Step-WISE Technical Toolkit Miniguide Part 3 & 4

Public Document

Changelog

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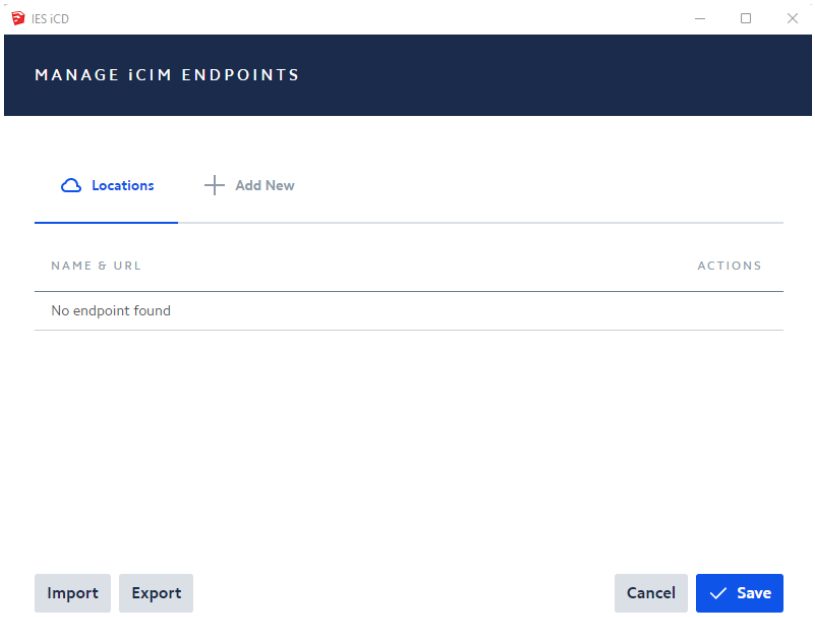
1 iCIM

1.1 iCIM synchronisation process

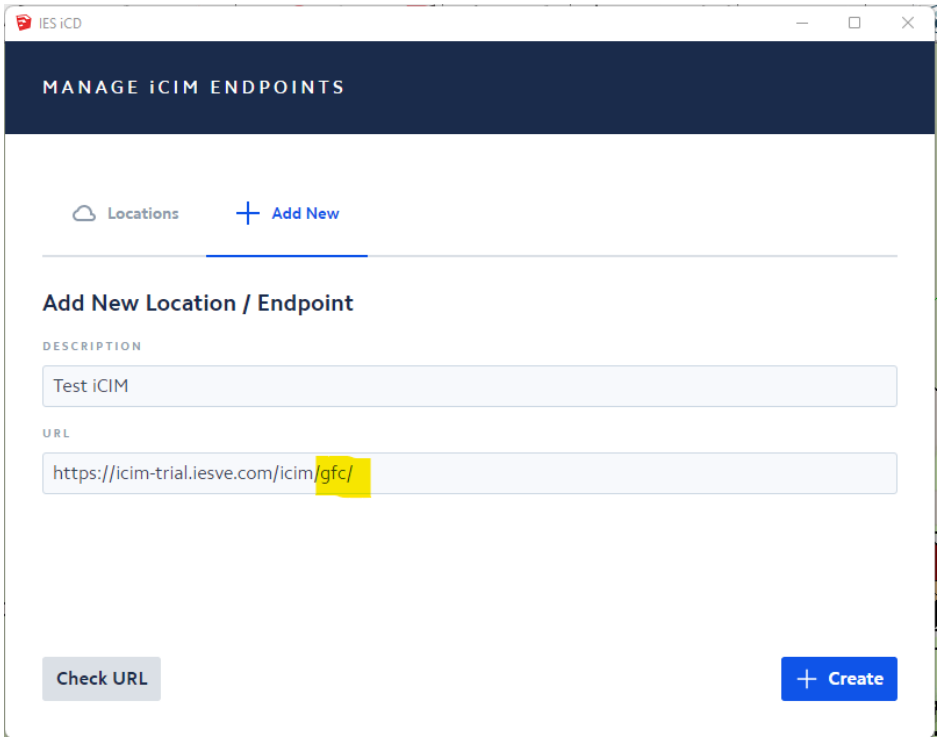
The iCIM synchronisation was improved to allow to connect to an existing iCIM project an iCD model that already contains objects. This process is meant to facilitate the synchronisation of several iCD model to a single iCIM project.

1.2 iCD Opening

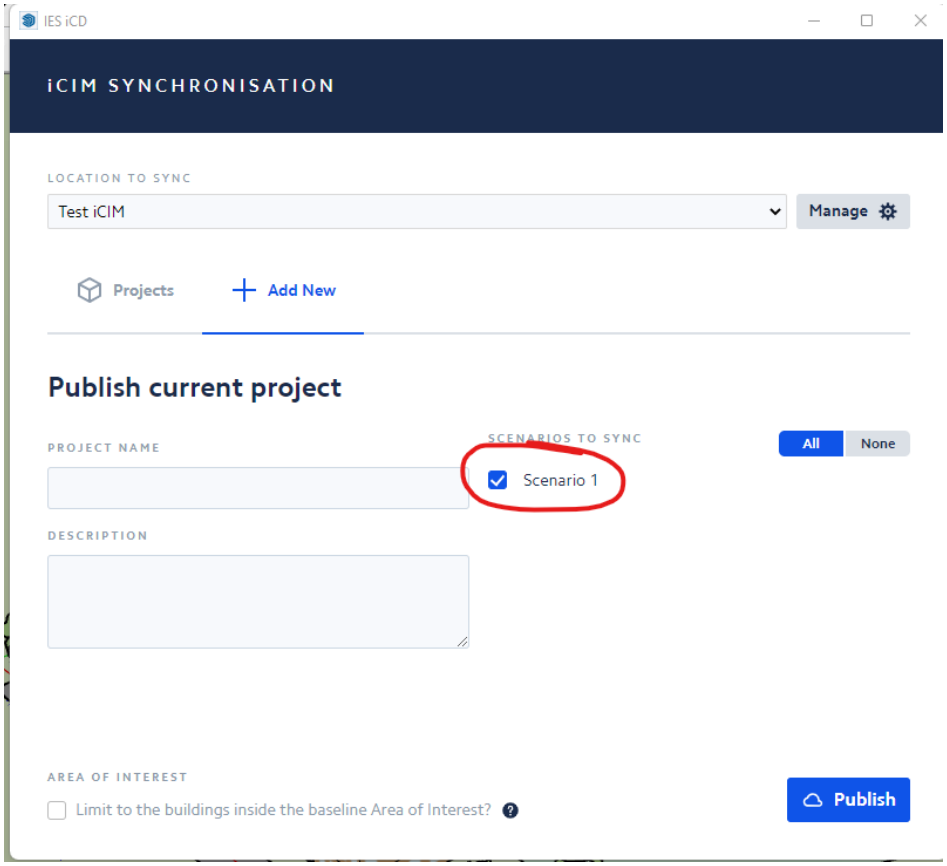
1. Open the model developed on iCD.
2. Select Extensions> IES iCD>IES iCIM Client>Advanced> Enable dangerous operations.
3. Open iCIM web page: https://icim.iesve.com/trial/#/
4. Select Extensions> IES iCD>IES iCIM Client>Advanced> Manage Endpoints



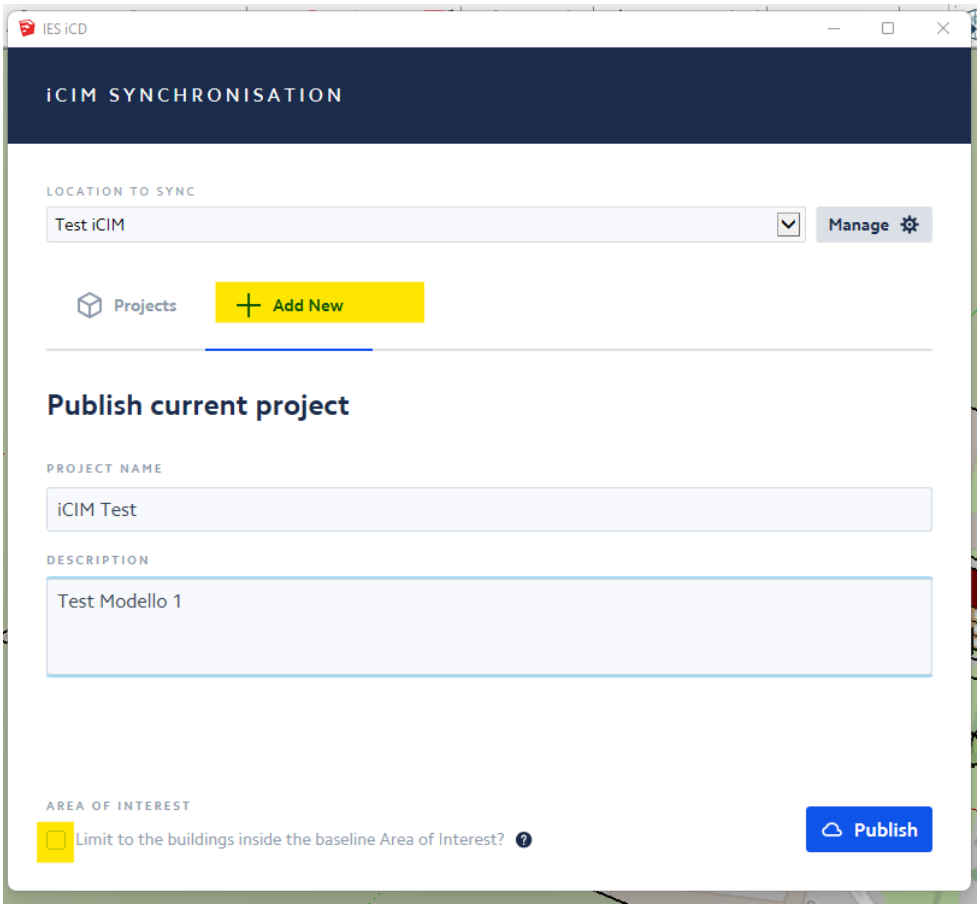
5. Click "Add New", paste iCIM URL, remove the asterisk and add: /gfc/
   Click on "Check URL" and then on "Save".



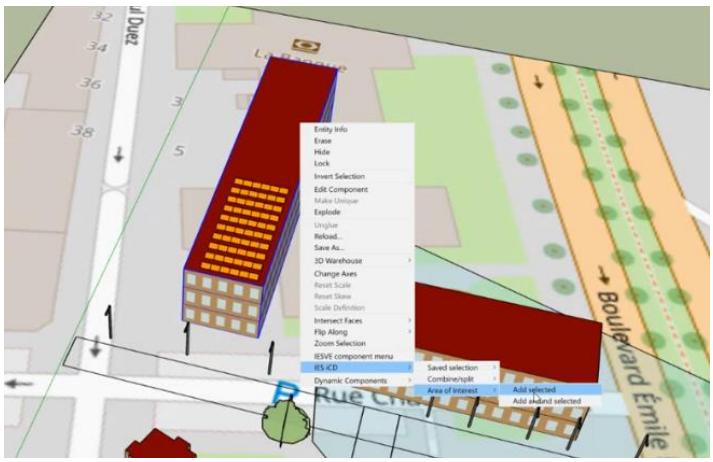
6. In the list of endpoints on the main screen, we can do "Export" to export the whole list (it will create a GeoJSON file). This can then be imported into other PCs. It is useful for sharing projects.



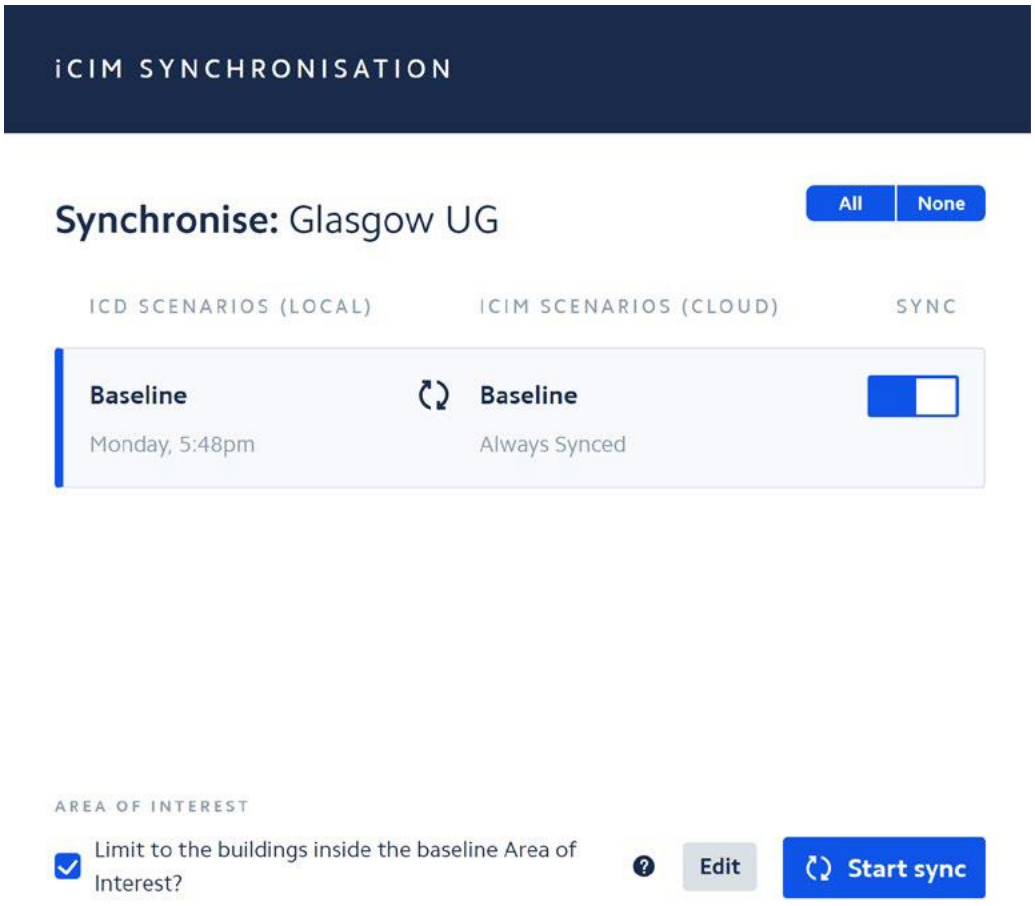
7. Synchronize the model with iCIM. You need to click on the Synchronize button (up and down arrow) on the iCD toolbar (it may ask for authentication). Select the "location to sync". Click on "Add New", enter your name and description and click on "Publish".
   NB: at the bottom, there is a tick to allow the partial upload of the model.



8. Select a building or area in the model to view it in iCIM. iCD now allows users to synchronise only a part of the iCD model that is within an “Area of interest” (AOI). The AOI is a geographical zone that can be defined in iCD. The iCIM Synchronisation process can limit the synchronisation only to objects within an AOI. This can be particularly useful to synchronise several different iCD models (covering different geographical areas) into a single iCIM project or if multiple users are independently editing and synchronising specific parts of an iCD model. In order to use an AOI to synchronise a model, it is first necessary to create it in iCD. To create an AOI:
   Right-click on the building(s) to select> IES iCD> Area of interest>Add Selected

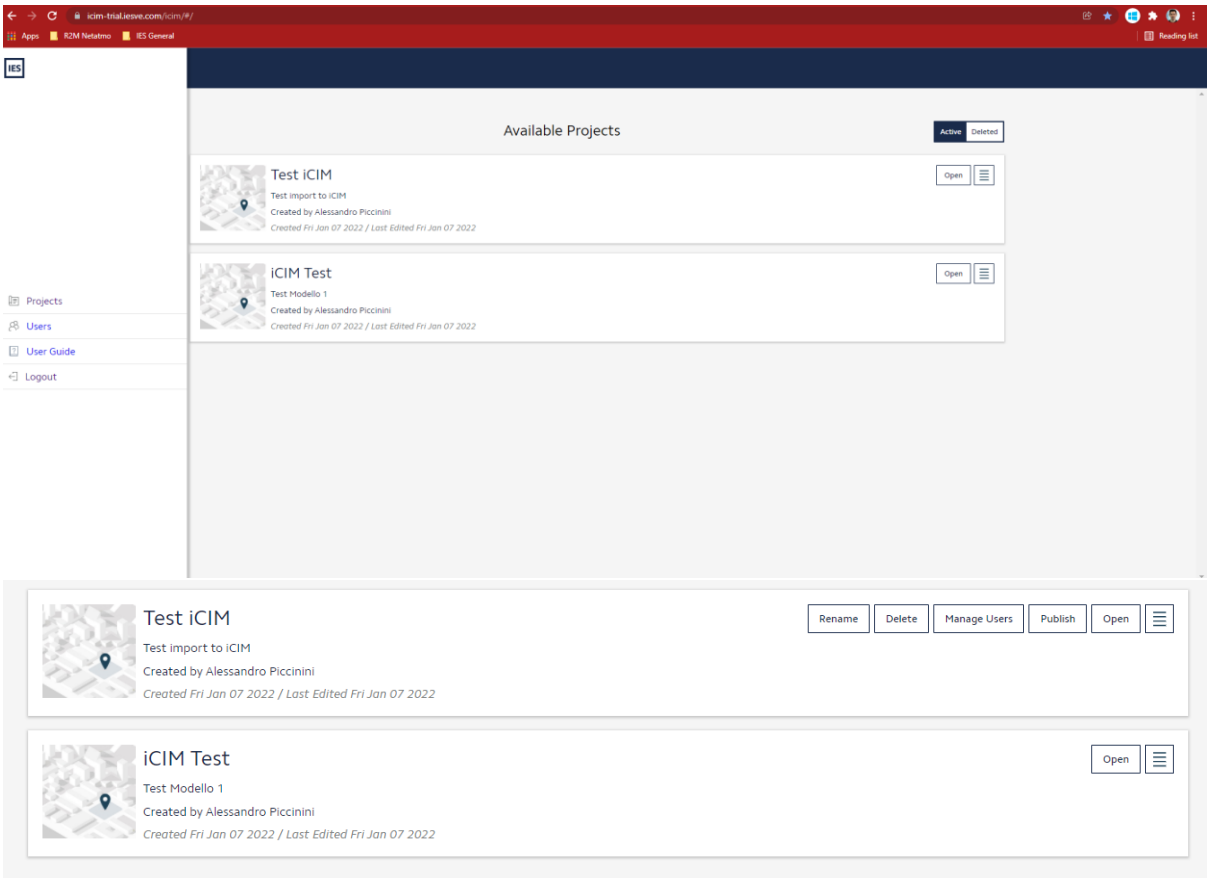


9. Now, to add, it is necessary to log out of iCIM in Extension>iCD>IES iCIM Client>Advanced> Clear all Settings.
   Click on the double arrow and create a new project. For the synchronisation process to consider only the changes that occurred within the AOI, the box *Limit to the buildings inside the baseline Area of Interest?* Should be ticked.



1.3 iCIM Opening

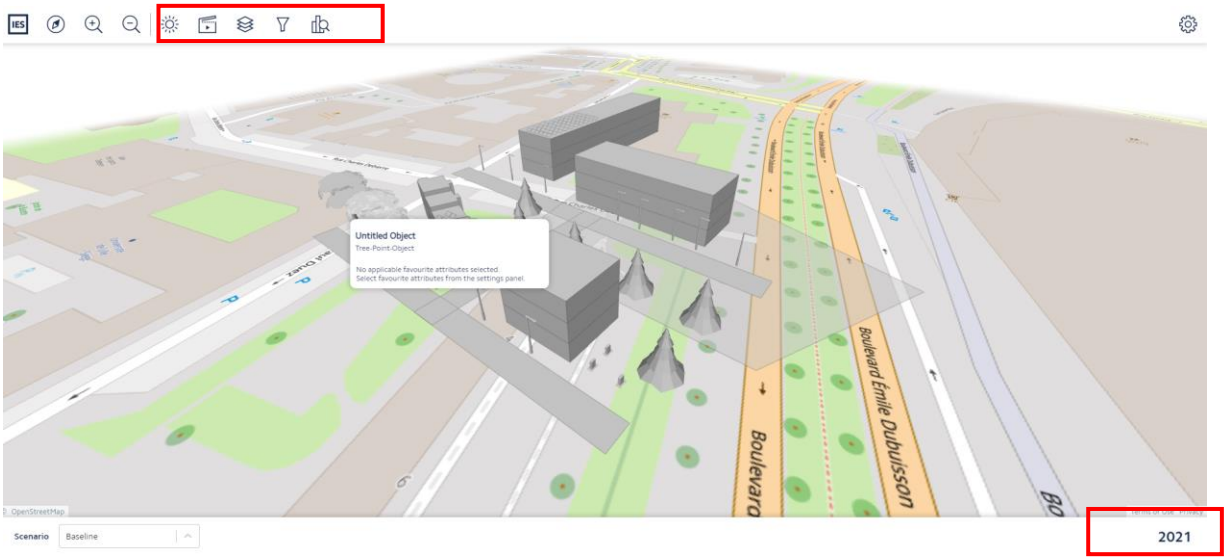
Open iCIM (https://icim.iesve.com/trial/#/). By clicking on the iCIM symbol in the top-left part of the screen, you can access the User Guide, which is the iCIM online guide.



By clicking on the four lines on the button to the right "Open" I can:

1. Rename the selected project.
2. Delete the project, which goes to the deleting page, and from there I can delete it permanently or even open it.
3. Make the project public or add people to the project and I can give privileges through "Manage Users".
4. Publish it via "Publish" so everyone can see it.
5. Open the project via "Open" and the Welcome page opens. It explains the ways in which it is possible to move in the model.

Below an example to explain the interface.

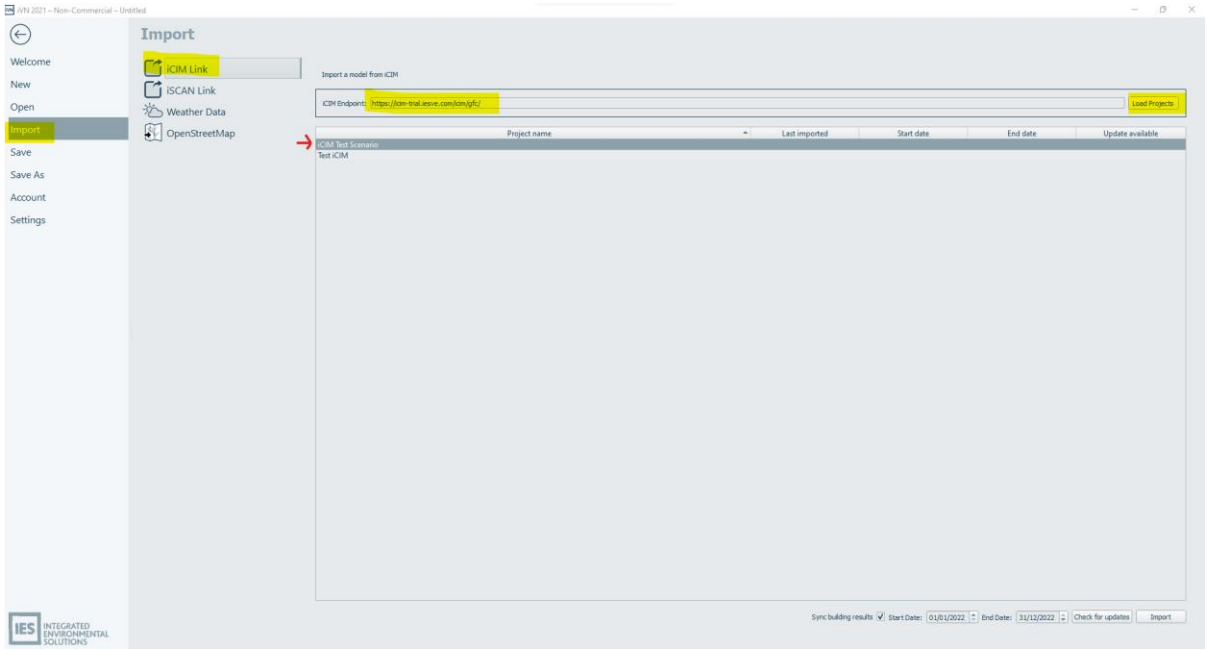


- Bottom 2021 is the scenario synchronization period
- Above, the sun creates shadows of the buildings.
- The camera is used to save views
- The layer button is to see the various layers of iCD
- "Filter" to filter the model based on some conditions. If I want, I can select several filters at once.
- Analysis that colours buildings based on metrics. It is possible to change the minimum and maximum values that can be displayed. With "Metrics Comparison", it is possible to compare the different scenarios that were simulated on the iCD.

You can click on a single building and drill down into the results for that building. In the "Attributes" it is also possible to click on "Edit". This is in case I made a small change in the model and I don't want to upload the entire model into iCIM.

1.4 Import iCIM model to iVN

Open iVN and click on the left bar on Import > iCIM Link. Put the link (https://icim.iesve.com/trial/gfc/), and login to IES. The projects will appear below. Furthermore, below, it is possible to indicate the start and end dates of the simulations I want to import. Finally, you can import all the data from the selected model.



2 iVN

2.1 iVN Setup

After creating an account with iVN you must log in to your account to get access to the tool.

After launching iVN, a browser window will open directing the user to the login page. Login to SSO platform via the browser by inputting account credentials. If an account has not already been created, the "Sign Up Now" button should be selected and a new password should be created along with entering the account email address.

Note: *The same email address as is assigned to the original iVN licence must be re-used here. A new email address will not be accepted.*

2.2 New Project

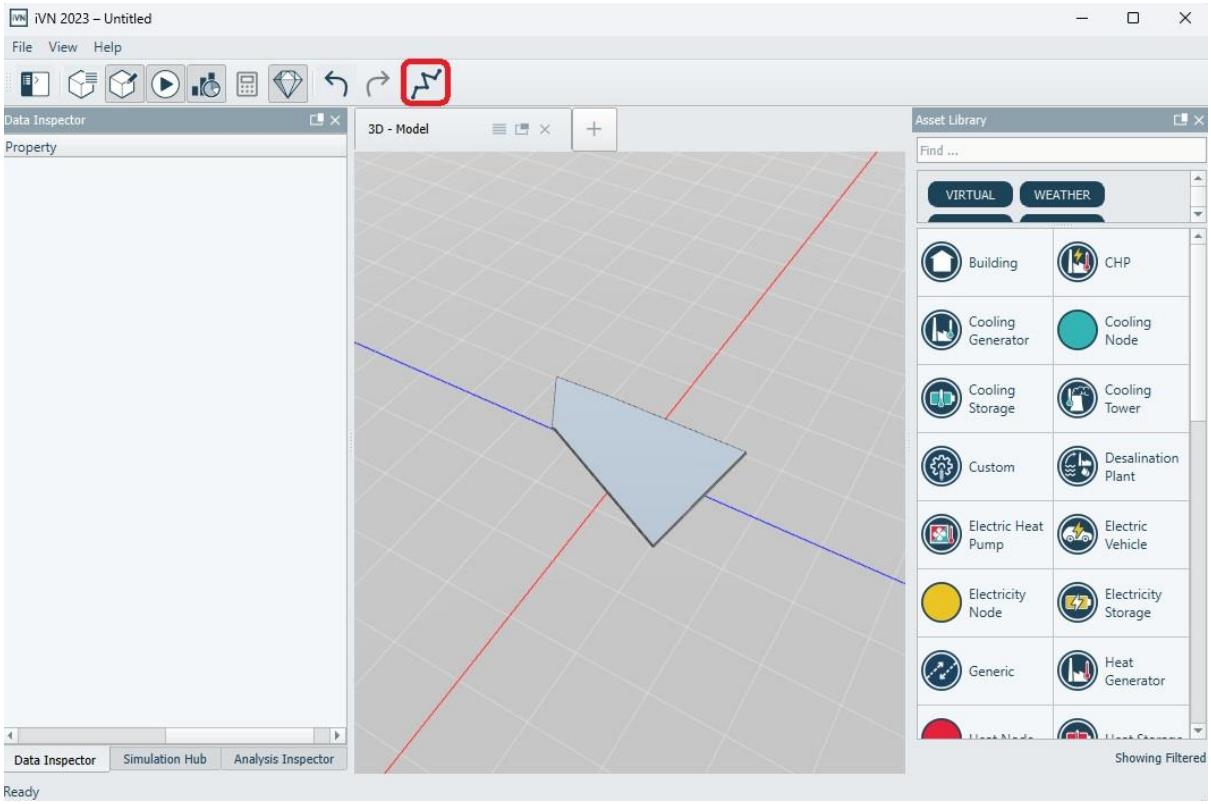
When opening iVN for the first time you are greeted with the iVN "Homepages". This "Homepages" provides useful links to additional resources and learning material along with the most up-to-date version of the software (including notifications of available updates).
To begin a new project from the "Homepages", click on the 'New' tab located on the left-hand tab column. This will open a blank project from where you can start to build your network simulation. The blank project opens the three-dimensional sketching space where you can begin to physically draw or import the infrastructure required for your network set-up.

2.3 3D Model Viewer

The 3D model viewer gives you the option to draw buildings/infrastructure to use within the network simulation.

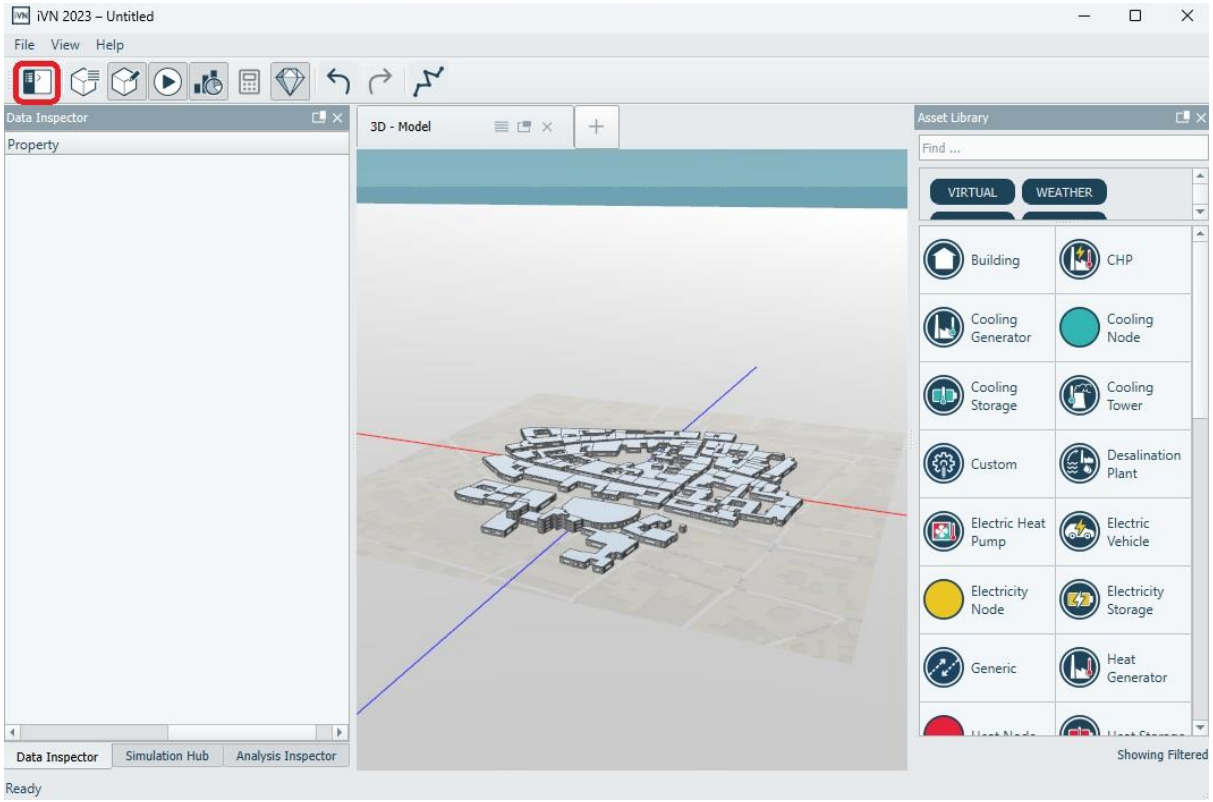
2.3.1 Draw Structures

To begin the sketch mode, select 'Draw Line' icon from the tool ribbon. The 'Draw Line' tool will draw lines along the chosen plane using the specified points selected by the tool. It works by tracing the perimeter of the floorplan on the canvas. If you have a middle mouse button, you can pan the view to make drawing the line easier.



2.3.2 Import from OpenStreetMap

From the “welcome screen”, the option is the “Homepages” to import buildings from OpenStreetMap is available from the import tab. Locate the specific area you wish to import for your network using the OpenStreetMap. Highlight the desired infrastructure using the click and drag function to select the specific area to import (alternative highlighting tools are available in the left-hand corner). Once the desired area is selected, import the data by clicking ‘Import data’ in the bottom right-hand corner of the tab.



2.4 Navigate the Interface

The three main components of the interface are the Data inspector, the Simulation Hub and the Analysis Inspector.

2.4.1 Data Inspector

The data inspector is the primary method of inputting data and parameters to the network. Click on an asset within the network either by physically clicking the icon in the project viewer or by selecting it from the list in the project browser. The parameters of the assets can then be input for the specific network.

Data Inspector

Property	Model
Name	Best Western Net Tower Hotel
ID	ce424aee-2cba-4248-aad9-2d9546a91125
Object Type	iVN Building
▸ Position	
▾ Building geometry	
Height (m)	85,00
No. of storeys	22
Storey height (m)	3,86
Footprint area (m^2)	904,54
Gross floor area (m^2)	19.899,95
Glazing (%)	25,00
▾ Building	
Construction year	1985
Construction type	Structural brick
Primary use	Single Family Attached
Infiltration	Average 7.0 ACH50
Space conditioning	Central heating - radiators
Heating/hot water generator efficiency	Modern boiler CoP 0.85
Cooling generator efficiency	Fair chiller CoP 3.8
Heating/hot water fuel	Gas
Ventilation type	Windows (natural)
Fresh air rate	Moderate 8 l/s.p
Hours of use	Hours of use 9:00 - 17:00
▸ Interventions	
▸ iVN building	
▸ Custom Properties	

2.4.2 Simulation Hub

The “Simulation Hub” contains the input parameters for the specifications of the intended simulation of the network. Here the length, reporting intervals and timesteps of the intended simulation are specified. Clicking the ‘Simulate’ button initiates the simulation.

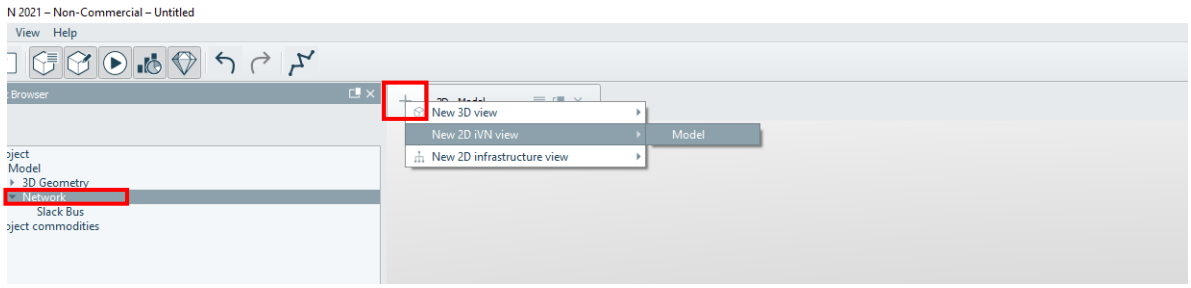
Note: In order to run a simulation, the network must be selected within the project browser.

2.4.3 Analysis Inspector

Once a simulation is complete, the results are accessible through the analysis inspector. From the analysis inspector the user can specify the particular set of results they wish to view by selecting them from the drop-down menu and then specifying the desired method of representation from the ‘Table Chart’, ‘Line Chart’ or ‘Bar Chart’ as shown below.

2.5 Virtual Network

Virtual network nodes are used in the iVN to represent groups of assets and, when connected together, define a supply hierarchy in the form of a tree. Create a 2D virtual network view by clicking on the plus icon in the top left-hand corner of the “project viewer”.



From here, multiple views and scenarios can be used to provide alternative views of the project. To create multiple scenarios/virtual/physical network views, right-click on the network located in the Object Browser and select “Open in new virtual network view”.

2.5.1 Creating a Virtual Network

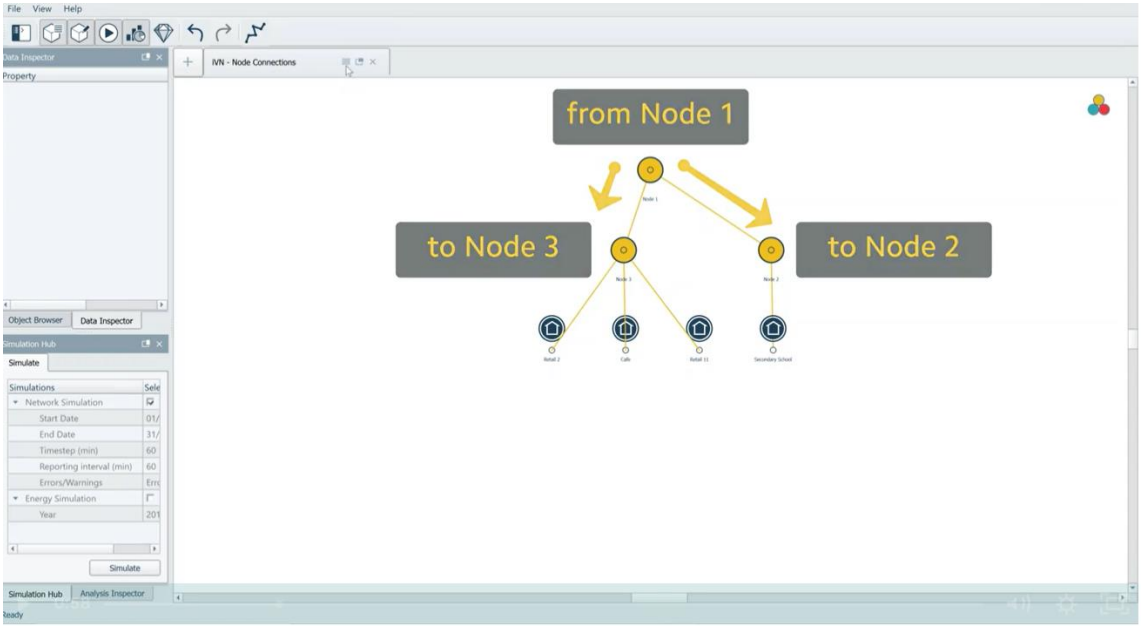
From the asset library tab located on the right hand of the project viewer, assets can be added by dragging and dropping into the virtual network viewer directly.

Similarly, when using imported buildings, assets can be selected from the asset library and dragged directly into the project space (virtual network viewer).
The Data Inspector will list every building that has a 3D geometry associated with it under the column "3D geometry". Dragging and dropping a building from the data inspector onto the virtual network view will add it to the virtual network, along with its floorplan. If 3D geometry is not available for a building, then the building can be added by dragging and dropping the "Building" asset from the asset library. If 3D geometry becomes available later for a building after the "Building" asset is added to the virtual view, then dragging and dropping the building listed under "3D geometry" in the data inspector onto an existing Building icon in the virtual network view will associate that geometry with the building asset, replacing the icon with the building's floorplan and relocating it to its geographical location.

To define a virtual network, assets are connected to nodes that represent the commodities (electricity node, cooling node, heat node, potable water node, waste water node) that are produced or consumed. Nodes can also be connected to other nodes to represent different "levels" where demand is aggregated.

2.5.2 Setting up a Virtual Network

In order for a virtual network to be set up individual nodes must be added to the network. Each node within the network acts as an aggregation point allowing the network to be inspected and analyzed on several levels. By connecting nodes of the same type together, a tree hierarchy is defined. At each node in the tree, the demand is aggregated from all attached assets and this demand is met, as much as possible, by any attached generators. Any residual demand left over is then passed to the next node in the hierarchy, where it is included in the demand aggregation for that node. This computation is calculated in sequence, starting from the “leaves” of the tree and continuing until the “root” node. Any demand not met at the root node is assumed to be provided by an external supply. So, it's important which way we make the connections. The starting nodes have the highest hierarchy and are the starting points of the flow. See the image below.



Assets can be connected to nodes by left-clicking the small circle in the center of the node or below an asset and dragging a connecting line. Colored circles below assets indicate the type of node that the asset can be connected to. For example, a red circle indicates that an asset can connect to a heat node. If the small circle below an asset is white, e.g. for buildings, then the asset can have 1-to-many connections with many different node types. However, an asset can only have one connection to a node of a particular type.

The parameters for each individual asset can be defined by clicking on the asset and using the data inspector. The demand and generation profiles can then be set for specific commodities by opening the 'Demand and generation editor' (access the editor by double clicking the asset / right clicking and selecting 'Set demand and generation'). This dialogue is available for buildings and generic installations.

Once the desired network is constructed and all parameters are inputted correctly, a network simulation can be conducted.

2.5.3 Network Simulation

Once the network is set up correctly, select the network as a whole in the project browser. Ensure the network parameters are correct using the data inspector. Set the desired network simulation parameters within the simulation hub tab:

- Start date: DD/MM/YYYY 00:00-23:59
- End date: DD/MM/YYYY 00:00-23:59
- Time step: 1-60
- Reporting interval: X ≥ Time step
- Errors and Warning preferences.

Now it is possible to click "Simulate". The results, when the simulation has finished running, can be viewed via the "Analysis Inspector".

2.6 Physical Network

In order to add assets to the physical network, they must first be present in the virtual network. Once present in the virtual network, assets can then be added to the physical network by right-clicking and 'Add to physical network'.

In order to create a physical network, additional add-on licenses must be present:

Heat: District Heat Network modelling allows for thermal energy design to be evaluated from a network infrastructure point of view and whether any changes or upgrades are required.

Optimise: An optimisation problem can be set up by defining the objective(s) (e.g. minimize carbon emissions), variables and constraints to automatically give the optimal sizing of all assets in the design that satisfy the energy demand.

2.7 Import Function

The 'Import' tab located on the "Homepages" provides the user with several options to import data into the iVN.

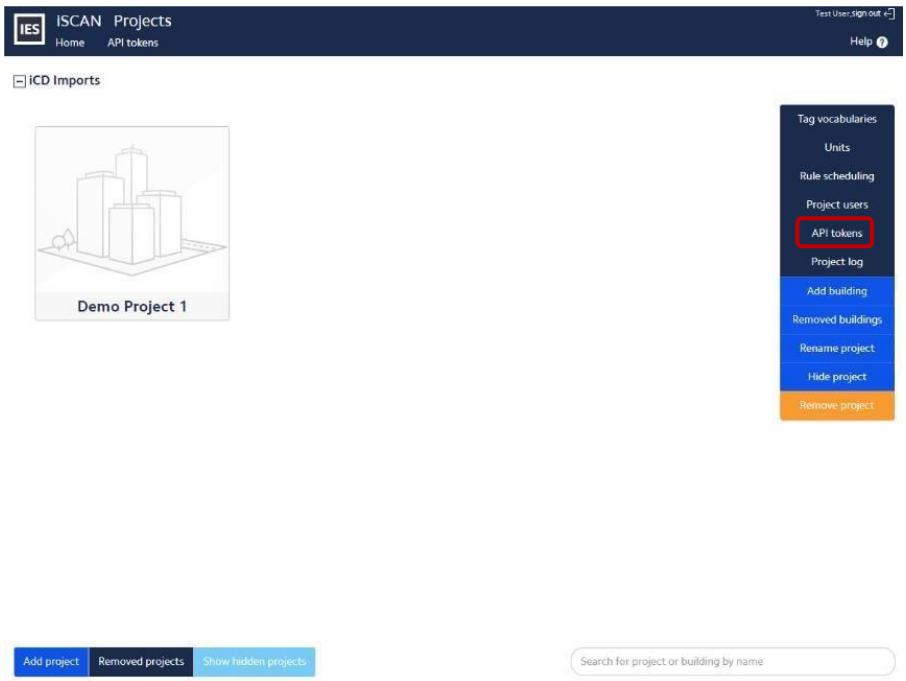
2.7.1 iCIM Link

Import a model from iCIM by loading the project's specific URL. Import from selected and specified start and end date. It is important to note that the iCIM endpoint to be copied and pasted into the import section shown below is as follows: https://icim.iesve.com/iesiclprojects/cim/project.
Once this is done, a prompt will pop up to enter iCIM login details. From there then the list of iCIM projects will be selectable in list form. A project can be selected from the list and then the "Viewer" button is clicked and a pop up will appear that will show the area captured by the iCIM project. There is an option then to either select an area of interest to import in the same way that is done for the OSM import, or the entire area can be imported.

2.8 iSCAN Link

iSCAN can be used to import metered time-series data or to create building benchmark data. To import time series data, the project URL and project API token links are required to be copied and pasted. Once this is done, log in to the iSCAN account through the pop-up dialogue. A list of channels will then appear and can be selected to import data between the dates defined in the bottom right corner.

To generate the iSCAN API token and get the project URL, log in to iSCAN and navigate to the desired project, and select "API tokens" in the menu on the right of the screen. Click "Create Token" on the next screen, and when creating it ensure that the expiry date is long enough in the future that is suitable, and that the "Operator" role is selected. The import will not work if these options are incorrect. Once created, the API token link to the top and the project URL on the bottom of the screen can be copied and pasted into the iVN as described previously.



2.8.1 CSV Import

Ability to import a timeseries profile in csv format into iVN. The timeseries can be utilised by the system and set as a profile to demand and supply units. When selecting a specific set of time series data in CSV format, the structure of the time series must be selected from the drop-down menu and imported in the appropriate format ("Row per profile" or "Column per profile").

"Row per profile" structure is shown below;

	A	B	C	D	E	F	G	H	I	J	K	L
1	name	start_year	start_month	start_day	end_year	end_month	end_day	timestep_minutes	values			
2	Test_Case_1	2022	1	1	2022	12	31	10	1	2	3	4

"Column per profile" structure is shown below;

	A	B
1	name	Test_case_1
2	start_year	2022
3	start_month	1
4	start_day	1
5	end_month	2022
6	end_day	12
7	timestep_minutes	31
8	values	1
9		2
10		3
11		4

Once the profiles have been imported, they are then available to be specified as time series data for demand/supply assets within an iVN Network.

By double clicking the desired asset or by right clicking the asset and selecting 'Set demand and generation' a profile can be added and the parameters set for its intended use within the 'Demand and generation editor'.

2.8.2 Weather Data

iVN Energy simulations require reference weather data for the location of the building. A set of standard simulation weather files is included within the iVN installation, or it can read any *.fwt or *.epw simulation weather file. Resources are provided here to give routes to acquire additional weather files that may be used in simulations.

To load a weather file from the install set, click on "Homepages" >> Import >> Weather Data then click the Browse icon. Model location parameters (latitude, longitude, elevation, and time zone) need to be set. This looks initially at any files saved inside the iVN weather files folder, but you may browse to a new file you have saved anywhere else on your local machine. When the desired file is set, you can then click Import to bring it into the project ready for simulation.

3 iSCAN

3.1 Project Setup

3.1.1 Building Details

The **Building > Building Details** page is used to edit information about the project, such as name, sample period, time zone, etc. This is also where the location and altitude of the site are added. This information may be used to obtain weather data for the site location.

3.1.2 Weather

Once the site location and altitude are entered to the Building > Building Details page, the weather data may be obtained. This is done from the Data > Weather page.

Highlight the dates for the required year(s) and select Populate Historical Data. Once populated, this data will be available in the iSCAN project.

To enable automatic updates of weather data, select the checkbox for Enable automatic weather updates. Weather forecasts may also be enabled here for a maximum of 5 days by entering the number of days to forecast by.

3.2 Data Import

Data may be imported via the **Data > Import** tab for a range of formats including:

- Manual imports (CSV, XML)
- Automated Imports ((SCAN Robot, web service connections, dedicated IoT connections e.g. MQTT, LoraWAN etc.)

3.3 Channel Settings

Once data has been imported to iSCAN, it will be available as Channels, and is displayed on the Data > Channel List page. Each channel represents a dataset containing timeseries data.

Channels will always be visible on the left-hand side of the screen. When a channel is selected, information about that channel will be available on the right.

On the "Channel Setting" tab, information may be added to each channel to give more meaning to the channel data. This includes; the channel name, units, sample type, min and max values and export options. Notes may also be added to channels to share information with other project users.

3.3.1 Tagging Channels

Tagging channels allows the user to give more meaning to Channel data and organise the iSCAN project as desired. Tags can be added from the **Project > Tag Vocabularies** page. Once a tag vocabulary is created, tags can be added to the vocabulary. Tags may be applied to channels from the **Data > Channel List** page, from the **Tags** tab.

3.3.2 Expressions

Expressions allows the use of mathematical functions to derive virtual channels from measured data channels within the iSCAN project. iSCAN expressions use their own syntax, which more detail is available within iSCAN, from the Syntax link on the Channels Settings tab.

In the Demo Project there are already some example Channels setup with the use of expressions. These are;

- **Total Electricity**:

  This channel uses a simple expression, summing up the electricity metered from the three electricity sub-meters within the building.

  `Electricity Meter 1`+`Electricity Meter 2`+`Electricity Meter 3`

  This is useful in cases where some areas of a building are metered, but not all. Instead of installing additional meters, expressions may be used to derive "virtual meters" from existing data within the building.

- **Window Opening**:

  This channel uses an expression to calculate a profile for window openings based on the outdoor air temperature and hours of occupancy.

  Building.`Occupied Hours` == 1 and Mean(Weather.`Dry Bulb Temperature`, 2 hr)>14? 1 : 0.01

  This means, when the building is occupied and when the outdoor dry bulb temperature is greater than 14°C for more than a 2 hour period, the window is open. Outside of occupied periods it takes a value of 0.01 to account for leakage when windows are closed.

3.4 Visualise Tool

The visualisation tool can be accessed from the **Investigate > Visualise** page and offers a range of plot types for different types of analysis. Some examples to try using the demo project include;

- **Calendar Tool**

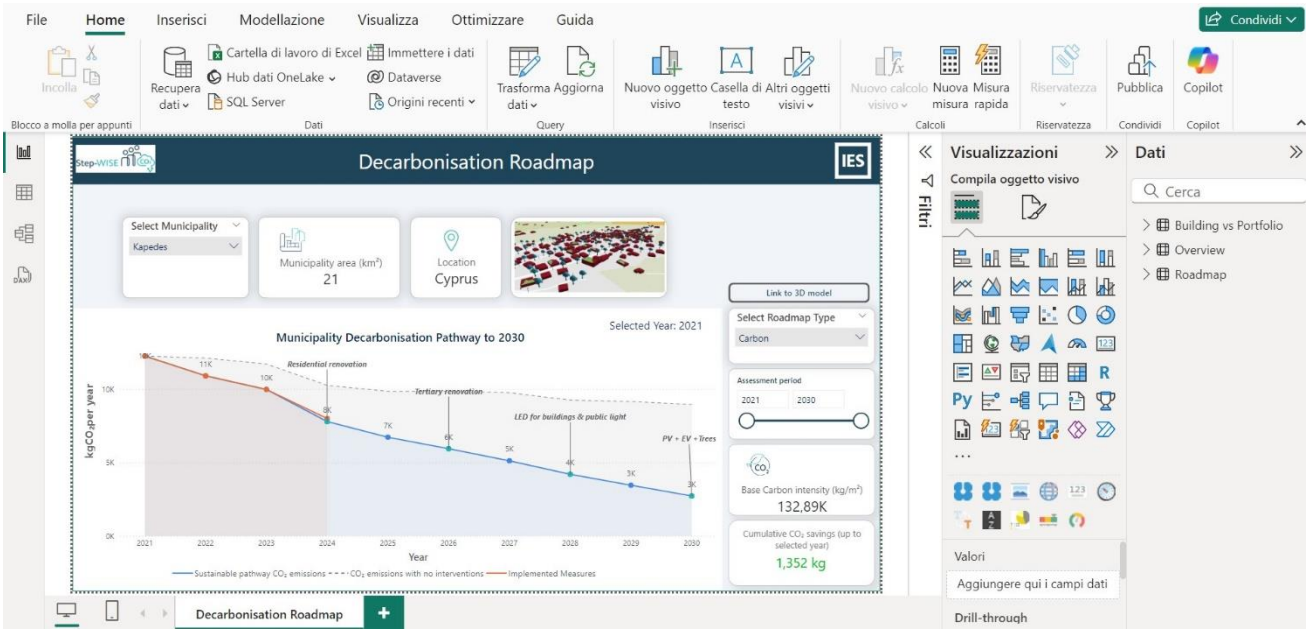
Select a channel measuring temperature from the channels list. On the calendar beneath the plot, select **Quality**. Days within the calendar will be color coded to show days with high vs. low data quality.

- **Heat Maps**

Plots types can be changes via the "Setting" tab on the Visualise page. Multiple channels can be selected at once using the CTRL key for each of the available plot types.

4 PowerBI

In order to create a roadmap for decarbonization, it is possible to use Power BI. Power BI is basically a free Microsoft tool, but IES created an RPI template to create a graph that represents the roadmap for decarbonization of a municipality.



So what happens when new retrofitting is applied to all the buildings? What happens when applying a new HVAC system, or what happens when applying a certain retrofit in 2023 in 2025? In order to use Power BI, you need two templates:

- MS PowerBI IES Roadmap template, which is the interface.
- MS Excel IES Roadmap template, where you can put the data needed by PowerBI.

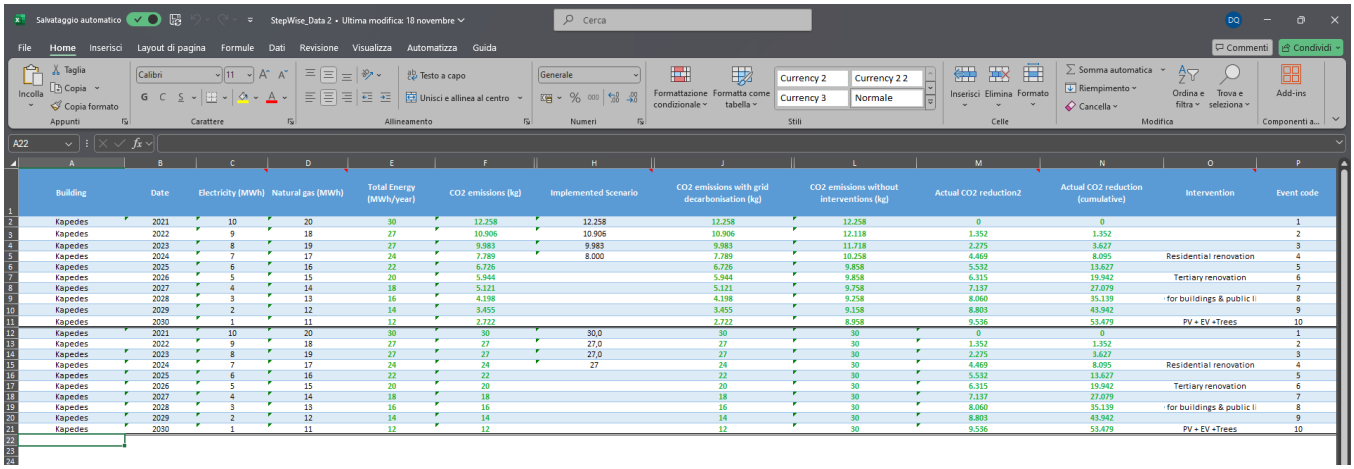
4.1 MS PowerBI IES Roadmap template

So, starting with the MS PowerBI IES Roadmap template, it is possible to select the municipality in the interface. This is in case we are studying more municipalities. So, you can select the one that you are interested in. So, you have some high-level information about the municipalities and the square meters. If you want to have a quick view of the ICD model, there is also a link that transfers directly to the online model. Going back to the roadmap, we have developed two types of roadmaps: carbon (CO2) and energy. So we can select one of them. Starting with energy, it gives the municipality MWh per year and how this parameter is changed, considering different energy efficiency scenarios to check the progress against what has been scheduled. The same consideration can be done for the carbon roadmap, but in this case, we have to consider the decarbonization factors. So, if you click over the different years, you can see the values of CO2 emissions, what the CO2 emissions are with no

interventions, and the cumulative CO2 savings that you are expected to achieve. The MS PowerBI IES Roadmap template is connected to a spreadsheet (MS Excel IES Roadmap template). So, in PowerBI, you can click “Transform Data” > ”Data Source Settings” and insert the file path where the spreadsheet is saved. So, every time you make changes in the spreadsheet, you just have to click on the “Refresh” button, and all the different values are uploaded in PowerBI.

4.2 MS Excel IES Roadmap template

Now considering the MS Excel IES Roadmap template, as is written in the intro, you don’t have to touch the green values. Do not change the red values. You need to change the required data in black in each spreadsheet of the Excel file according to the municipality considered.



Building	Date	Electricity (MWh)	Natural gas (MWh)	Total Energy (MWh/year)	CO2 emissions (kg)	Implemented Scenario	CO2 emissions with grid decarbonisation (kg)	CO2 emissions without interventions (kg)	Actual CO2 reduction2	Actual CO2 reduction (cumulative)	Intervention	Event code
Kapedes	2021	10	20	30	12.258	12.258	12.258	12.258	0	0		1
Kapedes	2022	9	18	27	10.906	10.906	10.906	12.118	1.352	1.352		2
Kapedes	2023	8	19	27	9.983	9.983	9.983	11.718	2.275	3.627		3
Kapedes	2024	7	17	24	7.789	8.000	7.789	10.258	4.469	8.095	Residential renovation	4
Kapedes	2025	6	16	22	6.726		6.726	9.858	5.532	13.627		5
Kapedes	2026	5	15	20	5.944		5.944	9.858	6.315	19.942	Tertiary renovation	6
Kapedes	2027	4	14	18	5.121		5.121	9.758	7.137	27.079		7
Kapedes	2028	3	13	16	4.198		4.198	9.258	8.060	35.139	for buildings & public li	8
Kapedes	2029	2	12	14	3.455		3.455	9.158	8.803	43.942		9
Kapedes	2030	1	11	12	2.722		2.722	8.958	9.536	53.479	PV + EV +Trees	10
Kapedes	2021	10	20	30	30	30,0	30	30	0	0		1
Kapedes	2022	9	18	27	27	27,0	27	30	1.352	1.352		2
Kapedes	2023	8	19	27	27	27,0	27	30	2.275	3.627		3
Kapedes	2024	7	17	24	24	27	24	30	4.469	8.095	Residential renovation	4
Kapedes	2025	6	16	22	22		22	30	5.532	13.627		5
Kapedes	2026	5	15	20	20		20	30	6.315	19.942	Tertiary renovation	6
Kapedes	2027	4	14	18	18		18	30	7.137	27.079		7
Kapedes	2028	3	13	16	16		16	30	8.060	35.139	for buildings & public li	8
Kapedes	2029	2	12	14	14		14	30	8.803	43.942		9
Kapedes	2030	1	11	12	12		12	30	9.536	53.479	PV + EV +Trees	10

Considering the “Overview” spreadsheet, which is about the Baseline, I have to insert the building name, building type, and location. About the Total floor area, I can see it directly in iCD. So, if I click on IES ICD > reports > ready-to-make reports > site report > full site report, the software shows the gross floor area. Then the software requires the Total Electricity and the Total Natural gas. These data can be found in the Energy Report of iCD baseline model. Furthermore, the table requires the latitude and longitude of the place (data that can be found on Google Earth). Then in “Image url” it is possible to insert a picture of the iCD model. So what I need to do is just to take a picture. Another important spreadsheet of the MS Excel IES Roadmap template is the “CO2 emissions factors”, where you have to update the electricity and the natural gas CO2 emission factors depending on the location and the progress projected year by year. Finally, we have the “P3 – Decarbonisation pathways” spreadsheet, where most of the changes happen. In the “date” column, it is possible to indicate when future scenarios are considered. Then there are the Electricity and Natural gas columns. From these, the Total energy and the CO2 emissions are automatically calculated, considering also the CO2 emission factors for the latter. Then there is a column about the “Implemented scenarios” in which it is possible to insert the target value of CO2 emission for each year. Furthermore, there is an “Intervention” column where to put the considered interventions (ex., residential renovation, PV, EV, etc.). Finally, there is the “Roadmap Type” column, which is “carbon” or “energy”, in order to allow the selection of different roadmaps. Note that for the Energy Road Type rows, in the CO2 emission column we will have the Total Energy values in MWh/year