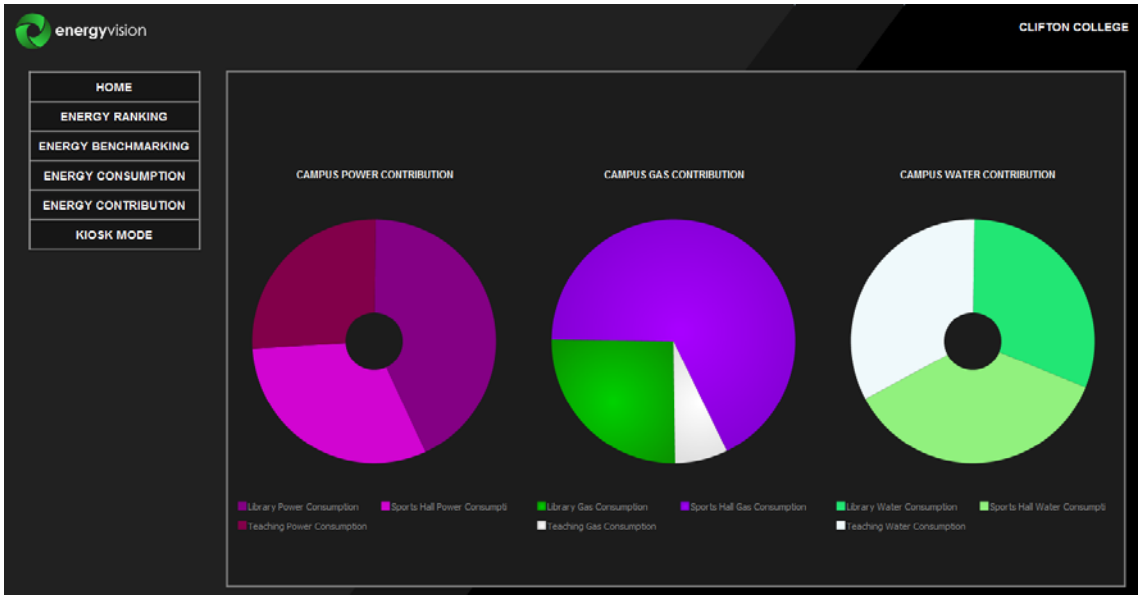


Figure 81 - Example Energy Contribution page using various types of Pie Charts

6. ENERGY VISION Demo Station

The ENERGY VISION Demo station includes a fully configured dashboard and energy benchmarking system, representing a school campus. The demo station includes randomly created history data for a collection of gas, water, and power meters, including meter aggregation components, ranking components, dials, charts, etc.

The ENERGY VISION Demo station has the following configured users:

Username: admin
Password: Claxadmin123
Rights: Super-user

Username: demo
Password: Claxdemo123
Rights: read only rights including the ability to access the web graphics, override/set points etc.

Username: guest_
Password: Claxguest123
Rights: read only rights including the ability to access the web graphics, override/set points etc.

7. Table of Figures

Manufactured for and on behalf of the Environmental and Combustion Controls Division of Honeywell Technologies Sàrl, Rolle, Z.A. La Pièce 16, Switzerland by its Authorized Representative:

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EN2Z-1012GE51 R0816