iVN 2023.1.0 – Quick Start Guide

July 2023

Contents

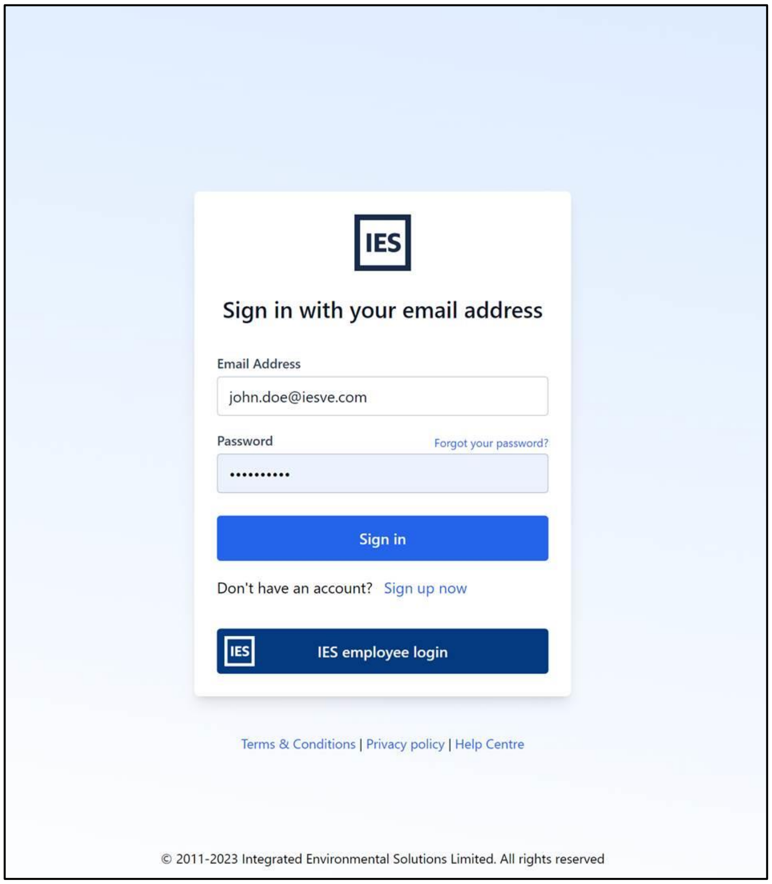
1 Setup

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 log in page. Log in 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.*

(For any account issues please contact support@iesve.com)

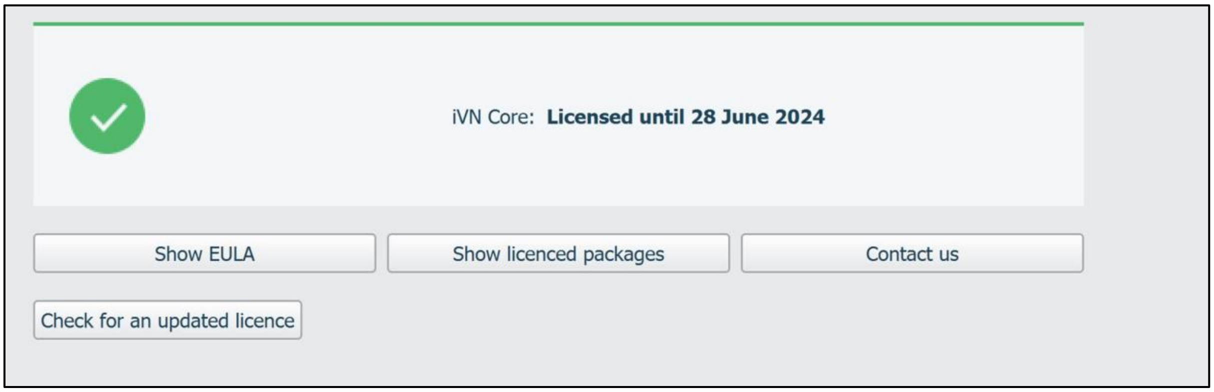


A notification will inform the user that the SSO log in has been successful and that the user can close the browser window.

Upon login, an update to any licence will be accompanied by a notification popup within iVN to inform the user of any new licence or any chances to previous licencing is available.

- An end-user license agreement (EULA) is required to be read and agreed to prior to the use/update of the iVN software.

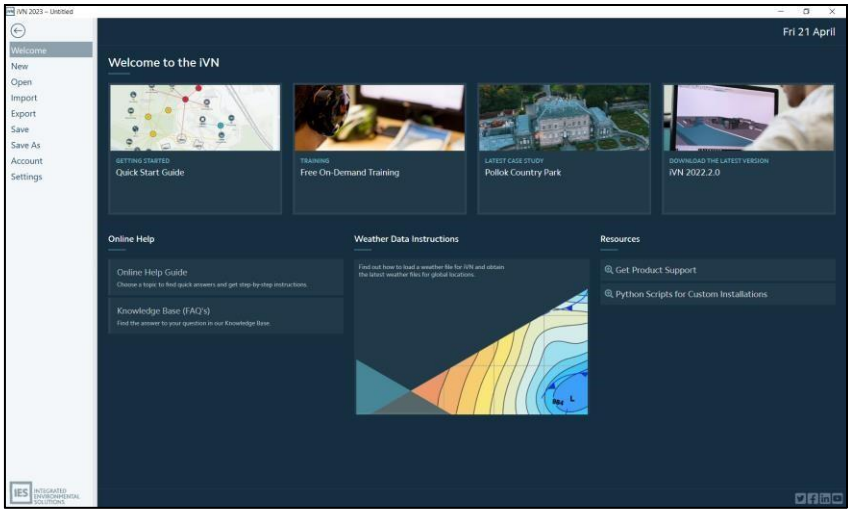
Information on current licensed packages will be available via the account tab. This is done within the "account" tab on the "Homepages" page.



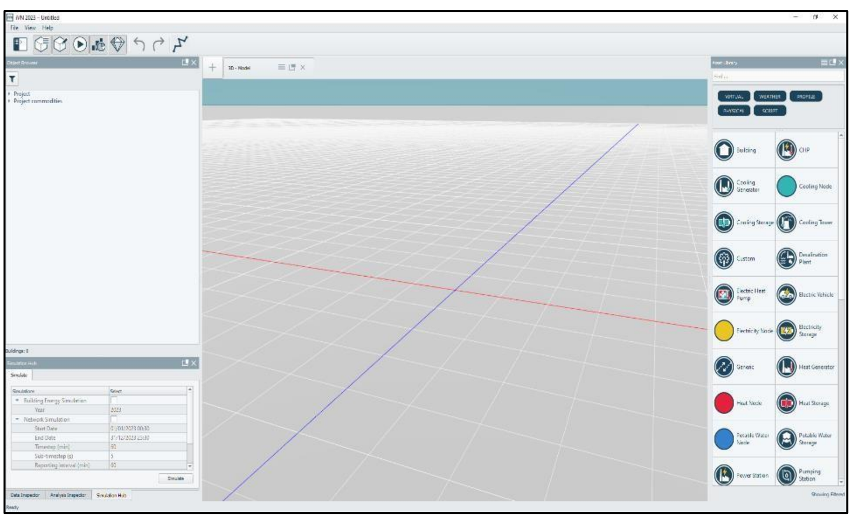
2 New Project: iVN

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.

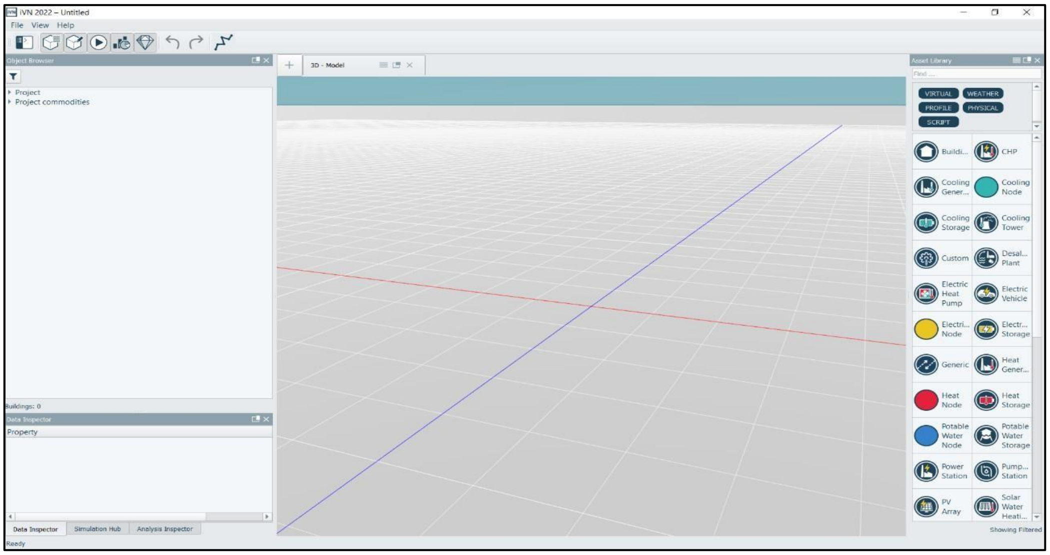


This will open a blank project from where you can start to build your network simulation. The blank project opens the three-dimensional sketching space where you can begin to physically draw or import your infrastructure required for your network set up.



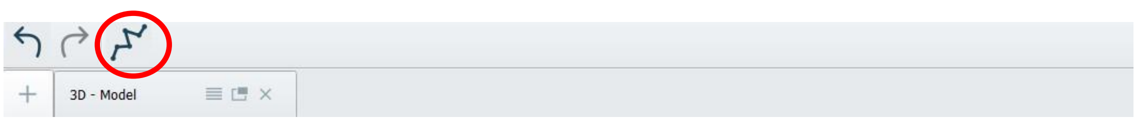
2.1 3D Model Viewer

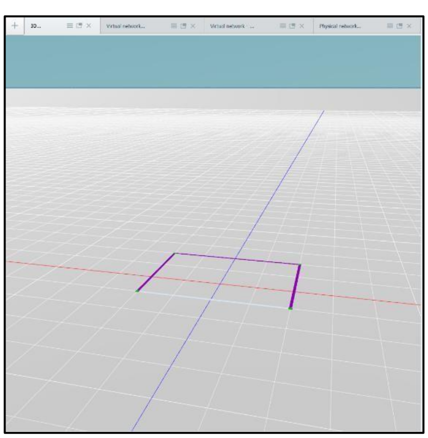
The 3D model viewer gives you the option to draw buildings/infrastructure to use within the network simulation.

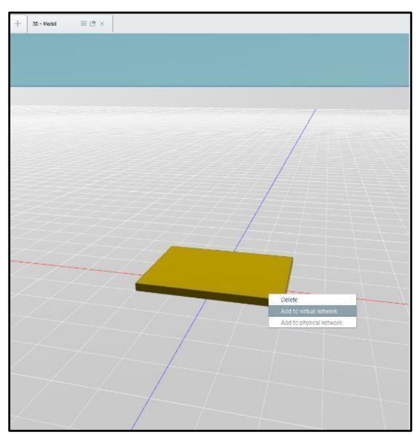


2.1.1 Draw Structures

To begin the sketch mode, select 'Draw Line' icon from the tool ribbon.



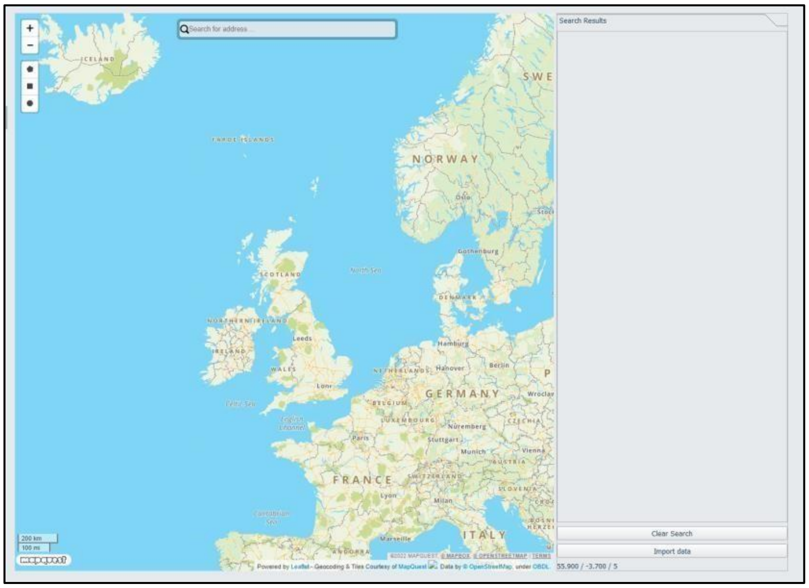




The 'Draw Line' tool will draw lines along the chosen plane using the specified points selected by the tool. It works by tracing the perimeter of the floorplan on the canvas. If you have a middle mouse button, you can pan the view to make drawing the line easier.

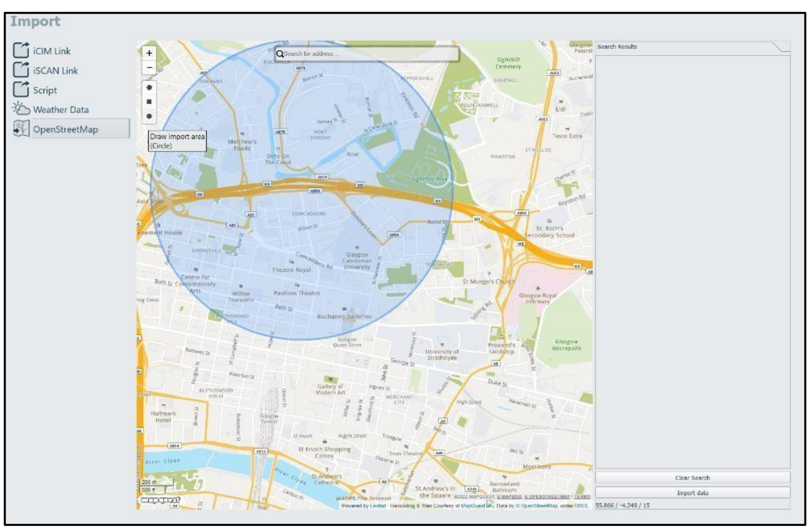
2.1.2 Import from OpenStreetMap

From the "welcome screen", the option is the "Homepages" to import buildings from OpenStreetMap is available from the import tab.



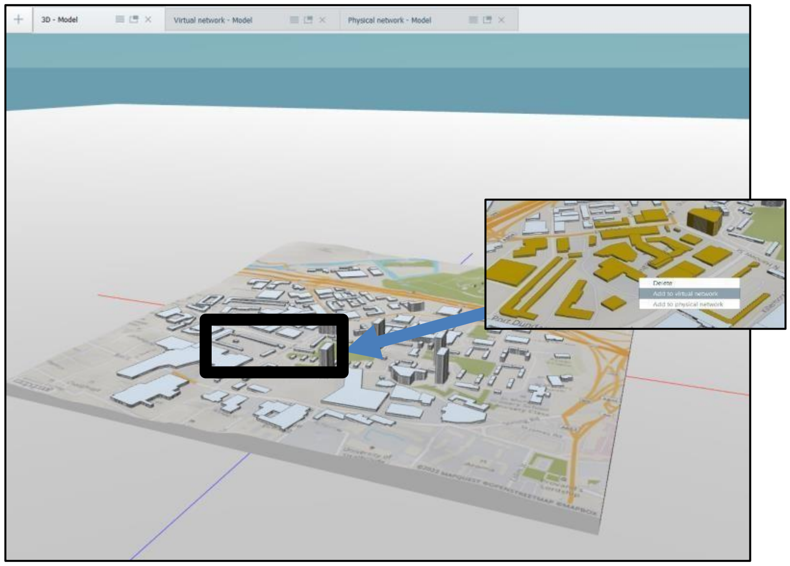
Locate the specific area you wish to import for your network using the OpenStreetMap. Highlight the desired infrastructure using the click and drag function to select the specific area to import (alternative highlighting tools are available in the left-hand corner).

Once the desired area is selected import the data by clicking 'Import data' in the bottom right hand corner of the tab.



The infrastructure highlighted within the selected area will then be imported into the 3D model viewer of your project.

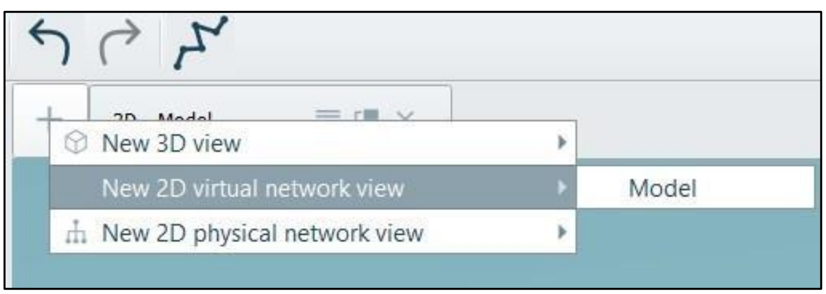
These buildings are now available to be added to the project's virtual network by selecting and right clicking add to virtual network.



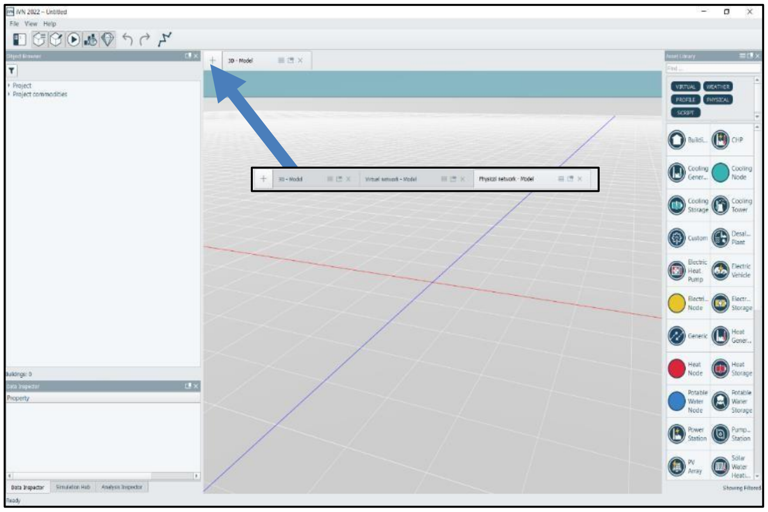
2.2 Virtual Network

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 for alternative views of the project.

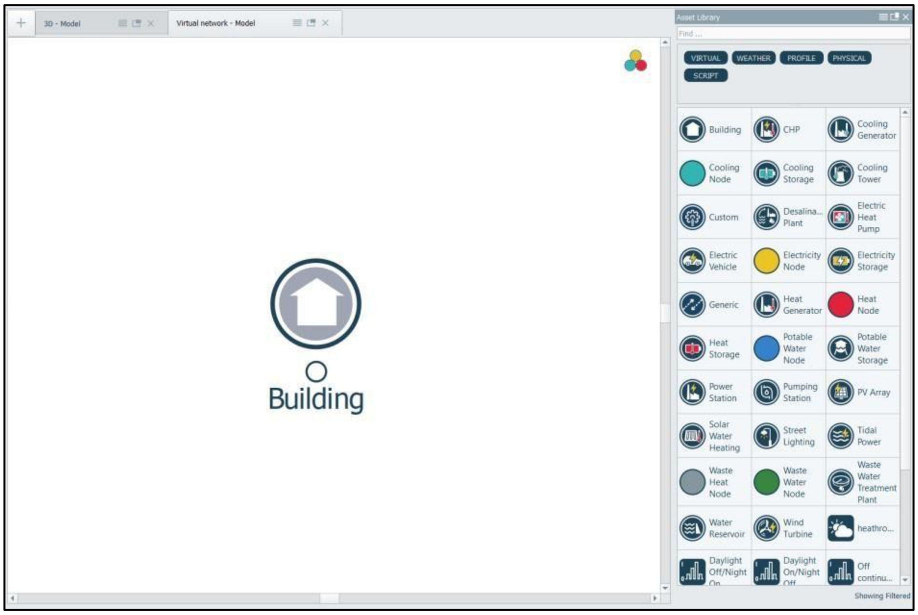


The multiple views and scenarios are spread across the top panel of the viewer window.

To create multiply scenarios/virtual/physical network views right click on the network located in the object browser and select open in new virtual network view.

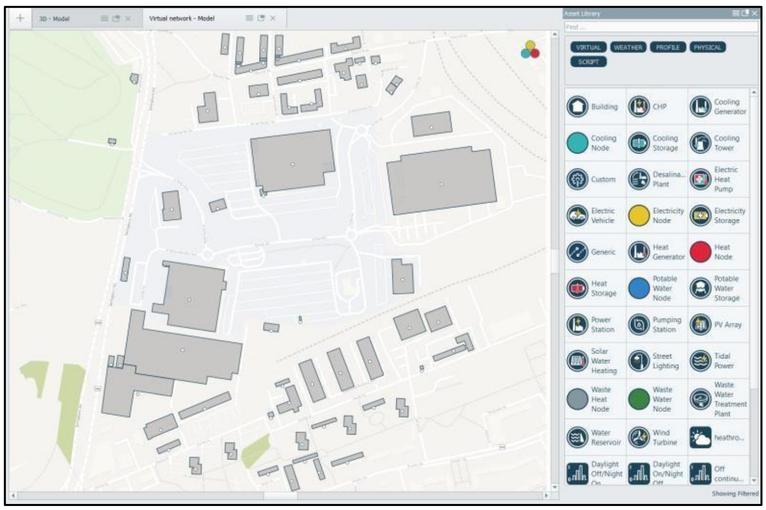
2.2.1 Adding Virtual Assets

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.



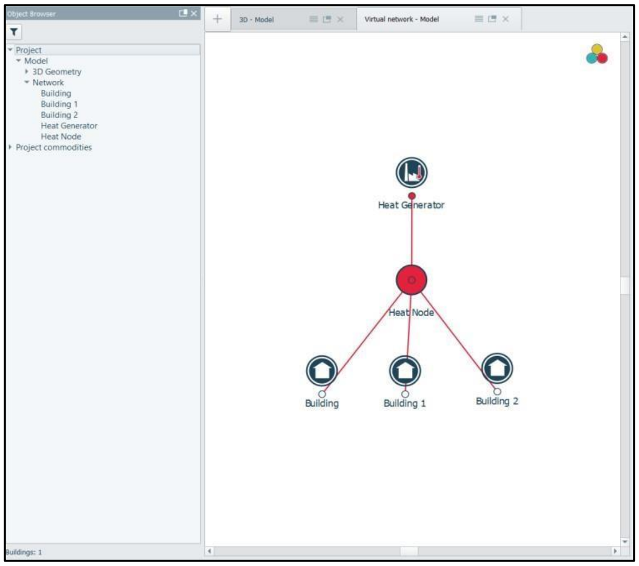
Similarly, when using imported buildings assets can be selected form the asset library and dragged directly into the project space (virtual network viewer).

The data inspector (see 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.



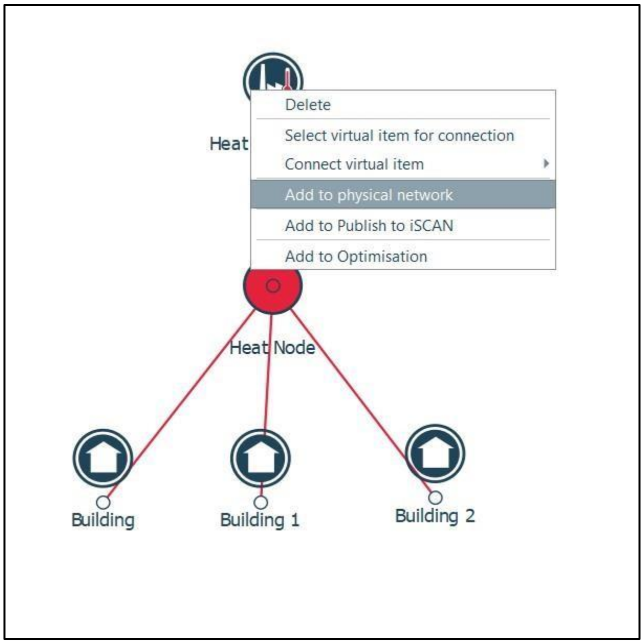
2.2.2 Creating a Virtual Network

To define a virtual network, connect assets to nodes that represent the commodities which are produced or consumed. Nodes can also be connected to other nodes to represent different "levels" where demand is aggregated. For more details about virtual networks, see Setting Up and Simulating a Virtual Network. A virtual network can be created by adding assets to the virtual network from the asset library. The network is outlined under the network drop down within the project located in the object browser.



2.3 Physical Network

In order to add assets to the physical network they first must 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'.



Requirements for a Physical network:

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

Heat:

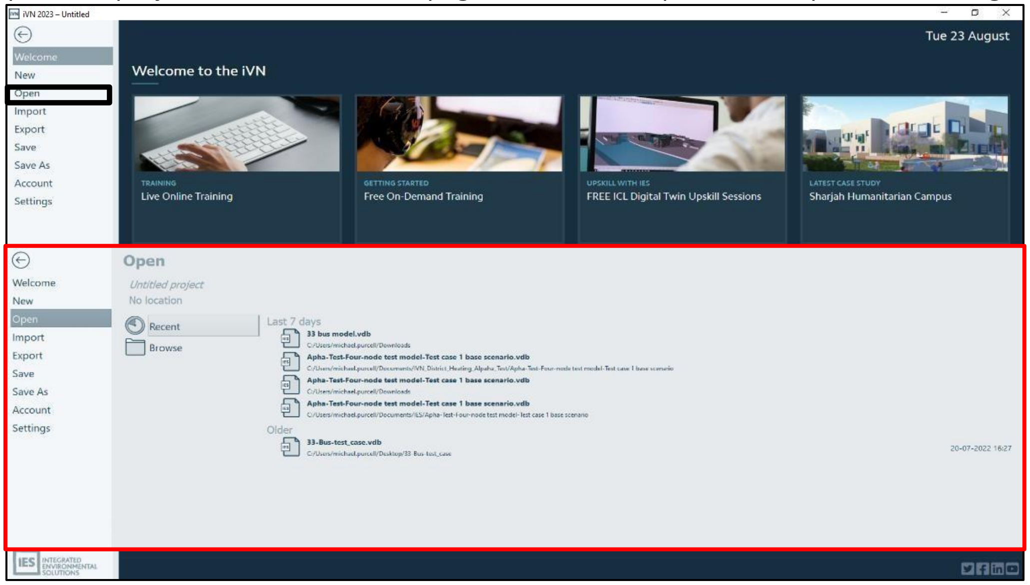
District Heat Network modelling allows for thermal energy design to be evaluated from a network infrastructure point of view and whether any changes or upgrades are required.

Optimise:

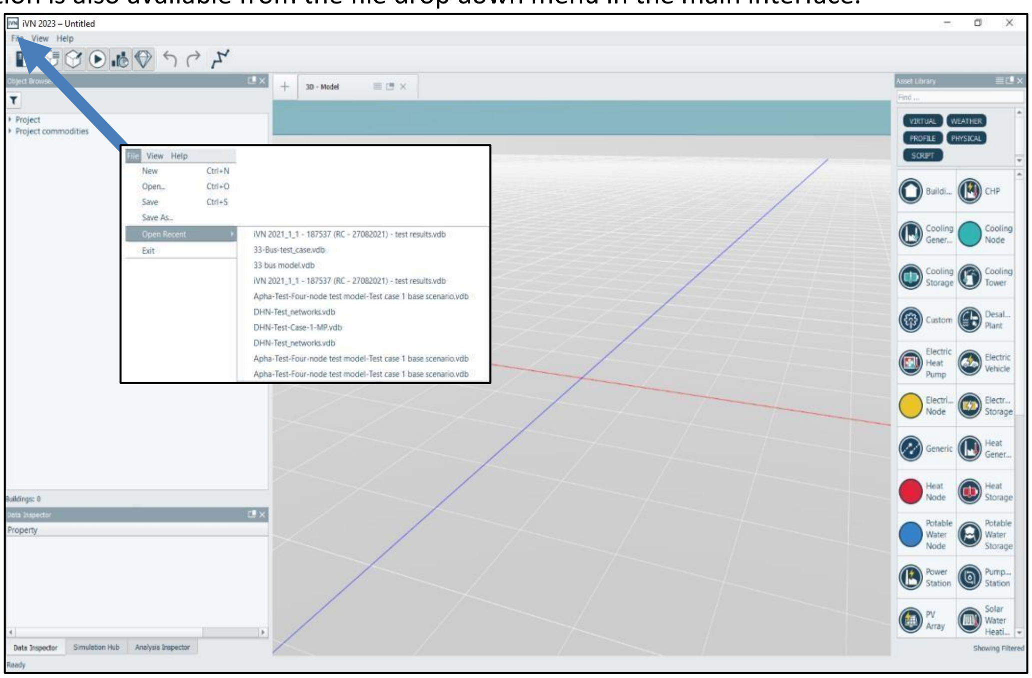
An optimisation problem can be set up by defining the objective(s) (e.g. minimize carbon emissions), variables and constraints to automatically give the optimal sizing of all assets in the design that satisfy the energy demand.

3 Open Previous Project

To open a previous project from the welcome page, click on the 'Open' tab to open and existing iVN project.



This function is also available from the file drop down menu in the main interface.



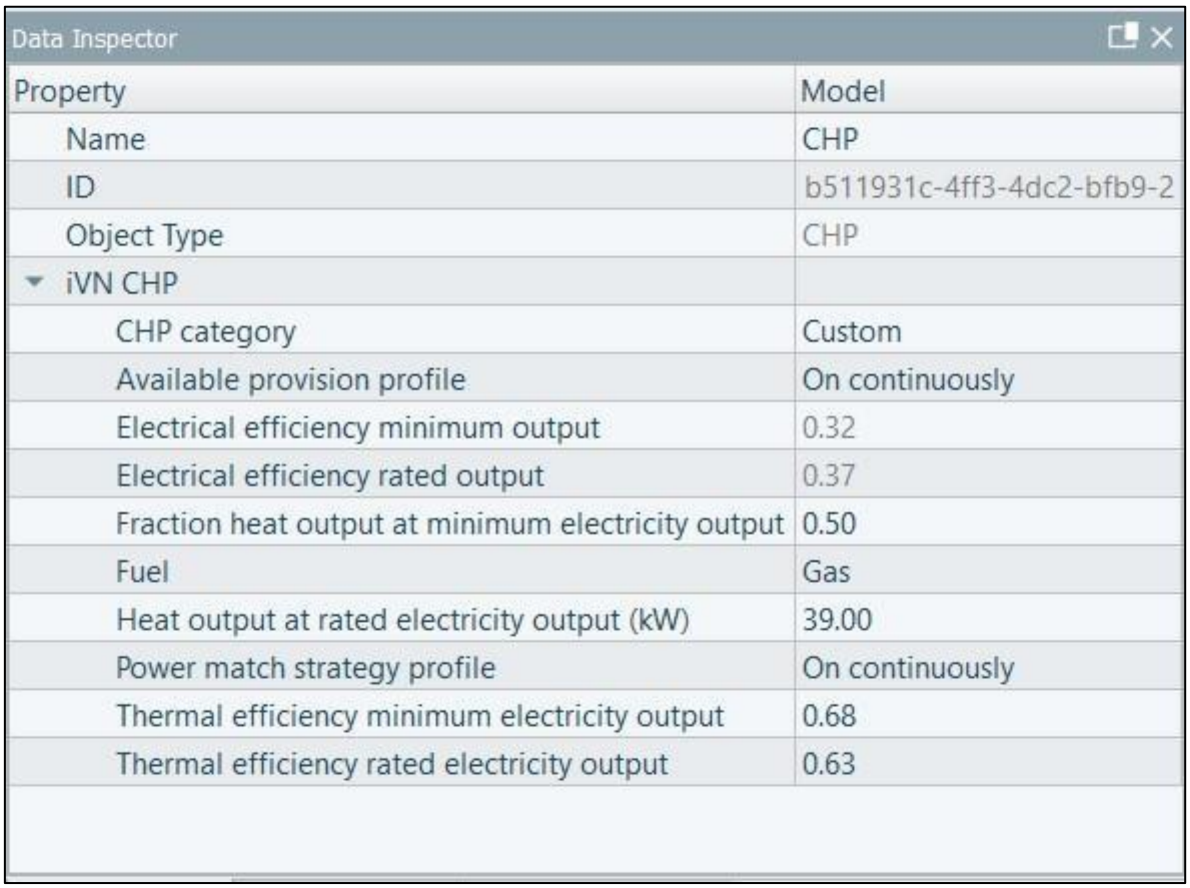
4 Navigate the Interface

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

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

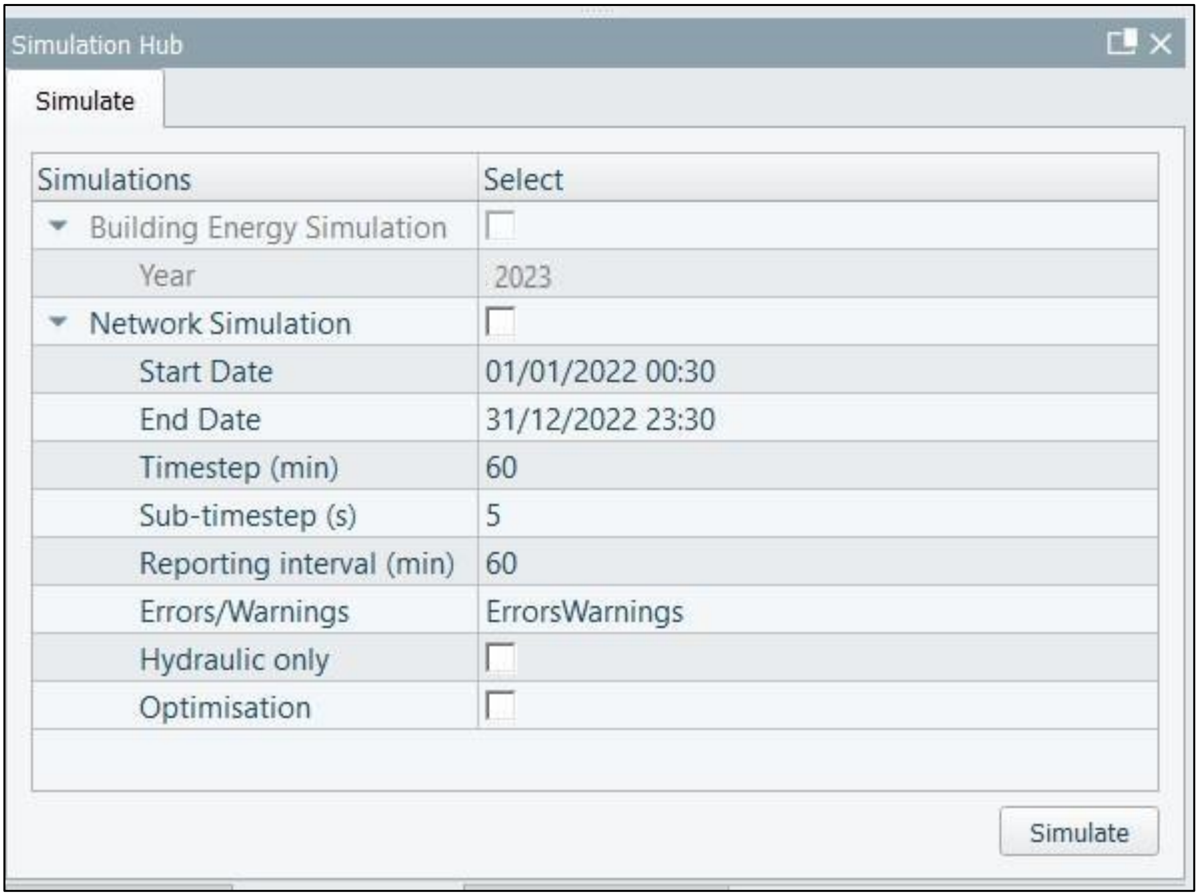
Property	Model
Name	CHP
ID	b511931c-4ff3-4dc2-bfb9-2
Object Type	CHP
iVN CHP	
CHP category	Custom
Available provision profile	On continuously
Electrical efficiency minimum output	0.32
Electrical efficiency rated output	0.37
Fraction heat output at minimum electricity output	0.50
Fuel	Gas
Heat output at rated electricity output (kW)	39.00
Power match strategy profile	On continuously
Thermal efficiency minimum electricity output	0.68
Thermal efficiency rated electricity output	0.63

(Image shows and example of a CHP asset parameters)

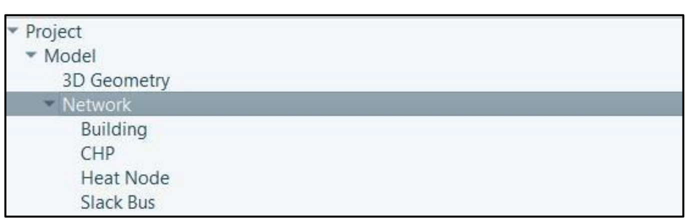
4.2 Simulation Hub

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.



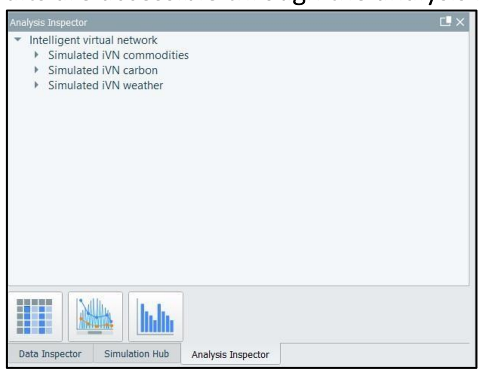
Note: In order to run a simulation, the network must be selected within the project browser.



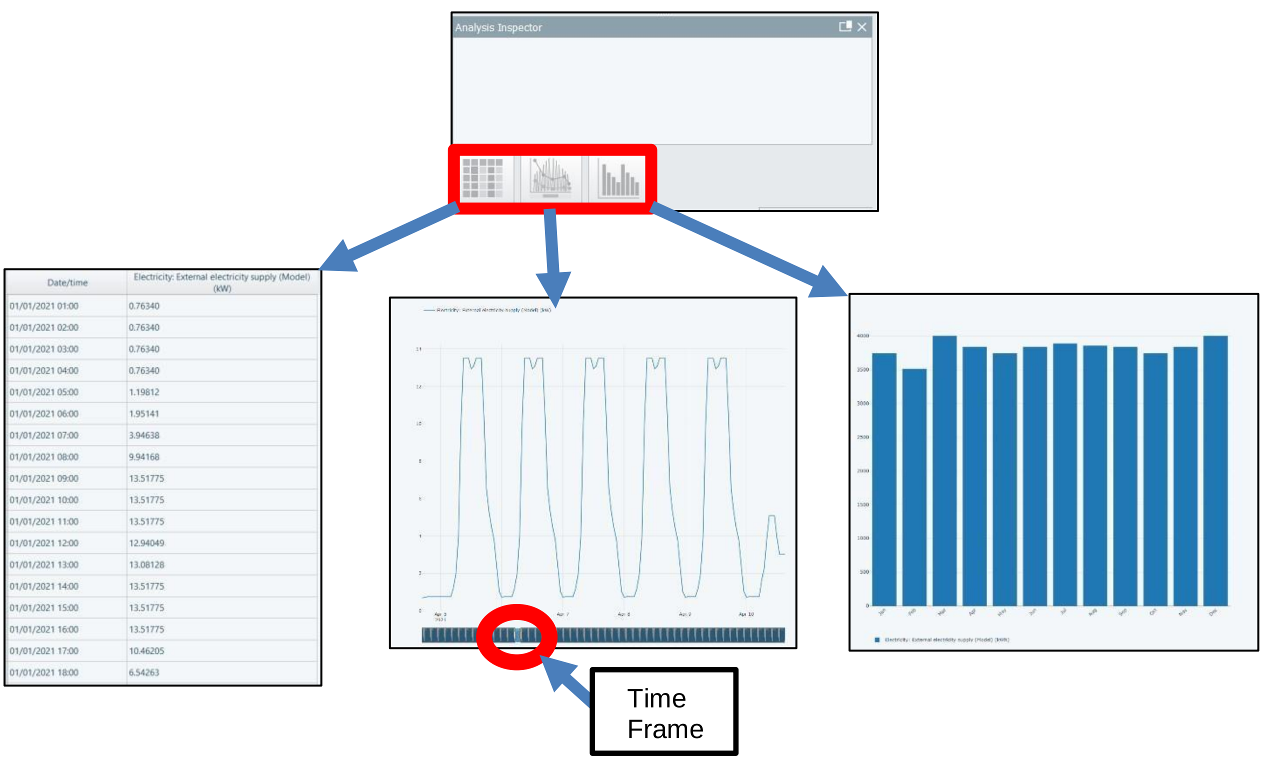
Note: Hydraulic only & Optimisation options are only available with additional corresponding license addons.

4.3 Analysis Inspector

Once a simulation is complete, the results are accessible through the analysis inspector.



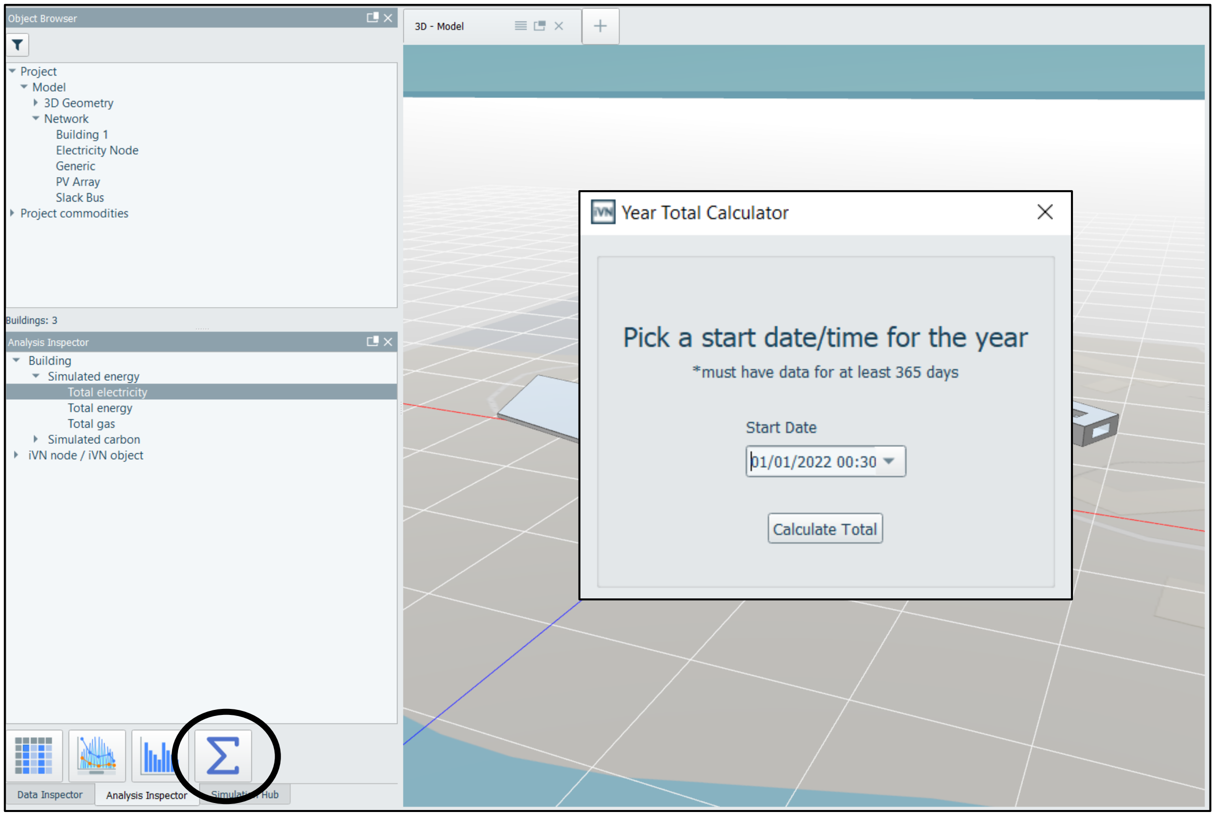
From the analysis inspector the user can specify the particular set of results they wish to view by selecting them from the drop-down menu and then specifying the desired method of representation from the 'Table Chart', 'Line Chart' or 'Bar Chart' as shown below.



Date/time	Electricity: External electricity supply (Model) (kW)
01/01/2021 01:00	0.76340
01/01/2021 02:00	0.76340
01/01/2021 03:00	0.76340
01/01/2021 04:00	0.76340
01/01/2021 05:00	1.19812
01/01/2021 06:00	1.95141
01/01/2021 07:00	3.94638
01/01/2021 08:00	9.94168
01/01/2021 09:00	13.51775
01/01/2021 10:00	13.51775
01/01/2021 11:00	13.51775
01/01/2021 12:00	12.94049
01/01/2021 13:00	13.08128
01/01/2021 14:00	13.51775
01/01/2021 15:00	13.51775
01/01/2021 16:00	13.51775
01/01/2021 17:00	10.46205
01/01/2021 18:00	6.54263

The yearly totals can be calculated for any simulated result that has data for at least one year.

The start date must be defined with at least 365 days of subsequent data in order for a yearly total to be calculated.



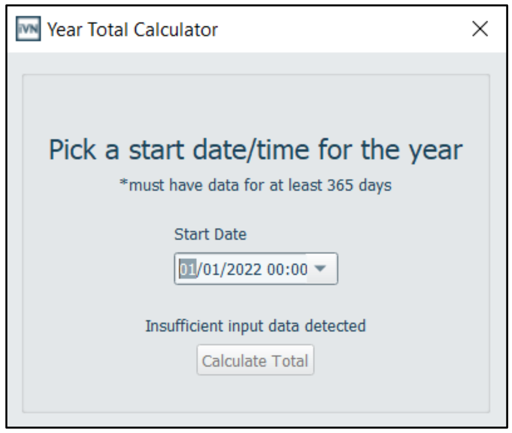
Once a yearly total is clouted a new tab will open displaying the specified yearly total variable, the specified start date, the end date (start date +365 days) and the resulting yearly total sum.

Variable name	Start Date/Time	End Date/Time	Total
Helix Building: Total electricity (Model) (kWh)	01/01/2022 00:30	01/01/2023 00:30	39605.85593

Each time a year total is calculated a new tab will be opened.

The chosen result variable must have at least 365 days of data in order to calculate a yearly total. If there is less than 365 days of data the user will be presented with a warning outlining insufficient data.

Insufficient data also occurs if the specified start date input does not have subsequently data for 365 days from the start date.



5 Licensing

Current packages available:

iVN Core:

The core functionality of the iVN, including generation asset simulation, virtual network creation, building demand simulation, ICL integration, and energy balancing and aggregation calculations.

iVN Core

iVN Heat:

District Heat Network modelling, allowing customers to further evaluate a thermal energy design from a network infrastructure point of view and whether any changes or upgrades are required.

iVN Heat

iVN Optimise:

Allows the customer to set up an optimisation problem, 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.

iVN Optimise

iVN Economics:

The ‘Economics’ tool package is designed for a user to be able to predict how long it will take to get a return on investment (ROI) for a designed network scenario. In order to make informed and economically concise decisions within the design and planning stages of a project, the cost and revenue of a project must be taken into consideration. Giving the user a valuable insight into the feasibility and profitability of their project from an early stage.

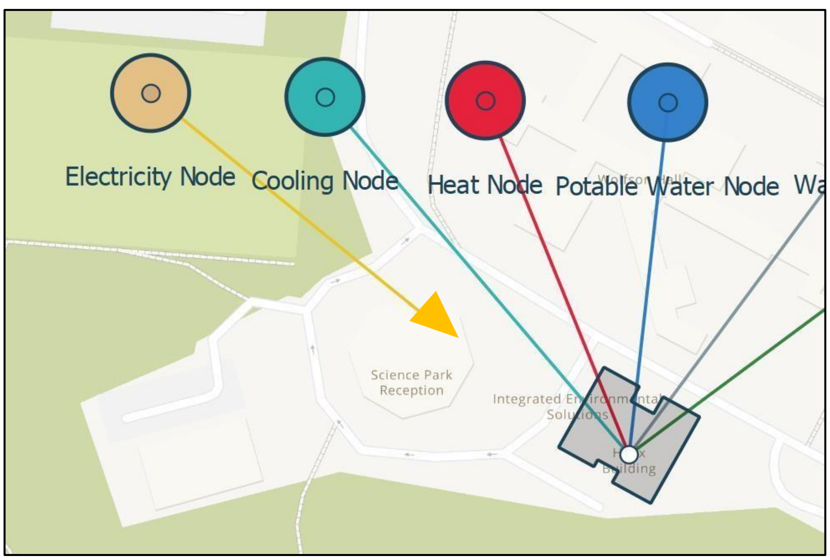
iVN Economics

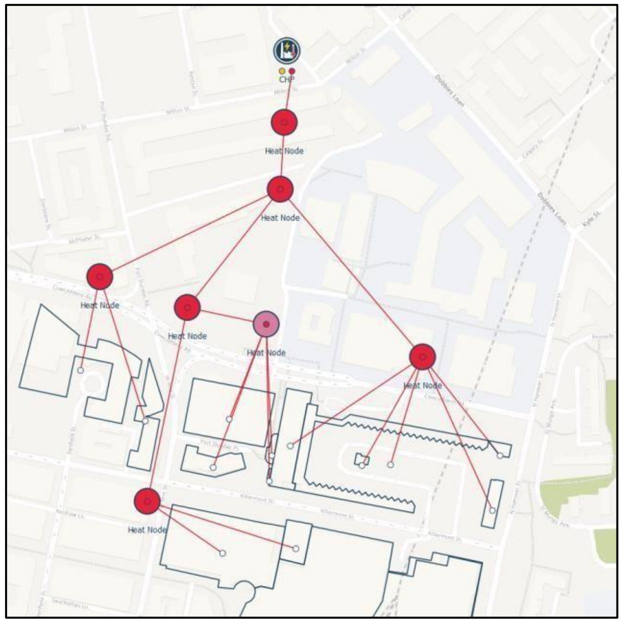
6 Setting Up and Simulating a Virtual Network

6.1 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.

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 a 1-to-many connections with many different node types. However, an asset can only have one connection to a node of a particular type.

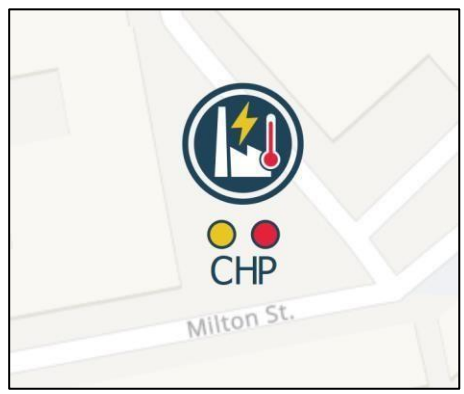




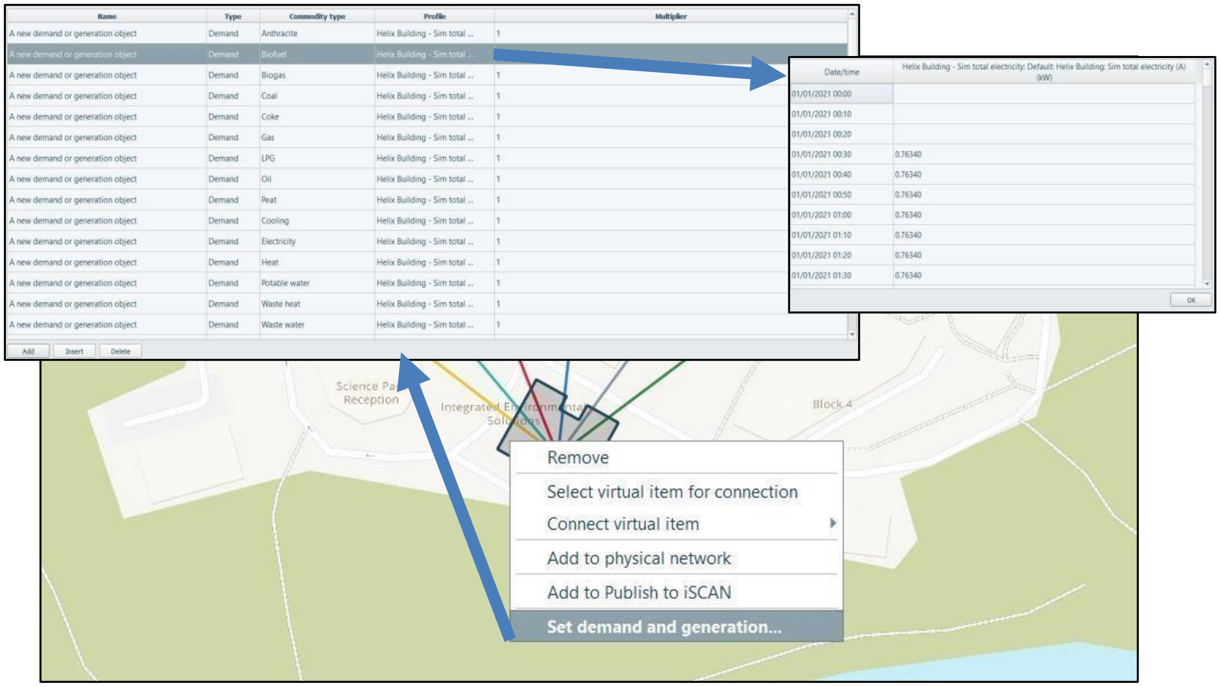
The parameters for each individual asset can be defined by clicking on the asset and using the data inspector.

Data Inspector

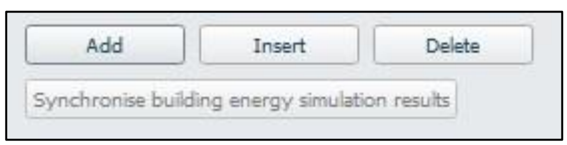
Property	Model
Name	CHP
ID	70b46820-2795-4915-8dd6-c5c96e49e6ad
Object Type	CHP
iVN CHP	
CHP category	Custom
Available provision profile	On continuously
Electrical efficiency minimum output	0.32
Electrical efficiency rated output	0.37
Fraction heat output at minimum electricity output	0.50
Fuel	Gas
Heat output at rated electricity output (kW)	39.00
Power match strategy profile	On continuously
Thermal efficiency minimum electricity output	0.68
Thermal efficiency rated electricity output	0.63



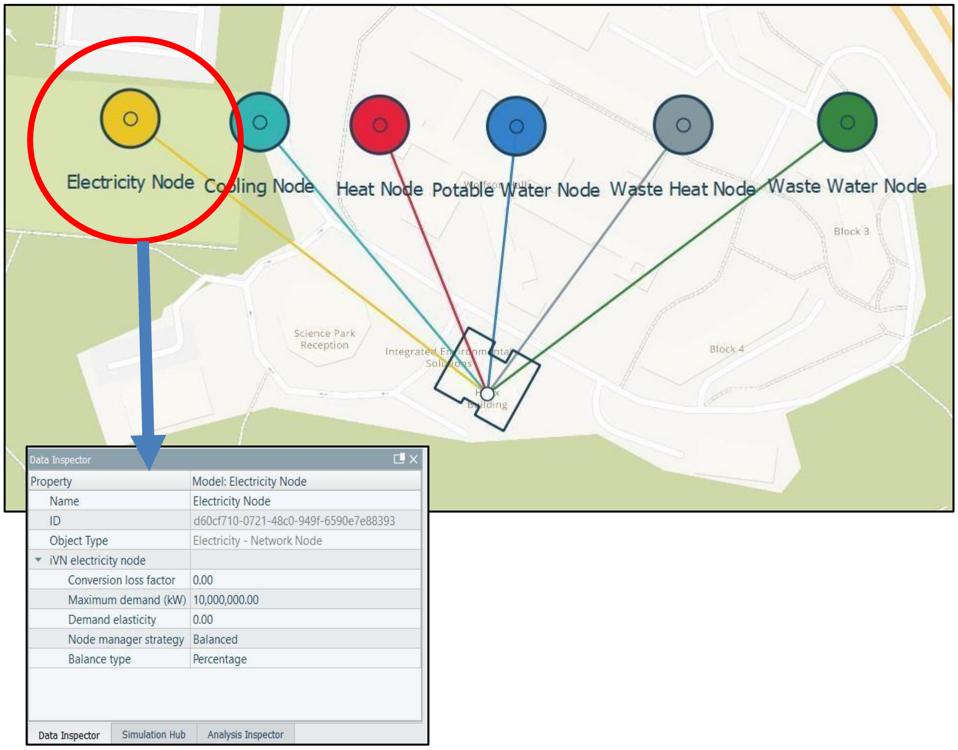
The demand and generation profiles can then be set for specific commodities by opening the ‘Demand and generation editor’ (access the editor by double clicking the asset / right clicking and selecting ‘Set demand and generation’). This dialog is available for buildings and generic installations.



The specific parameters of each node can also be defined using the data inspector.



When setting 'demand and generation' values for a building, the "Synchronise building energy simulation results" allows users to import demand and supply data obtained via an Apache energy simulation. Import the required data via the iCIM import function.



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

6.2 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;

Network Simulation:

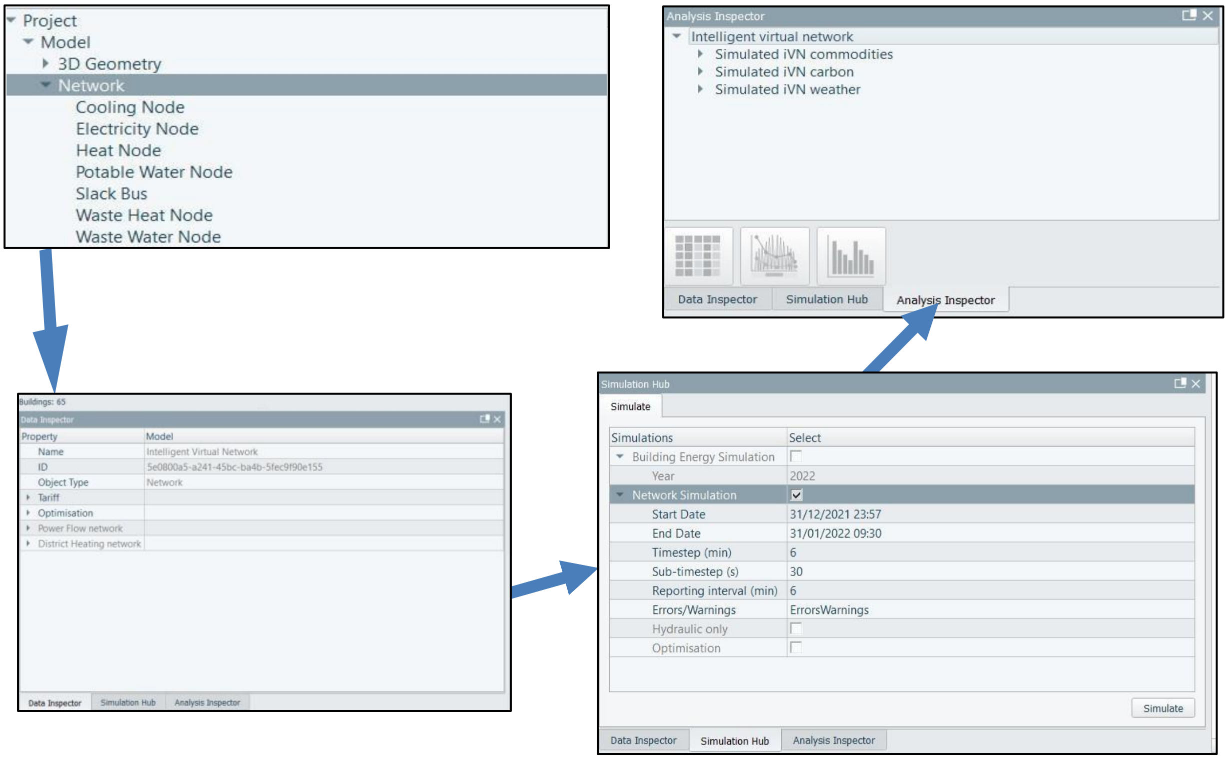
Start date: DD/MM/YYYY 00:00-23:59

End date: DD/MM/YYYY 00:00-23:59

Time step: 1-60

Reporting interval: X ≥ Time step

Errors and Warning preferences.



To run a virtual network simulation:

1. In “Object Browser”>>Project>>Model>>Network, make sure that “Network” is selected
2. In “Simulation Hub” make sure that the checkbox next to “Network Simulation” is ticked 3.

   Click “Simulate”

4. The results, when the simulation has finished running, can be viewed via the “Analysis Inspector”

Once the simulation is complete the results can be viewed using the analysis inspector as outlined previously in Analysis Inspector.

7 Setting Up and Simulating a Physical Network

In order to access the physical network, set up within iVN the user must have an additional add on package other than iVN Core (iVN Heat/Optimise). The current packages available are outlined in Section 4 Licensing.

To set up the physical network you should add all assets to the physical network (heat junctions and connect everything together).

To check volume flow rates, run a hydraulic-only simulation.

Set the "Maximum volume flow rate" parameter for the district heating network to a value slightly higher than the plotted maximum

Configure pipe parameters appropriately to "length override" if appropriate.

Changing the sub timestep can improve simulation run time and errors.

Note: If a user imports or opens a previous project containing unlicensed networks/assets it will still be openable as a READ-ONLY file

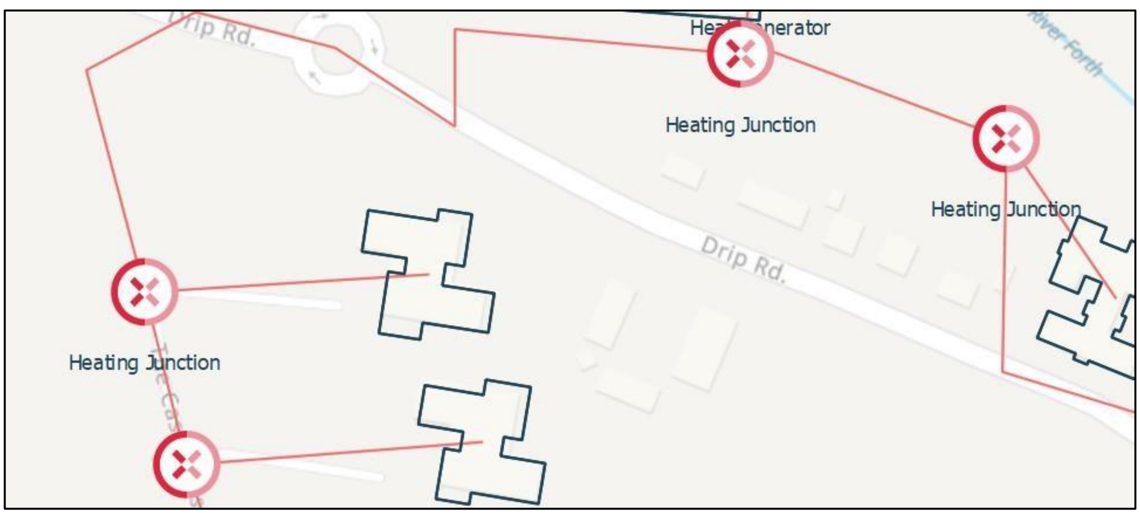
7.1 iVN Heat

7.1.1 iVN Heat Set-up

In order to create a district heating network, the user must have access to an iVN Heat license.

All assets required in the network must first be established within the virtual network of the project. Once the assets are added to the physical network the physical infrastructure of the heat network can now be drawn.

Each length specified consist of a Supply and Return pipe. The specific parameters of these pipes can be defined using the data inspector, a defined length can be implemented using the length override input.



Heating junctions as shown above are used as junction points along the network. Heating junctions are draggable assets available from the asset library. Heating junctions are also used along a district heating network to specify the specific point's elevation or the fixed head of a heat network along with the other heating network assets and buildings.

Note: Each heat network must only have one defined point with a fixed head value.

Heating junction data inspector input variables:

Data Inspector

Property	Heating Junction	supplyNode	returnNode
Name	Heating Junction	supplyNode	returnNode
ID	01bc04ec-f5b9-4e2a-b14d-8e25	457c5bbe-a92d-4d9d-b57f-f663	05405702-84c3-4a33-af78-f0293d8bb6b1
Object Type	District Heating Network Object	District Heating Network Object	District Heating Network Object
Node			
Is head fixed		false	false
Fixed head (m)		0.00	0.00
Elevation (m)		0.00	0.00

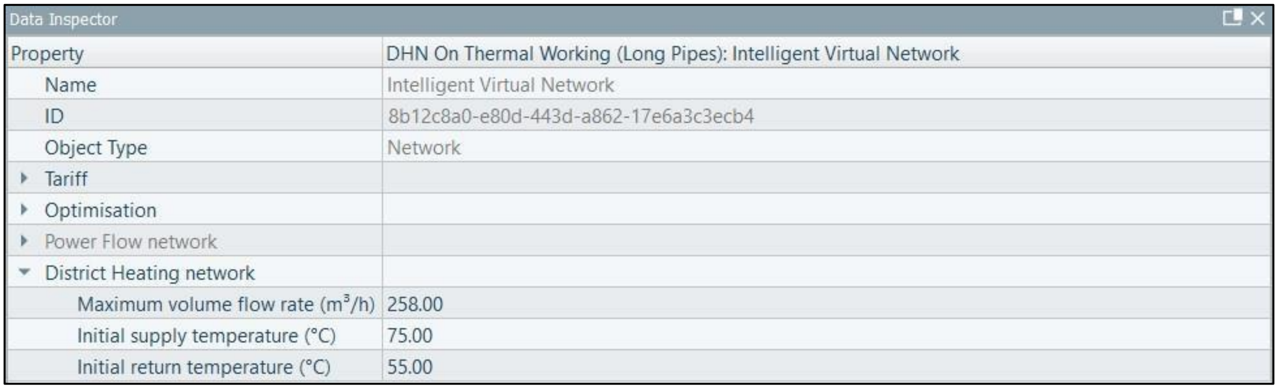
The data inspector outlines the specific input variables required when creating a district heating network for each asset involved. The data inspector below shows the input variables available for a specific run of pipes within a district heating network.

Data Inspector

Property	DHN On Thermal Working (Long Pipes)			DHN On Thermal Working (Long Pipes)
Name	Return Link	Return Pipe	Supply Pipe	Supply Link
ID	61f647cd-ccc5-4fd1-a6c5-025fd8b3a2cc	d31246c1-f77e-4f3a-8c9d-a41d	e2997e03-37f6-4055-841b-6f43	145730cf-bd59-4c40-b5e0-e3c5327c76e9
Object Type	District Heating Network Object	District Heating Network Object	District Heating Network Object	District Heating Network Object
Link				
Maximum volume flow rate override	false			false
Maximum volume flow rate (m^3/h)	258.00			258.00
Pipe				
Diameter (mm)		150.00	150.00	
Length override		true	true	
Length (m)		2,000.00	2,000.00	
Thickness (mm)		50.00	50.00	
Density (kg/m^3)		7,850.00	7,850.00	
Heat capacity (J/(kg·K))		465.00	465.00	
Roughness (mm)		0.0500	0.0500	
Thermal conductivity (W/(m·K))		100.00	100.00	
Thermal transmittance (W/(m^2·K))		0.04	0.04	

Data Inspector | Simulation Hub | Analysis Inspector

The district heating parameters for the network are set when the network as a whole is selected from the project browser. The maximum volume flow rate (m^3/h) parameter should be set to a value that is just slightly greater than the maximum flow rate found in the network. A simulation performed in hydraulic only mode (see section 7.1.2) can be used to help identify this value. Initial temperatures for the supply and return sides of the network can also be set. The initial supply and return temperatures should be set to values equal to (or close to) the typical design operating temperatures of the network to ensure that there are sufficient temperature differences across heat consumers.



Property	DHN On Thermal Working (Long Pipes): Intelligent Virtual Network
Name	Intelligent Virtual Network
ID	8b12c8a0-e80d-443d-a862-17e6a3c3ecb4
Object Type	Network
Tariff	
Optimisation	
Power Flow network	
District Heating network	
Maximum volume flow rate (m^3/h)	258.00
Initial supply temperature (°C)	75.00
Initial return temperature (°C)	55.00

7.1.2 iVN Heat Simulation

Similarly, to the virtual network the network simulation parameters are specified within the "Simulation Hub" tab Network Simulation:

Start date: DD/MM/YYYY 00:00-23:59

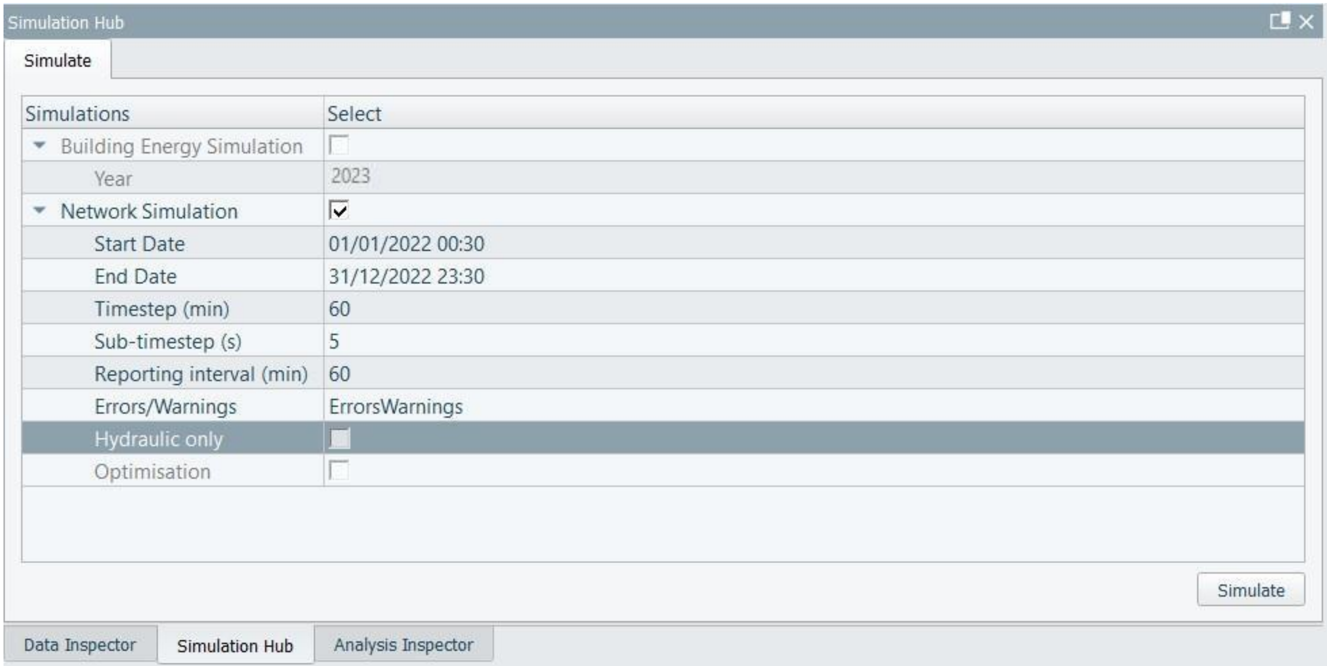
End date: DD/MM/YYYY 00:00-23:59

Time step: 1-60

Reporting interval: X ≥ Time step Errors

and Warning preferences.

iVN Heat also has the option to run a 'Hydraulic Only' simulation allowing the user to only calculate a steady state hydraulic problem to determine the head at each node, and the volume flow rate through each link of the network.



The hydraulic model is used for computing the flow rate and pressure head for each pipe. iVN uses the nodal method in combination with demand-driven analysis to assume a steady-state solution. This involves the solution of the Bernoulli equation considering flow rate boundary conditions and head losses in pipes due to friction - but as water is assumed to be incompressible and its properties are temperature invariant, the problem becomes framed in terms of volume flow rate.

7.1.3 Configuring a District Heating Network

The following steps can be taken to help configure a district heating network and deal with common errors that can occur when performing simulations of district heating networks:

1) Since district heating calculations can take a very long time, it is convenient to use a short simulation period (such as 1 day or 1 week) for simulations when testing different configurations. Setting the sub-timestep parameter in the simulation hub tab to 30 seconds also significantly improves simulation times.
2) Check to ensure that there is exactly one fixed-head node in the model. If both the supply and return nodes of a single heat junction are set to be fixed-head nodes, then one of these nodes should be set to have fixed head false.
3) Check to ensure that each building that requires heat from the district heating network has a heat demand profile set in the demand and generation dialog. Since heat demand is used to determine flow rate boundary conditions in the network, heat demand data is also required for hydraulic-only simulations.

4) Check to ensure that there is enough heat generation to meet the heat demands in the network. This means having heat generators or CHP plants with sufficient capacity to meet the heat demand for all buildings in the network. When using CHP plants in district heating networks, it can help to set them to be heat-driven (this is achieved by setting the "power-matching profile" parameter to "Off continuously") and to set the minimum heat output to zero (this is achieved by setting the "fraction of heat output at minimum electricity output" parameter to 0). This makes sure that heat generators generate enough heat at all times to meet the heat demand, ensuring smooth operation.

5) Check to ensure that the maximum volume flow rate for the district heating network is set to a value that is slightly greater than the maximum volume flow rate encountered in the network. A good value to choose can be found by performing a hydraulic-only simulation and checking the flow rate in all parts of the network. If the maximum volume flow rate is too small, then flow rates at buildings will be too small to meet demand, giving rise to issues in the simulation.

6) The thermal solution of the district heating network is a conditional algorithm that requires a Courant Friedrichs-Lewy (CFL) criterion to be satisfied. If simulation errors are reported relating to this CFL criterion, or to undersized pipes, then the following changes can be made to help mitigate this: a. Increase pipe diameter

   b. Set the length override to "true" and increase the pipe length

   Increasing pipe diameter, in particular, is the best measure to improve the stability of the thermal solution and mitigate the CFL errors. This is because a larger diameter increases the pipe cross-sectional area, which consequently decreases the water flow speed, which is the main run-time variable that affects the CFL criterion. Increasing pipe diameter is often necessary for pipes situated close to heat supply units (examples include heat generators and CHP plants) and for pipes that act as trunks that carry most of the hot water through the network.

   Decreasing the sub-timestep parameter in the simulation hub also helps reduce the occurrence of these errors, but it significantly increases the simulation run-time. Therefore, it is not recommended to set the sub-timestep to a value lower than 5 seconds.

7) If the temperatures of nodes are dropping considerably, then double-check that the heat generators are providing heat (step 1 above). If there are substantial heat losses from pipes, then reducing the "thermal transmittance" parameter of pipes will reduce the losses to the environment. Increasing pipe thickness and heat capacity will increase the thermal inertia of the pipe material. This doesn't necessarily reduce heat losses to the environment, but it will make these losses more consistent, reducing temperature fluctuations in the pipe and, consequently, in the fluid contained within the pipe.

7.1.4 Network Considerations

Basic considerations when building a district heating network:

- Supply/demand units cannot inject/remove heat from a single side
- Supply/demand units cannot be attached to the same junction

- Supply/demand units cannot be connected to 1+ junctions
- States iVN does not allow more than 1 isolated district heating networks
- Recommended that all demand units in the network have demands > 0
- The model can take hours to days to settle down
- Buildings can only be connected to 1 generating asset (either heat generator, CHP, or heat pump)
- All heat networks must be connected to electricity to function

District heating network properties to check before running the simulation:

- Set one fixed head node (definition in Glossary)
- Make sure to click network before running the simulation
- For the demand/generation, in the "virtual" network, change the type from electricity to heat
- The slack bus should be connected via electricity to other assets
- Check that imported data dates i.e. iSCAN (ISCAN Link)
- Heat storage is only in the virtual

7.2 iVN Optimise

In order to optimise a specific network, the user must have access to an iVN Optimise license.

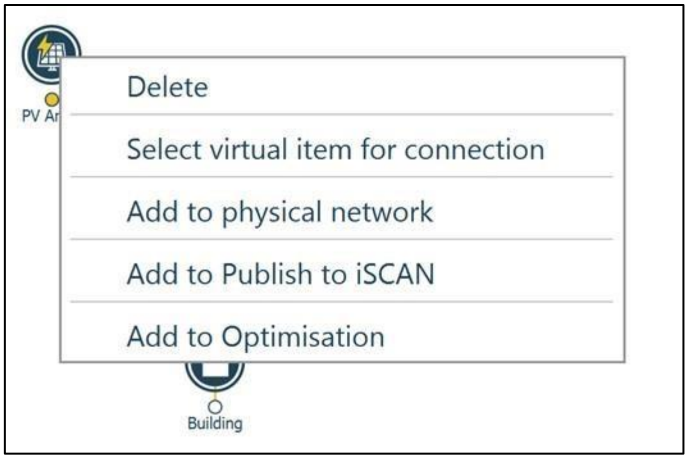
The optimisation feature depends greatly on the iVN model and the input parameters set by the user, the current optimisation capabilities have been purposefully limited to a small set of objective functions. To be specific, the feature currently only supports the minimization of the external supply of electricity, heat and/or cooling. Consequently, the main use case for the optimisation feature is the sizing of intermittent renewable energy sources based on the input weather data, the rated powers and the total demand.

7.2.1 Setting Up an Optimisation Problem

In order to set up a model for optimisation:

1. Add assets to be optimised using the 2D virtual network view
2. Set optimisation parameters in the optimisation dialog

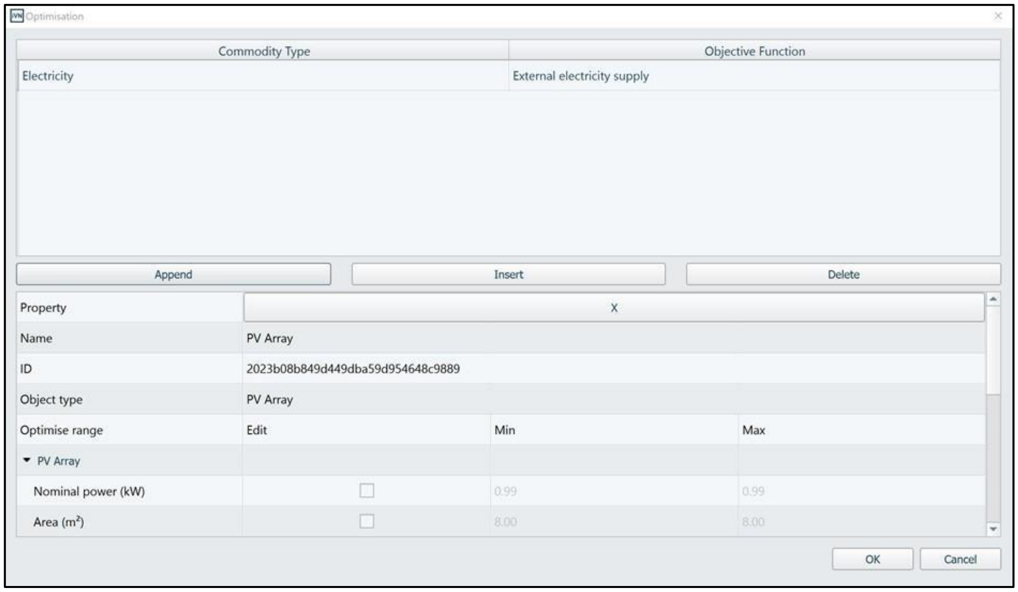
To achieve step 1, right-click on any asset you wish to optimise in the 2D virtual network view and choose "Add to Optimisation".



This will add the asset to the list of assets that can be configured in the optimisation dialog.

To open the optimisation dialog, select "Network" in the object browser and then click the cell "Set optimisation" twice. This cell is to the right of the "Setup" property of the optimisation category, as shown in the diagram below:

A button will appear allowing the user to open the optimisation dialog.



If the bottom section is empty, make sure to do step 1 above, which will add assets to the optimisation dialog.

At the top of the panel there is a list of objective functions. Click “Append” or “Insert” to add a new objective function to the list which will appear below the current selection. To delete an objective function, click on it, then click “Delete” to remove it. The objective functions are used to determine the overall aim of the optimisation algorithm. For example, if “External electricity supply” is chosen as an objective function, the optimisation algorithm will try to optimise the parameters in such a way as to minimize the external electricity demand.

The list of objective functions to choose from is currently limited, but as the IVN continues to be developed, this list will expand to include more objective functions.

At the bottom of the panel there is a list of assets that have been added to the optimisation dialog. To remove an asset from the optimisation, click the “X” button. For each asset, select which parameters are going to be optimised and, consequently, become decision variables for the optimisation algorithm by clicking the check boxes under the “Edit” column. For each parameter the minimum and maximum values that the optimisation algorithm will consider can be set.

7.2.2 Optimisation Results

The end result of an optimisation is an individual with the best fitness score. Because the fitness score is a direct representation of the ability of the model to minimize or maximize particular variables of interest to the user, the decision vector for the optimal result can be used.

The following dialog will appear:

The files generated by the optimisation algorithm can be probed in order to look at more detailed results.

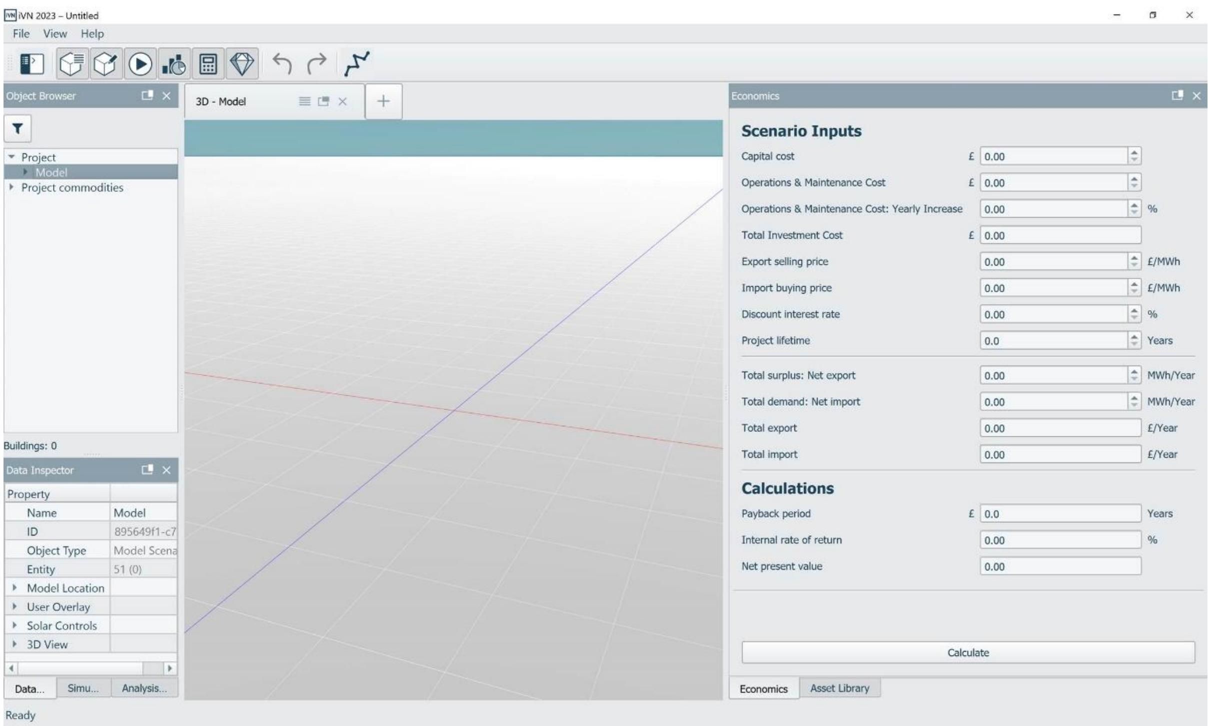
Clicking “OK” will replace the parameters in the model which were set to be decision variables to those calculated as the optimal solution. Clicking “cancel” will keep the parameters as they were before the optimisation was initiated.

7.3 iVN Economics

The Economics package is a tool designed to include economic factors associated with designing a network at a scenario level and asset level. It is designed in order for a user to determine the economic feasibility of a design or project.

The Economics package is designed in order for the user to be able make informed and economically concise decisions within the design and planning stages of a project by incorporating the total cost and revenue of a project. Giving the user a valuable insight into the feasibility and profitability of their project from an early stage.

7.3.1 Set up



The economic panel can be accessed by the RHS docked panel viewer. It can be toggled via the economic ribbon icon , alternatively it can also be toggled on/off via the view settings and by right clicking the top panel.

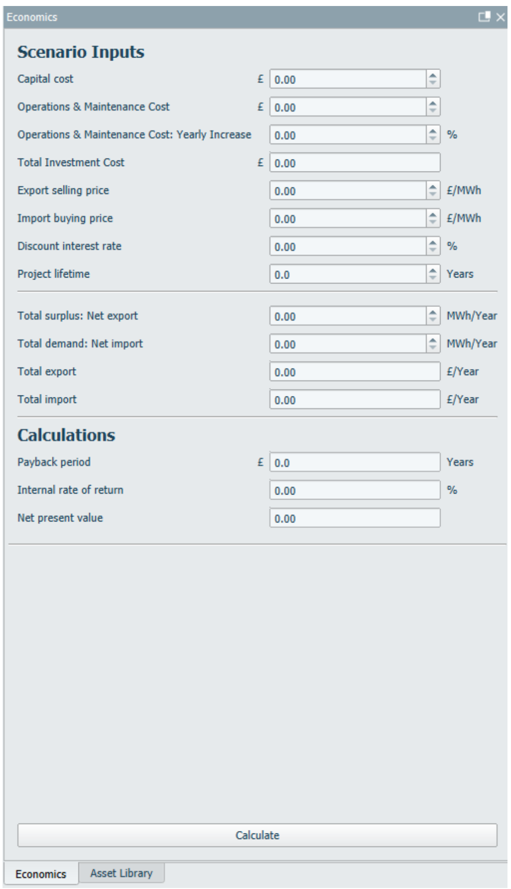
Once the economic panel is visible the input variables will only be editable at and model scenario level.

To activate the panel the 'Model' must firstly be selected via the object browser.

Once the economic panel is active the input fields will become editable.

The 'Calculate' button will remain inactive until the required input criteria are met.

Scenario inputs	Unit	Criteria
Capital cost	£	Positive rational number
Operations & Maintenance cost	£	Positive rational number
Operations & Maintenance cost: Yearly Increase	%	Range of 0-100%
Export selling price	£/MWh	Positive rational number
Import buying price	£/MWh	Positive rational number
Discount interest rate	%	Range of 0-10%
Project lifetime	Years	Positive integer
Total surplus: Net export	MWh/Year	Positive rational number
Total demand: Net import	MWh/Year	Positive rational number



7.3.2 Results

Once all input variable criteria are met a calculation can be completed by clicking the 'Calculate' button.

The results will populate within the text boxes located in the calculations section.

Calculated economic results:

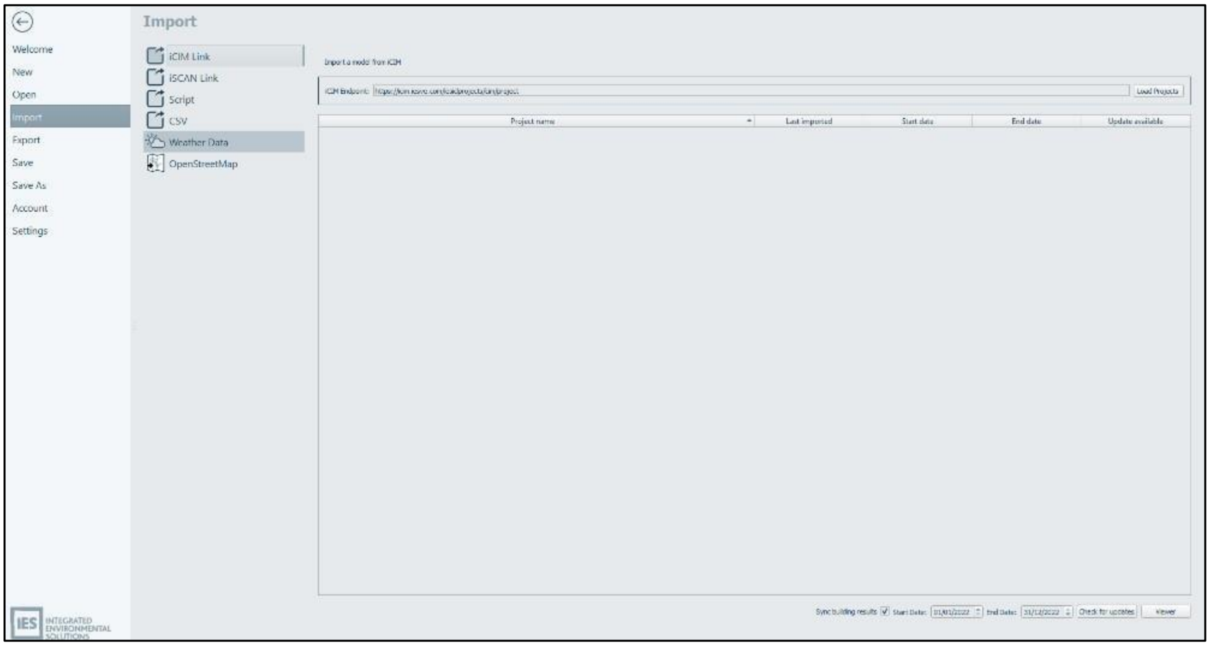
- Payback period - The number of years required to recover the original investment.
- Internal rate of return - The expected compound annual rate of return that will be earned on a project or investment.
- Net present value – The current total value of the investment opportunity.

If the user updates/edits any of the defined input variables after a calculation has be completed the calculated results will become outdated/out of sync with the current set of inputs, this is highlighted by the calculations turning red.

Re-calculating the results will update the results field to match the now updated input variables.

8 Import Function

The ‘Import’ tab located on the “Homepages” provides the user with several options to import data into the iVN.



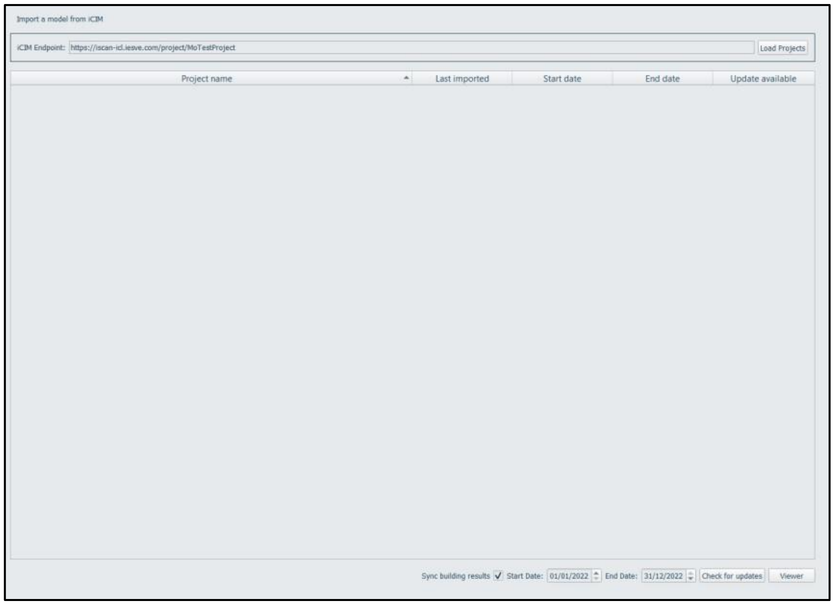
8.1 iCIM Link

Import a model from iCIM by loading the projects 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:

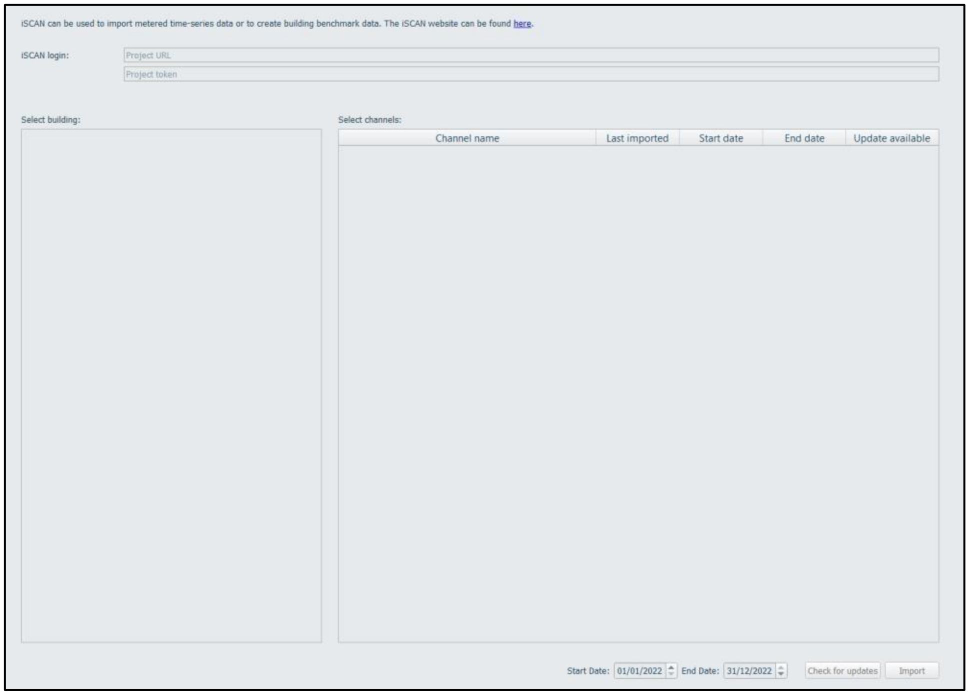
https://icim.iesve.com/iesiclprojects/cim/project

Once this is done a prompt will pop up to enter iCIM log in 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.

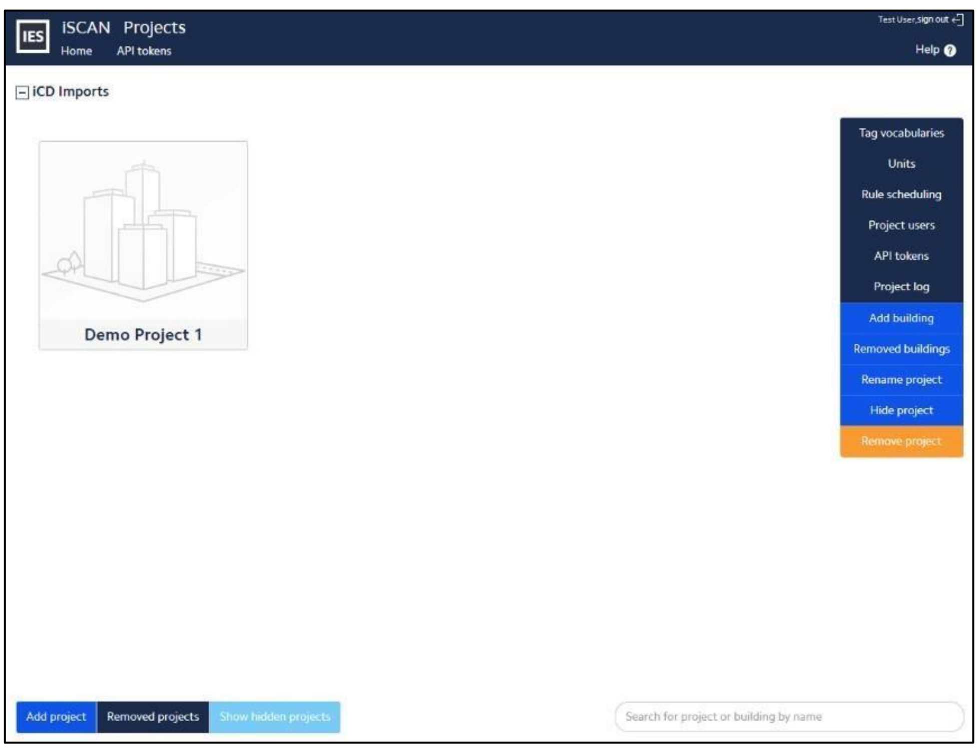


8.2 ISCAN Link

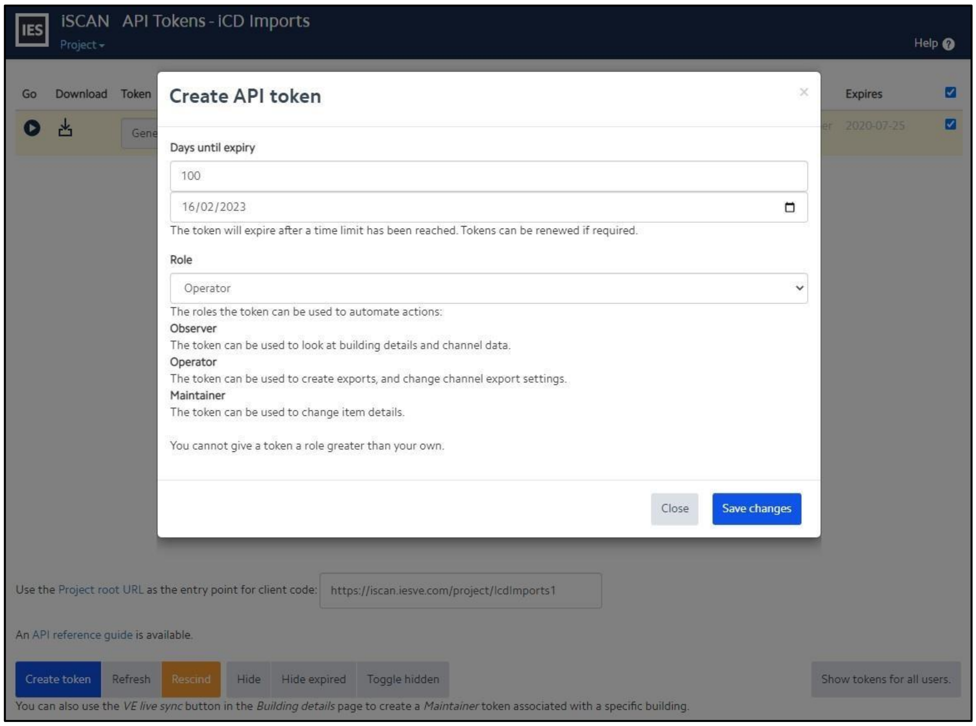
iSCAN can be used to import metered time-series data or to create building benchmark data. To import time series data, the project URL and project API token links are required to be copied and pasted into the section shown below. Once this is done, log in to the iSCAN account through the pop-up dialogue.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



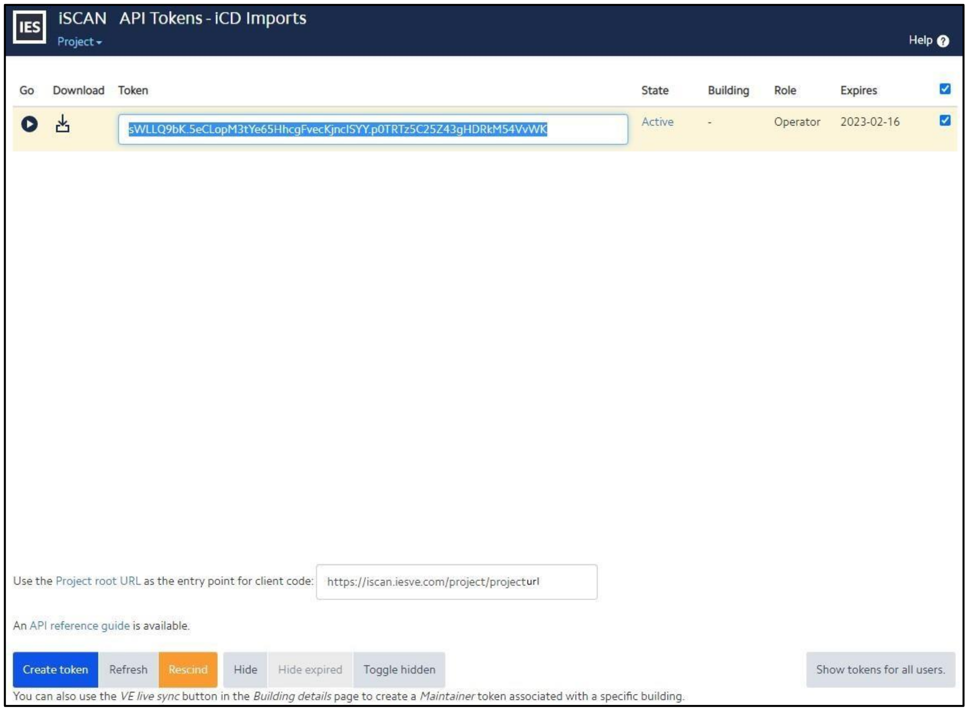
To generate the iSCAN API token and get the project URL, log in to iSCAN and navigate to the desired project, and select "API tokens" in the menu on the right of the screen.



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.



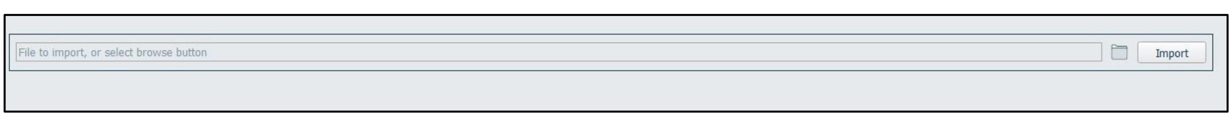
8.3 Weather Data

iVN Energy simulations require reference weather data for the location of the building. A set of standard simulation weather files are 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) needs 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.

8.4 Script

The import of python scripts is done in much the same way as the weather installations. Default python scripts are available on the IES website, or the user can create their own.



These python scripts can be used to simulate the behavior of specific assets not available as standard in the iVN asset library. Once a script has been imported, it can be used through the custom installation asset in the virtual network. A custom installation is added to the virtual network, and the python script can be selected through the data inspector when the custom installation in question is highlighted.

8.5 OpenStreetMap

Outlined in Import from OpenStreetMap.

8.6 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 according format;

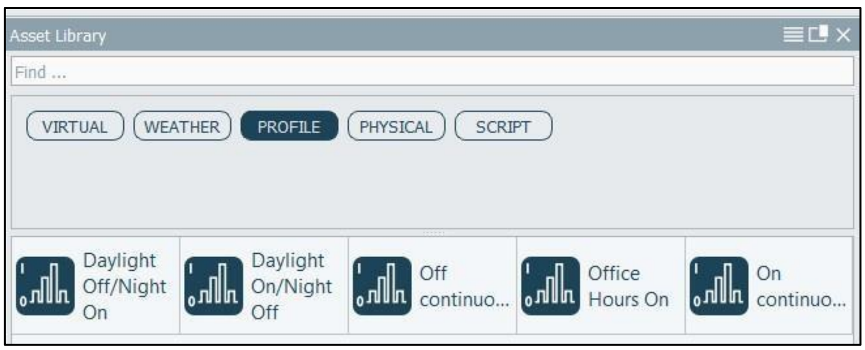
'Row per profile' structure shown below;

	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

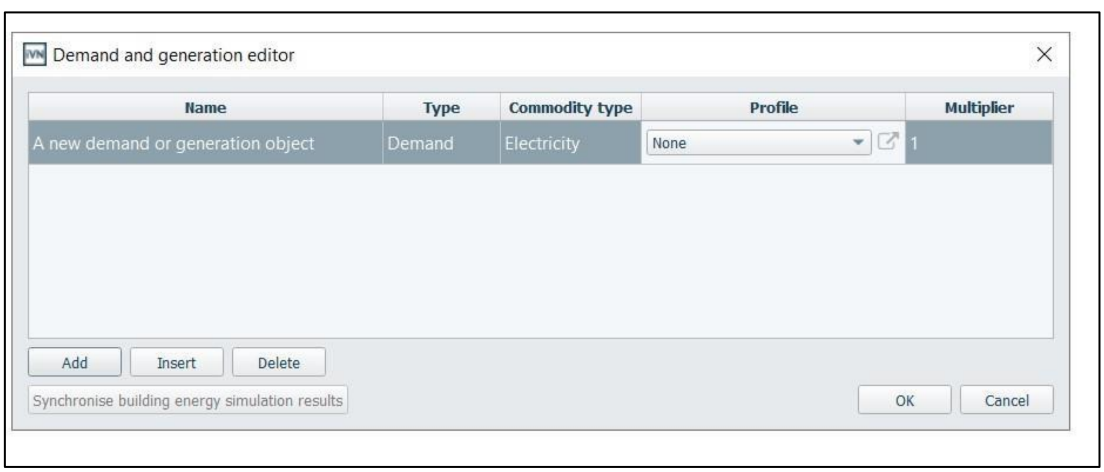
‘Column per profile structure shown below;

	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

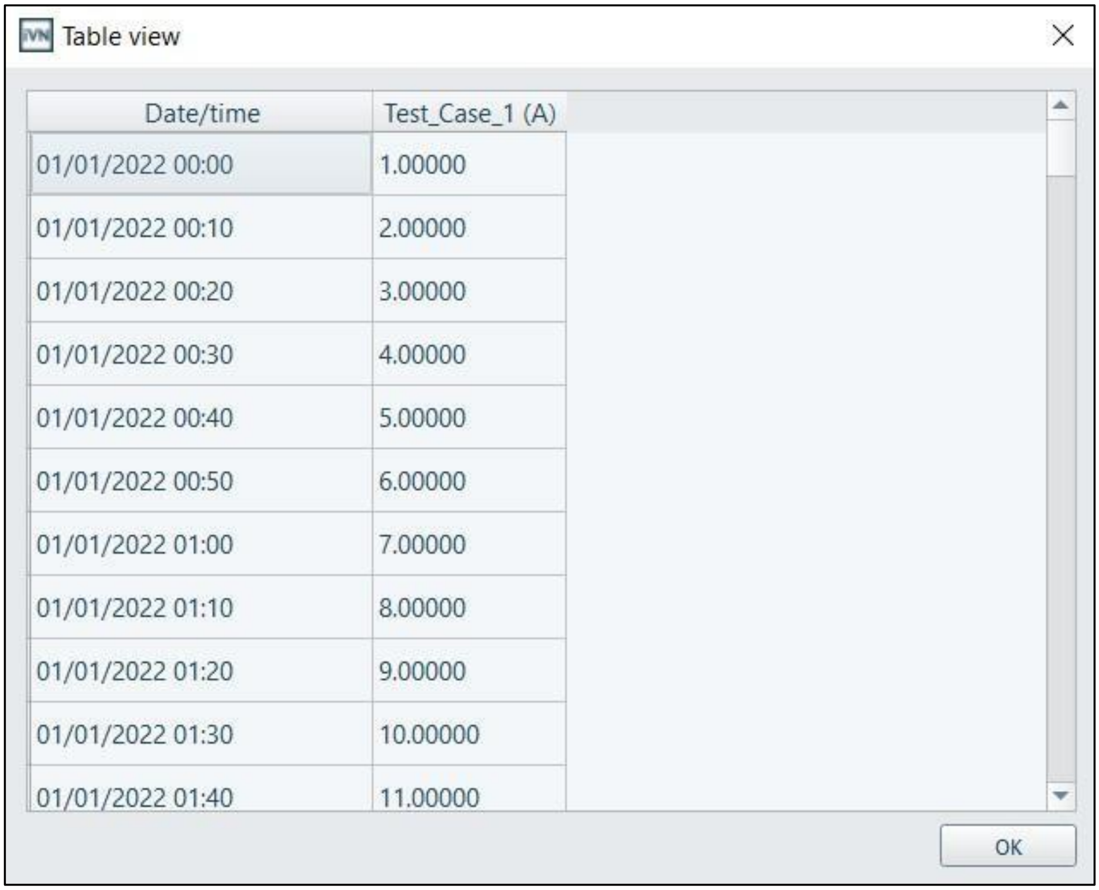
Once the profiles have been imported they are then available to be specified as time series data for demand/supply assets within an iVN Network.



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’.



The profile selected can then be previewed in order to ensure the correct profile is being assigned.



Date/time	Test_Case_1 (A)
01/01/2022 00:00	1.00000
01/01/2022 00:10	2.00000
01/01/2022 00:20	3.00000
01/01/2022 00:30	4.00000
01/01/2022 00:40	5.00000
01/01/2022 00:50	6.00000
01/01/2022 01:00	7.00000
01/01/2022 01:10	8.00000
01/01/2022 01:20	9.00000
01/01/2022 01:30	10.00000
01/01/2022 01:40	11.00000

9 Additional Resources

9.1 Glossary

- **Heat generator**: Provides heat by burning a fuel (similar to power stations and CHP), and can be used to approximate electric heat pump installations in cases where fuel is used instead of electricity. Only 1 can be connected to a given asset e.g. a building. One of its variables that can be set is the k factor which is used to apply a weighting of how much water can flow to the generator. It comes from a coefficient in the Bernoulli equation.

- **CHP, combined heat and power**: Provides electricity and heat by burning a fuel (similar to power stations and heat). This installation must be connected to 2 nodes: they can only meet the demand for electricity or heat (not both) with the other commodity generated as a useful by-product. When appropriate, ensure that the CHP plant is in heat-driven model ("power matching profile" set to "Off continuously"), because otherwise the CHP plant is only configured to meet electricity demand. Not setting the CHP plant to heat-driven mode causes it to provide zero (or too little) heat to the DHN, preventing normal operation and causing errors.

- **Heating junction**: Heating junctions are used as junction points along the network and are draggable. They are also used along a district heating network to specify the specific points elevation or the fixed head of a heat network along with the other heating network assets and buildings. They are used when a user wants to define a point in space where the pipes are connecting to show ensure that there will always be a supply and return. It is recommended to include them when possible.

- **Heat storage** or **thermal storage**: Primary method to store heat in a network using the 'energy bin model' (like electricity storage). The model doesn't use a latent tank model and treats the storage device as a container for energy. As this is currently not possible to model in district heating networks, it can only be set in the virtual network.

- **Fixed head**: One fixed head should be set because it becomes the boundary condition that is used to solve equations used in the engine's solver. Care must be taken by the user to set a node that has this property and its value is important for the results. It is typically set to a location where a supply pump or a reservoir is present. Note: using none or multiple fixed node heads makes solving the equations difficult and long; therefore, one is recommended.

- **Elevation**: This need not necessarily be the elevation above sea-level, but can be any elevation above a reference point. It can be used to obtain values for total pressure at each node (rather than pressure head). Consequently, it's a parameter required for post-processing of results data and is very important for district heating systems design.

- **Electric heat pump**: This provides heat by consuming electricity by meeting a given heat demand at a heat node at the expense of an increased electricity demand at an electricity node.

9.2 Additional Resources

iVN Support Page:

https://www.iesve.com/support/ivn

License Keys and Configuration:

https://www.iesve.com/support/guides/ivn/ivn-installation-guide-licence-configuration1119.pdf

If you do not have this access yet then please contact your Account Manager or else keys@iesve.com to request it.

Online help guide:

https://help.iesve.com/ivn2022/

FAQs:

https://www.iesve.com/support/ivn/knowledgebase_faq On-

Demand Training:

https://distance-learning.iesve.com/courses/category/community-energy-and-renewables