ERGON MANUAL - #01

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First issue of ERGON manual

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Abstract

The present document serves as a technical guide and a user manual for the IES cloud based tool called ERGON. This document is aimed at presenting all the basic features and systematic procedure for using ERGON. Wherever possible, illustrative examples will be provided that will aid new and experienced user alike in using the tool effectively and efficiently. The document will first explain the basic workflow associated with ERGON and will go through each step and sub steps associated with it and introduce the feature and components of the tool that is applicable for that particular step.

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1. Introduction

ERGON is the cloud-based tool developed by IES R&D that allows integration and transfer of operational data from a variety of sources through the creation of free form data (FFD), which can be imported into Apache-pro and used for simulations through VE. This allows user to do calibrated simulations and performance analysis of energy models with actual measured data, thereby reducing the performance gap between the design and reality. Creating standardized operational profiles from similar benchmarked buildings allow the user to create an "informed" model right from the beginning that will be closer to reality than the model created based on common design assumptions.

2. ERGON workflow

The basic function of ERGON is to take operational data and convert it into a format easily usable in VE. However, the whole process itself requires a number of interventions to allow smooth transition of data from one form to another. **Fig.1** below shows a basic workflow associated with ERGON.

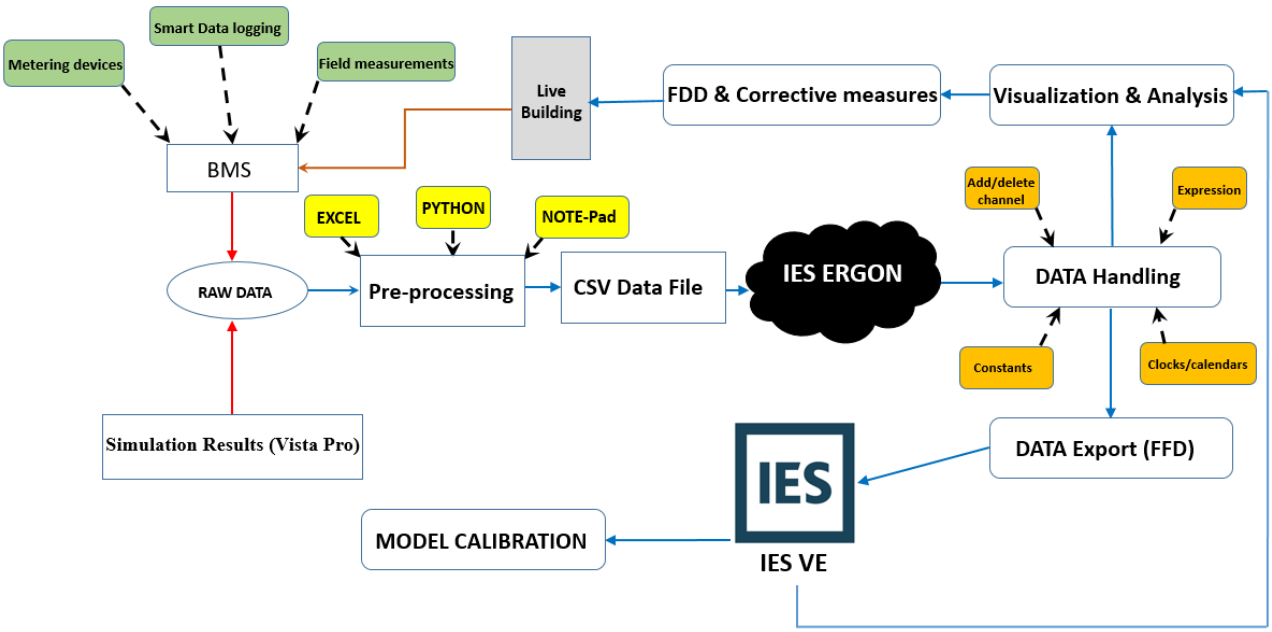


Fig.1 ERGON workflow

The proceeding sections will explain each of the constituent step and the associated feature in detail.

The constituent steps are listed below:

- Collection of Raw data
- Pre-processing of data and creation of csv files
- Setup of project details and importing data into ERGON
- Processing and handling of data in ERGON
- Export of free form data (FFD) from ERGON
- Creating free form profile from FFD data in Apache-Pro
- Data visualization and fault detection through ERGON

3. Collecting Raw data

Raw data can either be collected directly from BMS system or can be obtained from VE simulation output. In both cases, it will be in the form of time series table with a specific interval between two consecutive data points. In case of VE simulation, this will depend on the reporting interval that is specified before running the simulation. The basic frequency of data collection through some data logger can be as low as 1 min.

In order to synchronize the simulation calendar in VE with the operational year, the weekday for 1st Jan in that particular year should be specified under 'simulation calendar' tab (**Fig.2**). Please note that at present VE only performs simulation for 365 days a year (pre 2016 VE version). That means in order to incorporate the data for a leap year, additional manipulation, in form of interpolation (between 28th Feb and 1st March) or intelligent guess, should be done to fill up the data for 29th Feb manually.

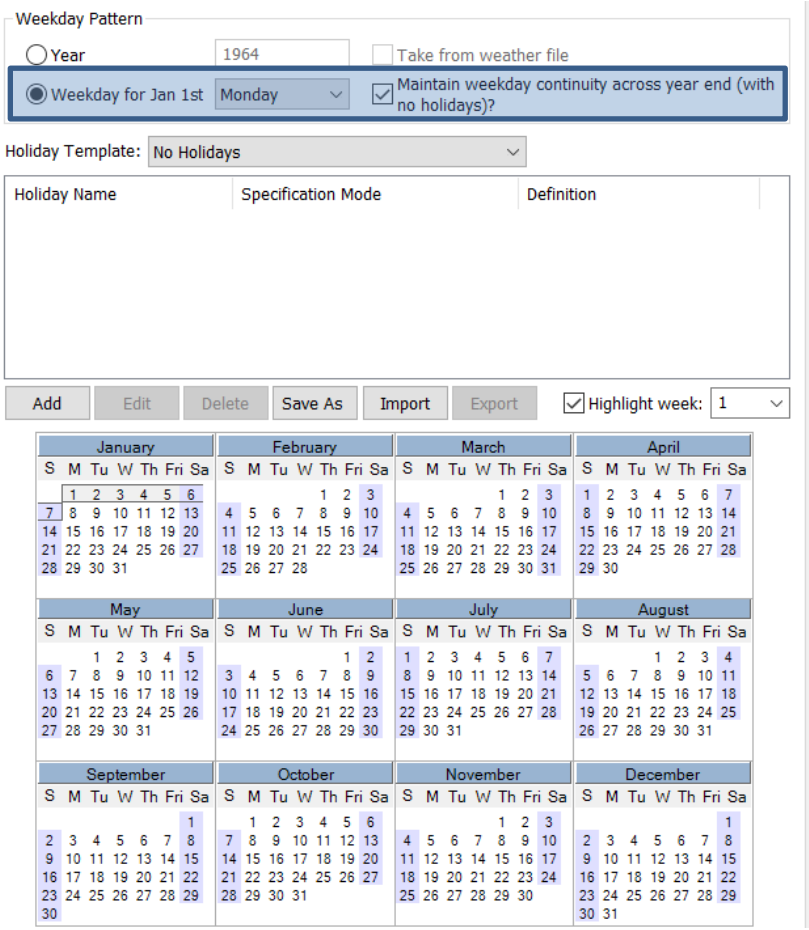
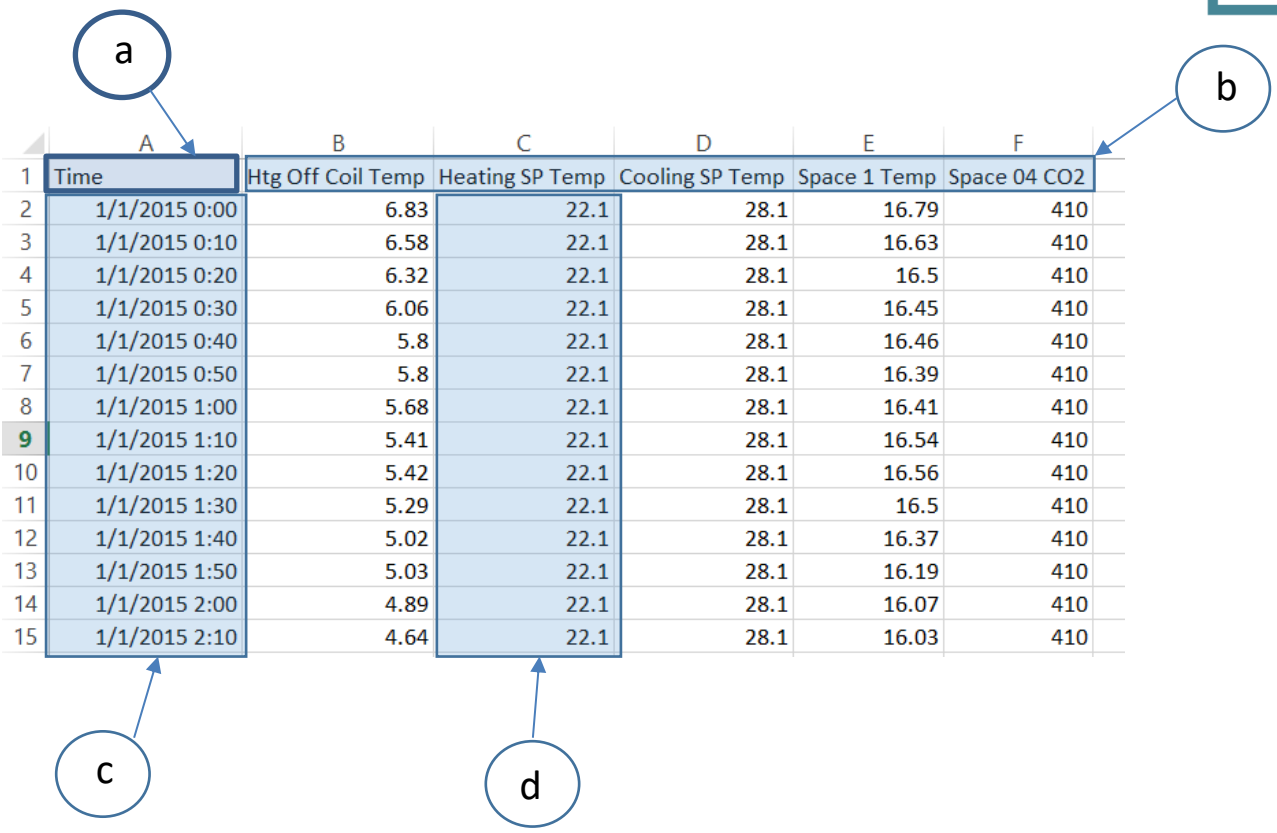


Fig.2 Synchronizing simulation calendar with operational year

A user can fill up the gap in measured data table with the ones obtained through simulations, provided, the data frequency is maintained throughout. Therefore, if the data logging system is measuring and noting the data at a 10 min interval through Jan-April and June-December, then in order to incorporate vista data for the month of May, the user must change the reporting interval of the simulation to 10 min.

4. Pre-processing raw data: CSV file creation

In order to export data into ERGON, a specific format should be followed. Raw data collected at the previous step should be arranged in a tabular format as shown in **Fig.3.**



	A	B	C	D	E	F
1	Time	Htg Off Coil Temp	Heating SP Temp	Cooling SP Temp	Space 1 Temp	Space 04 CO2
2	1/1/2015 0:00	6.83	22.1	28.1	16.79	410
3	1/1/2015 0:10	6.58	22.1	28.1	16.63	410
4	1/1/2015 0:20	6.32	22.1	28.1	16.5	410
5	1/1/2015 0:30	6.06	22.1	28.1	16.45	410
6	1/1/2015 0:40	5.8	22.1	28.1	16.46	410
7	1/1/2015 0:50	5.8	22.1	28.1	16.39	410
8	1/1/2015 1:00	5.68	22.1	28.1	16.41	410
9	1/1/2015 1:10	5.41	22.1	28.1	16.54	410
10	1/1/2015 1:20	5.42	22.1	28.1	16.56	410
11	1/1/2015 1:30	5.29	22.1	28.1	16.5	410
12	1/1/2015 1:40	5.02	22.1	28.1	16.37	410
13	1/1/2015 1:50	5.03	22.1	28.1	16.19	410
14	1/1/2015 2:00	4.89	22.1	28.1	16.07	410
15	1/1/2015 2:10	4.64	22.1	28.1	16.03	410

Fig.3 Data arrangement

The data labels are explained below:

a → The timestamp tag. Under this column, particular time period is noted at which the measurement is taken.

b→ The channel tags. Under these columns, measured (or simulated) values corresponding to a particular time period is noted.

c→ Displays the time period of measurement. Specific formats for timestamp values needed to be followed for creating csv file.

d→ These are the measured (or simulated) values under a particular channel.

The raw data can be arranged into this format by many tools like Python, Notepad, Excel, etc. However, it is much easier to do in Excel due to its inherent matrix format for data input. In the proceeding section, the formats applicable for data arrangement and the appropriate steps required are explained in detail.

4.1 Timestamp formats

An applicable timestamp format can be defined in excel. **Fig.4** shows the format applicable for time stamp in excel.

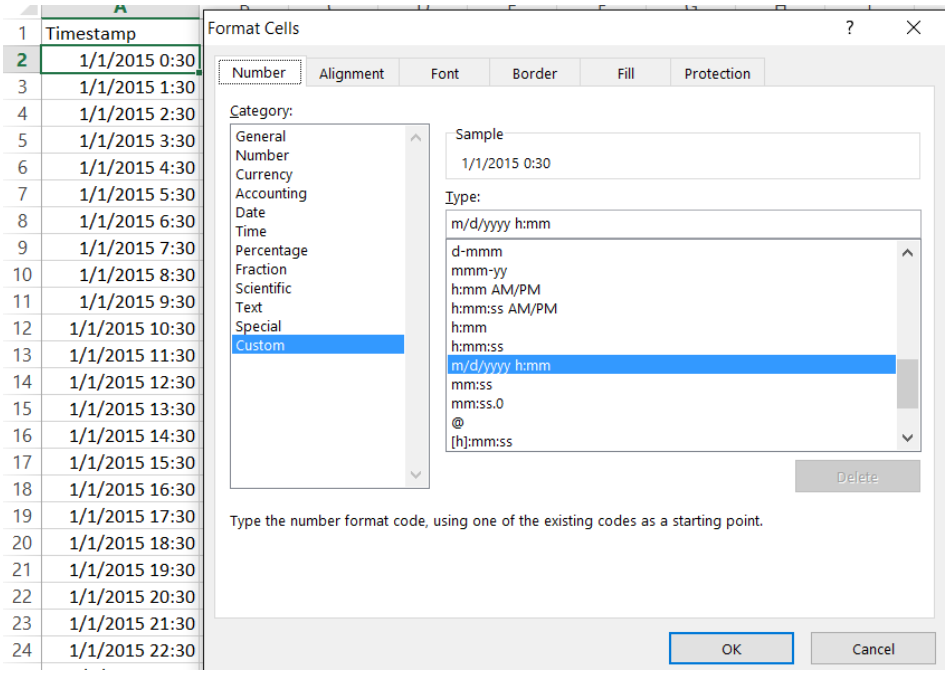


Fig.4 Format for timestamp values.

Depending on the frequency of measured or simulated data, the subsequent time stamp values can be derived in excel using insert function feature, if the first value is entered as per the format shown in **Fig.4.** The generalized equation for defining the timestamp is given by:

$$Timestamp\ value = Previous\ timestamp\ value + \frac{a}{(24 * 60)}$$

where,

$$a = Frequency\ of\ measurement\ or\ reporting\ inetrval\ of\ simulation\ (in\ minutes)$$

Another applicable format for defining timestamp values is the ISO 8601 format, which is shown in **Fig.5** below:

	Time step	Wind speed (m/s)	Expected wind turbine output (kW)	VPP Wind turbine output result (kW)
2	2015-01-01T00:00Z	1	0	0
3	2015-01-01T01:00Z	1	0	0
4	2015-01-01T02:00Z	1	0	0

Fig.5 ISO 8601 timestamp format for UTC.

The tabular output from vista-pro for a simulation can be copied in an excel sheet and arranged in the format shown in **Fig.4 or 5**. The custom format for timestamp as shown in **Fig.4** can be converted into ISO format using a function in excel as shown in **Fig.6**

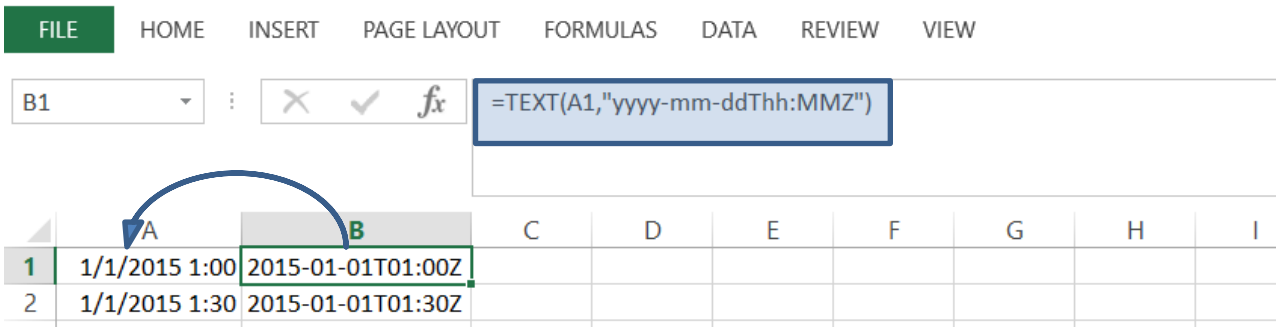


Fig.6 Custom timestamp format to ISO 8601 format conversion.

4.2 Data format for ERGON import

The excel or the text file with the data arranged in appropriate formats can be imported to ERGON. The excel file should be first saved as a .csv file. Data can be imported into ERGON with files that are either in .txt or .csv formats.

5. Project setup and data import in ERGON

After preprocessing data, the measured data can now be imported into ERGON for further processing and creating free form data (FFD) to be exported back into VE.

5.1 Project and building setup

First, the user need to register on IES website and create an account with ERGON. Further details are available on IES VE website or at ERGON website: *https://ergon.iesve.com.*After creating an account, the user can directly log on to the ERGON website by user the same user name and password that has been used for registering on IES-VE website. **Fig.7** is the project setup window that appears first after logging to ERGON.

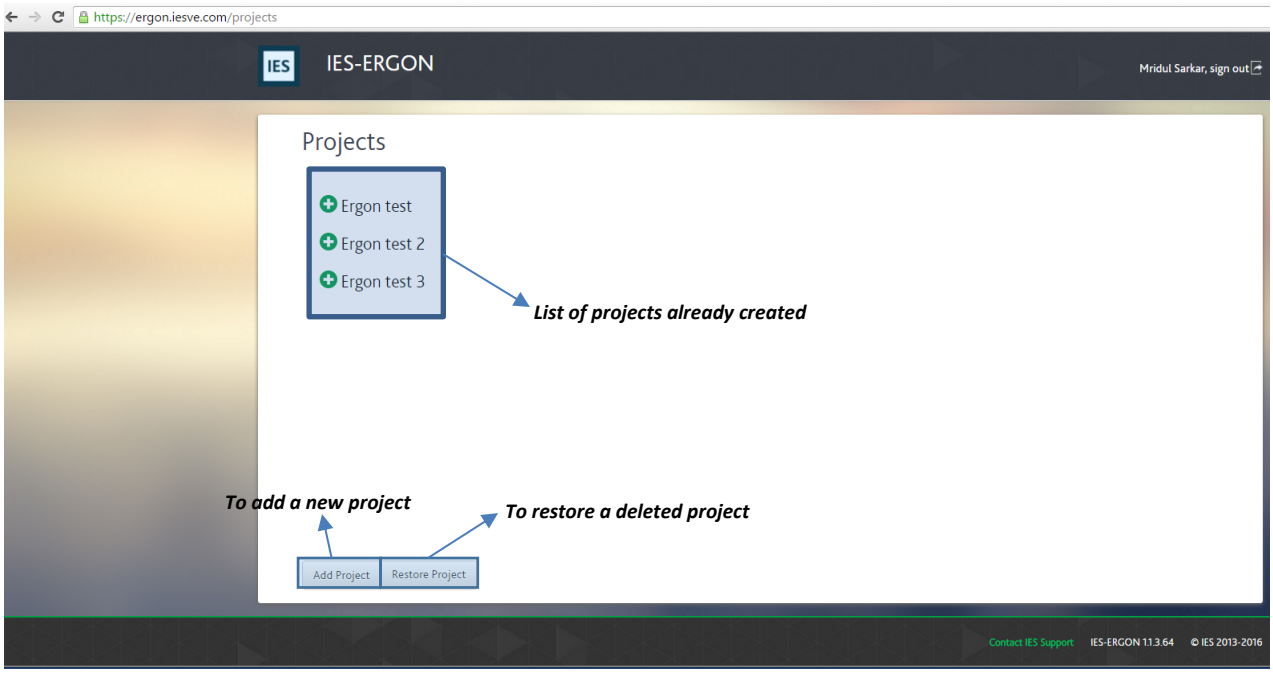


Fig.7 Project setup window.

On clicking "Add Project" tab and giving a name will add it in the project list displayed above. On selecting the new project name from the list, all the buildings under that project will be shown. A new building can be added under a project by clicking the "Add Building" tab. **Fig.8** below shows the procedure to add a building under a project.

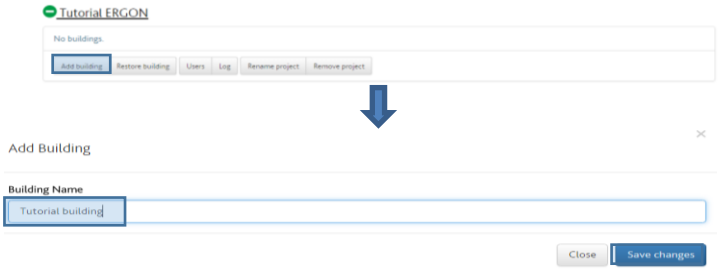


Fig.8 Adding building under a project.

"Remove project" will remove the particular project from the list. A particular deleted building can be restored back under a project by "Restore building" tab.

Fig.9 shows the building setup window that appears after adding a new building under a project. In the building set up window shown above, the user needs to specify the parameters as shown. The "Sample period" defines the data frequency in which ERGON process the data and create FFD. If the data frequency of the imported csv file is different from the sample period defined in building setup, ERGON will interpolate the data to fit it into the new time step. The units can be set to either Metric or Imperial. On hovering over the query symbol besides each parameter will display what that parameter implies.

Note: Allowing interpolation by ERGON in case of different sample period than measured data frequency is only applicable for entities that are process dependent only (e.g. loads, flows or temperatures) and are measured discreetly. On the other hand, entities like measured energy or total volume collected, which also depends on the time period in which the measurement is taken should not be interpolated using this method. In that case, the user is advised to set up the sample period to match the csv data frequency or adjust the data in csv file to match the predefined sample period by first interpolating the process variables (like load or volume flow rate) and multiplying it with the data frequency period.

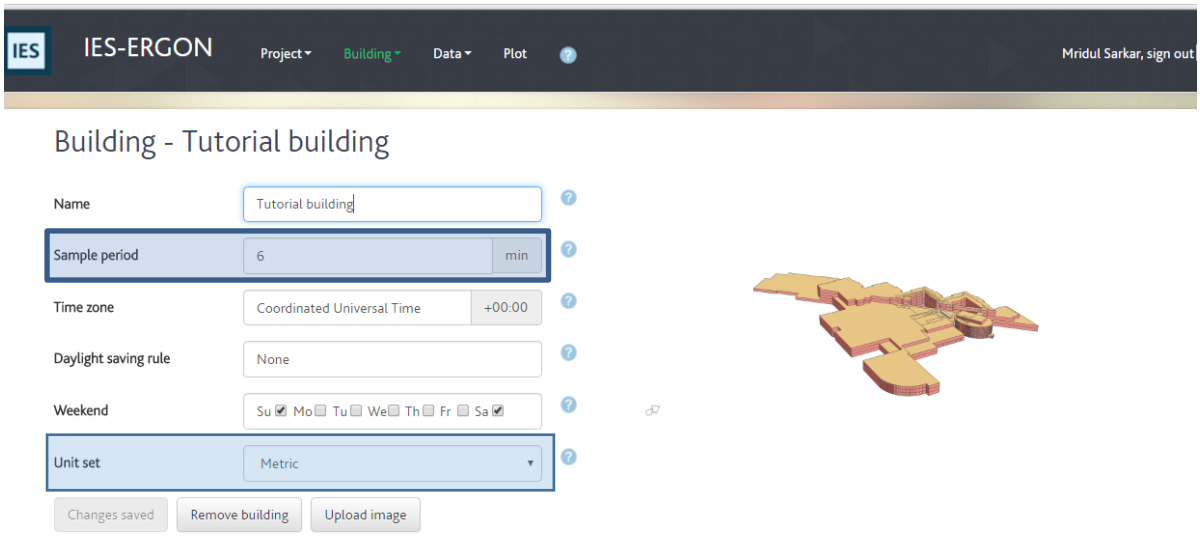


Fig.9 Building setup under a project.

User can remove the building by "Remove building" tab and add a customized image of the building by "Upload image" tab. User can access additional information and proceed further or go back to project setup window by clicking on the appropriate tabs that appear just above the building setup window (**Fig.10**).

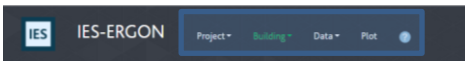


Fig.10 Access options for a building.

5.2 Importing data into ERGON

After setting up and entering the building parameters, the next step is to import the data from csv or txt file into ERGON. Under the "Data" tab shown above in access options for building, click the "Import" option. This will direct to a new window as shown in **Fig.11**.

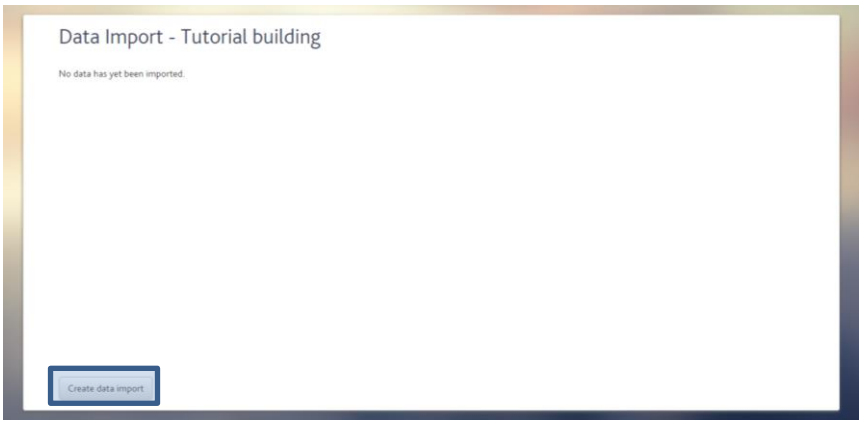


Fig.11 Data import window.

Clicking on "Create data import" will direct to a new window that prompt the user to choose the type of format, the reference name for the data file and the data file to be imported. See **Fig.12** below.

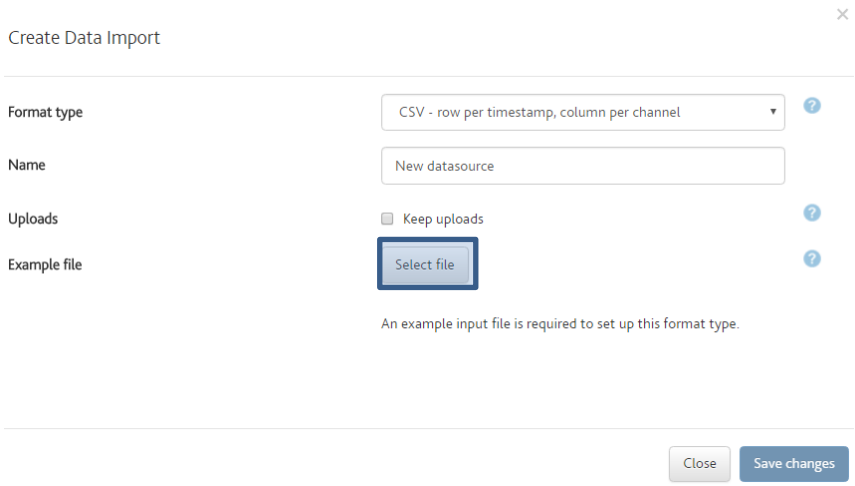


Fig.12 Data file import prompt.

The 'CSV-row per timestamp, column per channel' is the most common data format type. It is the best choice, when there are more than one channel to be imported and processed. ERGON website can hold onto the raw data file for a total of six weeks before it is removed from the database. However, ERGON will hold onto the imported data.

Now one need to select the data file and save the changes to exit from this window and to proceed further. This will lead to the Format mapping window as shown in **Fig.13**, where the quality check of the raw data and final import of data into ERGON is completed.

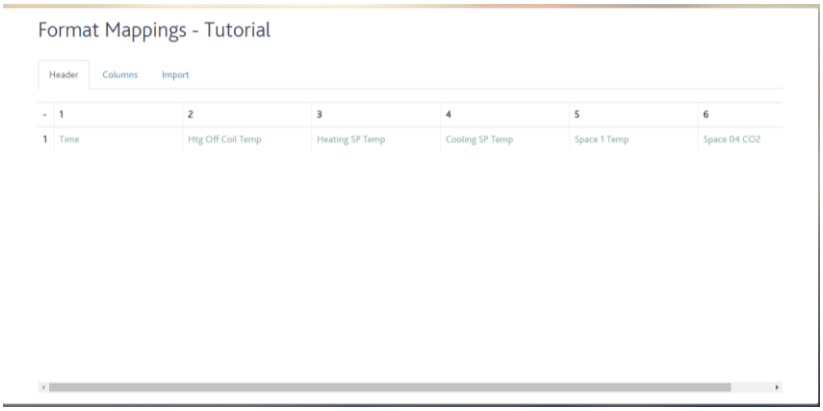
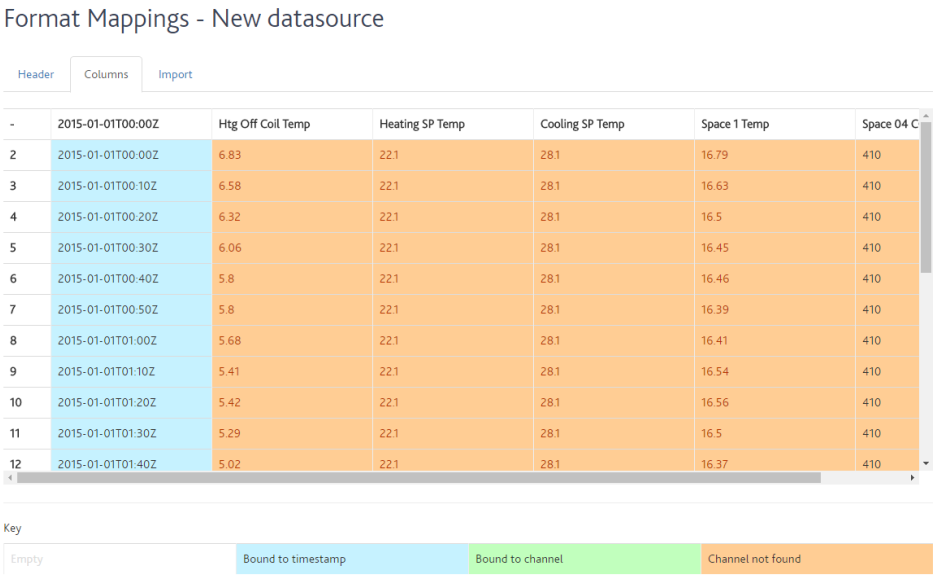


Fig.13 Format mapping window.

The 'Header' tab shows the first row of the csv file, which is usually the time stamp and channel tags. On clicking the Columns tab, the user will be able to view the data as it appears in the raw data file. See **Fig.14** below:



-	2015-01-01T00:00Z	Htg Off Coil Temp	Heating SP Temp	Cooling SP Temp	Space 1 Temp	Space 04 C
2	2015-01-01T00:00Z	6.83	22.1	28.1	16.79	410
3	2015-01-01T00:10Z	6.58	22.1	28.1	16.63	410
4	2015-01-01T00:20Z	6.32	22.1	28.1	16.5	410
5	2015-01-01T00:30Z	6.06	22.1	28.1	16.45	410
6	2015-01-01T00:40Z	5.8	22.1	28.1	16.46	410
7	2015-01-01T00:50Z	5.8	22.1	28.1	16.39	410
8	2015-01-01T01:00Z	5.68	22.1	28.1	16.41	410
9	2015-01-01T01:10Z	5.41	22.1	28.1	16.54	410
10	2015-01-01T01:20Z	5.42	22.1	28.1	16.56	410
11	2015-01-01T01:30Z	5.29	22.1	28.1	16.5	410
12	2015-01-01T01:40Z	5.02	22.1	28.1	16.37	410

Fig.14 Data display window.

The color codes for the cells displayed above can be inferred under “key” just below the displayed data. By default, the cells with timestamp values are already filled with cyan color showing it is “Bound to timestamp”. ERGON can recognize the timestamp format and bind it with the timestamp channel readily. If that is not the case, user may experience import error on proceeding further. This occurs due to minute formatting errors usually very difficult to spot in excel. Hence, it is advised that user should convert the format of the timestamp from custom to ISO format. In most of the cases, it solves the problem.

The values under a channel are covered in orange color showing “channel are not found” status. One must first bind the values to the particular channel before proceeding further. This can be done by clicking on the on a cell and binding it with the appropriate created channel before saving the changes. **Fig.15** below shows the pictorial depiction of this process. A value under a channel can be float or integer. By default, ERGON will recognize the type. User can navigate to the next column using the forward and backward buttons provided at the top of the data column window and repeat the process of binding the values in other columns with the appropriate channels. This is done until all the cells with channel values are turned to green color showing “Bound to channel” status.

After binding all the values to the corresponding channels, the data can now be formally incorporated into ERGON by the “Import” tab. The import tab will display a new window with an Import button displayed in green (**Fig.16**). This step is an important one that will finally import all the converted raw data into ERGON. Without this, the data can neither be accessed further in ERGON nor be converted into FFD. On clicking the “Import” button, ERGON will display the import log. If there are any inconsistencies in the quality of raw data format, ERGON will display an “Import Failed” action status. User can just click on the error status box to see the details of the import error and need to repeat the import process by checking the sanity of raw data again. On successful import, ERGON will display the credits used for the import of raw data at the top of import log window (**Fig.16**). To check the setting of the current import or to add another data file user can click the tabs that appear at the bottom of import log window.

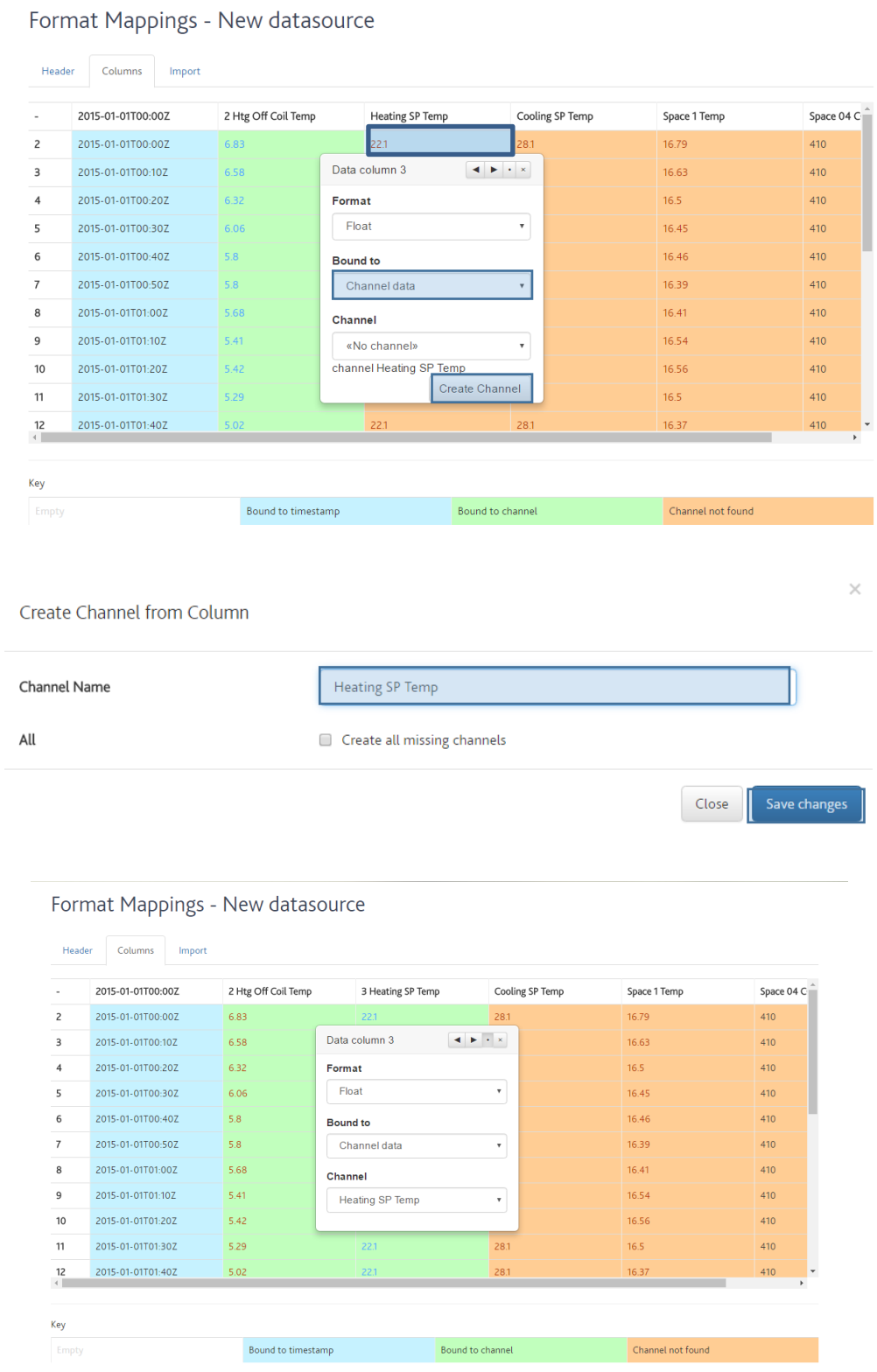


Fig.15 Binding data value to channel.

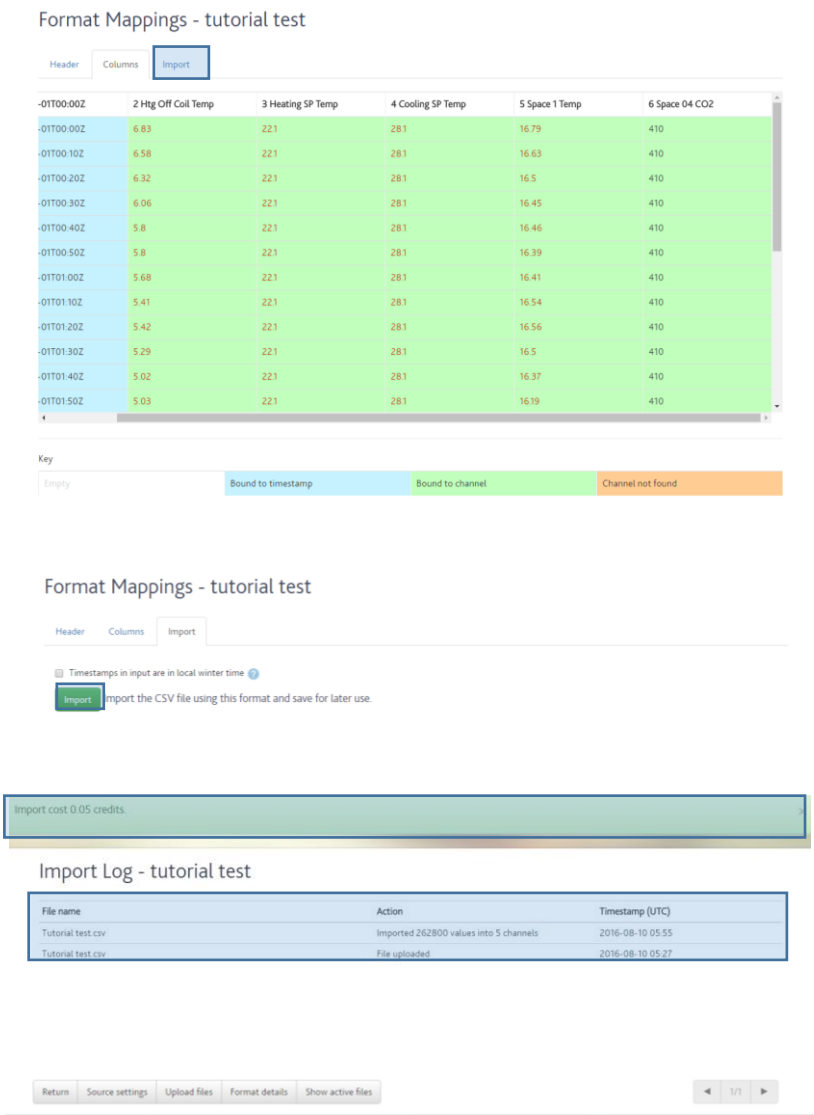


Fig.16 Import log window.

5.3 Adding new channels or missing data in a channel

User may add additional channels even after importing. In the raw data file, user need to add additional columns with new channels and the corresponding values. The modified data file is then saved as a new csv file. On creating a new import point for the same building and importing this csv file, ERGON will recognize all the new channels and add it with the group of channels imported earlier. In the earlier example, 5 channels with measured values are imported into ERGON. If user wants to add a new channel (let's say with name RH) to this list, first a new column with corresponding values

and RH name label needed to be added in the old excel file and saved as a new csv file. Now by repeating the steps shown in **Fig.11** and **12**, user will now find a new channel being added with the ones that has already been bound and imported earlier. This is shown in **Fig.17**.

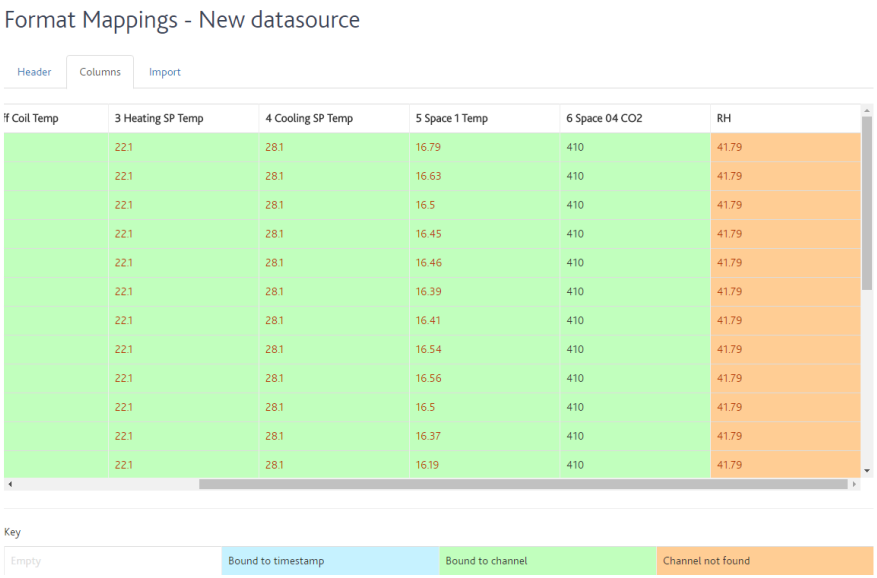
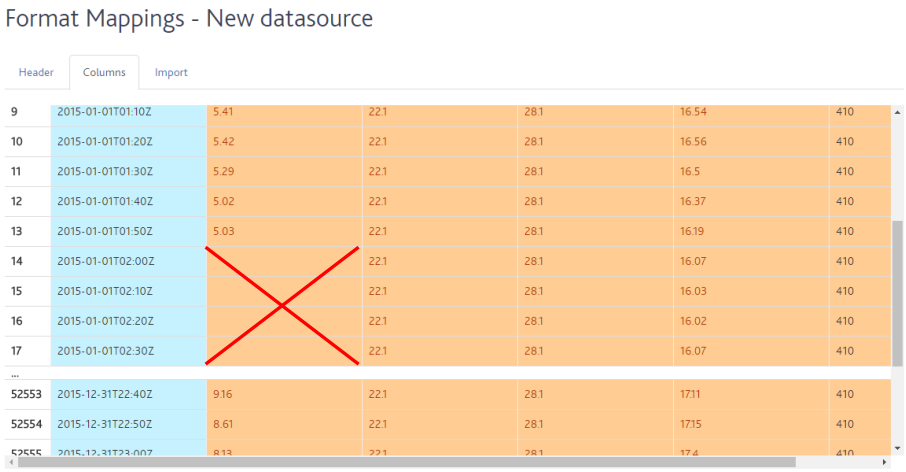


Fig.17 Adding new channel.

Repeating the process described in fig. 15 and 16 will allow the new channel to be imported and ERGON can now access 6 channels and the corresponding data. Another way is by creating a csv file with only the new channel data along with channel label, timestamp label and timestamp values and importing it. ERGON will collate the data along with the ones already being imported.

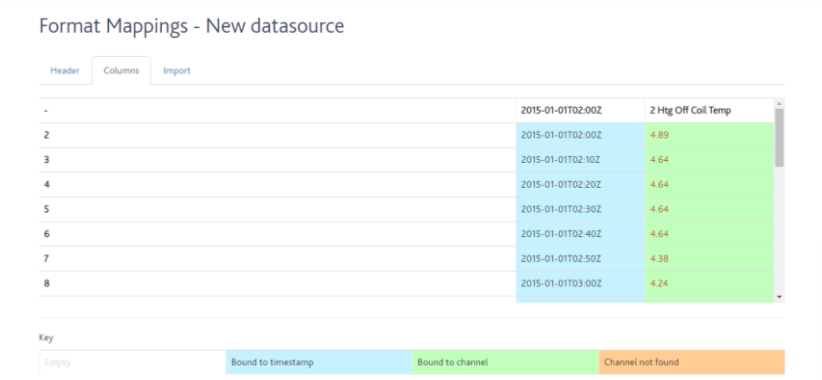
Adding missing data in a channel works in a similar way as adding new channels. Consider the previous example, where data for the channel named "Htg. Off Coil Temp." during the time period 1/1/2015 02:00 to 1/1/2015 04:00 is not available. After importing the csv file with the missing data, the display window will be as per **Fig.18**. Repeating the data import process as per previous section will result in all the raw data being imported into ERGON except for the channel "Htg. Off Coil Temp" between the mentioned time period. Later the missing data corresponding to the time for this channel is available and the user wants to incorporate that into the project. For this, one must prepare a new csv file and import it again into ERGON with only the missing timestamp, channel label and the

corresponding remaining data. This time ERGON will show only the missing data, but it will already be bound with the channel (see **Fig.19**). Proceeding further, the missing data will be automatically placed into the corresponding slots, thereby completing the set. The important thing to remember here is the order in which the csv files are uploaded, consistency of channel tags and maintaining the timestamp width between two consecutive rows. Importing a csv file with deleted rows corresponding to missing data will result in an error.



9	2015-01-01T01:10Z	5.41	22.1	28.1	16.54	410
10	2015-01-01T01:20Z	5.42	22.1	28.1	16.56	410
11	2015-01-01T01:30Z	5.29	22.1	28.1	16.5	410
12	2015-01-01T01:40Z	5.02	22.1	28.1	16.37	410
13	2015-01-01T01:50Z	5.03	22.1	28.1	16.19	410
14	2015-01-01T02:00Z		22.1	28.1	16.07	410
15	2015-01-01T02:10Z		22.1	28.1	16.03	410
16	2015-01-01T02:20Z		22.1	28.1	16.02	410
17	2015-01-01T02:30Z		22.1	28.1	16.07	410
...						
52553	2015-12-31T22:40Z	9.16	22.1	28.1	17.11	410
52554	2015-12-31T22:50Z	8.61	22.1	28.1	17.15	410
52555	2015-12-31T23:00Z	8.13	22.1	28.1	17.4	410

Fig.18 Channel display with missing data.



-	2015-01-01T02:00Z	2 Htg Off Coil Temp
2	2015-01-01T02:00Z	4.89
3	2015-01-01T02:10Z	4.64
4	2015-01-01T02:20Z	4.64
5	2015-01-01T02:30Z	4.64
6	2015-01-01T02:40Z	4.64
7	2015-01-01T02:50Z	4.38
8	2015-01-01T03:00Z	4.24

Fig.19 Missing data.

6. Data handling in ERGON

Importing data from csv file allows ERGON to read the data. The next step in ERGON is to define the units, type of data and further process it before exporting as free form data (FFD). The proceeding section will explain the whole data handling process through different subtopics to show the data processing capabilities of ERGON.

6.1 Channel specification

Clicking on the "channels" button listed under "Data" tab will open a new window as shown in **Fig.20**, which displays all the imported channels on the left side of window. These channels are listed only when the import is successful.

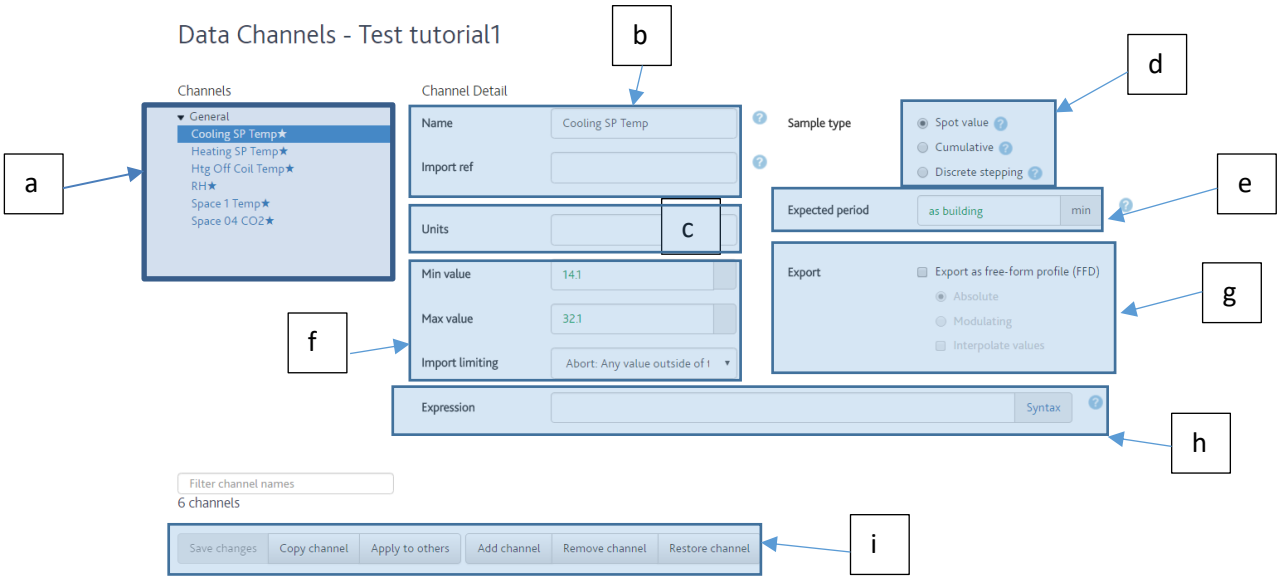


Fig.20 Channel specification window.

a. This is the list of the channels that are successfully imported into ERGON. The small star icon appearing on the right side of the channel name implies that the unit of this particular channel has not yet been defined.

b. These two tabs are useful for identification of the channel. "Name" implies the channel label that has been used in the csv file for importing data. By default after the data import, the name

of the channel used in data file will appear in this box. If the name appearing in the data file is not the actual name of the channel intended, then the user can provide a new name in "Import ref" box to identify the channel. However, this is optional and user may skip this step.

c. User can provide the units for the particular data set. For exporting modulating profiles, user can put "Number" as a unit. For absolute profiles, user need to put the appropriate unit for the channel (e.g. Load kW, Temperature ^{o}C etc.).

d. This defines the type of data. "Spot value" is the most common type of data sample that is used for creating variation profiles used for calibration. "Cumulative" sample types are used when the measured data at any time period depends on the data from the previous sample period. "Discrete stepping" is used for continuous recording of data rather than a historical data sampling.

e. This defines the sampling period of the data that is to be exported. By default, it will be set to "as building". User may put a different sampling period for particular channel if required. This can also be used to test whether there are any missing data points for a particular channel.

f. The max and min value of the data set appears by default in green color. User can define particular range of the data to be exported and specify the "Import limiting" condition to restrict the data in that channel as per the specified max and min values.

g. User must check the box "Export as Free Form Data" to export the data from ERGON. Data exported can be absolute or modulating type. If a different sampling period than the actual data frequency of the imported data for that channel has been selected, user must check the "Interpolating values" box too for exporting.

h. "Expression" works in a similar way as 'insert function' in excel. User can define new channels whose data at each time step depends directly on the corresponding data values of other channels. More details of the "Expression" capability can be viewed by clicking on the "Syntax" box. Few examples showing the working of this feature will be shown in the proceeding sections.

i. User can copy, create, delete and restore any deleted channel by clicking on the appropriate tabs provided at the bottom of "Data Channels" window.

User needs to specify the details for the channel wherever required in order to export data as FFD for that particular channel. **Fig.21** shows the specification of a particular channel that is ready for VE export.

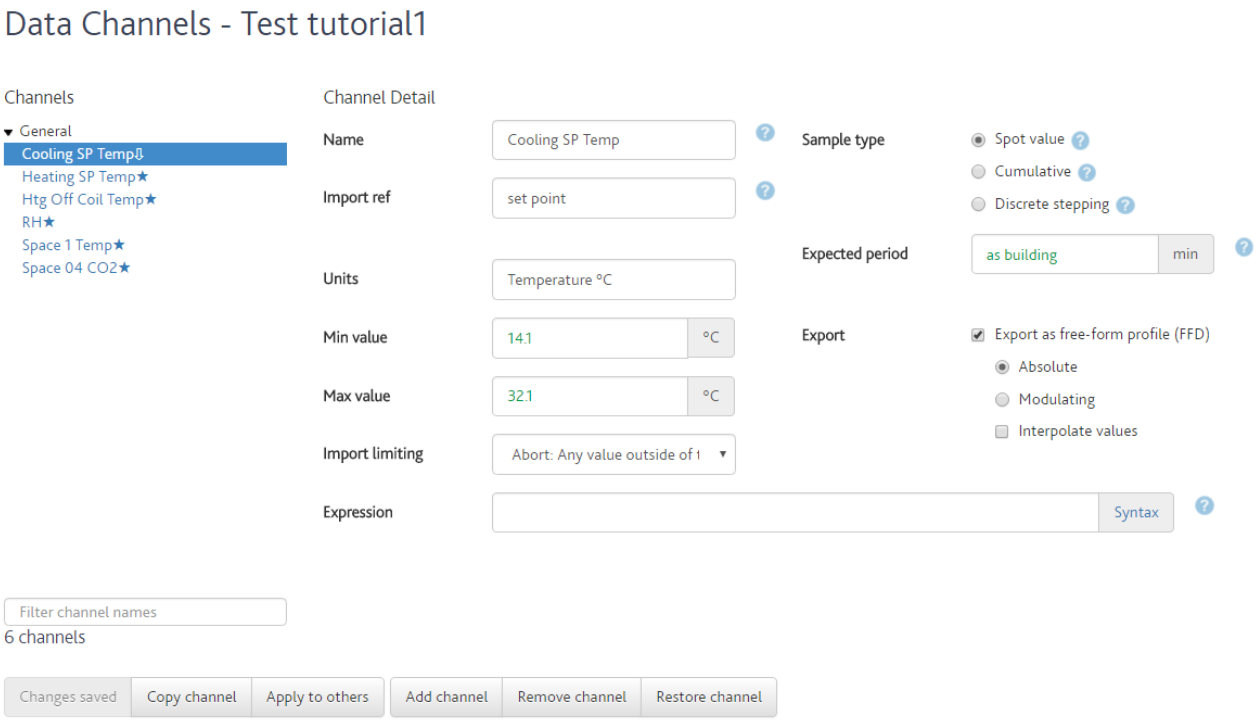


Fig.21 Full channel specification for VE export.

6.2 Data table and overview feature

"Data table" option under the "Data" tab displays the tabular data of imported channels at a particular date that can be selected by the calendar tab at the right side of data table window. The table has two columns for the data display of a particular channel: one shows the measured values (displayed by label "M") and other shows the interpolated values (displayed by label "I"). If the building sampling time is set equal to the data frequency of the raw data, this table displays the same value under both the

columns. However, on setting the two different sampling periods, interpolated values are calculated by ERGON and displayed under the second column. **Fig.22** shows the data table display with building sampling time set to 10 min, 5 min and 30 min with raw data frequency maintained at 10 min.

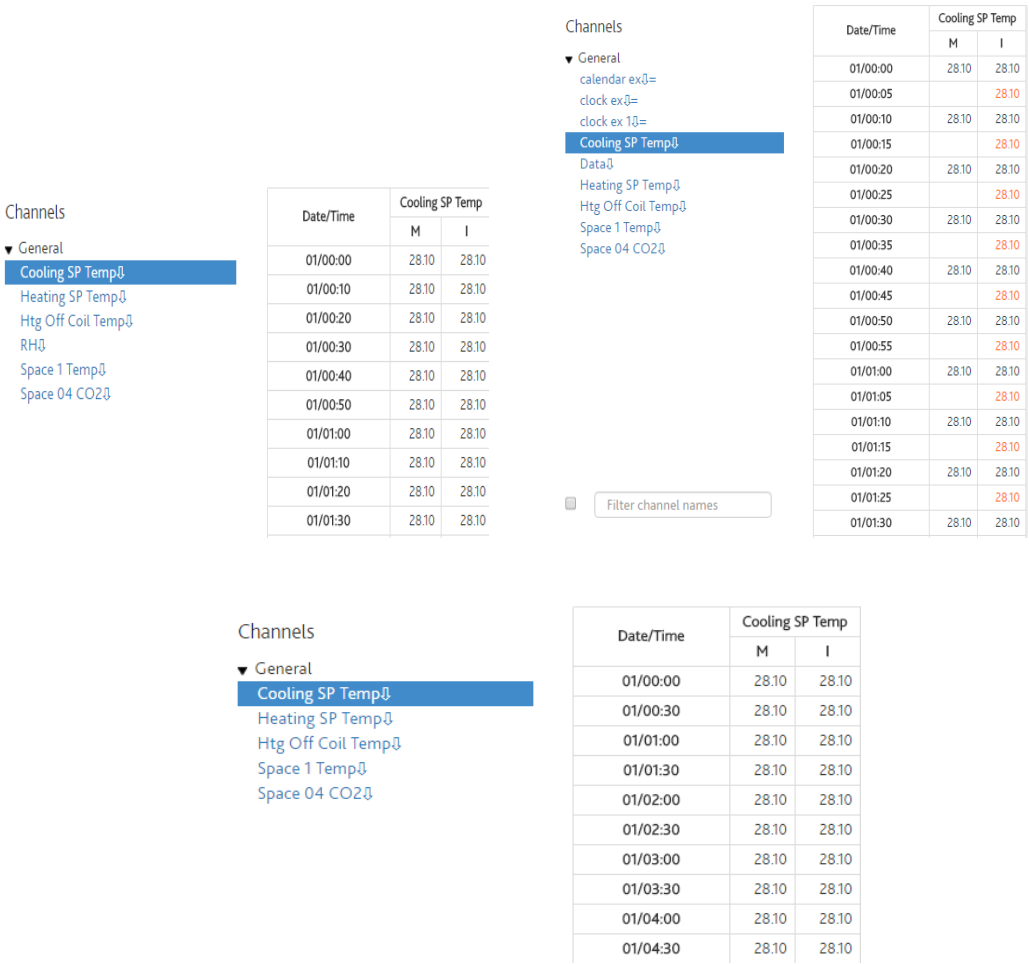


Fig.22 Data table display of the imported data.

The "Overview" option under the "Data" tab displays the data completeness checks for each month as per the imported raw data. ERGON performs the completeness checks and displays the status of the data for each month on selecting the "Overview" option under the "Data" tab. **Fig.23** shows the "Data overview" window displayed after importing raw data into ERGON.

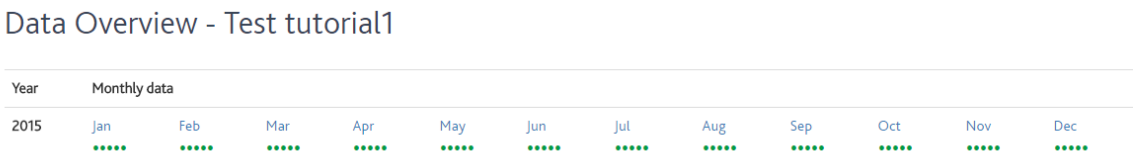


Fig.23 Data overview window.

The number of dots and its color under the displayed month implies whether all the channel data are available for that month and whether there are any missing data in any of the channels. If a full channel itself is missing for the whole month, the number of dots will be less. ERGON will display orange color dots when the imported channels have partial data or missing data for few time steps. Even though ERGON interpolates the data when building sampling period is set lower than the data frequency in csv file, it would still display orange dots implying that partial data being imported from the source file. **Fig.23** shown above implies that all the data are available in the channels for every month in the year 2015. Clicking on any month will redirect the user to Data table display window.

6.3 Using Expression feature

Expression feature in ERGON will allow user to customize or create new channel data using simple mathematical and logical operators. For example in Fig.24, a new channel called “Total elec load” is created which is the combination of 8 other channels imported into ERGON through a csv file. In the “Expression” box, the data from all the other channels are added. The “=” sign appearing at the right hand side of “Total elec load” label implies that expression has been used to derive this particular channel. Details on the type of operations and rules can be inferred by clicking on “syntax” box shown at the right hand side of expression box.

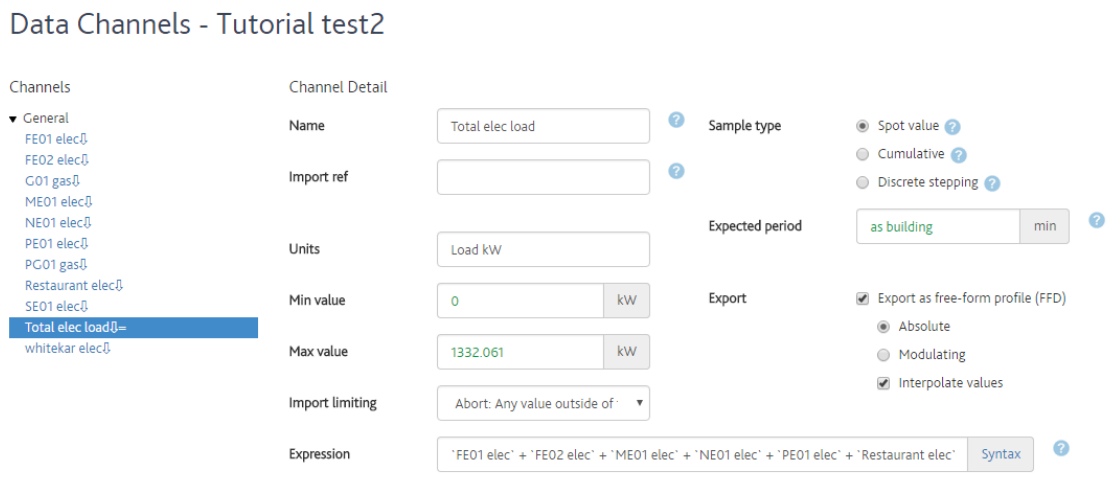


Fig.24 Using expression feature.

One simple rule should be followed while using the expression feature: If the name of a channel contains characters other than letters A to Z, a to z, digits 0 to 9 and underscore _, then the name should be enclosed in back-quotes `. Hence, the name of the channel can be entered as it is into the expression box if it contains only one word or multiple words with underscore symbol between them. In the above example, channels have names such as FE01 elec, FE02 elec, ME01 elec etc. They are multiple words separated by space. Therefore, by rule they should be enclosed with the back-quote symbol and entered into the expression box.

6.4 Using constants, clocks and calendar feature

The rules for using the constants, clocks and calendars for data manipulation with "Expression" feature are almost the same as that described in the previous section. The only difference is these parameters are defined under the "Building" access tab and should be entered in the expression box with a prefix "Building." followed by its name that complies with the rule explained in section 6.2. Hence, all the constants, clocks and calendar names should be unique. For example in **Fig.25** a constant named "kW to Btu/h" is defined with the value 3412.12. In a new channel called "British load", the kW load is converted into Btu/h using this constant. The data from the constants can be exported and

imported in csv formats using “Export Values” or “Import values” tabs at the bottom on constants window.

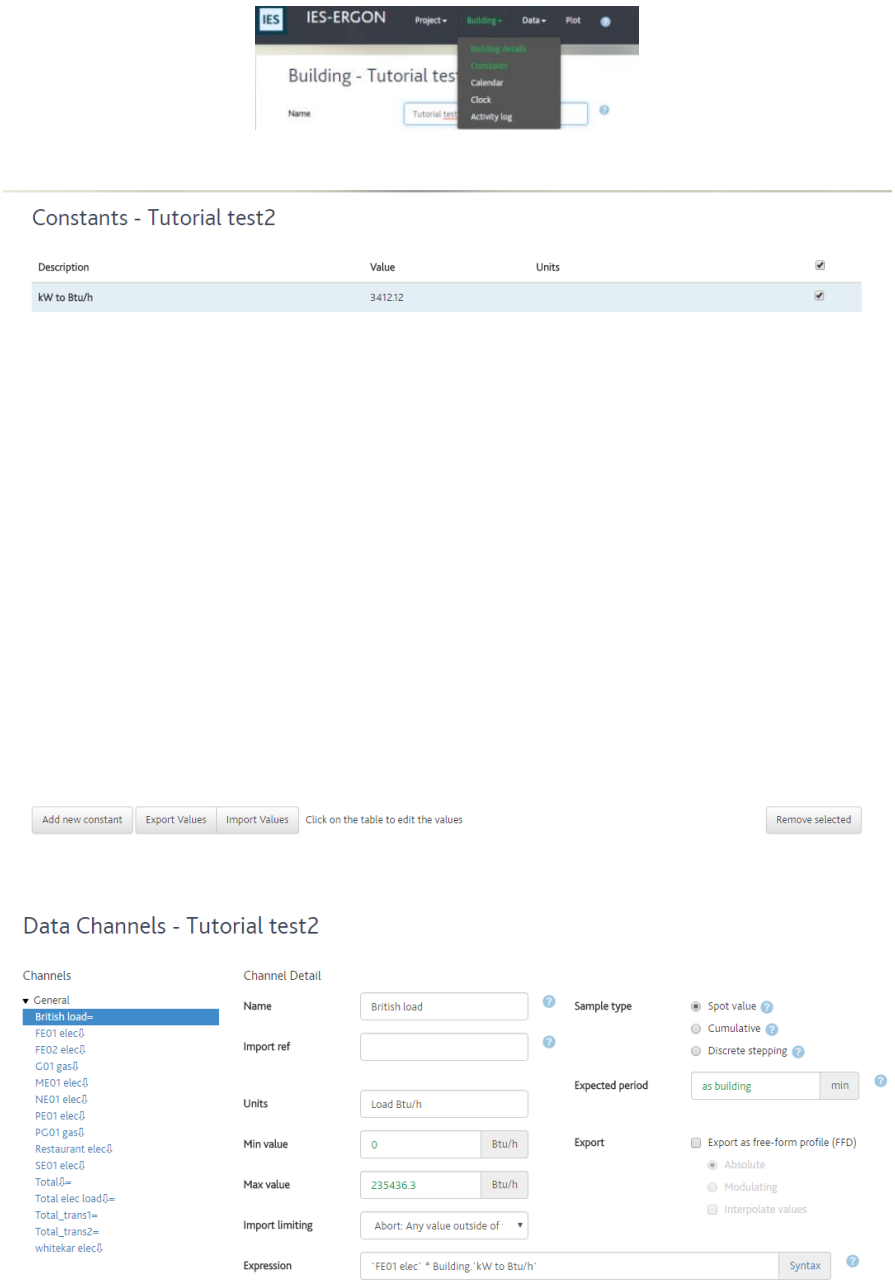


Fig.25 Using building constants with expression feature.

So far, data manipulation capability of “Expression” feature has been discussed. The “clock” and “calendar” feature under Building drop down list allows user to customize or create new profiles. Their

functionality can be compared with Apache-Pro of IES-VE. In fact, they can be used as an alternative way for creating operational profile.

Calendar feature will allow user to assign a value to all the dates in the calendar as per requirement. That value will be the same for all the 24 hours of the day. This feature is used when there is no variability of a quantity throughout the day. For example, the operational profile of a HVAC system running at full speed throughout the day for the months Jan-March, “turned off” during the months Apr-Aug. and again turned back with 50% fan speeds throughout Sept-Dec can be created by Calendar as shown in **Fig.26**.

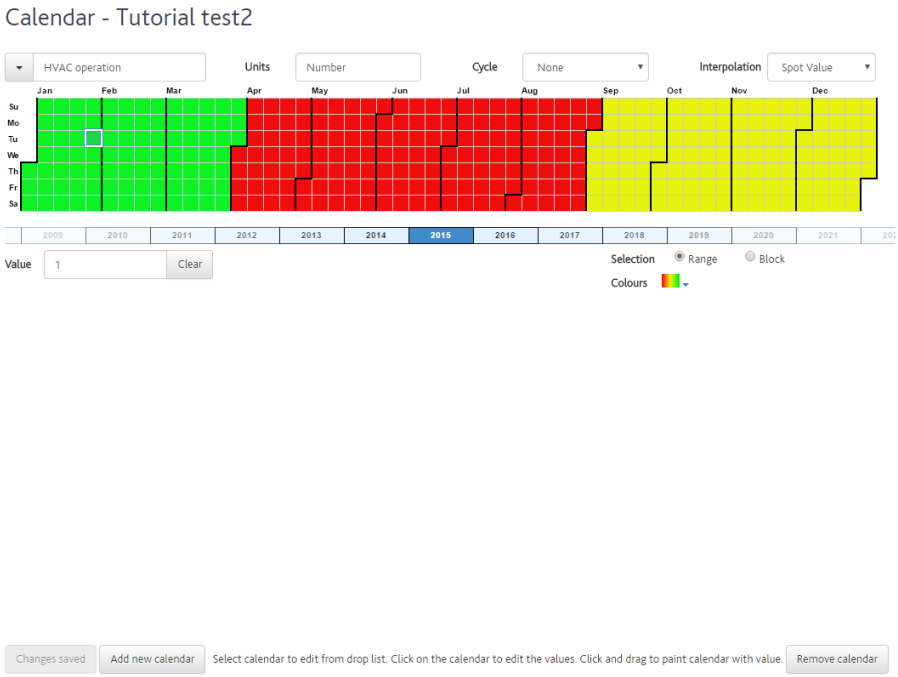


Fig.26 Operational profile creation using Calendar.

The steps are as follows:

- Adding a new calendar.
- Specifying the details like name, units, cyclic nature and format type.
- Selecting the days from the calendar display and entering a value applicable for this period in the “value” box provided and apply enter keystroke. Repeating this for the rest of the period.

Fig.27 shows a new channel that is created based on the data from Calendar and can be exported to create the Free Form Profile in VE.

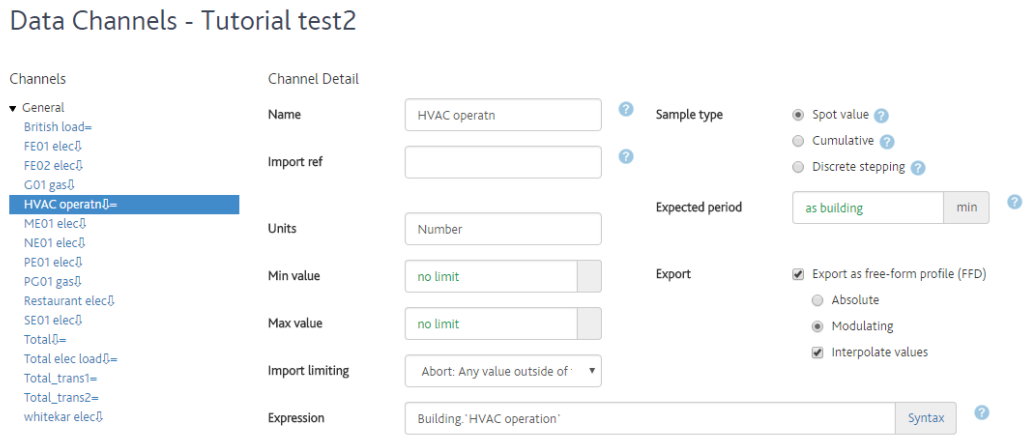


Fig.27 Creating channel in ERGON using Calendar.

The "Clock" feature is a more generalized version of "Calendar" feature that allows modulation on an hourly basis and can be used to create any kind of customized operational profile for the whole year (or years). **Fig.28** shows an example. The steps in creating a clock profile are somewhat similar to Calendar profile except for few minor changes:

- Now variation in a day is defined first (similar to assigning values in Calendar feature) and ERGON will automatically assign a color scheme tile to it.
- User must select the days in the calendar graphics and define the operational profile by assigning the color tiles to it.

The methodology of integrating the Clock with a channel is exactly the same as Calendar feature.

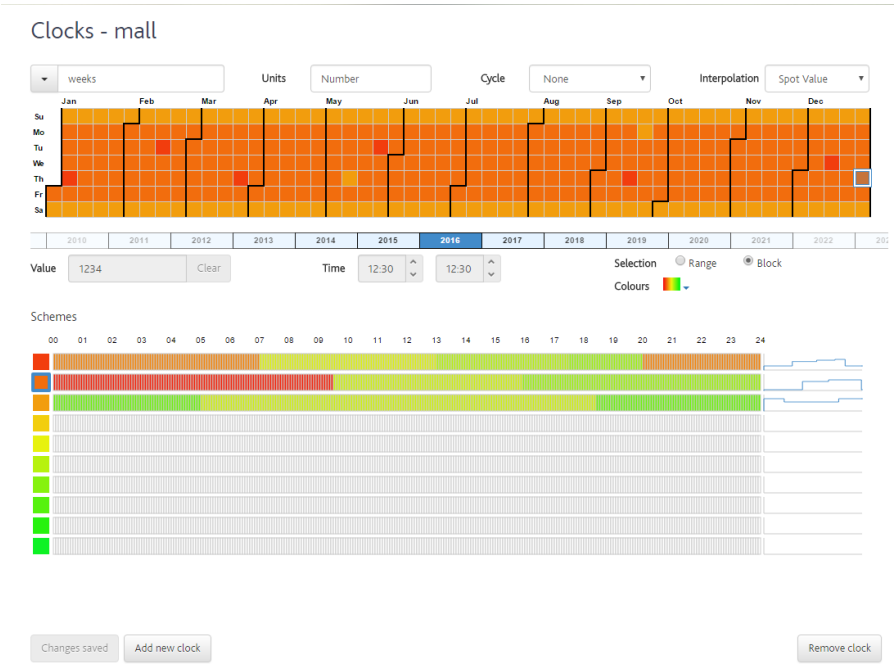


Fig.28 Operational profile creation using Clock.

The level of simplification and ease of customization makes this feature an attractive alternative for creating operational profiles for VE simulations.

7. Free Form Data export

After processing data in ERGON, it can now be exported as Free Form Data (FFD) into IES VE. Clicking on the "VE Export" will direct the user to export window. Then user must click the box "Create new data export for download" to export all the data in the channels between the specified date range. **Fig.29** shows the export data window. User can specify the export range by either entering the dates manually or by dragging it through the calendar. The cells corresponding to the days of the year in the calendar will be filled with green color only when full data for all the channels are imported into ERGON. In the channel specification table just below the calendar display, the user has the choice to select the channels to be exported as FFD. On confirming the transaction, the credits will be deducted from the user account.

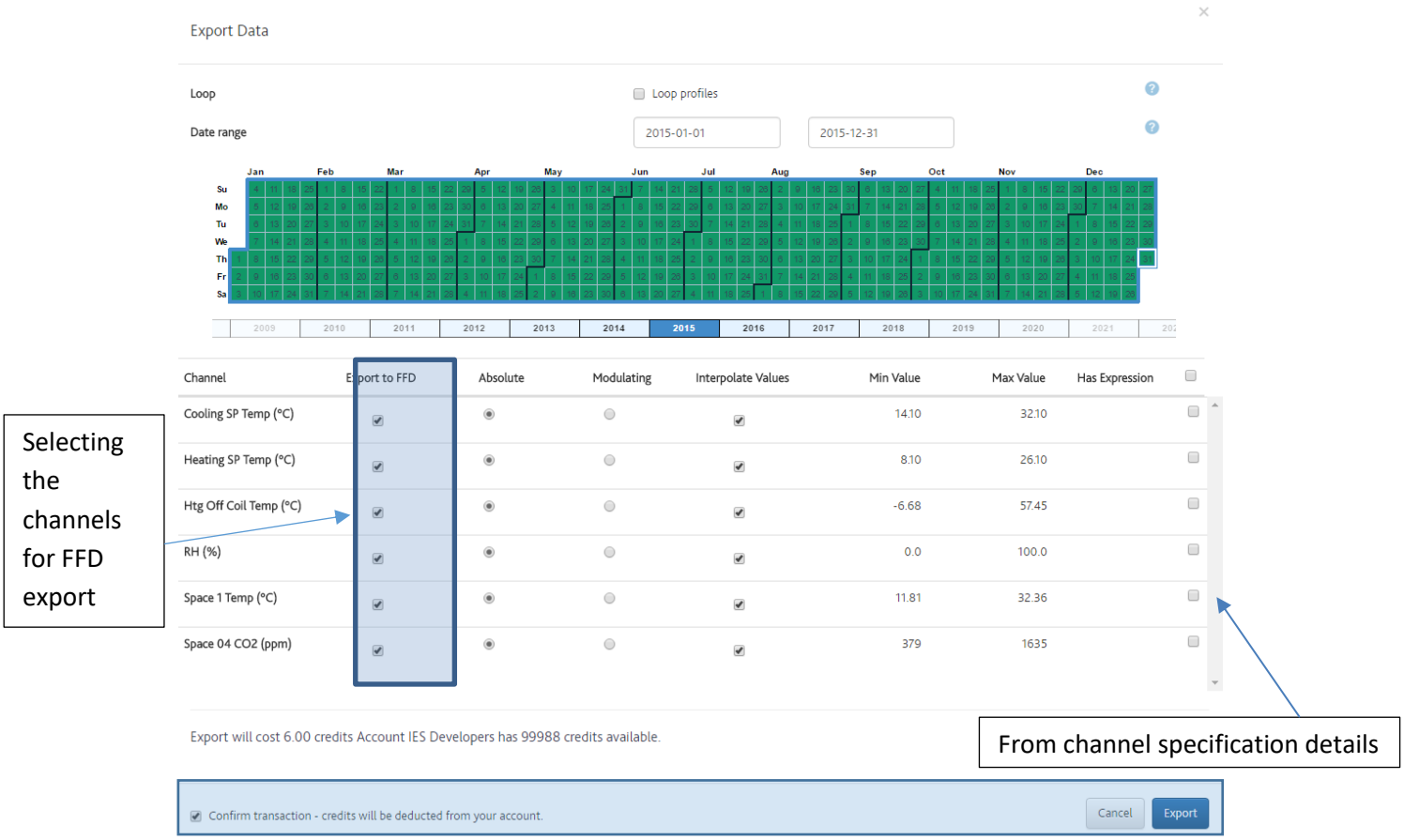


Fig.29 Data export window.

On clicking the "Export" button, ERGON will create the FFD zip file, which can be exported into IES-VE to create free form profiles. **Fig.30** shows the FFD zip file created by ERGON.

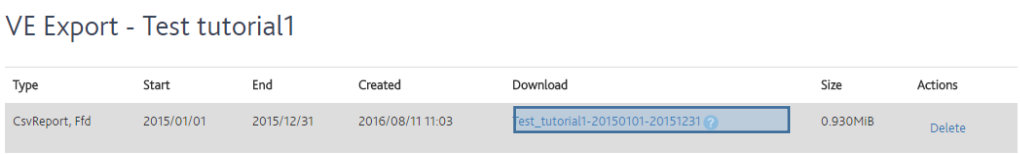


Fig.30 ERGON Zip file for data export to FFD.

Clicking on the file link will download a zip file on the computer. The zip file needs to be copied directly into the VE-project directory. IES VE version 2015 and above will be required to create free form profiles from FFD exported by ERGON. The zip file should be extracted with "extract here" option and

all the free form data files with channel name followed by .ffd extension will be automatically extracted into the Apache folder of the project directory.

7.1 Creating Free Form Profiles (FFP) from FFD

On extracting the FFD zip into the project directory, user can now create free form profiles (FFP) in Apache Pro for running calibrated simulations and bridging the performance gap. Visualizing the measured data in the form of plots, data tables, bar graphs and heat maps provide important information about the operational characteristics of the building and help in detecting any faults.

In all the versions post VE-2015, a new option called "Free Form Profiles" has been added under the pattern tab in Apache profile database manager. All the ERGON FFD data can be converted into usable profiles by this option. VE will direct the user to a new window to create FFP as shown in **Fig.31** on selecting "New" from the "Free Form Profiles" option.

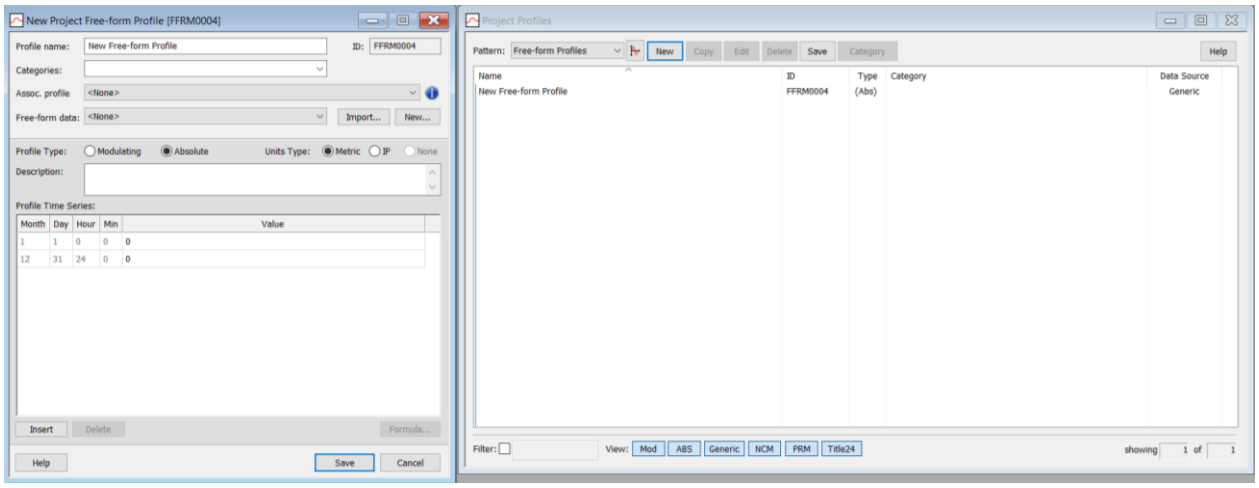


Fig.31 Creating new Free Form Profile.

Now, user can give an appropriate name to this profile and select the ffd file from the drop down option under "Free Form Data" to create the profile as per the raw measured data that can be used into VE for further simulations and analysis. **Fig.32** shows a sample free form profile created by loading the ffd file. User is advised to check whether the profile is Modulating type or Absolute type and the unit type

for the data in it. A time series summary for the profile will be displayed at the bottom half of the window. In a similar way user can create new free form profiles by selecting the corresponding ffd files.

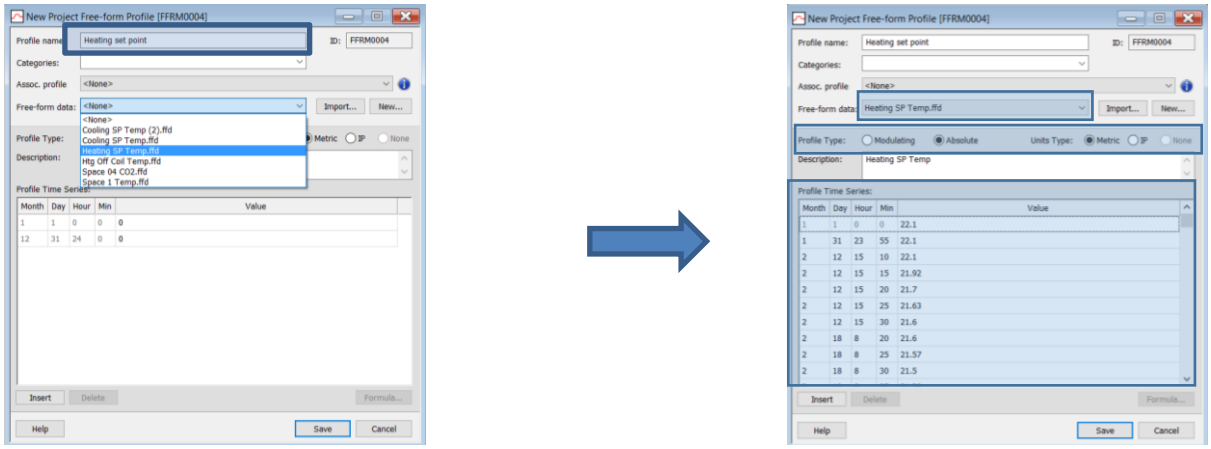


Fig.32 Free Form Profile from FFD.

After saving, user can also check the graphical plot of the free form profile by clicking on icon. Fig.33 shows the graphical plot of the FFP from Fig.32.

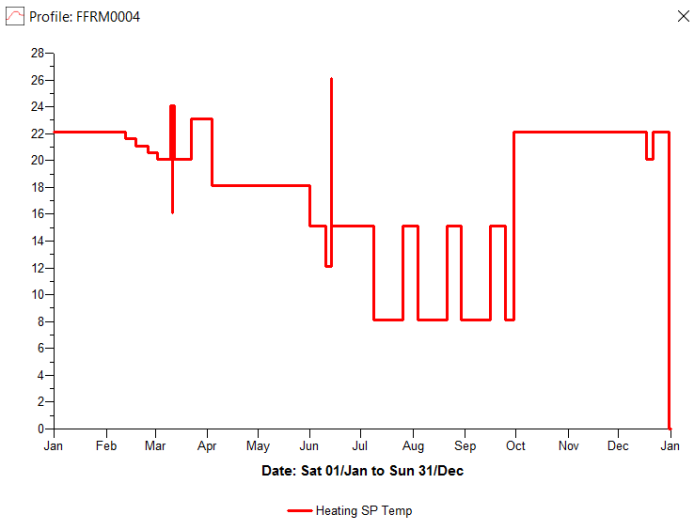


Fig.33 Graphical plot of a Free Form Profile.

To incorporate the profiles into simulations, user must assign the appropriate profiles into the thermal templates.

8. Data visualization and Fault Detection & Diagnosis (FDD)

The time series variation of data in a channel can be visually displayed for the specified date range by the "Plot" option in ERGON to analyze the behavior of the system and to gather important information whether the system is operating in the way it is supposed to. This will allow the user to detect faults and suggest corrective measures to be applied in the real building. A typical ERGON time series plot is shown in **Fig.34**. The calendar graphics under the display window allows the user to select the range of dates in a year to plot the variation of data.

Running simulations in VE with the Free Form Profiles will allow the user to access more of the graphical, tabular and visual tools to visualize data through vista-pro. Some of the these are: x-y plots, heat maps, stacked bar charts, 3-D plots, peak day plots and tabular hour by hour data display. Heat maps are particularly powerful in visualizing the characteristics variation of a particular parameter through color gradient. A typical heat map plot is as shown in **Fig.35**.

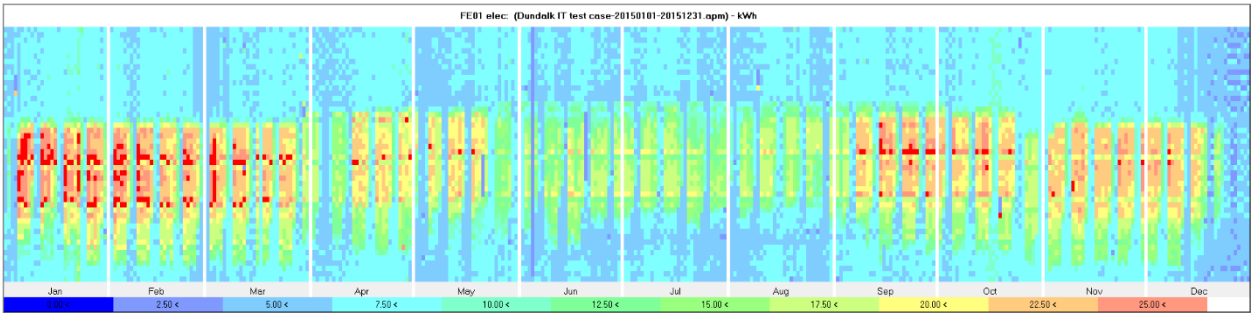


Fig.33 Typical heat map display through Vista-Pro.

More details can be referred through the Vista-Pro help manual.

Fig.34 presents an example showing the difference in modeling results based on design assumptions and actual measured data. This clearly proves that how actual operational variation affects the energy consumption and why is it so important to incorporate the measured data into the simulations to close up this performance gap.

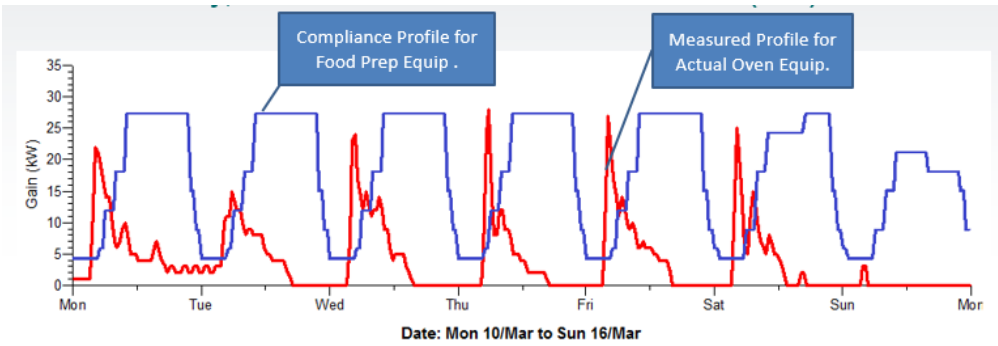


Fig.34 Variation of equipment loads modeled by standard design assumption and actual measured data.

The visualization of measured data also allows user and facility executives to make informed decisions on the working of a system and rectifying any operational faults. For example in **Fig.35** the operational profile of an all-air heating system and the measured room temperatures are plotted together for a particular day.

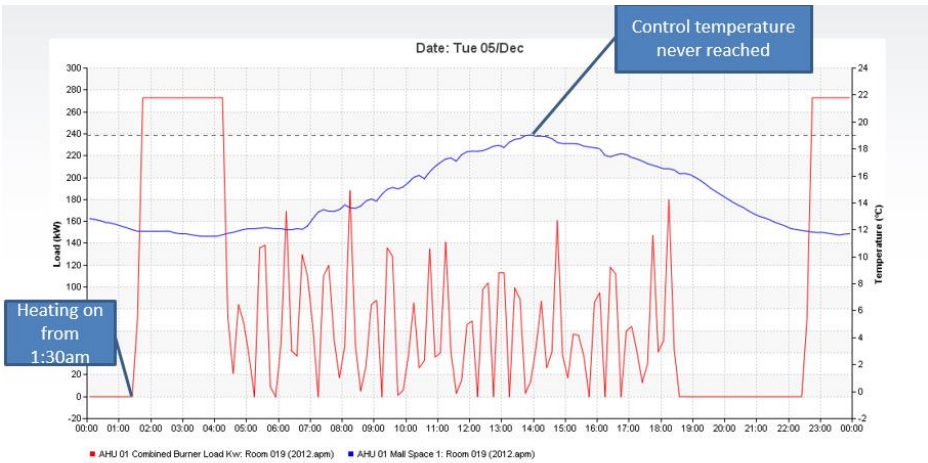


Fig.35 Plots of system operation and room temperature for a typical heating day.

One can infer from the above plots that even though heating system has been working for the whole day and substantial heating energy is expended, the control set point is never reached and thermal comfort is not achieved. This implies either the coils are not working or there is a problem with the airflow. On checking the system and the adjoining components, restricted airflow is detected to be the main culprit. On rectifying this fault, the room temperatures are measured again and found out be within the controlled set point throttling range (**Fig.36**). This shows capability of ERGON tool is detecting the

functional faults in the system and allow user to rectify them for conserving energy and providing thermal comfort to occupants.

Fig.36 Variation of controlled parameters after rectifying operational faults.

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