H2020 Work Programme

D5.3 – VALIDATION OF THE SO WHAT TOOL IN REAL DEMO CASES

Lead Contractor: IES R&D (IESRD)

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Executive summary

Overall, it can be stated that the SO WHAT advanced tool has been tested by each demo site using their real data and can be said to be validated as much as possible by the demo sites. Whilst not all of the testing objectives were completed, this was mainly due to a lack of data from the demo sites to enable the correct setup of district heating networks. The below table acts as a summary of the status of each testing objective:

Testing Objective	Tested & validated	Comment
TO1 - Development/estimation of demo-site WH/C resource time series (annual, hourly resolution)	Yes	
TO2 - Identification of 1 to 3 relevant WH/C recovery/exploitation technologies	Yes	
TO3 - Setup of possible future DHNs for exploitation of WH resource (baseline and scenarios)	Partially complete	Lack of demo-site data meant this could not be completed fully
TO4 - Identification of plan for exploitation of WH/C resource and for use of SO WHAT tool (including TO2)	Yes	
TO5 - Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs	Partially complete	Lack of demo-site data meant this could not be completed fully
TO6 - Identification of 3 to 5 relevant WH/C exploitation technologies	Yes	
TO7 - Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs (baseline and scenarios)	Partially complete	Lack of demo-site data meant this could not be completed fully
TO8 - Development/estimation of (W)H/C resource time series on DHN supply/demand sides	Yes	
TO9 - Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN	Partially complete	Lack of demo-site data meant this could not be completed fully. Software issues also meant this could not be completed. A workaround was used with further investigation and possible development required to fully resolve the issue.
TO10 - Detailed modelling of demo-site building(s)	Yes	

Through this process, a large number of bugs were identified which have now been repaired. Key fixes to the software were identified, and where possible have been corrected. As well as this, improvements to the software were highlighted and these have now been added to a list of items to be prioritised for development if time and resources allow.

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Abbreviations

ASHRAE:	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CSV:	Comma Separated Values
DCN:	District Cooling Network
DHN:	District Heating Network
DHHEX:	District Heating Heat Exchanger
iCD:	Intelligent Community Design
iCIM:	Intelligent Community Information Model
iSCAN:	Intelligent Control and Analysis
iVN:	Intelligent Virtual Network
OS:	Operating System
OSM:	Open Street Map
RES:	Renewable Energy System
TO:	Testing Objective
TRL:	Technology Readiness Level
UI:	User Interface
UX:	User Experience
URL:	Uniform Resource Locator
VE:	Virtual Environment
W H/C:	Waste Heat/Cooling

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1 Introduction

1.1 Objective of the Task

This document represents the work completed as part of Task 5.2 – Testing and refinement of the tool, and as such shows how each part of the SO WHAT advanced tool has been tested using the real data from the demo sites so that it can be concluded that validation of the software has occurred in real life scenarios. The Grant Agreement states:

"The aim of this task is testing and fine-tuning of the SO WHAT tool (WP4). This will be achieved through unit testing of the individual components, ahead of full end-to-end testing of the integrated system. This task will include bug-fixing based on outcomes of the testing and fine-tuning of the tool based on user feedback, to ensure it is easy to use and fit for purpose. Outcomes from market uptake analysis, value chain and business models will provide an important feedback to the development of the tool. The cost-benefit simulation tool will also strengthen the environmental impacts and replication aspects of the project."

1.2 Relationship with other activities in the project

The relationship in terms of inputs and outputs of this task to the rest of the WPs and tasks in the project are as follows:

Inputs into this task are:

- Task 1.1 – Industrial process assessment and algorithm update – the data received from the demo sites regarding their processes and energy use will be used as a starting point to test the tool.
- Task 4.2 – SO WHAT Software development – this task developed the tool in terms of its waste heat and network modelling function. These will be key areas for testing.
- Task 4.3 – Integrate Costs Analysis Functionality and Energy Performance Contracting tool within SO WHAT – this integrated the financial and economic part of the software and will be tested in the task.

Outputs from this task will be used for:

- Task 4.5 - UX and UI and final dashboard for non-technical staff of the simulation software – This task in part develops the manuals for the software, and the learnings from the testing will be invaluable in writing them.
- Task 7.2 - Public and market acceptance of SO WHAT TOOL: TRL9 roadmap – In order to gain market acceptance it is imperative that the tool has been fully tested not only in a theoretical sense but also on real demo cases. Task 5.2 will ensure that.

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1.3 Structure of the document

The rest of the report is organised as follows.

Section 2 focuses on the testing and validation methodology, by providing an overview of how testing and validation of the detailed SO WHAT tool was carried out, as well as the scope and limitations of the testing objectives considered throughout such activities.

Sections 1 to 10 focus on the analysis of issues encountered throughout tool installation and the completion of each testing objective, separately, as well as on the outcomes derived from overcoming such issues. It should be noted that Testing Objectives 2, 4, and 6, did not require the use of the software but are pre-requisites to the completion of other testing objectives. For these, no feedback relevant to the testing and validation could be collected and these are not mentioned as separate Sections.

Section 11 provides the conclusions of the testing and the next steps to be followed.

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2 Testing and validation methodology

2.1 Overview of software used for SO WHAT

It should be remembered that the SO WHAT Advanced tool is made up of several pieces of software which are integrated via smooth data exchange mechanisms. When the software is used according to the SO WHAT methodology and processes (see D2.4), this is termed the SO WHAT Advanced Tool.

The next sub sections briefly describe each piece of existing software, what its functions are in the project. The diagram below shows the overall functions of the SO WHAT Tool, and the high level user workflow through the different software.

For more details, please refer to D2.3 'Common IT Framework Specifications ', and D4.3 'Detailed Version of SO WHAT that Includes Network Modelling Capabilities to Enable a More Flexible and Cost Effective Solution across the Industrial Environment'.

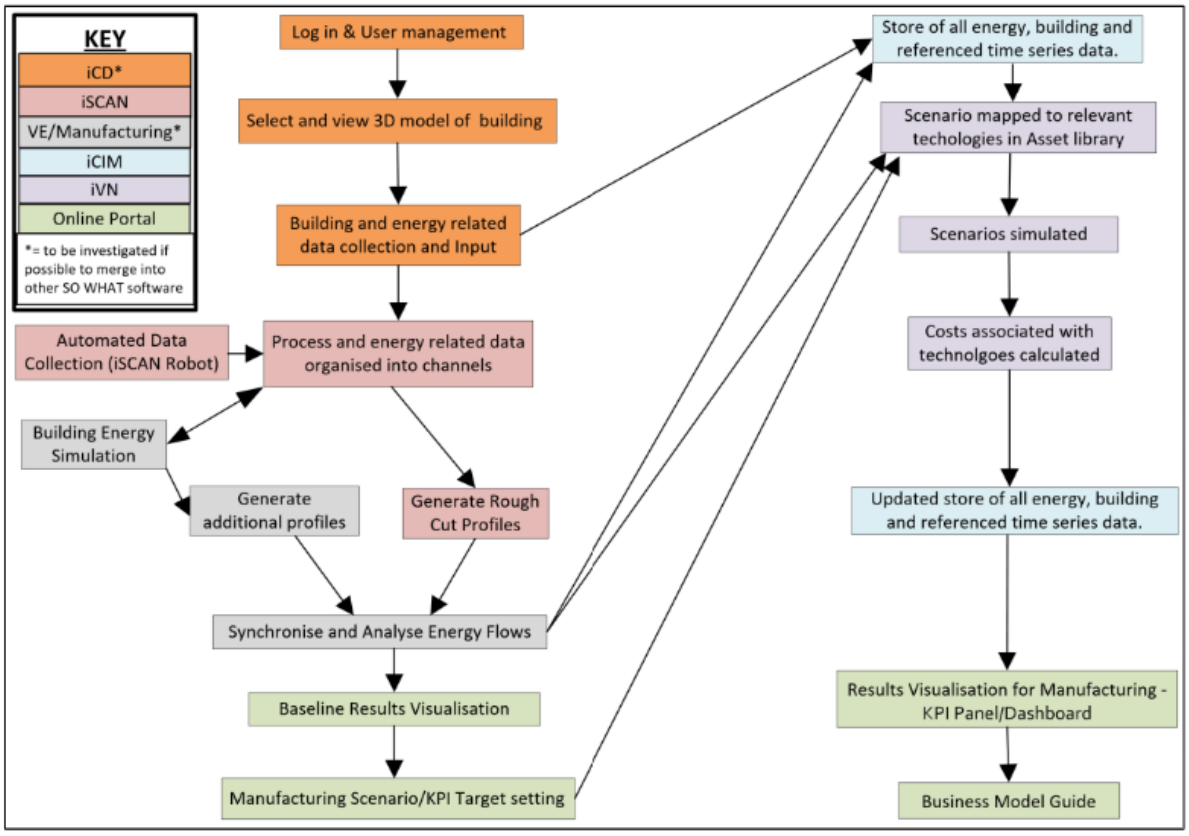

Figure 1 SO WHAT Tool functions and software workflow

2.1.1 iSCAN (Intelligent Control and Analysis)

iSCAN is a web based software that allows the import and integration of time-series operational data into in a single tool. It stores, processes, tags, manipulates, plots and exports operational building data and allows for advanced analysis of the data through iSCAN specific analysis tools, as well as

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enabling continuous monitoring of a building's performance and the identification of faults delivered through a bespoke rules, alerts and notifications system.

In SO WHAT, iSCAN will be used in the advanced tool for the functions of:

- Data import of utility bills, sub meters and service/process energy related data
- Organisation and Generation of rough cut profiles

2.2.2 iCD (Intelligent Community Design)

The iCD (Intelligent Community Design) is IES' 3D urban sustainability master planning software whose primary function is to allow the simulation of energy performance of buildings at a wide scale from communities to cities. In the SO WHAT project, the iCD will be used to enable the functions of user management, project setup, 3D visualisation and data collection.

2.2.3 VE (Virtual Environment) & VE Manufacturing

Virtual Environment (VE) by IES is a whole building and system dynamic energy simulation software. It is composed from multiple modules which allow users to investigate the performance of a building and associated energy systems. In SO WHAT, the VE is used to create a basic building model in order to attach processes and components and the Manufacturing Module (from FP7 project REEMAIN) inside the VE is used to generate additional rough cut profiles and conduct energy flow analysis.

2.2.4 iCIM (Intelligent Community Information Model)

The iCIM is a platform that can be used to store, change and visualise an urban model and acts as a central database to share, visualize, access, download, edit and upgrade the city wide information easily and effectively. In the SO WHAT project, it will be used to bring together and store all data relating to the manufacturing facility, community buildings, and energy demand and supply. It will also be the key software that imports and exports data with the rest of the SO WHAT tools, and as such will also be considered as a relational database, whereby it will also store referenced data that is held in other databases so that its stores and provides access to data points that are related to one another.

2.2.5 iVN (Intelligent Virtual Network)

An energy network modelling and simulation tool operating on the cloud or desktop. It designed to perform "as-is" and future scenario simulations of a community's energy demand and supply distribution network. In the SO WHAT project, the ability of the iVN to model and simulate heat flows and networks has been created, as has the ability to simulate different waste heat and cooling technologies. The iVN performs the following capabilities:

- Modelling a range of technologies for recovering and reusing waste heat.
- Model the District heating and cooling infrastructure network and run simulations.
- Reporting improvements and analysis to show where opportunities exist to supply a community with excess WH/C and integrate with renewables.
- Potential demand response flexibility - identify what times demand response could be used to reduce the load-mismatch between available WH/RES and demand.
- Allow user to export iVN data to the iCIM e.g. for access by the SO WHAT dashboard.

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2.2 Summary of Testing and Validation Methodology

The methodology adopted for the SO WHAT tool testing and validation split the demo-sites into 3 main testing groups, and then assigned each site 3 key testing activities depending on the testing objectives (TOs) that were identified for each site, from TO1 to TO10, as further detailed in following the section.

The identification of testing objectives for each demo-site was dependent on the:

- Demo-site type - industry or DHN
- Foreseen exploitation plan for the WH/C resource potential - internal / on-site; external / through a DHN/DCN.
- Recommended use case for the workflow through the software based on the type and quality of data that may be available, accessible and shareable.

  These were created based on the findings from D1.1 'Report on industrial site demo assessment'. This recommended five different ways to use the software depending mainly on the type of data (utility bill, sub-metering, or a combination of these) that would be available, accessible and shareable. These were called Data Use Cases, with having an associated set of minimum additional information required. The Data Use Cases are as follows:
  - C8.1 - Utility bill data only,
  - C8.2 - Partial sub-metering data only,
  - C8.3 - Utility bill & partial sub-metering data,
  - C8.4 - Detailed sub-metering data,
  - C8.5 - Utility bill & detailed sub-metering data.

2.3 Testing Objectives and Demo Site Assignment

The testing objectives set and split amongst the demo sites are summarised in the list below:

- TO1 - Development/estimation of demo-site WH/C resource time series (annual, hourly resolution);
- TO2 - Identification of 1 to 3 relevant WH/C recovery/exploitation technologies;
- TO3 - Setup of possible future DHNs for exploitation of WH resource (baseline and scenarios);
- TO4 - Identification of plan for exploitation of WH/C resource and for use of SO WHAT tool (including TO2);
- TO5 - Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs;
- TO6 - Identification of 3 to 5 relevant WH/C exploitation technologies;
- TO7 - Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs (baseline and scenarios);
- TO8 - Development/estimation of (W)H/C resource time series on DHN supply/demand sides;
- TO9 - Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN;
- TO10 - Detailed modelling of demo-site building(s).

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These testing objectives were then split by each demo-site as show in the table below:

Table 1 Demo sites split by testing objective

Demo-site name	Recommended data use case	Testing Activity 1	Testing Activity 2	Testing Activity 3	Testing group number
ISVAG Waste-to-Energy	C8.2	TO1	TO2	TO3	2 (2.1)
IMERYS Carbon black manufacturing	C8.1	TO1	TO4	TO7	2 (2.2)
UMICORE Rare material Centre	C8.4	TO1	TO2	TO3	2 (2.1)
ENCE Pulp mill	C8.4	TO1	TO6	TO7	2 (2.2)
Pessione Distillery	C8.3	TO10	TO6	TO7	3
LIPOR Maia Waste-to-Energy Plant	C8.3 > C8.5	TO1	TO2	TO3	2 (2.1)
Innovation in steel industry pilot	C8.3	TO10	TO6	TO7	3
Petromidia refinery	C8.4	TO1	TO4	TO7	2 (2.2)
Constanta DHN	C8.2 - C8.4	TO8	TO5	N/A	1 (1.1)
GOTEBORG Multi WH DHN	C8.4	TO8	TO5	TO9	1 (1.2)
Pulp Mill DHN	C8.4	TO8	TO5	TO9	1 (1.2)

In this way, by distributing a set of individual testing objectives to each demo-site, the SO WHAT tool testing could ensure that all of the components of the software were tested while limiting duplication of effort amongst demo sites. Additionally, as each demo-site was assigned with specific testing objectives, all testing participants were able to test individual components of the SO WHAT tool, as well as the integrated software, including the interoperability between the various platforms that are integrated into the SO WHAT tool.

Also, such a distribution of demo-sites into testing groups facilitated the development of a more detailed testing planning for each testing objective, as well the follow-up of testing activities completion for each demonstration site, as detailed in Annex 1 – Detailed Testing Plan.

A SO WHAT tool testing tracker was created in order to enable demonstration sites to log any issues encountered, and any other relevant feedback, throughout testing activities, as well as for IES to provide any assistance in overcoming such issues. This can be sen in the image below:

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Demo-site SO WHAT tool testing tracker

Demo-site name	Testing group n...	Testing objectiv...	Issue	Issue description	Images	Date reported	Issue logged by
EEN	2 (2.2)	TO7	DHHEX Scripts-Heat Transfer Coefficient (u...	Regarding the scripts of the DHHEX, the units of the Heat Transfer Coefficient ("U") are not very clear (below image): • (kW/,m2•K) in the default value • (W/,m2•K) in the Table 1		6/22/2022	Pablo Fernández (ELI
LLM		TO1	Time zone	The data starts on June 01 but iSCAN interprets the data one hour earlier, due to time zone.		5/6/2022	Icíar Bernal
IKA	2 (2.1)	TO3	IVN: When creating a virtual network, drag...	As folowing the tutorial selected buildings in the object browser who are drgede and dropped in the 2D model are visible in the 2D view but are not placed under Network. A network simulation of those connected buildings cannot be run because of that issue		5/4/2022	Bob De Maeijer

Figure 2 SO WHAT Testing Tracker

The tool testing tracker was accessible online (link), in order for all testing participants to be aware of all the past and current issues raised by any testing participant in a transparent and live manner, as well as of possible solutions and workarounds suggested by IES, thus limiting the duplication of issues raised, as well as facilitating the collection and analysis of these issues.

Furthermore, for each of the testing objectives, a series of sub-tasks was identified, as well as an estimation of the testing objective completion time and effective workload, as detailed in Annex 1 – Detailed Testing Plan.

2.4 Limitations

Having set out a details methodology an plan for the testing of the tool , it should be recognised that there are some limitations to this due to resource and time constraints.

The scope of the proposed list of testing objectives did not cover the unit testing of any of the following individual components or features of the detailed SO WHAT tool:

- District cooling network infrastructure modelling – this was not yet developed in time for this task.
- Cost-benefit simulation tool to strengthen the environmental impacts and replication aspects of the project – this was not yet developed in time for this task.
- PlanHeat integration to model demand and potential RES supply using actual data from the demo sites - although this functionality is developed, a lack of data meant the inability to conduct the testing.

Such individual components or features of the detailed SO WHAT tool will be tested and validated as part of completion and submission of deliverable report D4.4 – Delivery of a simulation software that also includes cost data and business model data.

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There were also some testing objectives which do not require an actual use of the advanced SO WHAT tool, but are pre-requisites to the completion of other testing objectives.in particular:

- TO2 (Identification of 1 to 3 relevant WH/C recovery/exploitation technologies)
- TO4 (Identification of plan for exploitation of WH/C resource and for use of SO WHAT tool)
- TO6 (Identification of 3 to 5 relevant WH/C exploitation technologies),

These were completed via discussions with each relevant demo site and did not require the testing and validation of the SO WHAT tool. Instead the sites reviewed the information contained with 'D1.6 Report on H/C recovery/storage technologies and renewable technologies' to gain an understanding of which technologies would be appropriate for their sites.

Therefore, no feedback relevant to the testing and validation of the SO WHAT tool could be collected on the completion of these testing objectives TO2, TO4 and TO6, and these are not mentioned further in this report.

As well as this, the testing of each waste heat/cooling technology which has been developed and implemented into the tool occurred as part of D4.3' Detailed Version of SO WHAT that Includes Network Modelling Capabilities to Enable a More Flexible and Cost Effective Solution across the Industrial Environment'.

It should also be noted that the following sets of testing objectives are similar, such as:

- TO3 (Setup of possible future DHNs for exploitation of WH resource), TO5 (Setup of existing DHN for exploitation of WH resource and integration of RESs), and TO7 (Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs);
- TO1 (Development/estimation of demo-site WH/C resource time series) and TO8 (Development/estimation of WH/C resource time series on DHN supply/demand sides).

Although similar, these testing objectives slightly differ one from another because they are relevant to different demo-site types (e.g. TO1/TO8) or to different planned exploitation strategies of WH/C resource potential (e.g. TO3/TO5/TO7). However, such a similarity within these sets of testing objectives enables testing participants to test individual components of the SO WHAT tool that are aligned with their specific needs, as well as the integrated software, including the interoperability between the various platforms that are integrated into the SO WHAT tool.

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3 Tool Installation

The below sub sections explain any issues that were encountered by users for this stage and breaks them down into incorrect use (training), small issues (bugs), or larger issues (improvements needed or further investigations required). The sections also demonstrates whether the bug was fixed, whether short term workaround to the issue was given or what new features could be developed or investigated to solve the issue.

It should be noted, that where a bug has been fixed, or a short term workaround was produced, the testing stage was completed and validated by the users.

3.1 Overview of issues encountered and outcomes

Table 2 Overview of issues for Tool installation

Outcome category	Details on issue in section	Details on outcome in section
Training on SO WHAT tool use	3.2.3	3.3.3
Bug to be fixed	3.2.1; 3.2.2	3.3.1; 3.3.2
Feature improvement suggestion	3.2.4	3.3.4
Further investigation needed	None	None

3.2 Details on issues encountered

3.2.1 Issues while installing the iCD tool

iCD plugin does not support SketchUp 2022. It works with older versions of SketchUp (2019).

3.2.2 iCD does not recognise SketchUp 2022 install

The user installed the latest version of SketchUp (version 22.0.316 64 bit windows) and tried to install iCD but it refused to install, with an error message about SketchUp not being installed. A workaround was tried by installing an older version of SketchUp, i.e. SketchUp version 21.1.332 (64 bit windows), which enabled a successful installation of iCD.

3.2.3 VE location

The user has set up the iCD plugin for SketchUp software as instructed in the activation keys email, but when trying to run a test building energy simulation, the below error message is displayed.

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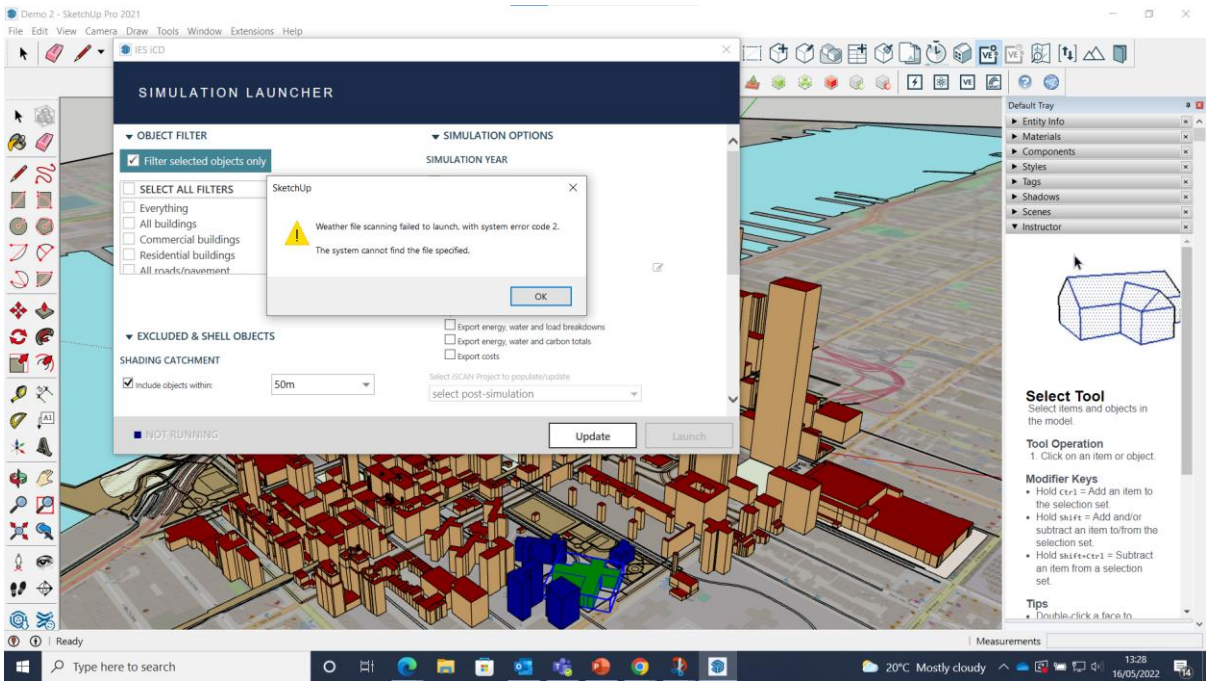

Figure 3 Error on VE location

3.2.4 Installation of SO WHAT tool on Mac OS

The user tried to install the IES VE, one of the SO WHAT tool software, but realised that it does not run directly on a Mac OS machine, but rather via VMware Fusion, Parallels Desktop or Boot Camp.

3.3 Details on outcomes

3.3.1 Issues while installing the iCD tool

This issue has now been solved with the release of iCD 2022 version that supports SketchUp 2022 versions.

3.3.2 iCD does not recognise SketchUp 2022 install

This issue has now been solved with the release of iCD 2022 version that supports 2022 versions of SketchUp. Indeed, former iCD versions (i.e. pre-2022) did not support SketchUp 2022, so a less recent version of SketchUp (e.g. 2021) had to be installed when using a pre-2022 version of iCD. Please note that with the recent release of iCD 2022, it is now required to use the 2022 version of iCD in order to enable interoperability API with iCIM 2022, so any post-2018 version of SketchUp will suit.

3.3.3 VE location

The issue encountered by the user is related to the setup of the location of the VE building energy simulation engine, which is used in the background by iCD when running a building energy simulation, and which can be checked in SketchUp/iCD >> Extensions >> IES iCD >> Set VE Location (or in SketchUp/iCD >> Extensions >> IES iCD >> Preferences >> MISCELLANEOUS >> VE Location >> Browse). The "apps" folder (C:\Program Files (x86)\IES\VE 2021\apps) should be selected, as seen in the image below, and as per the "iCD & VE Configuration" section in the iCD Installation Guide here (https://www.iesve.com/support/guides/icd/icd-installation-guide-licence-and-config-121119.pdf).

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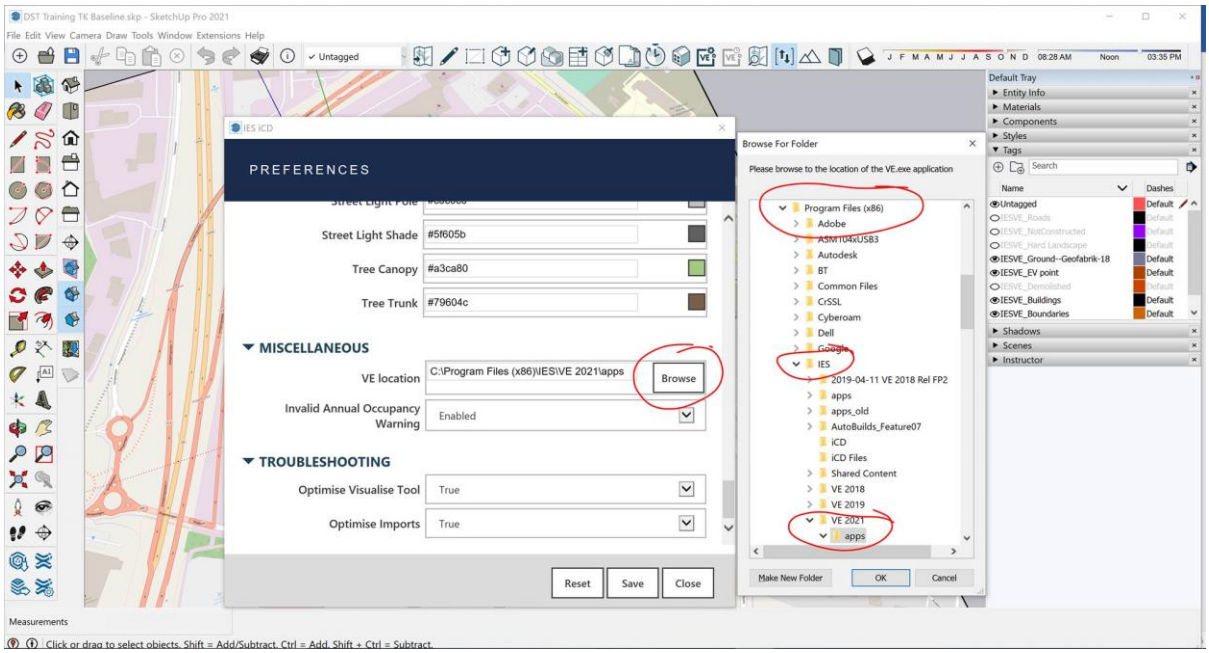

Figure 4 Solution to VE location issue

3.3.4 Installation of SO WHAT tool on Mac OS

Indeed, an installation and use of the IES VE on a Mac OS system is not ideal. In fact although it is technically possible to install the VE on such a system through the run of a Windows emulator on the Mac (see FAQ here https://www.iesve.com/support/ve/knowledgebase_faq/faq/1598 and a quite outdated but explanatory video showing it on Parallels here https://www.youtube.com/watch?v=PdQHKQZAXvM), return of experience on the use of IES VE on such a virtual machine is not great (e.g. need to activate the licence keys on Windows and to keep all project data on the Windows machine partition as well; many difficulties faced in loading the project files from the Mac root folder; etc.).

Additionally, such issues are only for the installation and the use of the IES VE, whereas additional issues are foreseen for the installation and use of other software, e.g. for iCD SketchUp would need to run on the Windows machine partition rather than the Mac OS, and there is no return of experience on the interoperability of all pieces of software (VE, iCD, iVN, iSCAN, iCIM) that are part of the SO WHAT tool in such a framework.

Therefore, overall it is strongly advised to consider installation of all pieces of software on a Windows machine, if possible.

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4 Testing objective 1 - *Development/estimation of demo-site WH/C resource time series*

The below sub sections give an explanation of any issues that were encountered by users for this stage and breaks them down into incorrect use (training), small issues (bugs), or larger issues (improvements needed or further investigations required). The sections also demonstrates whether the bug was fixed, whether short term workaround to the issue was given or what new features could be developed or investigated to solve the issue. It should be noted, that where a bug has been fixed, or a short term workaround was produced, the testing stage was completed and validated by the users.

The table below gives an overview of the result of the testing and the sub steps in the workflow:

Table 3 Results overview for TO1

Task - Testing Objective	**Testing and validation successfully completed by demo site**
TO1 - Development/estimation of demo-site WH/C resource time series (annual, hourly resolution)	**Yes**
TO1.1 Request and collect relevant data available and shareable	Yes
TO1.2 Data formatting, upload to iSCAN, mapping and/or pre-processing	Yes
TO1.3 Rough-cut profiling and/or data processing and/or upload to iSCAN	Yes

4.1 Overview of issues encountered and outcomes

Development/estimation of demo-site WH/C resource time series (annual, hourly resolution).

Table 4 Overview of issues for TO1

Outcome category	Details on issue in section	Details on outcome in section
Training on SO WHAT tool use	4.2.1; 4.2.2; 4.2.3; 4.2.4; 4.2.5; 4.2.6	4.2.7; 4.2.8; 4.2.9; 4.2.10; 4.2.11; 4.2.12
Bug to be fixed	None	None
Feature improvement suggestion	None	None
Further investigation needed	None	None

4.2 Details on issues encountered

4.2.1 Cannot upload data into iSCAN

IES RD has created some basic data to represent furnace chimney flue gas but cannot upload it into iScan. The data is simple columnar .csv with timestamp and 2 columns.

Video instructions on iScan online learning appear to be for another version of the software.

4.2.2 Format of the CSV file uploaded to iSCAN

The CSV format admitted by iSCAN is the following: "." as decimal separator, and "," as list separator.

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This is due to the "British" format of the CSV files versus the "European" format of the CSV files in Windows Systems. This is not a fixable issue in the software, but maybe the following CSV format could also be integrated: "," as decimal separator, and ";" as list separator.

4.2.3 Interpretation of hourly data

When excel autocompletes a set of dates hourly, many times it happens that instead of passing from 3:00 to 4:00, it does so as 3:00 to 3:59, this is an error for iSCAN because it does not interpret 3:59 as 4:00. This problem was fixed by user by setting all minutes to :00.

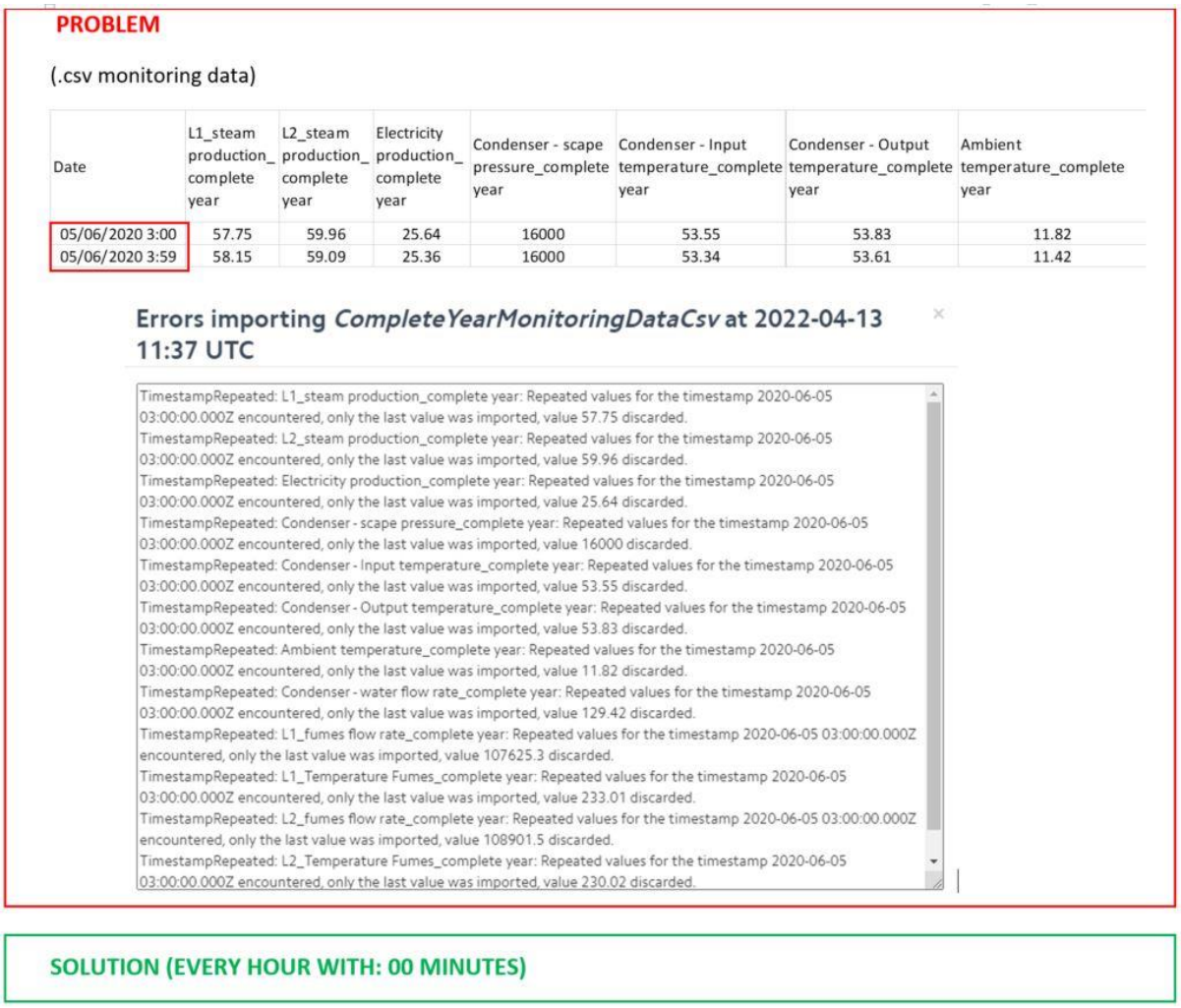

Figure 5 Error on hourly data interpretation

4.2.4 Data import cannot be actualized

If you want to actualize the data that is already uploaded, you cannot do it in the same data import because it causes an error. Ways to do it in order to avoid the "Duplicate file uploaded message" (capture Image):

1) Start the import since the data import 1st step (you do not have to delete all);

2) Delete data import and upload a new one, but then you have to rename the archive.

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Event	Description	File name	Event Time (UTC)	Data Time (UTC)	Query (ms)	Import (ms)	Bytes
Duplicate file uploaded		Complete year_monitoring data_prueba.csv	2022-04-13 10:46	2022-04-13 10:46	-	-	849,416
File import had warnings	Imported 105,108 data points into 12 channels between 2020-06-01 00:00 and 2021-05-31 23:00 UTC (more)	Complete year_monitoring data_prueba.csv	2022-04-13 10:43	2022-04-13 10:43	-	1,447	849,416
File uploaded		Complete year_monitoring data_prueba.csv	2022-04-13 10:43	2022-04-13 10:43	-	-	849,416

Figure 6 Issue with data import duplication 1

Errors importing *CompleteYearMonitoringDataPruebaCsv* at 2022-04-13 10:43 UTC

TimestampRepeated: L1_steam production_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 58.83 discarded.
TimestampRepeated: L2_steam production_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 60.5 discarded.
TimestampRepeated: Electricity production_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 24.76 discarded.
TimestampRepeated: Condenser - pressure_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 17000 discarded.
TimestampRepeated: Condenser - Input temperature_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 56.18 discarded.
TimestampRepeated: Condenser - Output temperature_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 56.12 discarded.
TimestampRepeated: Ambient temperature_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 17.03 discarded.
TimestampRepeated: Condenser - water flow rate_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 130.1 discarded.
TimestampRepeated: L1_fumes flow rate_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 117716.5 discarded.
TimestampRepeated: L1_Temperature Fumes_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 240.32 discarded.
TimestampRepeated: L2_fumes flow rate_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 115768.6 discarded.
TimestampRepeated: L2_Temperature Fumes_year: Repeated values for the timestamp 2020-10-25 01:00:00.000Z encountered, only the last value was imported, value 238.89 discarded.

Close

Figure 7 Issue with data import duplication 2

4.2.5 Error uploading data to a channel

The data uploaded into the channel was from 2020 until 2021, a sample was generated the day the test was done (2022-04-13). This sample (the one of the image) does not appear in the .csv uploaded.

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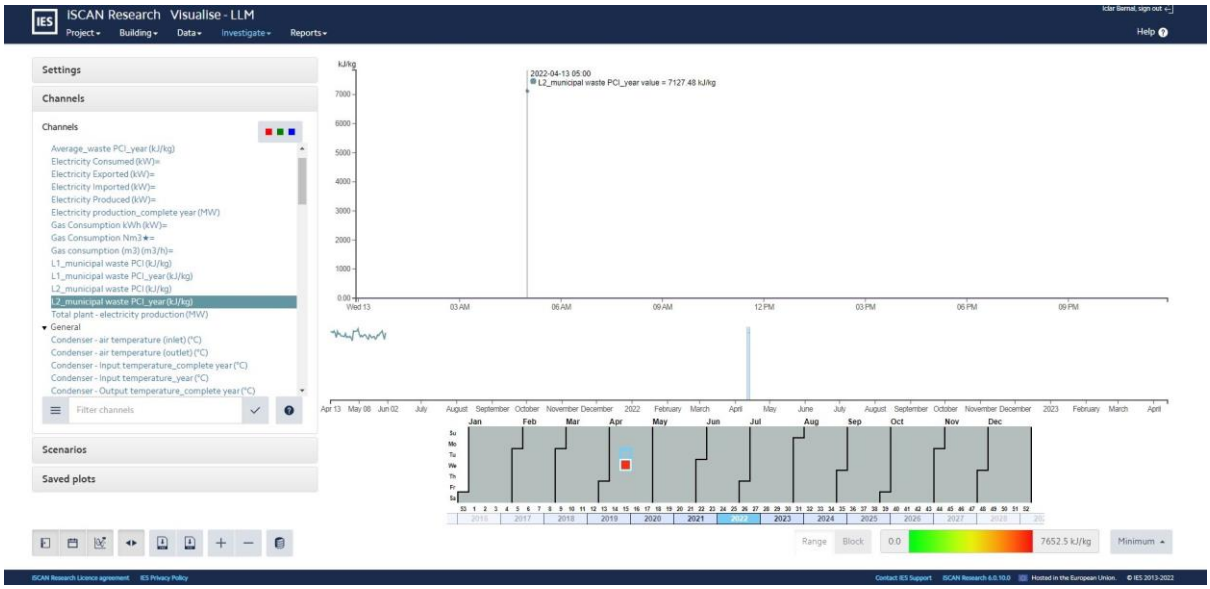

Figure 8 Error uploading data to a channel

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4.2.6 Time zone

The data starts on June 01 but iSCAN interprets the data one hour earlier, due to time zone.

A data for 31 may 2020 is recorded, but the csv starts with the 01 June 2020

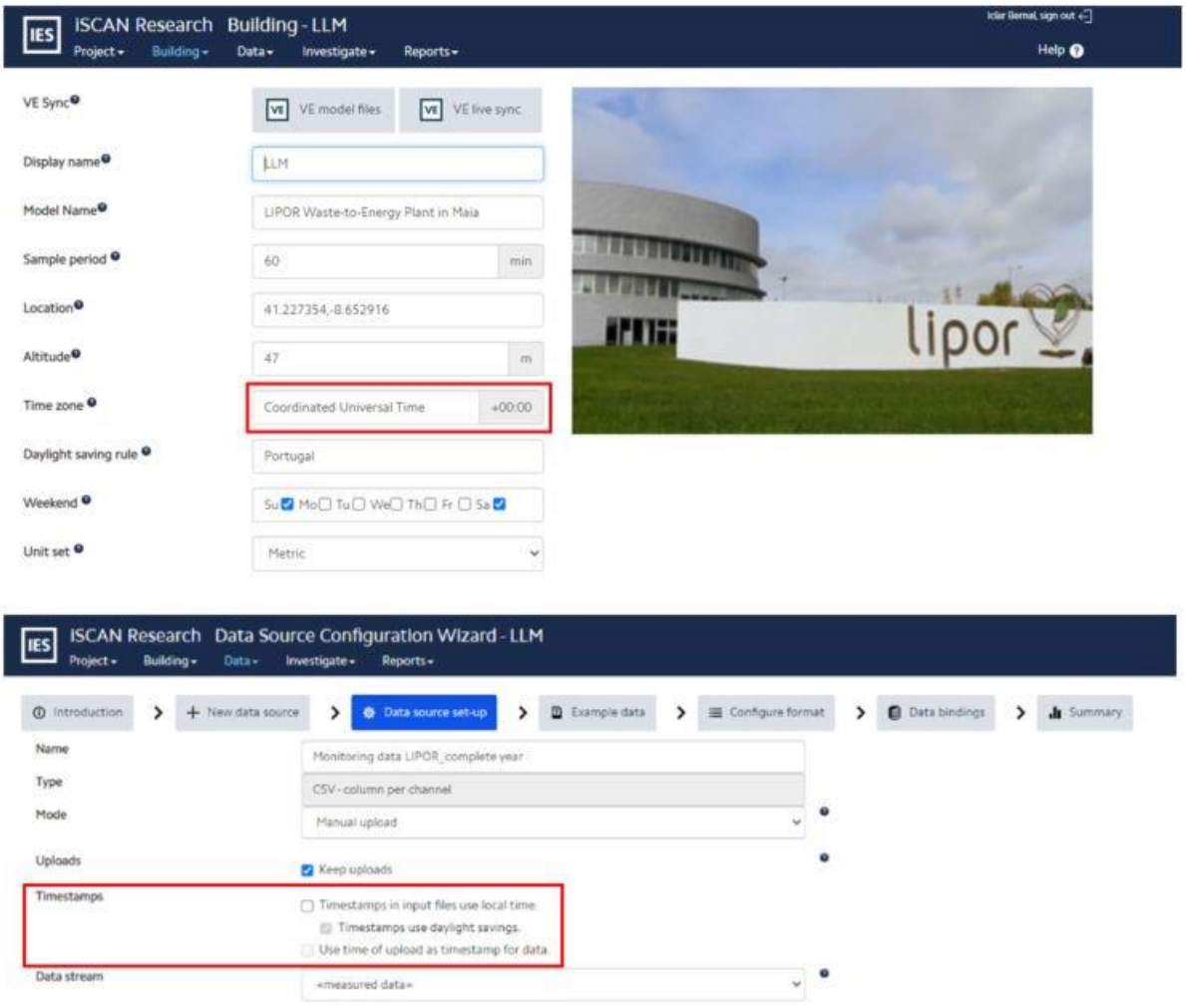

Figure 9 Data upload issue due to time zone

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4.3. Details on outcomes

4.2.7 Cannot upload data into iSCAN

Two distinct issues were identified, as follows:

a. Boxes to create channels in order to bind data uploaded to these channels were not checked at the end of the "Data bindings" step.
When attempting to upload the file, it may have forgotten to select the data columns from this file and click on the "create channels" button at the end of the "Data bindings" step, see screenshot below.

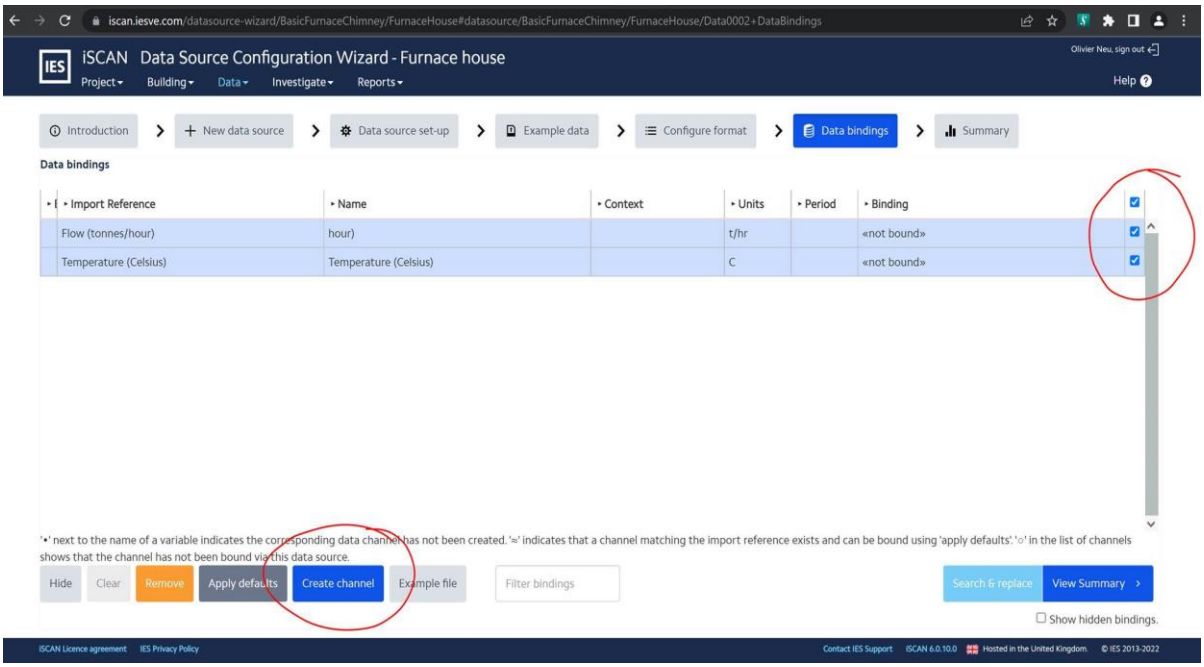

Figure 10 iSCAN data upload resolution step 1

It then brings you to the "Add Channel" pop-up window in which the level can be selected for the channels to be created, although this can be amended once channels are created and data bound to these channels.

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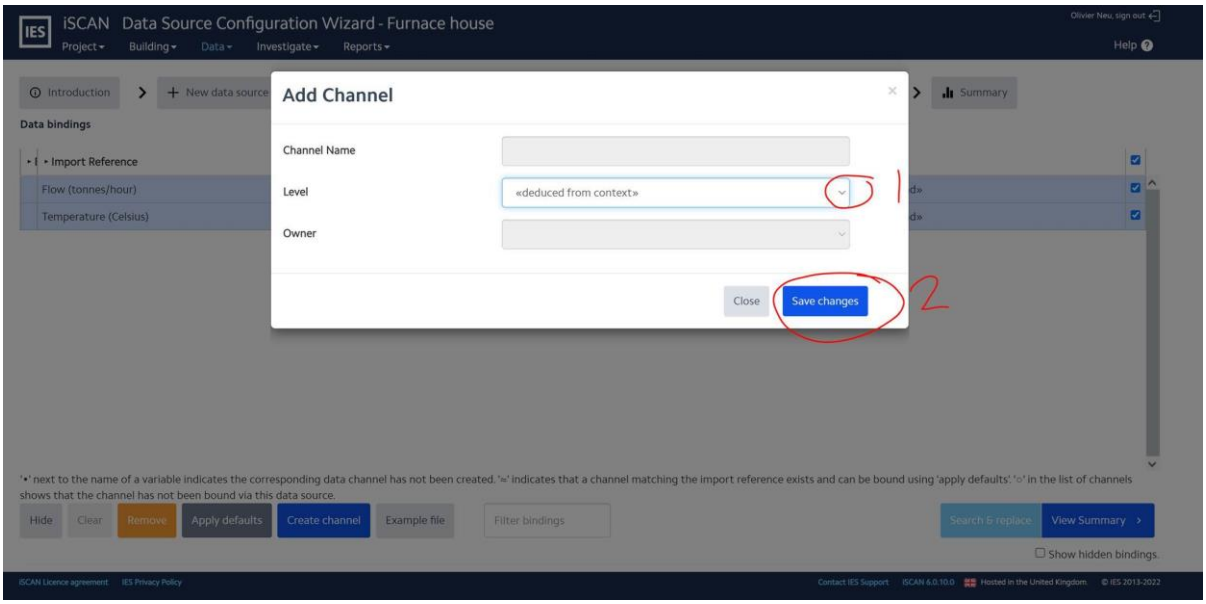

Figure 11 iSCAN data upload resolution step 2

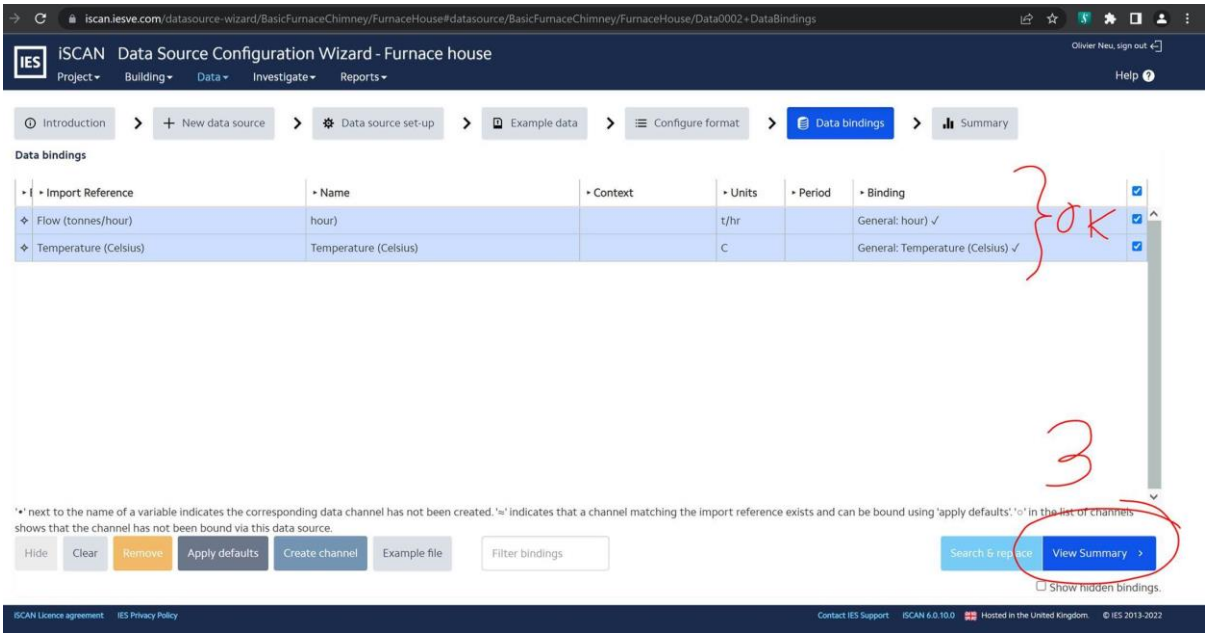

Figure 12 iSCAN data upload resolution step 3

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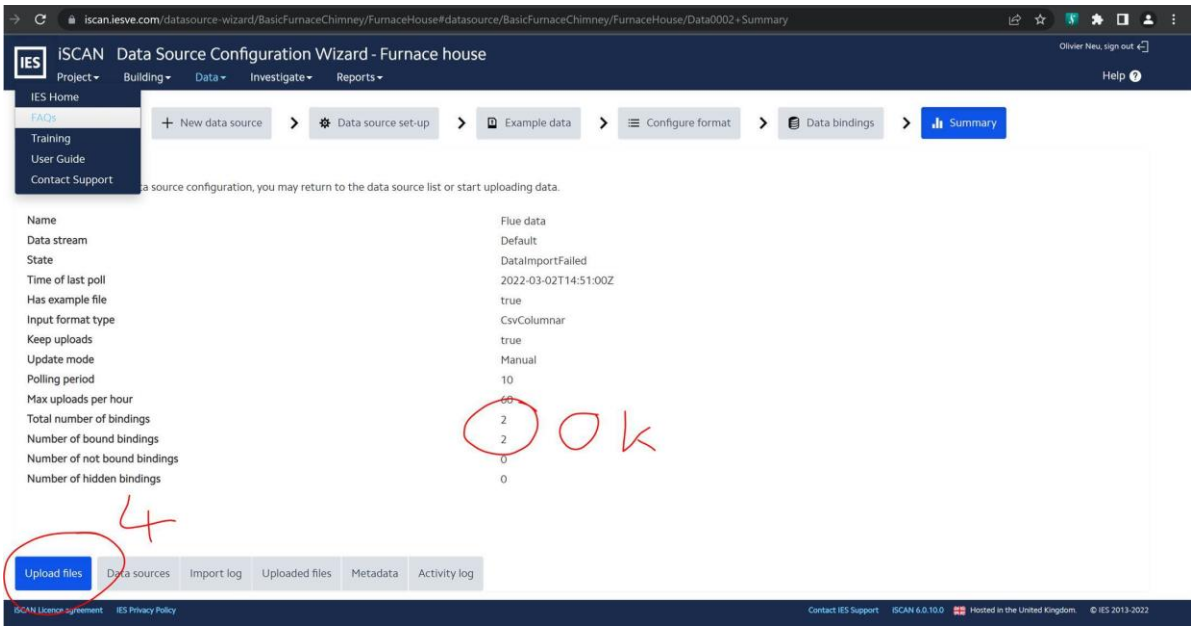

Figure 13 iSCAN data upload resolution step 4

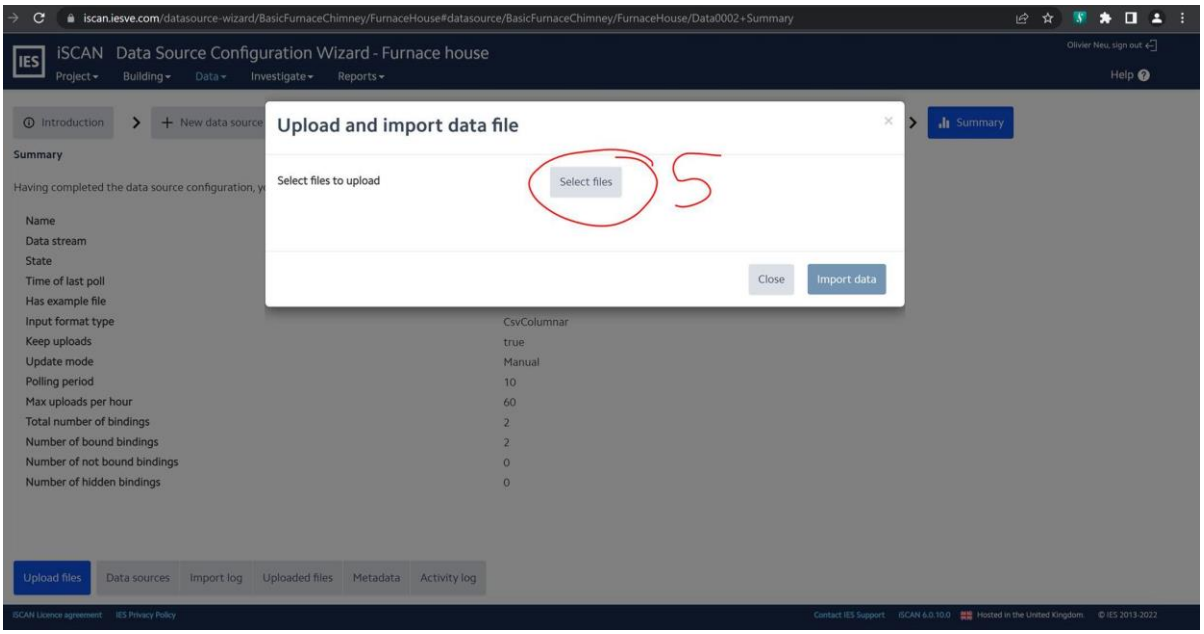

Figure 14 iSCAN data upload resolution step 5

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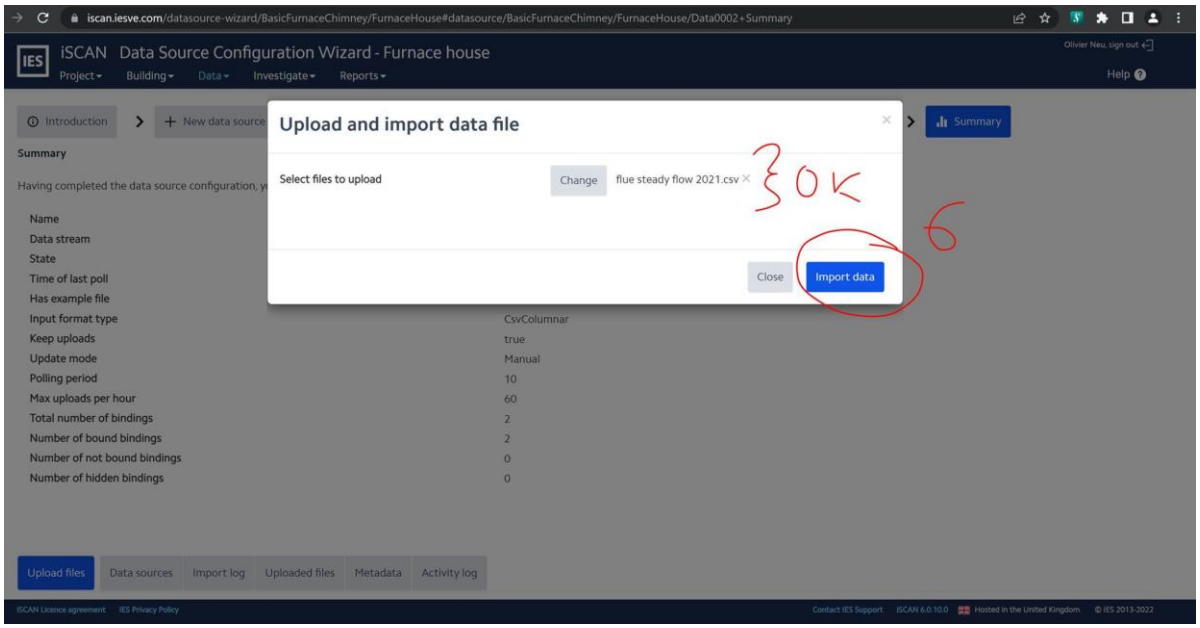

Figure 15 iSCAN data upload resolution step 6

b. Date/time format which was recognized by default in iSCAN was not aligned with that of the timestamp column in data file to be imported at the "Configure format" step e.g. using MM/DD/YYYY when format was actually DD/MM/YYYY, so when reaching 13th day in data file iSCAN did not accept it as a 13th month.

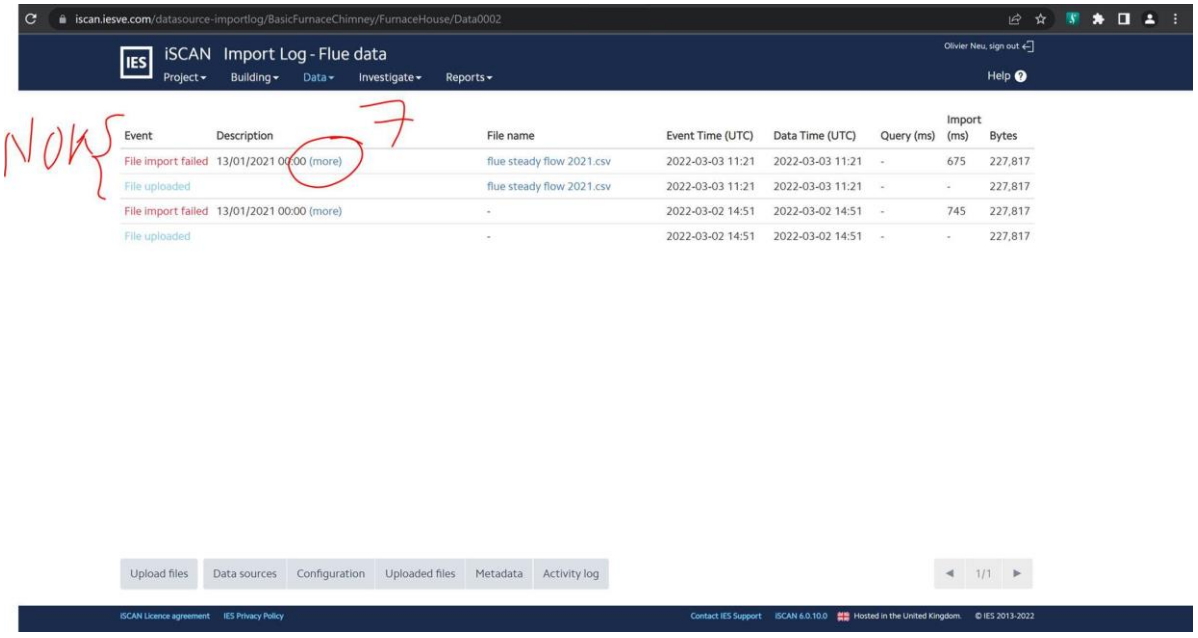

Figure 16 iSCAN data upload resolution step 7

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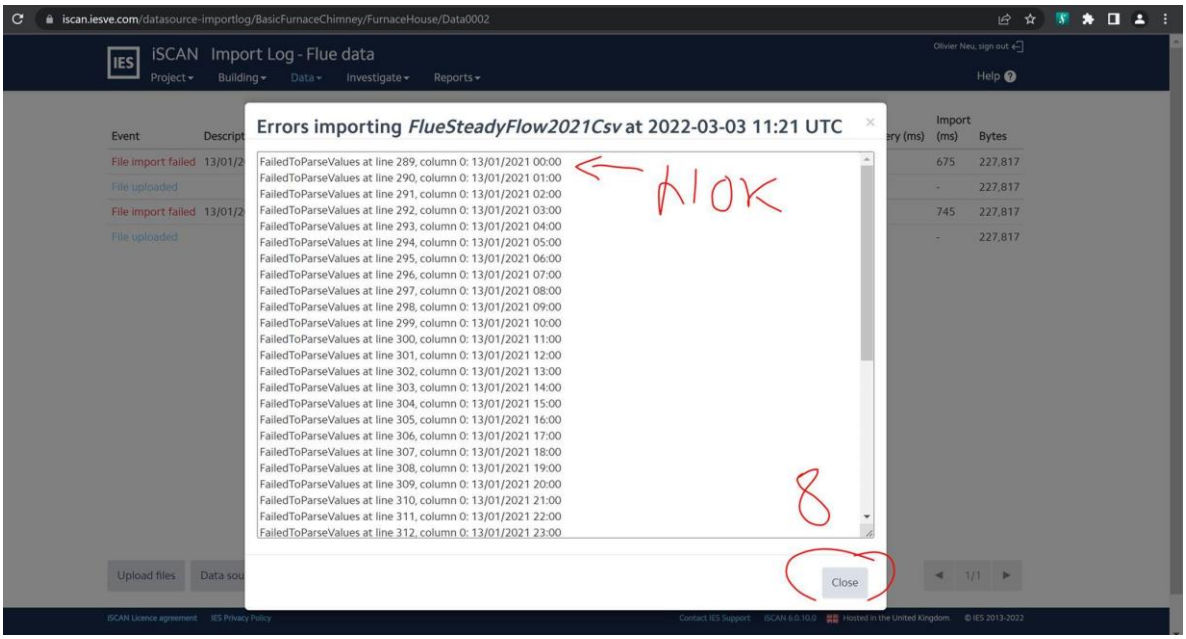

Figure 17 iSCAN data upload resolution step 8

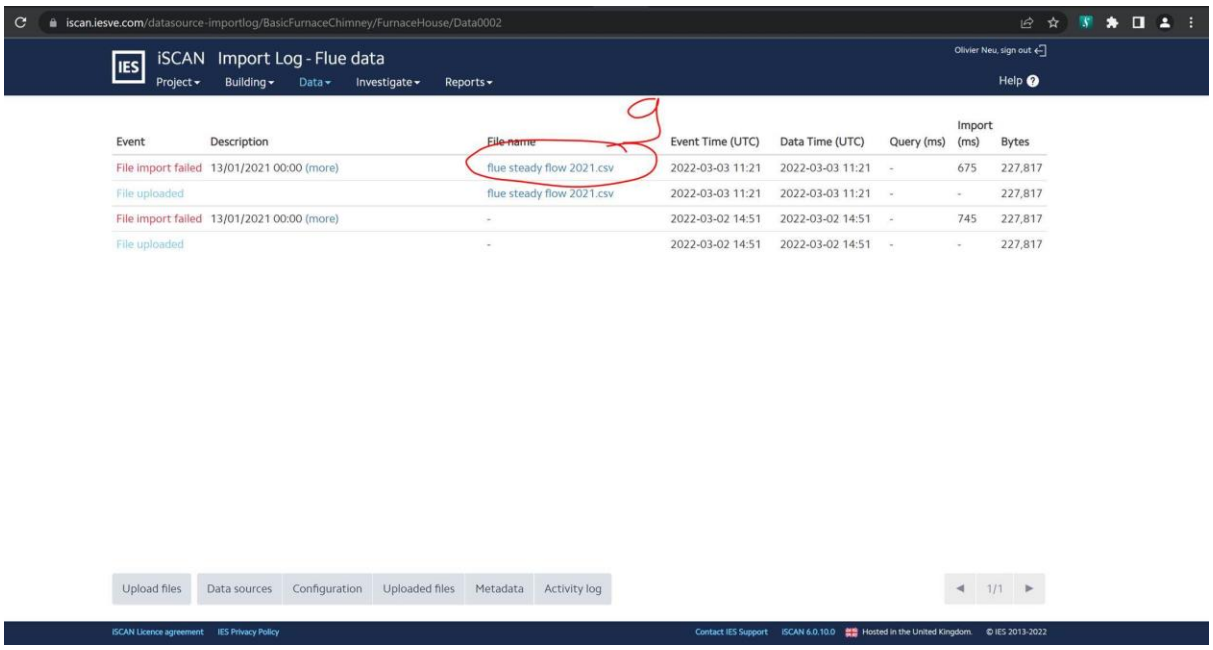

Figure 18 iSCAN data upload resolution step 9

There was indeed an issue at the 13th day of import, most likely because 13 was considered as the 13th month rather than the 13th day. As can be seen below, when getting back to Data Source Configuration, at the "Configure format" step, it looks like the Date/Time format that was detected for the first column was "Date/Time MM/DD/YYYY hh:mm AM (0)", rather than "Date/Time DD/MM/YYYY (8760)".

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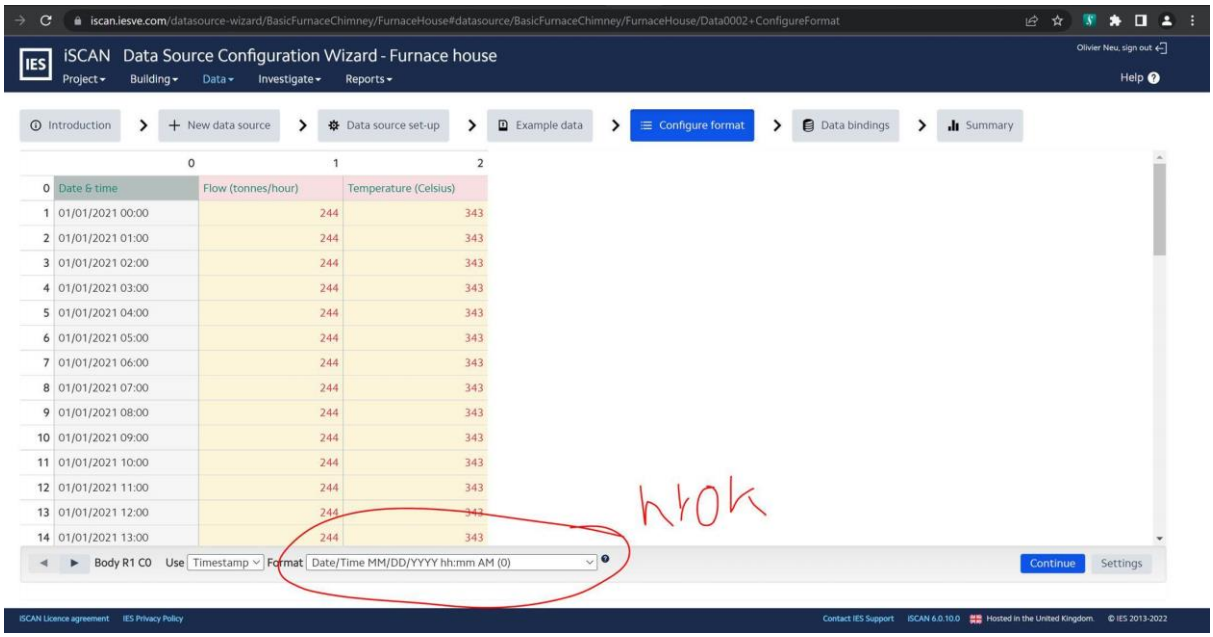

Figure 19 iSCAN data upload resolution step 10

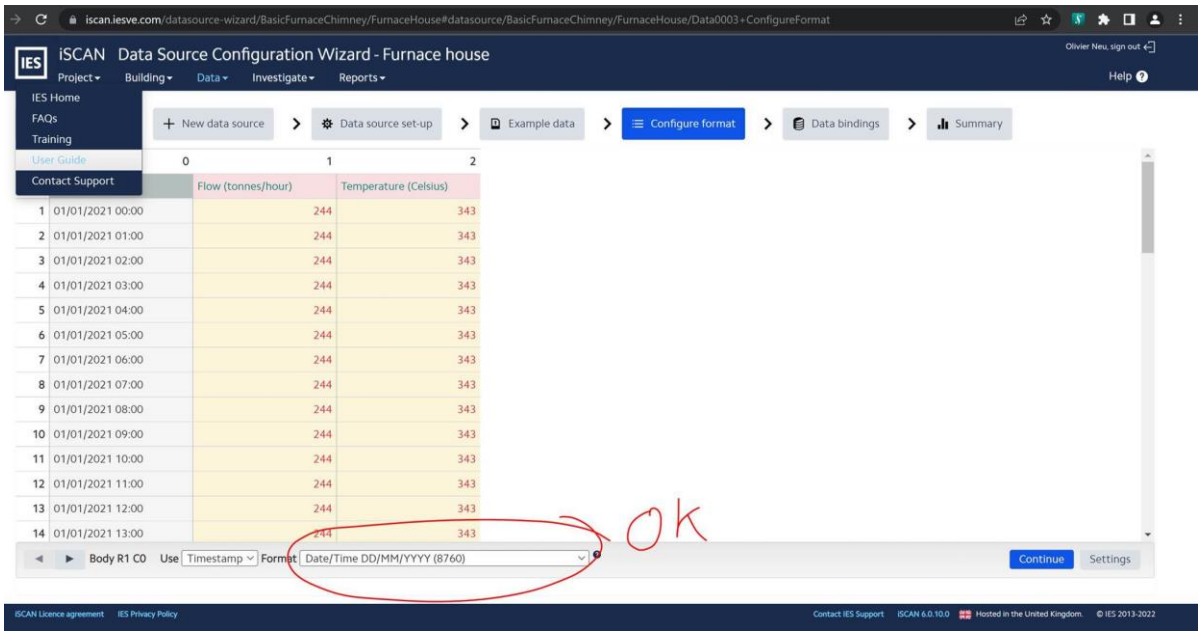

Figure 20 iSCAN data upload resolution step 11

Therefore, data import configuration must be checked Date/Time format must be adjusted for the timestamp column.

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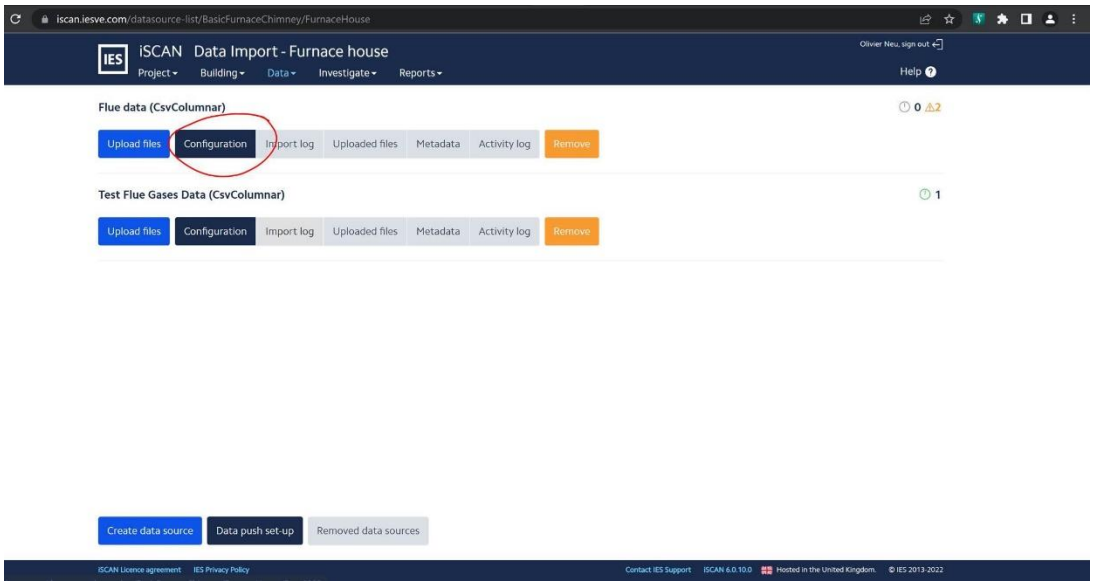

Figure 21 iSCAN data upload resolution step 12

With regards e-learning videos, some of the online user guide and e-learning material are indeed not up to date with the most recent UI, but in principle the approach is the same, there are just more explanations and options provided into the new UI, with clear and separated steps in order to setup an appropriate data format, which was not the case before.

4.2.8 Format of the CSV file uploaded to iSCAN

In relation to decimal separator, please note that iSCAN does support data import with numbers as float format but with comma as decimal separator, some demonstration sites (e.g. PMP) have managed to import data from a .csv file with such data format, by making sure that the appropriate data format, i.e. "float (decimal comma)", is detected automatically, or adjusted manually, at the "configure format" step of data import in iSCAN.

However, iSCAN does not indeed support import of.csv files created with ";" as column/list separator rather than with ",", which can occur when MS Office settings are set to "," as decimal separator and "." as thousands separator, rather than "." as decimal separator and "," as thousands separator, so MS Office settings should be amended accordingly. It can also occur when decimal symbol and list separator are set in Windows settings (Time & Language / Related settings - Date, time & regional formatting / Related settings - Additional date, time & regional settings / Region - Change date, time or number formats / Additional settings – Decimal symbol & List separator) as "," and ";", respectively, rather than as "." and ",", respectively, so Windows settings should also be amended accordingly. It is also advised to use a text editor (e.g. Notepad, Notepad++, etc.) in order to check the format of the .csv file created is appropriate, in particular with regards the column/list separator, prior to proceeding with a .csv file data import in iSCAN.

4.2.9 Interpretation of hourly data

It is indeed more appropriate to have a precise hourly timestamp column when importing an hourly dataset, rather than using a timestamp column auto-filled by Excel with discrepancies in minutes and seconds.

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However, this issue encountered by user could not be reproduced when importing an hourly dataset with a timestamp column auto-filled by Excel, and thus by including non-exact hourly timestamps due to a delay building up in terms of seconds and minutes. Throughout such a data import test case, iSCAN was able to make the difference between for example 3:00, 3:59 and 4:00 timestamps, without reporting any error due to repeated timestamps. Furthermore, data was imported and could be visualised without any interpretation or rounding of timestamp at 3:59.

Therefore, user was asked to check what values were kept when the error due to repeated timestamp 2020-06-05 03:00:00.000Z was met (i.e. do the values kept match these from your .csv monitoring data file at 05/06/2020 3.59?), as there may actually be some repeated timestamps in the user .csv monitoring data file, which usually is the cause of such an error message being displayed.

4.2.10 Data import cannot be actualized

There were issues (warnings) in the original file import, possibly due to some timestamps being repeated in the timestamp column of the file the user tried to upload, e.g. timestamp 2020-10-25 01:00:00.000 seems to be duplicated, which usually is the cause of such an error message being displayed. It is a good practice to click on "more" and confirm what the source of warnings is.

With regards the subsequent "Duplicate file uploaded" error, such a message appears when a user attempts to upload a data file with the same data as of that from a data file already uploaded in the last 24h, even if the data file name is different. In fact, data actualization is possible for a data import that has already been configured, by uploading another or the same file, but with different data within, thus without having to re-configure a new data import and file upload from scratch.

4.2.11 Error uploading data to a channel

Indeed, the channels "Average_waste PCI_year", "L1_municipal waste PCI_year" and "L2_municipal waste PCI_year" display a value on the date of 2022-04-13, i.e. the date of data import, which is the same value as for the last day in the .csv uploaded, i.e. date of 2021-05-31, whereas the equivalent channels "Average_waste PCI", "L1_municipal waste PCI" and "L2_municipal waste PCI" do not display any value on the date of 2022-04-13.

It should be noted that such an issue could not be reproduced by IES, so the user was asked to provide IES with more details about the steps that led to the erroneous data import, i.e. import of data which was not present in the imported data file, as well as about the difference between these two data imports (correct vs. erroneous), in order to enable a reproduction of the issue and an identification of its root cause. Also, following up from an escalation of this issue to the IES Software Development Team and further investigations conducted, it appears that previous attempts of data import and binding with the channels "Average_waste PCI_year", "L1_municipal waste PCI_year" and "L2_municipal waste PCI_year", as illustrated in the image below, may be the source of data being displayed on the date of 2022-04-13 at 05:00 for these channels.

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Event	Description	File name	Event Time (UTC)	Data Time (UTC)	Query (ms)	Import (ms)	Bytes
File import had warnings	Imported 6 data points into 6 channels between 2022-04-13 05:00 and 2022-04-13 05:00 UTC (more)	Annual waste incinerated_prueba.csv	2022-04-13 06:00	2022-04-13 06:00	-	340	21,907
File uploaded		Annual waste incinerated_prueba.csv	2022-04-13 06:00	2022-04-13 06:00	-	-	21,907

Figure 22 Resolution to data display issue

In such a situation, it should be noted that channel data for chosen days can be cleared directly in iSCAN through the Data Overview feature, as illustrated in the image below.

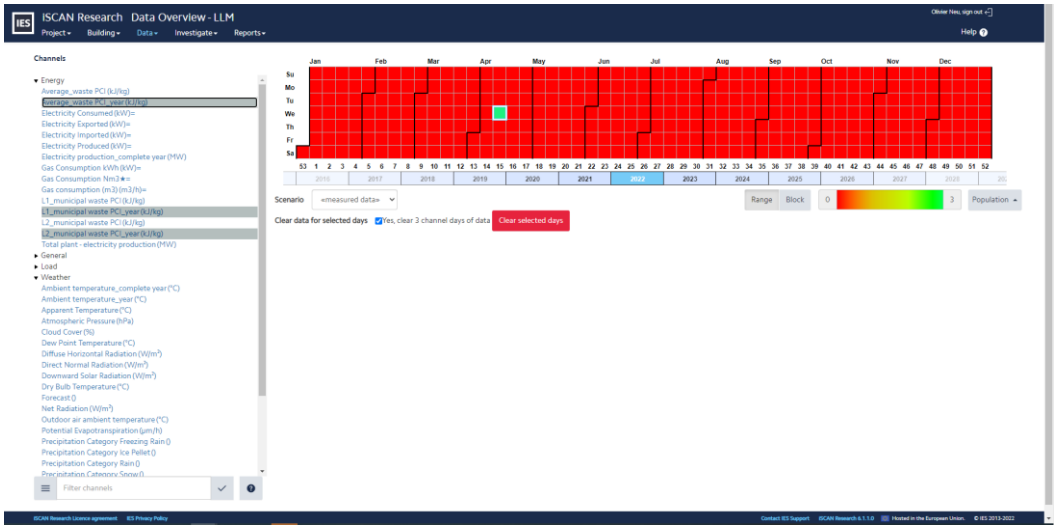

Figure 23 Error upload issue resolution

4.2.12 Time zone

The 1-h mismatch between iSCAN and the data file is related to daylight saving time. Indeed, the data files imported are in local time but do use daylight saving times, so the box "Timestamps in input files use local time" should be ticked when setting up a data import, as well as the box "Timestamps use daylight savings". In particular, by checking the timestamp column in the data files imported, it is noted that on the 29/03/2020, 01:00:00 timestamp is skipped, whereas on the 25/10/2020, 02:00:00 timestamp is duplicated. However, time is continuous in iSCAN, i.e. when a channel data is visualised, timestamps are continuous and exclude daylight saving time switches, thus without skipping an hour at the beginning of the daylight saving period on the last Sunday of March, and without duplicating an hour at the end of the daylight saving period on the last Sunday of October. So any imported data in local time that includes daylight saving time, i.e. that includes a duplicated timestamp on the 25/10/2020, will be visualised in local winter time in iSCAN. Therefore, in this case, any data visualised after the 25/10/2020 at 1am will be aligned with that from the data file, in terms of timestamps, because both are in winter time, whereas any data visualised before the 25/10/2020 at 1 am will appear delayed by 1 hour compared to that from the data file imported.

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5 Testing objective 3 - *Setup of possible future DHNs for exploitation of WH resource*

The table below gives an overview of the result of the testing and the sub steps in the workflow:

Table 5 Results overview for TO3

Task - Testing Objective	Testing and validation successfully completed by demo site
TO3 - Setup of possible future DHNs for exploitation of WH resource (baseline and scenarios)	Partially complete
TO3.1 Develop and calibrate iCD building model (demo-site buildings and relevant buildings located in DHN/DCN area of interest)	Yes
TO3.2 Export data from iSCAN to iCD	Yes
TO3.3 Synchronisation of iCD data with iCIM model	Yes
TO3.4 Export data from iCIM model to iVN project	Yes
TO3.5 Setup iVN project parameters	Yes
TO3.6 iVN baseline network model (inc. virtual and physical networks, simulation and export of results)	Not complete due to lack of data from demo site
TO3.7 iVN network model scenario #1 (inc. virtual and physical networks, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To3.6 completion first
TO3.8 iVN network model scenario #2 (inc. virtual and physical networks, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To3.6 completion first
TO3.9 iVN network model scenario #3 (inc. virtual and physical networks, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To3.6 completion first
TO3.10 Comparison against baseline results (inc. export of simulated results for baseline and scenario network models)	Not complete due to requiring To3.6 completion first

5.1 Overview of issues encountered and outcomes

Setup of possible future DHNs for exploitation of WH resource (baseline and scenarios)

Table 6 Overview of issues for TO3

Outcome category	Details on issue in section	Details on outcome in section
Training on SO WHAT tool use	5.2.1; 5.2.2; 5.2.5; 5.2.6; 5.2.7	5.3.1; 5.3.2; 5.3.5; 5.3.6; 5.3.7
Bug to be fixed	5.2.1	5.3.1
Feature improvement suggestion	5.2.6	5.3.6
Further investigation needed	5.2.3; 5.2.4	5.3.3; 5.3.4

5.2 Details on issues encountered

5.2.1 Error import OpenStreetMap info into iVN

Fault message when trying to import OpenStreetMap data, engine stays running.

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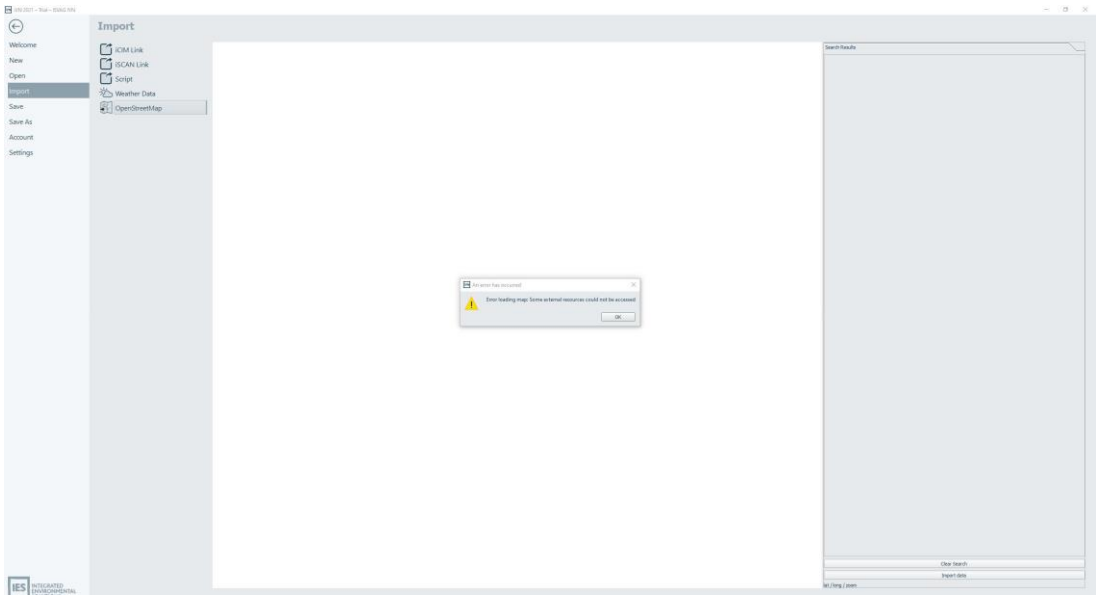

Figure 24 GIS Import error to iVN

5.2.2 iCIM / iCD endpoint

No url is given from IESVE as noted in the tutorials. Previously created url in ICD is not valid to share data between ICD and ICIM. No link can be made between ICD and IVN because of this.

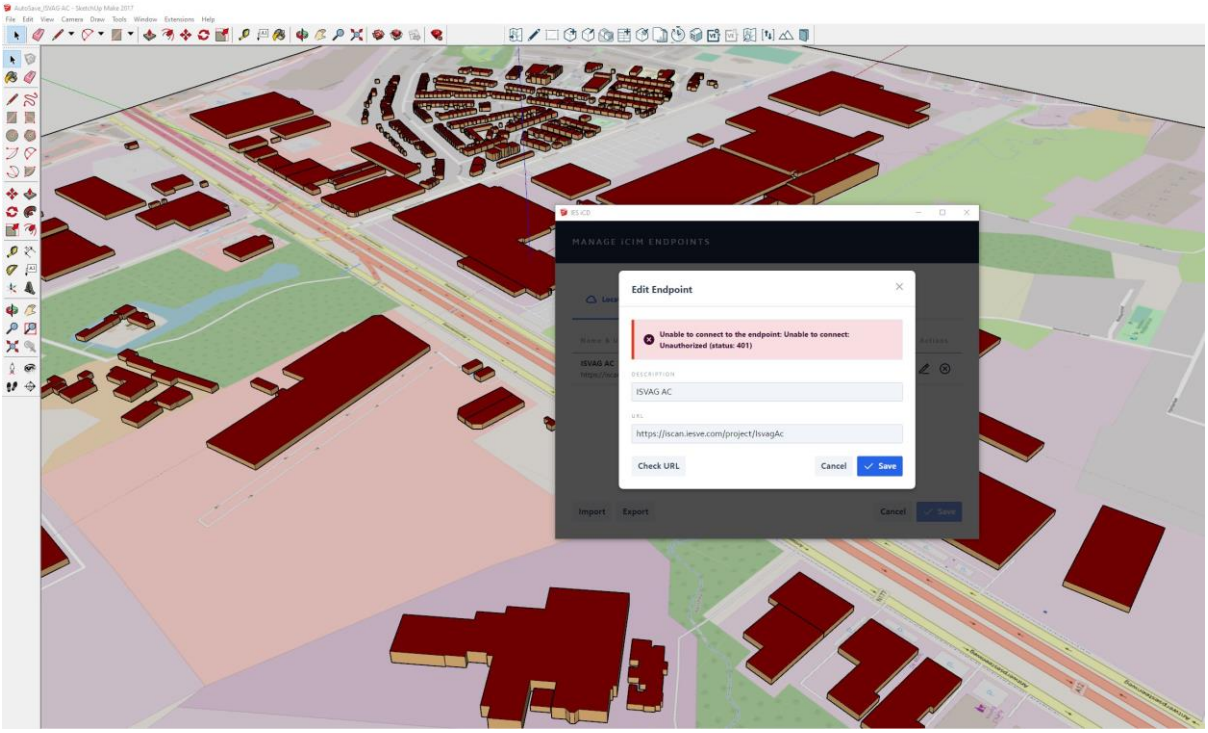

Figure 25 URL not available

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5.2.3 Virtual network buildings are not visible in object browser network

As following the tutorial, selected buildings in the object browser which are dragged and dropped in the 2D model are visible in the 2D view but are not placed under the Network tab.

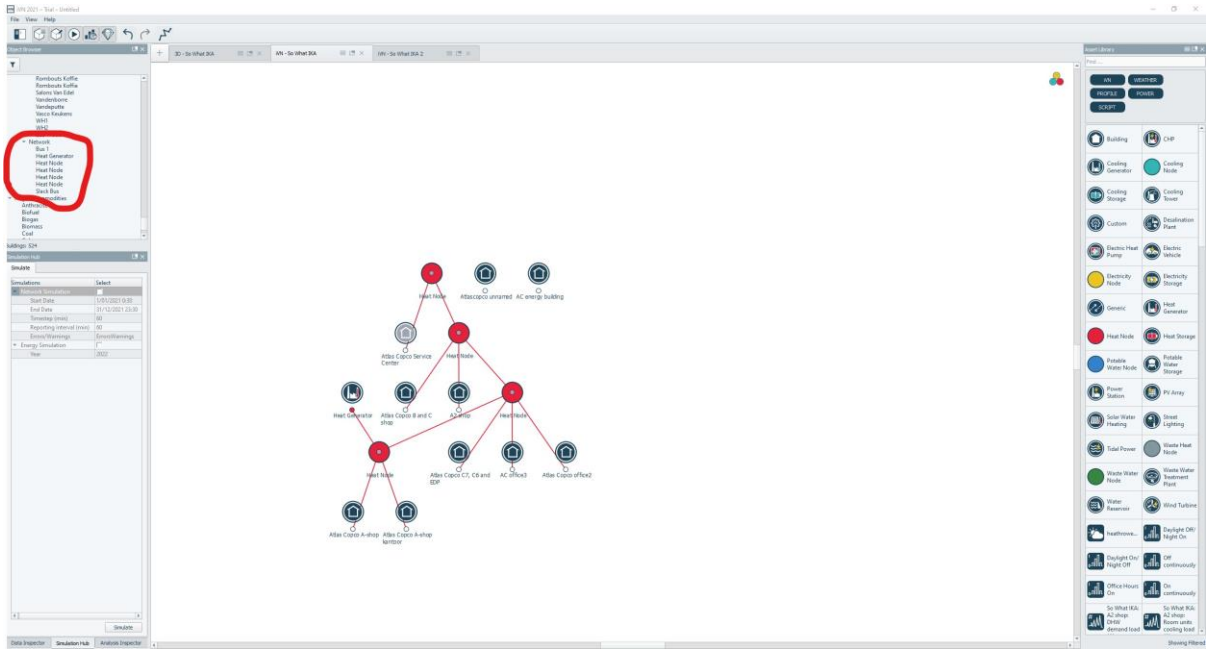

Figure 26 2D model not available in network view

A network simulation of those connected buildings cannot be run because of that issue.

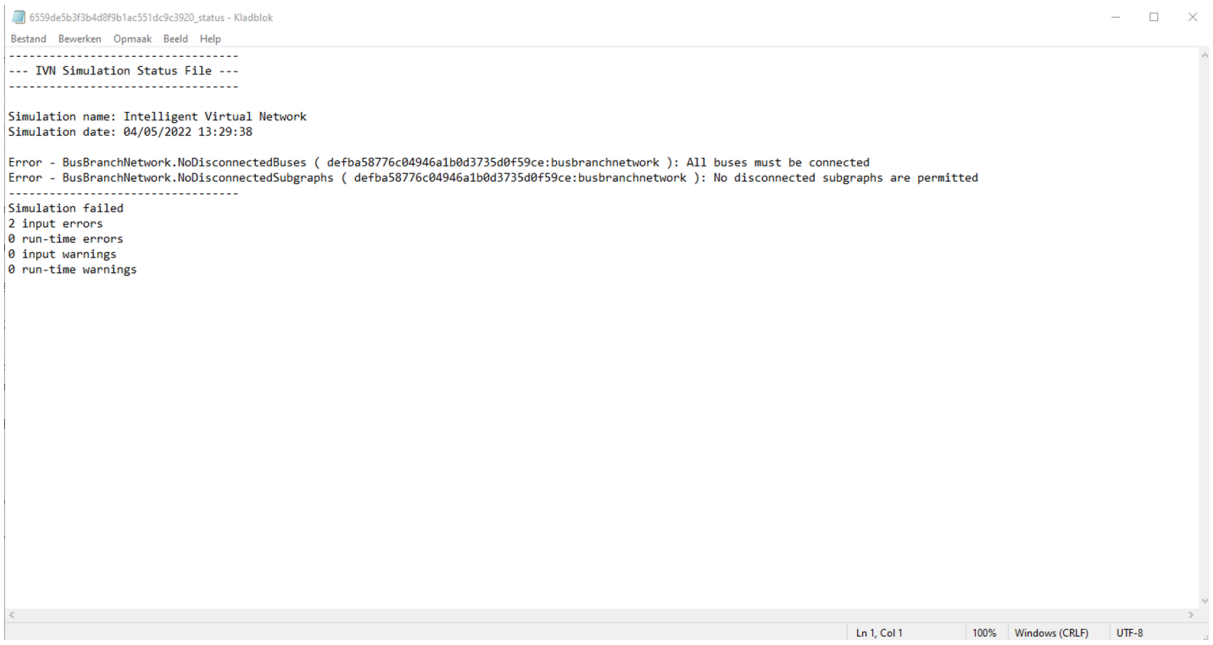

Figure 27 Network simulation not able to run

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5.2.4 Error selecting a larger investigation area in iCD

The user reported an error when selecting a large investigation area in iCD.

5.2.5 Building heights

The user reported that building heights in Belgium are incorrect for most buildings but easy to adjust in iCD.

5.2.6 Oldest roof covers not mentioned in iCD

The user reported that some specific building envelope construction materials, e.g. uninsulated asbestcement for roofs, are not included into the selection list.

5.2.7 iSCAN channel association in iCD

The user reported that after succeeding to import some data in iSCAN, the testing participant cannot associate these iSCAN channel data accurately to a building modelled in iCD.

5.3 Details on outcomes

5.3.1 Error import OpenStreetMap info into iVN

In order to import in iVN a model that was previously created in iCD and then exported to iCIM, "Import > iCIM Link" should be used instead of "Import > OpenStreetMap", because an OpenStreetMap import was already performed at the beginning of the building modelling process in iCD, and all the information contained into the iCD and iCIM models, including details from OpenStreetMap, will be imported in iVN from iCIM. To that end, either https://icim.iesve.com/trial/cim or https://icim.iesve.com/trial/gfc should be used as iCIM endpoint url in iVN.

In any case, the bug that was raised here, in relation to the OSM import feature in iVN, has already been fixed in iVN Beta builds, and such a fix will be included into the next version of iVN that will be released publicly.

5.3.2 iCIM / iCD endpoint

With regards iCD-iCIM synchronisation, the following iCIM Trial endpoint should be setup and used in iCD (https://icim.iesve.com/trial/cim or https://icim.iesve.com/trial/gfc). iCIM models that are synchronised with iCD models can be accessed in iCIM Trial here https://icim.iesve.com/trial/#/.

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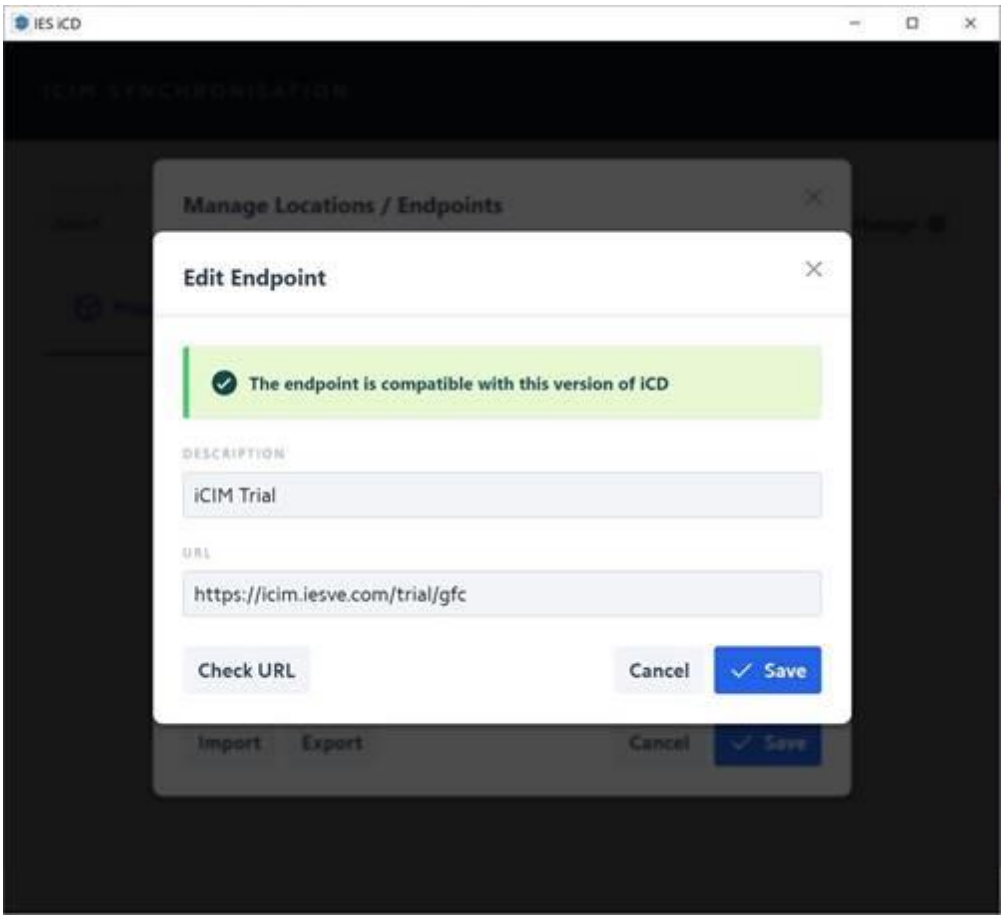

Figure 28 URL solution

5.3.3 Virtual network buildings are not visible in object browser network

The dragged and dropped buildings are not expected to appear in the Object Browser Network section, as they are already included into the Object Browser 3D Geometry section.

However, in the 2D iVN view (virtual network), two buildings are not connected to any node, which should not be the case. Also, in the Object Browser Network section, a "Bus 1" is included, which means the user may have attempted to create a 2D infrastructure view (physical network) for an electrical power flow network, or the user may have inadvertently right-clicked on any of the and then clicked on "Add to infrastructure" for any of the 2D iVN view (virtual network) buildings or supply units, thus kicking off the development of an electrical power flow model, which can be viewed in the 2D infrastructure view (physical network). If it were the case, the 2D infrastructure view should be opened and everything except for the Slack Bus (which cannot be deleted anyway) should be deleted, because it looks like the physical bus-branch electrical power flow model is incomplete, as based on the error message displayed, i.e. buses are not connected to each other.

5.3.4 Error selecting a larger investigation area in iCD

The user was asked to provide some more details about this error in order to enable further investigations and potential root cause analysis.

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5.3.5 Building heights

Indeed, it is best practice to check, and common practice to adjust, building geometry attributes for buildings of interest in iCD, e.g. storey height, number of storeys, glazing ratio, etc., in particular when these attributes are imported from Open Street Map, which database can be inaccurate, incomplete or even empty for some areas, as detailed in Sections 7.2.6 and 7.3.6.

5.3.6 Oldest roof covers not mentioned in iCD

Although the use of ICL VE simulation template enables more detailed building envelope and ventilation system modelling than default AHSRAE in iCD platform, it does not reach the level of details that may be reached through the IES VE detailed building energy simulation platform. However, an "Uninsulated asbestcement" construction type would be part of light or medium construction types, without or limited insulation by default, while U-values for different surfaces may be adjusted by modifying the date of construction, as well as the building envelope-related ICL interventions attributes, if necessary. IES R&D Consultants can help with the process of checking the U-values of building envelope construction materials when using an ICL VE simulation template in ICD, rather than the default ASHRAE template.

5.3.7 iSCAN channel association in iCD

Prior to carrying out an accurate association of data between relevant iSCAN channels and iCD building attributes, such data should be pre-processed. In particular, daily data unit should first be converted from MWh to kWh, prior to be uploaded through the iSCAN Utility Bills module in order to be converted into hourly profiles (rough-cut profiling). Also, a date/time column should be added to the hourly dataset, prior to be uploaded through the more conventional data import module in iSCAN.

Furthermore, once relevant data are pre-processed and imported in iSCAN, some tags should be added to the channels created in iSCAN in order to enable the iSCAN channel association in an iCD model. In particular, the user needs to make sure that buildings are named properly in iCD, with the right "Demo site_Building name", by ensuring the iCD building name is exactly the same as the "Demo site_Building name" tag in iSCAN, as exemplified in the images below:

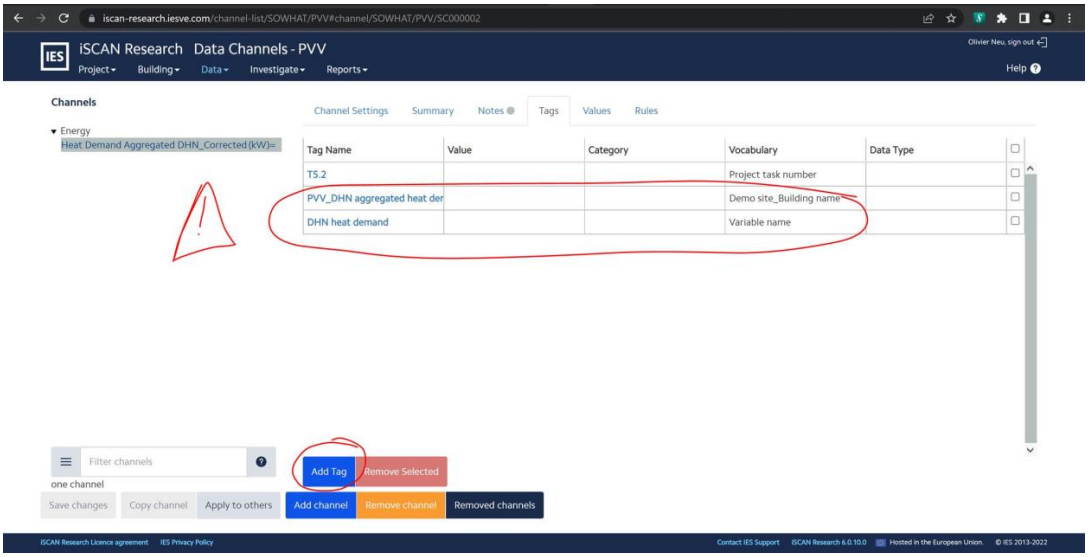

Figure 29 iSCAN channels association

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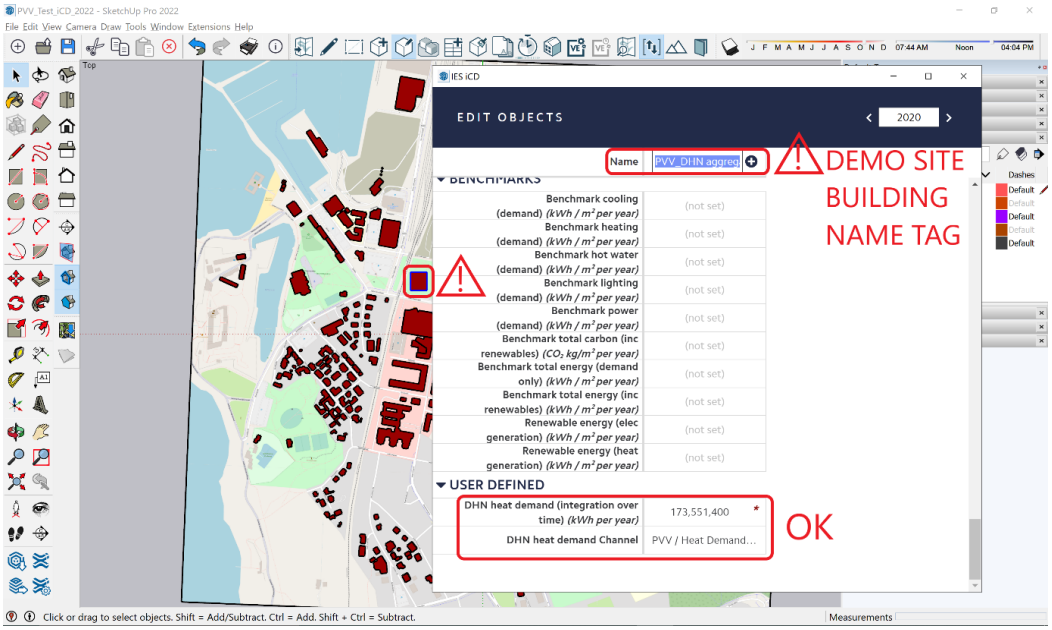

Figure 30 iSCAN channels association in iCD

Also, a tag should be added in the Variable name Tag vocabulary in iSCAN, in order to add another relevant tag for the variable of interest (in this case "DHN heat demand"), which name will be given to the user-defined attribute in iCD.

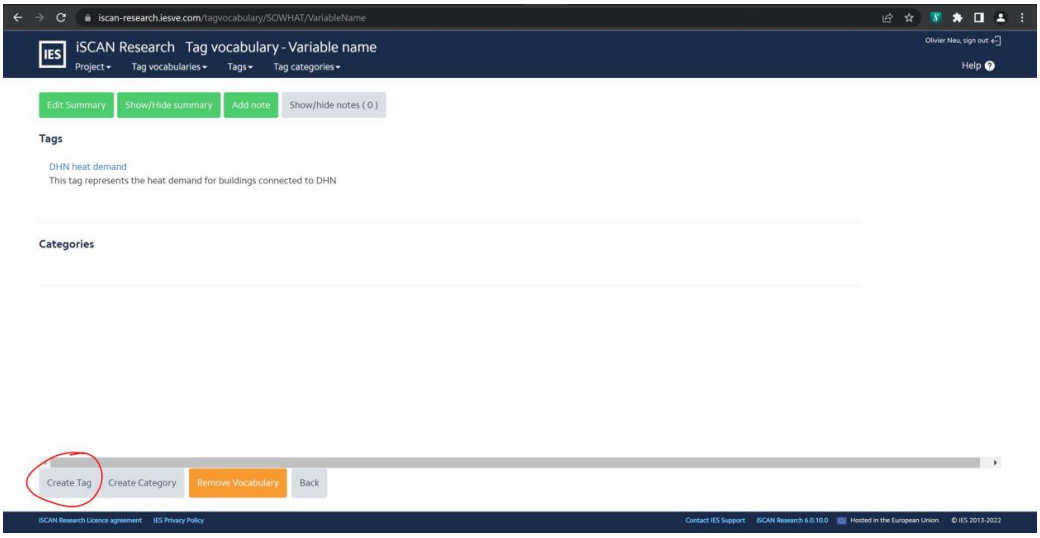

Figure 31 Create correct tag name

Also, as seen in the images below, an accurate integration over time of data associated from an iSCAN channel with an iCD building attribute, for a specific year (e.g. 2018 in the example below), is achieved by adjusting the year in iCD > Extensions > IES iCD > IES iSCAN Client > Year and scenario > iSCAN Year in order to refresh data and visualise the integrated over time value in kWh per year for that specific year of interest.

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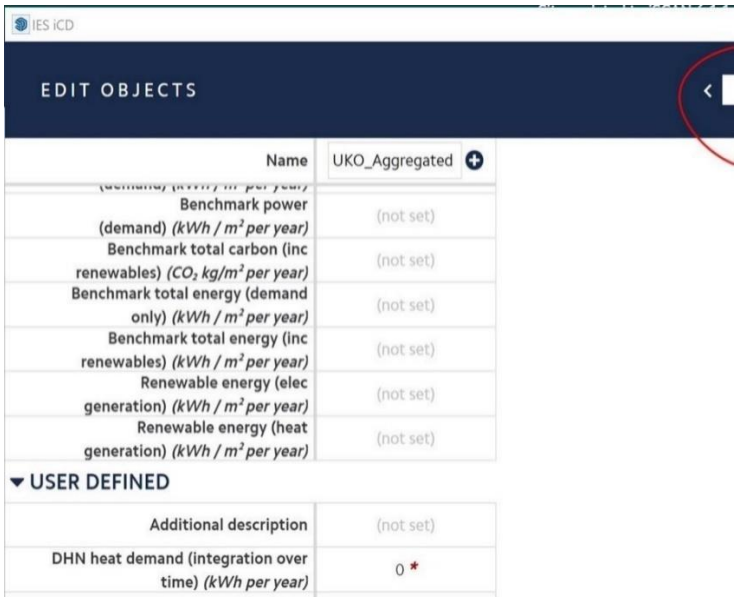

Figure 32 Add accurate year data

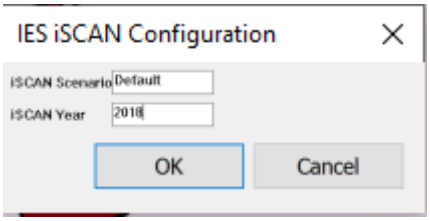

Figure 33 Ensure year format is correct

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6 Testing objective 5 - *Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs*

The table below gives an overview of the result of the testing and the sub steps in the workflow:

Table 7 Results overview for TO5

Task - Testing Objective	Testing and validation successfully completed by demo site
TO5 - Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs	Partially complete
TO5.1 Develop and calibrate iCD building model (demo-site buildings and relevant buildings located in DHN/DCN area of interest)	Yes
TO5.2 Export data from iSCAN to iCD	Yes
TO5.3 Synchronisation of iCD data with iCIM model	Yes
TO5.4 Export data from iCIM model to iVN project	Yes
TO5.5 Setup iVN project parameters	Yes
TO5.6 iVN baseline network model (inc. virtual and physical networks, simulation and setup of custom installation script)	Not complete due to lack of data from demo site
TO5.7 Export and visualisation of simulated results for baseline model	Not complete due to requiring To5.6 completion first

6.1 Overview of issues encountered and outcomes

Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs

Table 8 Overview of issues for TO5

Outcome category	Details on issue in section	Details on outcome in section
Training on SO WHAT tool use	None	None
Bug to be fixed	None	None
Feature improvement suggestion	6.2.1	6.3.1
Further investigation needed	6.2.2; 6.2.3	6.3.2; 6.3.3

6.2 Details on issues encountered

6.2.1 Cannot export simulated results from iVN

Export and visualization of simulated results was unavailable for baseline model from iVN.

6.2.2 iCD – OSM

The user cannot run an import from OpenStreetMap in iCD.

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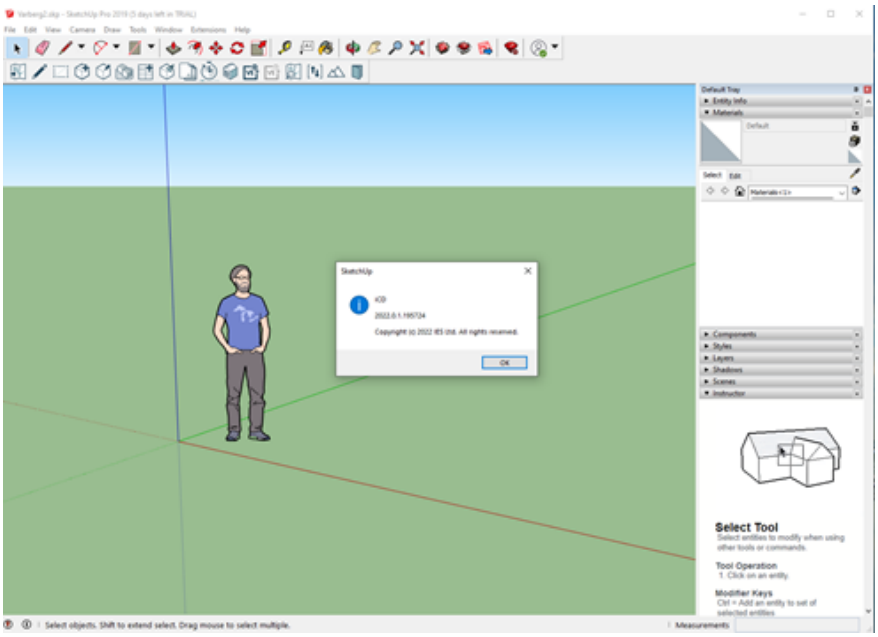

Figure 34 Unable to import GIS data into iCD 1

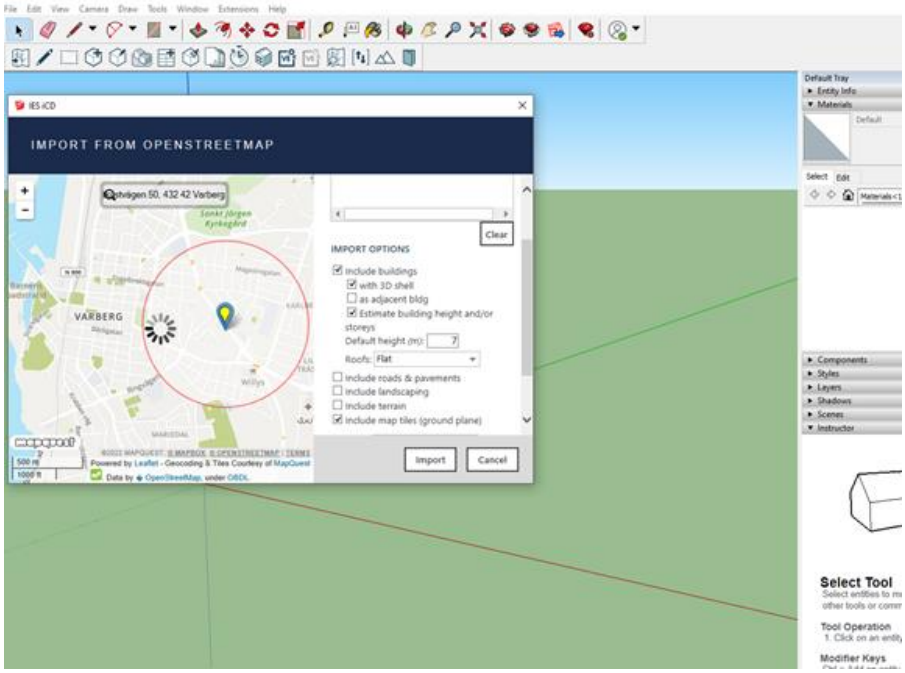

Figure 35 Unable to import GIS data into iCD 2

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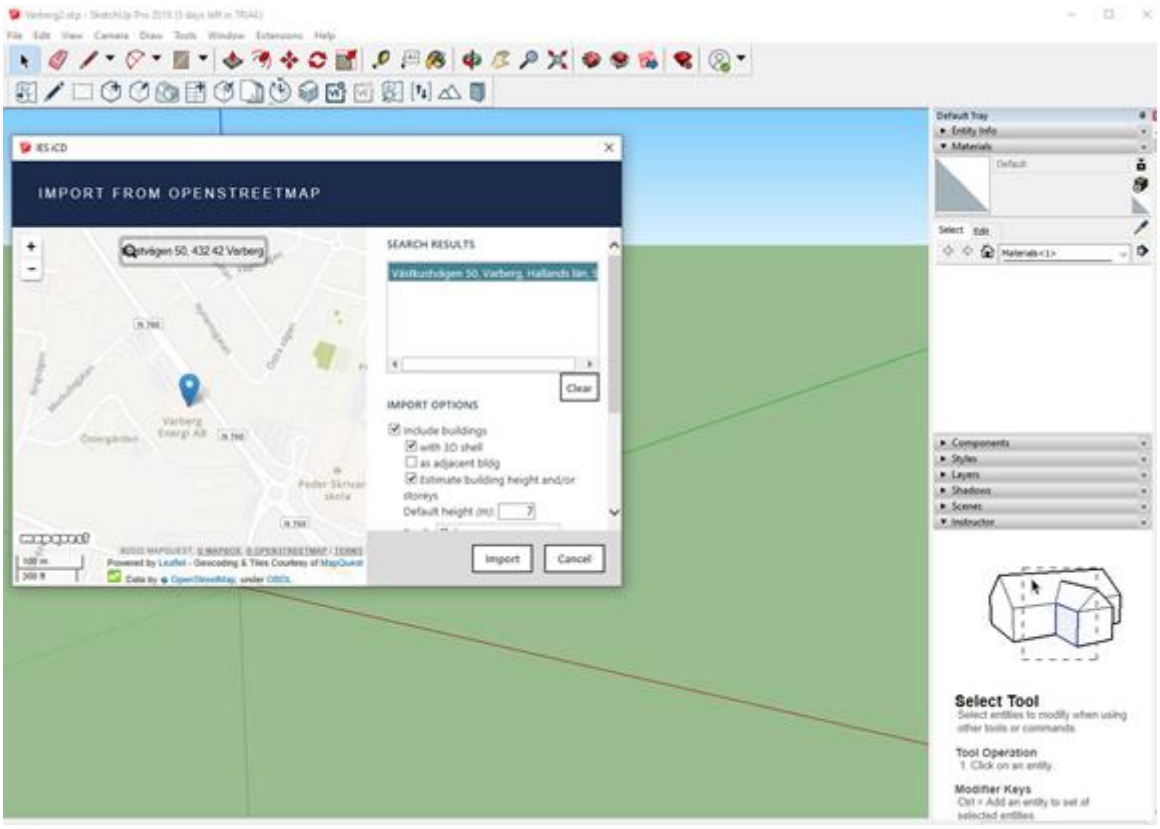

Figure 36 Unable to import GIS data into iCD 3

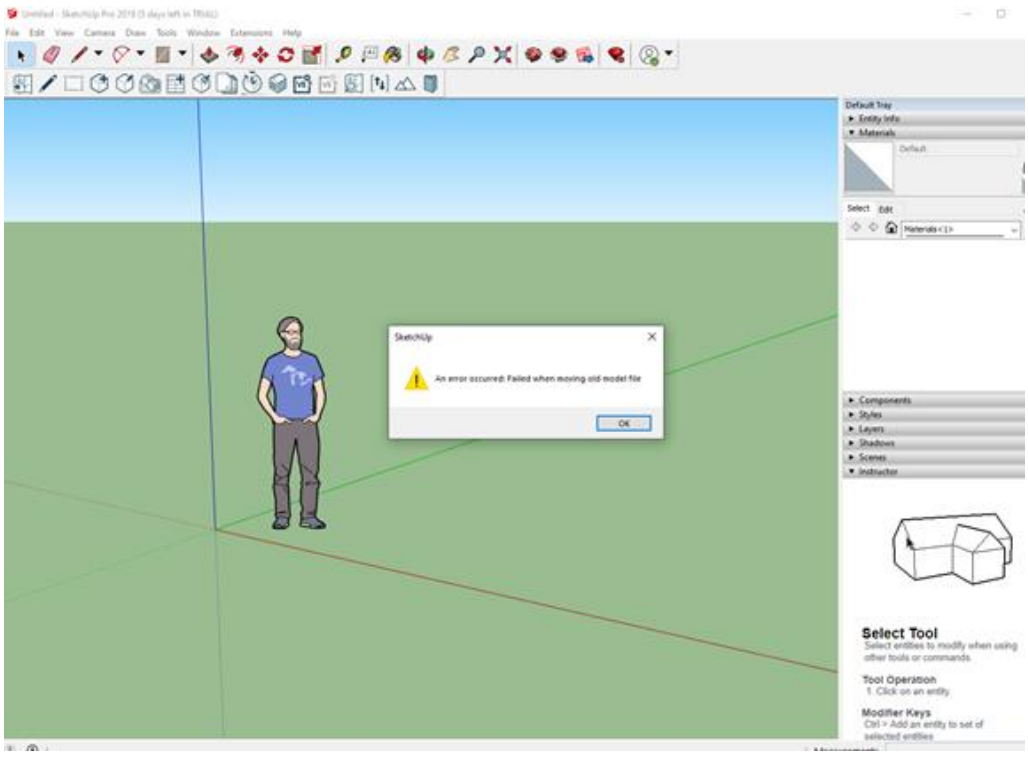

Figure 37 Unable to import GIS data into iCD 4

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6.2.3 iCIM Synchronisation

The user cannot synchronize iCD with an existing iCIM model. This issue is directly related with the "iCD – OSM" import issue detailed in Section 6.2.2, with the same error message being displayed, which appeared when trying to offering to the user to bypass the creation of an iCD model from scratch by synchronising with pre-existing iCIM model created by IES, as an immediate quick-response measure in the meantime of completing investigations and potential root-cause analysis for the "iCD – OSM" import issue.

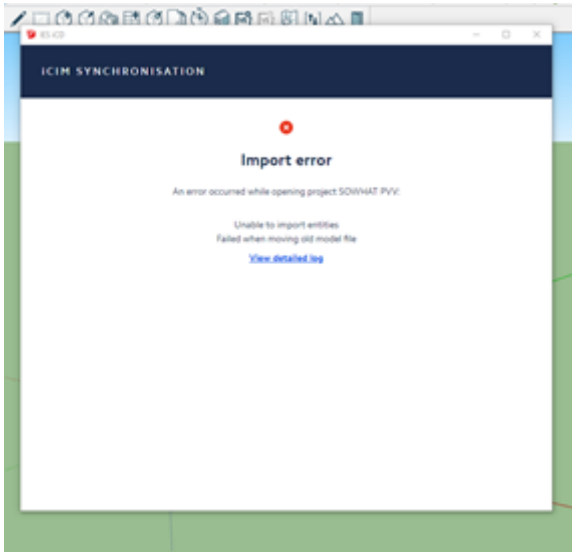

Figure 38 Issue synchronising with iCIM

6.3 Details on outcomes

6.3.1 Cannot export simulated results from iVN

Automatic export of simulated results from iVN to iSCAN is not a feature of the iVN version that can currently be downloaded from https://www.iesve.com/support/ivn/download for external use. This is a feature that is currently available with the most recent Beta versions of iVN that can be used internally or in the context of research projects such as SO WHAT, e.g. version with DHN physical infrastructure modelling feature, which can be shared with demonstration site testing users for further testing of these features. However, please note that iVN offers table, line and bar charts visualisation of simulated results. Also, simulated results for variables of interest can be copied and pasted from a table chart into an MS Office Excel file, prior to be imported manually into iSCAN.

6.3.2 iCD – OSM

This issue encountered by user could not be reproduced when creating a new model through SketchUp Pro 2021.1.332 64-bit (PVV_Test_iCD_2022) / iCD 2022.0.0.195139 (PVV_Test_iCD_2022) / iCIM 2022 (SOWHAT_PVV), so it was escalated to the IES Software Development Team for potential root cause analysis. As a way to further investigate on the potential root cause, a suggestion was made to the user to try saving their SketchUp/iCD model to a different place on their computer disk,

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somewhere with a simple path without any special/accented characters, where the user would have write access, e.g. "C:\tmp" or similar, but such a solution could not be validated by the user.

6.3.3 iCIM Synchronisation

This issue is directly related with the "iCD – OSM" import issue detailed in Section 6.2.2, with the same error message being displayed, and could not be reproduced when creating a new model through SketchUp Pro 2021.1.332 64-bit (PVV_Test_iCD_2022) / iCD 2022.0.0.195139 (PVV_Test_iCD_2022) / iCIM 2022 (SOWHAT_PVV), so it was escalated to the IES Software Development Team for potential root cause analysis. Similarly, as a way to further investigate on the potential root cause, a suggestion was made to the user to try saving their SketchUp/iCD model to a different place on their computer disk, somewhere with a simple path without any special/accented characters, where the user would have write access, e.g. "C:\tmp" or similar, but such a solution could not be validated by the user.

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7 Testing objective 7 - *Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs*

The table below gives an overview of the result of the testing and the sub steps in the workflow:

Table 9 Results Overview for TO7

Task - Testing Objective	Testing and validation successfully completed by demo site
TO7 - Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs (baseline and scenarios)	Partially complete
TO7.1 Export data from VE to iSCAN for calibrated detailed VE model of demo-site buildings	Yes
TO7.2 Export data from iSCAN to iCD	Yes
TO7.3 Synchronisation of iCD data with iCIM model	Yes
TO7.4 Export data from iCIM model to iVN project	Yes
TO7.5 Setup iVN project parameters	Yes
TO7.6 iVN baseline network model (inc. virtual network, simulation and export of results)	Not complete due to lack of data from demo site
TO7.7 iVN network model scenario #1 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To7.6 completion first
TO7.8 iVN network model scenario #2 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To7.6 completion first
TO7.9 iVN network model scenario #3 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To7.6 completion first
TO7.10 iVN network model scenario #4 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	Not complete due to requiring To7.6 completion first
TO7.11 Comparison against baseline results (inc. export of simulated results for baseline and scenario network models)	Not complete due to requiring To7.6 completion first

7.1 Overview of issues encountered and outcomes

Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs (baseline and scenarios).

Table 10 Overview of issues for TO7

Outcome category	Details on issue in section	Details on outcome in section
Training on SO WHAT tool use	7.2.1; 7.2.2; 7.2.3; 7.2.5; 7.2.6	7.3.1; 7.3.2; 7.3.3; 7.3.5; 7.3.6
Bug to be fixed	7.2.3; 7.2.4	7.3.3; 7.3.4
Feature improvement suggestion	None	None

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Further investigation needed	None	None

7.2 Details on issues encountered

7.2.1 Error importing iCIM Project to iVN.

The user was not able to import an iCIM Project to iVN (Error: "Failed to load iCIM projects due to an unexpected error"), supposing that the selected iCIM url endpoint was not correct.

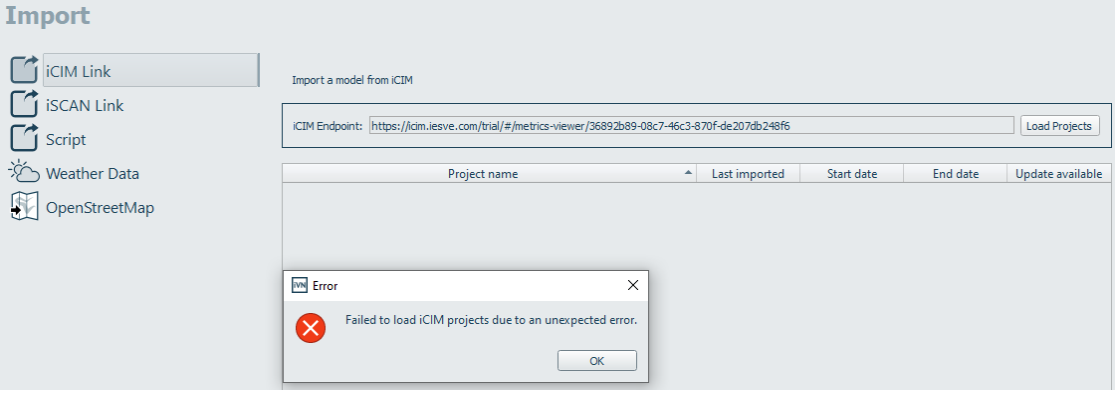

Figure 39 iCIM import to iVN issue

7.2.2 Synchronisation of iCD with iCIM

There is no iCIM endpoint available in the "manage endpoint tool" window when trying to set it up, even after enabling "dangerous operations".

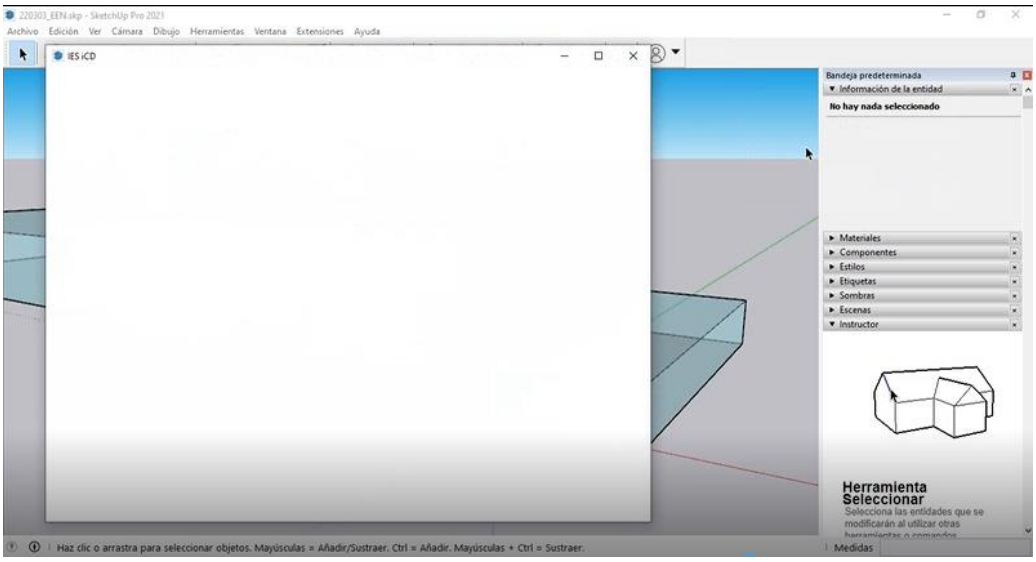

Figure 40 Issue synchronising iCD with iCIM 1

7.2.3 iCD trouble with iCIM synchronization

Despite the setup of iCIM Trial endpoint at the appropriate url (https://icim.iesve.com/trial/gfc), and despite reducing the length of the variable name tags and channel names in iSCAN, the iCD model

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cannot be fully synchronised with an iCIM project, with following export error message being displayed.

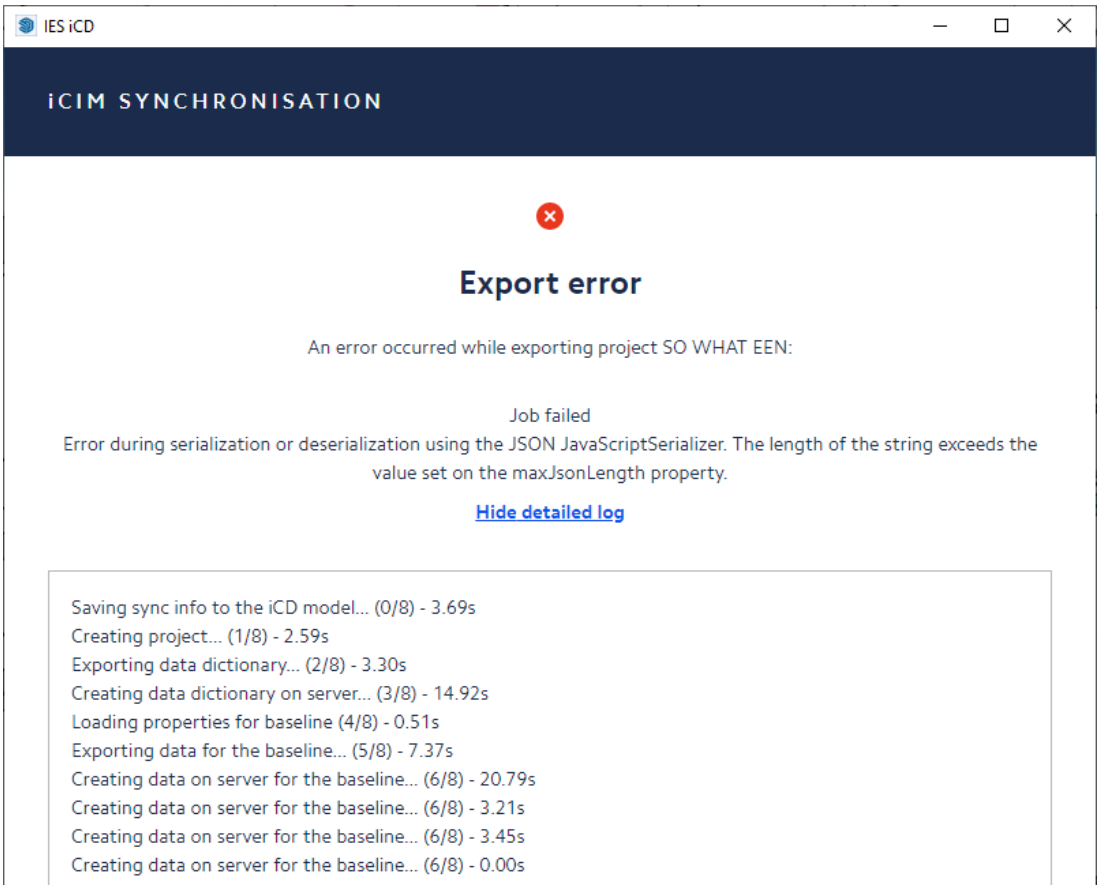

Figure 41 Issue synchronising iCD with iCIM 2

7.2.4 Cannot create iCIM project from iCD

Despite the setup of iCIM Trial endpoint at the appropriate url (https://icim.iesve.com/trial/gfc), the iCD model cannot be synchronised with an iCIM project, with error message 'Error: Unable to connect: Forbidden (status: 403)' being displayed.

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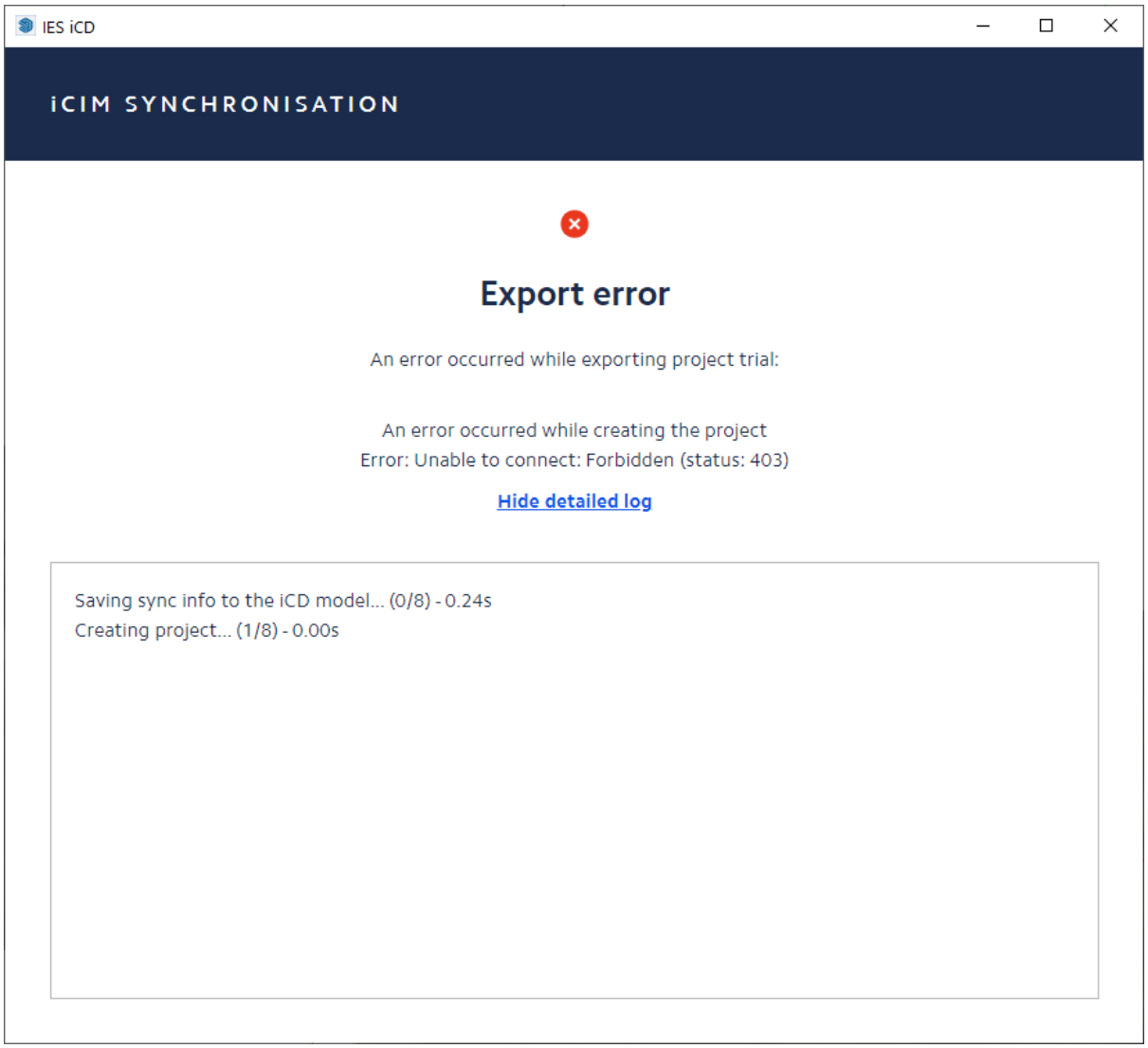

Figure 42 Issue creating a project

7.2.5 iSCAN import to iCD

Despite defining the iSCAN endpoints correctly in iCD, when the user tries to match and associate iSCAN channels with iCD objects, "Matching done" message is displayed but it is not possible to save the iSCAN channel association or to enter in the variables window.

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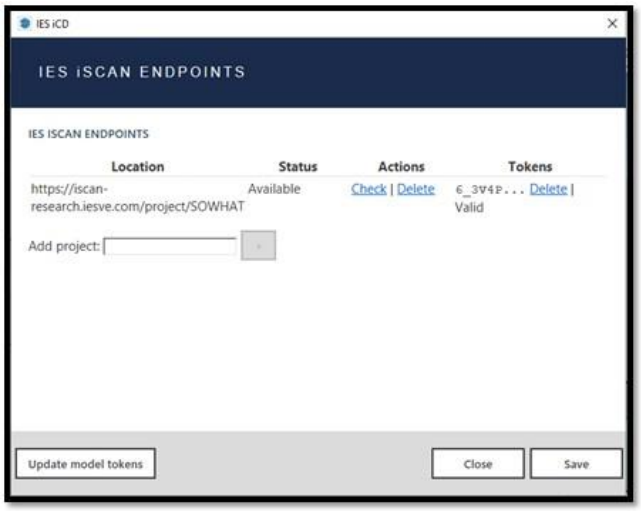

Figure 43 Issue importing data from iSCAN 1

Figure 44 Issue importing data from iSCAN 2

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Figure 45 Issue importing data from iSCAN 3

7.2.6 iCD OpenStreetMap import

No building or street appears when running an import from OpenStreetMap for an area around the site of interest, so the import fails, with the error message "An error ocurred: your chosen options resulted in an empty area" being displayed and no object being imported in the iCD model.

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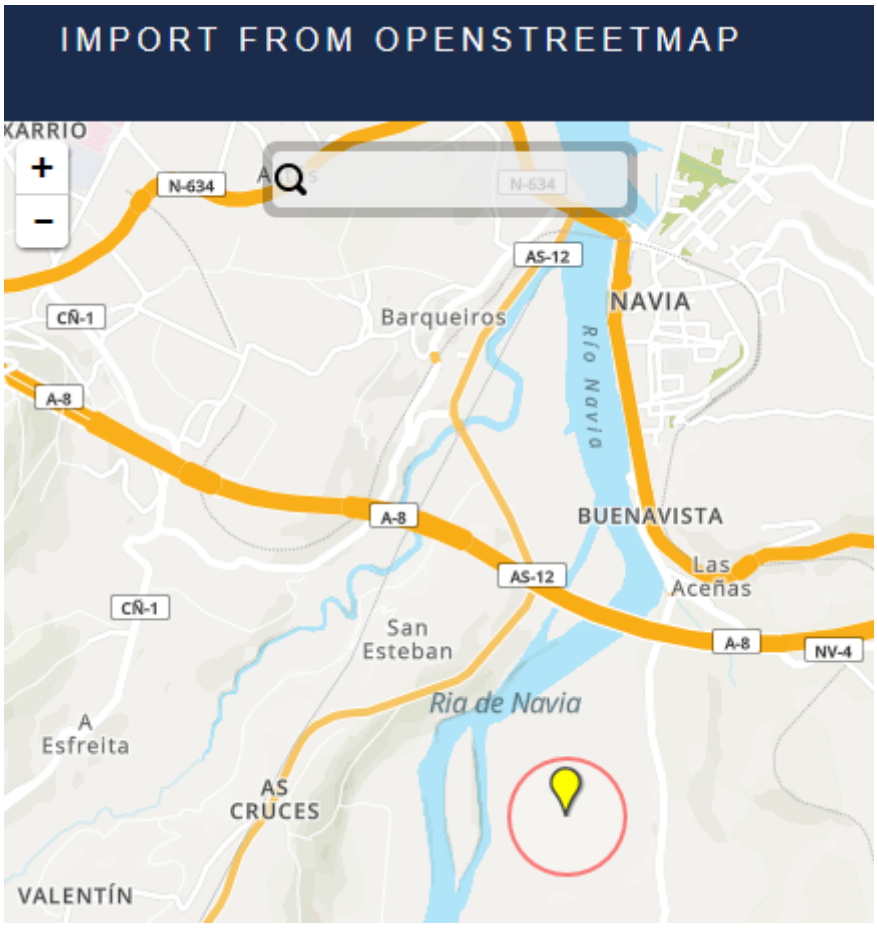

Figure 46 Issue importing from OSM

7.3 Details on outcomes

7.3.1 Error importing iCIM Project to iVN

In order to import a model in iVN from iCIM, the overall iCIM Trial endpoint url should be used, but by replacing the last character "#", by "cim" or by "gfc". So the following iCIM Trial url endpoint should be used in iVN, https://icim.iesve.com/trial/cim or https://icim.iesve.com/trial/gfc.

7.3.2 Synchronisation of iCD with iCIM

In relation to setting up iCIM endpoints, enabling of dangerous operations is not necessary, and the following iCIM Trial endpoint should be setup and used in iCD (https://icim.iesve.com/trial/cim or https://icim.iesve.com/trial/gfc), as per the series of screenshots below.

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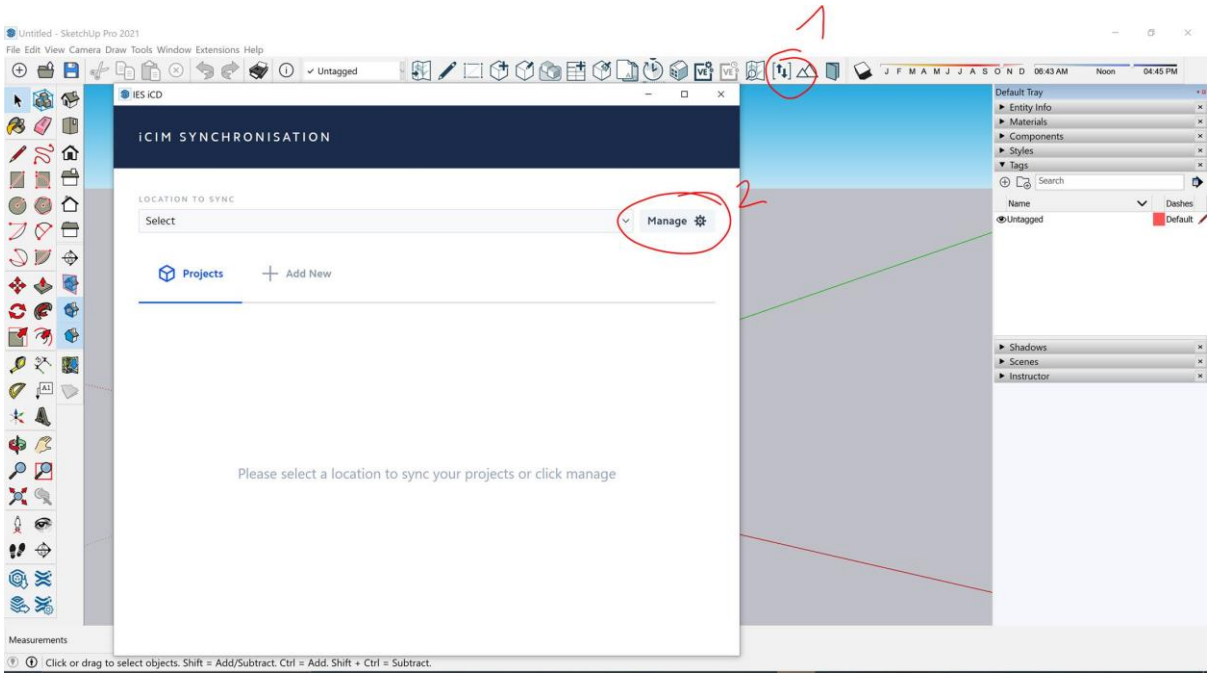

Figure 47 Solution to synchronisation issue 1

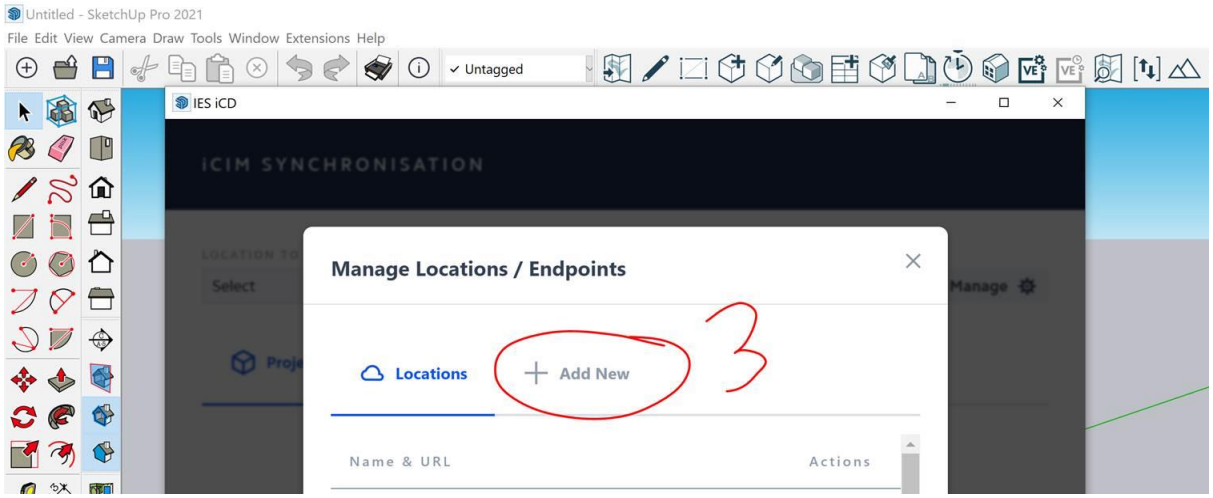

Figure 48 Solution to synchronisation issue 2

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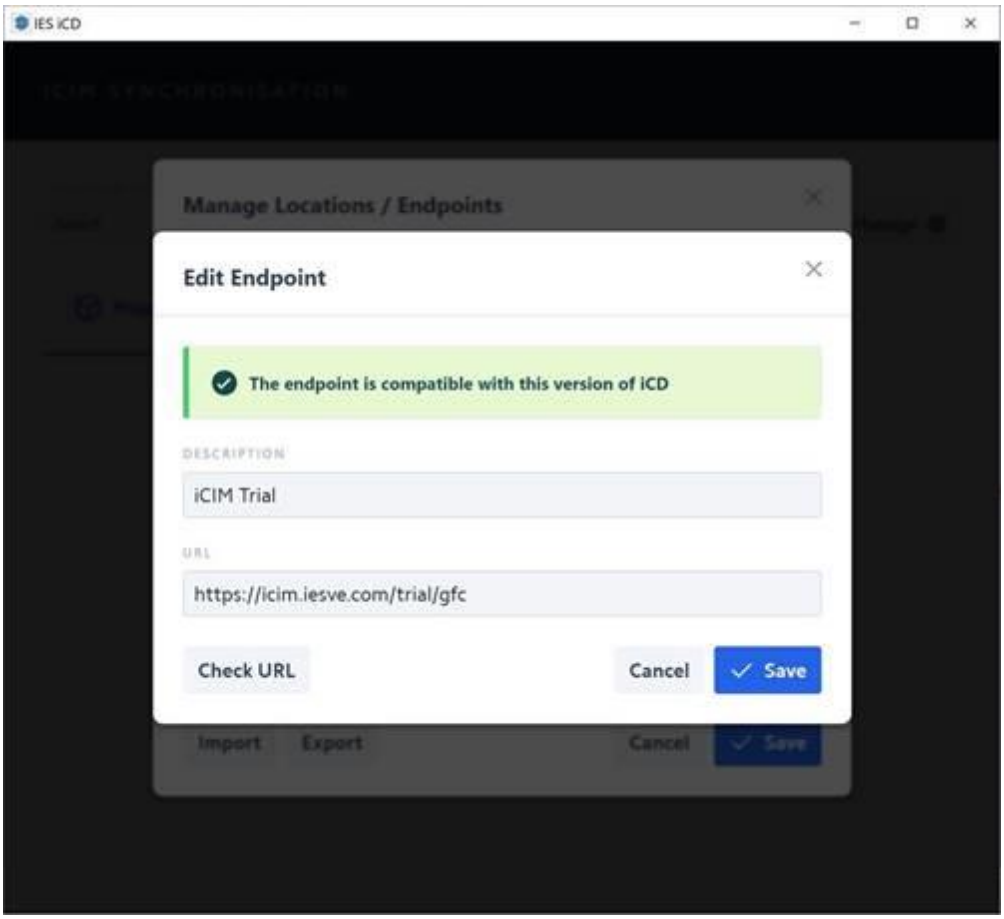

Figure 49 Solution to synchronisation issue 3

iCIM models that are synchronised with iCD models can be accessed in iCIM Trial here https://icim.iesve.com/trial/#/.

7.3.3 iCD trouble with iCIM synchronisation

All the landscaping objects (Water bodies, Soft Landscape, Hard Landscape), in particular the largest water body object, should be removed from the iCD model in order to enable a successful iCD/iCIM synchronisation. Although these objects can be included into an iCD model prior to be synchronised with an iCIM model, this issue is directly related to the large size of one of these objects (e.g. water body object for the Mediterranean Sea that spans from the Spanish coast up until Brittany coast), which may have created a size issue when synchronising with iCIM. This issue was escalated as a bug to the IES Software Development team in order to be investigated further, to identify the potential root cause and to make any adjustment, where necessary. However, these objects are not necessary in the context of on-going SO WHAT tool testing activities, so it is advised to remove these objects from the iCD model.

7.3.4 Cannot create iCIM project from iCD

The user email address was added twice in the iCIM Trial user database, and one of these email addresses was incorrect (with a space at the end). These two email addresses have been reconciled in the iCIM Trial user database.

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7.3.5 iSCAN import to iCD

In relation to this iCD-iSCAN channel association issue, the user needs to make sure that buildings are named properly in iCD, with the right "Demo site_Building name". In particular, the iCD building name should be exactly the same as the "Demo site_Building name" tag in iSCAN, as exemplified in the images below:

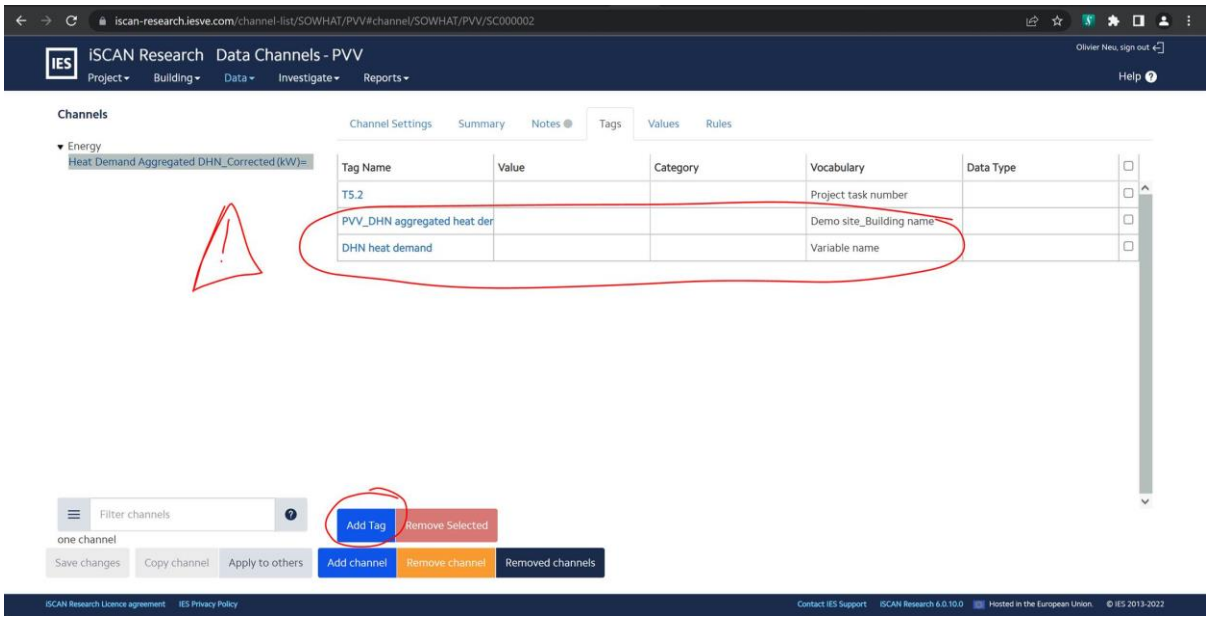

Figure 50 Solution to import issue 1

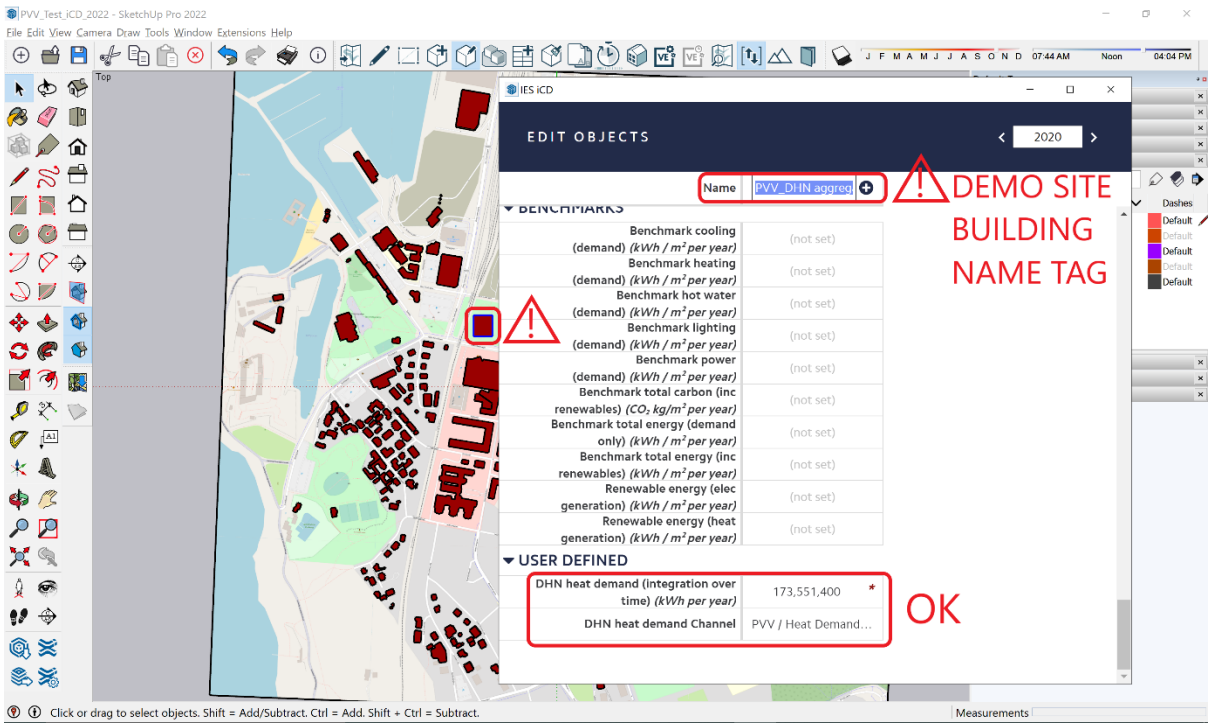

Figure 51 Solution to import issue 2

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Also, a tag should be added in the Variable name Tag vocabulary in iSCAN, in order to add another relevant tag for the variable of interest (in this case "DHN heat demand"), which name will be given to the user-defined attribute in iCD.

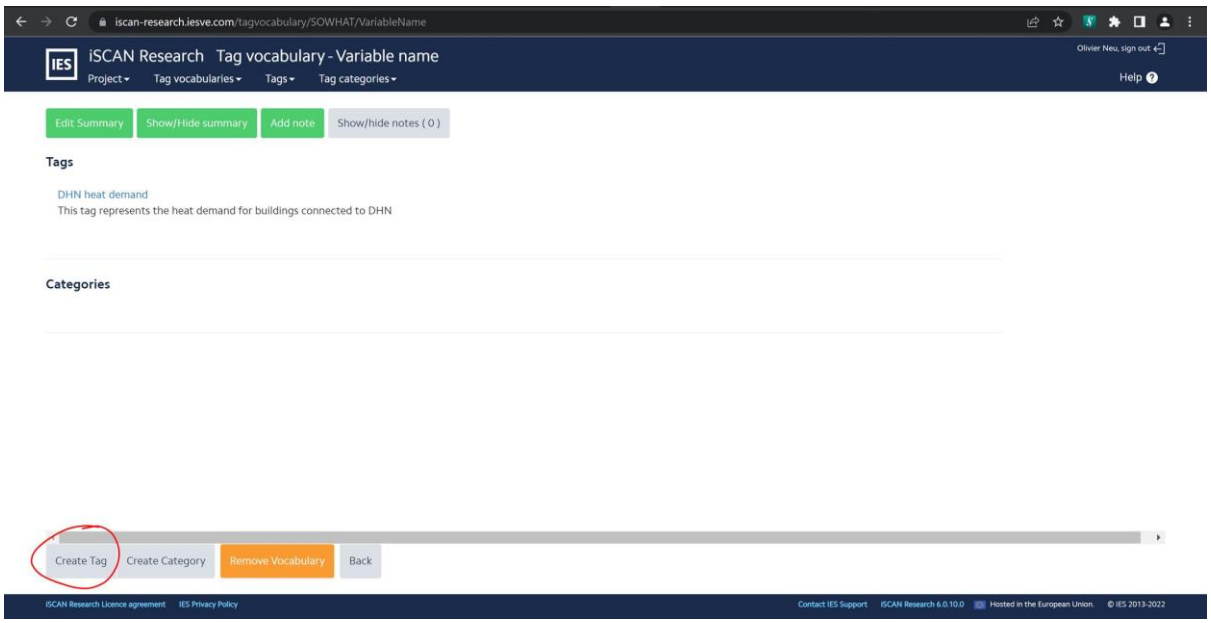

Figure 52 Solution to import issue 3

7.3.6 iCD OpenStreetMap import

Indeed, for some areas, the OSM database can be empty, i.e. no information available about buildings included into a specific area, or no information about building geometry, not even building footprint on map tiles in some cases. When an OSM import that should include buildings results in no building available, this import fails with such an error message displayed. In such cases, it is possible to try enlarging the radius of the area to import by right-clicking on the yellow tag located at the location to import on the map. For example, in this particular case, please note a radius of 1000m or 1500m is successful. An alternative is to run an OSM import without including buildings, just the map tiles. In both cases, it will be possible to create relevant building objects, and building geometries, manually, by using the SketchUp and iCD extension drawing tools, combined with the iCD extension "Create" to create new building objects or to adjust the geometry of buildings imported through an OSM import.

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8 Testing objective 8 - *Development/estimation of (W)H/C resource time series on DHN supply/demand sides*

The table below gives an overview of the result of the testing and the sub steps in the workflow. Please note that this section is relatively short because not too many issues occurred during the testing of the stage:

Table 11 Results Overview for TO8

Task - Testing Objective	**Testing and validation successfully completed by demo site**
TO8 - Development/estimation of (W)H/C resource time series on DHN supply/demand sides	Complete
TO8.1 Request and collect relevant data available and shareable	Yes
TO8.2 Data formatting, upload to iSCAN, mapping and/or pre-processing	Yes
TO8.3 Rough-cut profiling and/or data processing and/or upload to iSCAN	Yes

8.1 Overview of issues encountered and outcomes

Development/estimation of (W)H/C resource time series on DHN supply/demand sides.

Table 12 Overview of issues for TO8

Outcome category	**Details on issue in section**	**Details on outcome in section**
Training on SO WHAT tool use	8.2.1	8.3.1
Bug to be fixed	None	None
Feature improvement suggestion	None	None
Further investigation needed	None	None

8.2 Details on issues encountered

8.2.1 iSCAN Research

Initially, the user couldn't access the SO WHAT projects in iSCAN Research. Once access was granted access to the projects, the user couldn't create a new data source.

8.3 Details on outcomes

8.3.1 iSCAN Research

Testing participants should be added as users to the iSCAN-Research SO WHAT project, which can be found here https://iscan-research.iesve.com/project-list#project/SOWHAT. Once a testing participant accesses the SO WHAT project through iSCAN Research, user rights should be changed from "Operator" role to "Maintainer" role, which is necessary to enable data import/export.

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9 Testing objective 9 - *Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN*

The table below gives an overview of the result of the testing and the sub steps in the workflow. Please note that this section is relatively short because not too many issues occurred during the testing of the stage:

Table 13 Results overview for TO9

Task - Testing Objective	**Testing and validation successfully completed by demo site**
TO9 - Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN	Partially complete
TO9.1 Comparison and gap analysis between simulated results for WH/C recovery/exploitation technology models against real-life measured data.	Not complete due to lack of data from currently installed technologies.
TO9.2 Iterations with adjustment of user input parameters for WH/C technology models, re-simulation, results comparison and gap analysis	Not complete due to lack of data from currently installed technologies
TO9.3 Export and visualisation of simulated results for calibrated baseline model	Not complete due to lack of data from currently installed technologies.

9.1 Overview of issues encountered and outcomes

Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN.

Table 14 Overview of issues for TO9

Outcome category	**Details on issue in section**	**Details on outcome in section**
Training on SO WHAT tool use	**Error! Reference source not found.**	**Error! Reference source not found.**
Bug to be fixed	None	None
Feature improvement suggestion	None	None
Further investigation needed	**Error! Reference source not found.**	**Error! Reference source not found.**

9.2 Details on issues encountered

9.2.1 Missing asset in iVN

The user reported that an iVN standard asset was missing for the direct injection of waste heat from a waste-heat generation unit into the heat node of a baseline network model. An attempt to connect this waste-heat generation unit from the network waste heat node to the network heat node through the use of a custom installation asset, which was further associated with the script of a district heating

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heat exchanger (DHHEX), was not successful. In particular, while the modelling and simulation of iVN standard asset for heat generators (biogas, bio oil and biomass boiler) was successful, the user did not manage to reach satisfactory simulated results for the district heating heat exchanger custom installation script, even when adjusting the script user-defined input parameters.

9.3 Details on outcomes

9.3.1 Missing Asset in iVN

With regards setting up parameters for a DHHEX custom installation script in order to transform "waste heat" into "heat" with a 1:1 ratio, it is not clear how this could be achieved by using the DHHEX custom installation script directly. However, as a workaround, a waste heat generation profile could be injected directly into the heat node by removing the DHHEX custom installation, by setting the unit waste heat generation profile as heat generation profile, and by connecting this waste-heat generation unit directly to the network heat node rather than into the network waste heat node.

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10Testing objective 10 - *Detailed modelling of demo-site building(s)*

The table below gives an overview of the result of the testing and the sub steps in the workflow. Please note that this section is relatively short because not too many issues occurred during the testing of the stage:

Table 15 Results Overview for T010

Task - Testing Objective	Testing and validation successfully completed by demo site
TO10 - Detailed modelling of demo-site building(s)	Yes
TO10.1 Review building data checklist and request relevant data available and shareable through buidling data checklist	Yes
TO10.2 Review and/or complete building data checklist, and provide relevant data available and shareable	Yes
TO10.3 Collect, review and pre-process relevant data available and shareable through buidling data checklist	Yes
TO10.4 Collect, review and pre-process relevant data available and shareable through buidling data checklist	Yes
TO10.5 Develop and calibrate detailed VE/iCD building model (demo-site buildings)	Yes

10.1 Overview of issues encountered and outcomes

Detailed modelling of demo-site building(s).

Table 16 Overview of issues for TO10

Outcome category	Details on issue in section	Details on outcome in section
Training on SO WHAT tool use	10.2.1	10.3.1
Bug to be fixed	None	None
Feature improvement suggestion	10.2.1	10.3.1
Further investigation needed	None	None

10.2 Details on issues encountered

10.2.1 iCD buildings object does not have the option for uninsulated sheet steel roof or ventilated workshop space

When creating an industrial 'shed' type building there is no option for an uninsulated steel roof as is common on this type of buildings. There is also no option for high level vents which is common, particularly where there are higher temperature processes in the building or the potential for harmful gases to build up.

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10.3 Details on outcomes

10.3.1 iCD buildings object does not have the option for uninsulated sheet steel roof or ventilated workshop space

Although the use of ICL VE simulation template enables more detailed building envelope and ventilation system modelling than default ASHRAE in iCD platform, it does not reach the level of details that may be reached through the IES VE detailed building energy simulation platform. However, a "Steel frame" construction type is part of light construction types, without any insulation by default, while U-values for different surfaces may be adjusted by modifying the date of construction, as well as the building envelope-related ICL interventions attributes, if necessary. IES R&D Consultants can help with the process of checking the U-values of building envelope construction materials when using an ICL VE simulation template in ICD, rather than the default ASHRAE template. With regards ventilation system, passive vents (natural ventilation) can be set in ventilation type attribute.

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11 Conclusions and Next Steps

Overall it can be stated that the SO WHAT advanced tool has been tested by each demo site using their real data and can be said to be validated as much as possible by the demo sites. Whilst not all of the testing objectives were completed, this was mainly due to a lack of data from the demo sites to enable the correct setup of district heating networks. The below table acts as a summary of the status of each testing objective:

Table 17 Summary of Testing Objectives status

Testing Objective	Tested & validated	Comment
TO1 - Development/estimation of demo-site WH/C resource time series (annual, hourly resolution)	Yes	
TO2 - Identification of 1 to 3 relevant WH/C recovery/exploitation technologies	Yes	
TO3 - Setup of possible future DHNs for exploitation of WH resource (baseline and scenarios)	Partially complete	Lack of demo-site data meant this could not be completed fully
TO4 - Identification of plan for exploitation of WH/C resource and for use of SO WHAT tool (including TO2)	Yes	
TO5 - Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs	Partially complete	Lack of demo-site data meant this could not be completed fully
TO6 - Identification of 3 to 5 relevant WH/C exploitation technologies	Yes	
TO7 - Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs (baseline and scenarios)	Partially complete	Lack of demo-site data meant this could not be completed fully
TO8 - Development/estimation of (W)H/C resource time series on DHN supply/demand sides	Yes	
TO9 - Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN	Partially complete	Lack of demo-site data meant this could not be completed fully. Software issues also meant this could not be completed. A workaround was used with further investigation and possible development required to fully resolve the issue.
TO10 - Detailed modelling of demo-site building(s)	Yes	

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Through this process, a large number of bugs were identified which have now been repaired. Key fixes to the software were identified, and where possible have been corrected. As well as this, improvements to the software were highlighted and these have now been added to a list of items to be prioritised for development if time and resources allow.

There were also functions that could not be tested and validated because development had not yet finished on them. These were:

- District cooling network infrastructure modelling – this was not yet developed in time for this task.
- Cost-benefit simulation tool to strengthen the environmental impacts and replication aspects of the project – this was not yet developed in time for this task.
- PlanHeat integration to model demand and potential RES supply using actual data from the demo sites - although this functionality is developed, a lack of data meant the inability to conduct the testing.

These items will now be carried over to be tested and validated as part of D4.4 '– Delivery of a simulation software that also includes cost data and business model data.'D4.4 will also update on the parts of this deliverable that could not be completed due to software bugs or lack of data from demo sites.

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Annex 1 – Detailed Testing Plan

Table 18 Detailed Testing Plan

Task - Testing Objective	Dependency	Planned Start	Planned End
TO1 - Development/estimation of demo-site WH/C resource time series (annual, hourly resolution)	***cf. D1.1 report §3.1***	***31/01/22***	***02/02/22***
TO1.1 Request and collect relevant data available and shareable		31/01/22	31/01/22
TO1.2 Data formatting, upload to iSCAN, mapping and/or pre-processing	TO1.1	01/02/22	01/02/22
TO1.3 Rough-cut profiling and/or data processing and/or upload to iSCAN	TO1.2	02/02/22	02/02/22
TO2 - Identification of 1 to 3 relevant WH/C recovery/exploitation technologies	***cf. D1.6 report & T4.2_TechnologyDatabaseImplementationD1.9_PythonBasicTemplatePrepData_v3***	***31/01/22***	***03/02/22***
TO2.1 Review and share list of WH/C recovery/exploitation technologies (D1.6 report) with relevant stakeholders	-	31/01/22	31/01/22
TO2.2 Meet with stakeholders to select relevant WH/C recovery/exploitation technologies	TO2.1/TO1	03/02/22	03/02/22
TO3 - Setup of possible future DHNs for exploitation of WH resource (baseline and scenarios)	***cf. WP4_IESRD.pptx (GA6)***	***04/02/22***	***17/02/22***
TO3.1 Develop and calibrate iCD building model (demo-site buildings and relevant buildings located in DHN/DCN area of interest)	TO2/TO1	04/02/22	07/02/22
TO3.2 Export data from iSCAN to iCD	TO3.1	08/02/22	08/02/22
TO3.3 Synchronisation of iCD data with iCIM model	TO3.2	08/02/22	08/02/22
TO3.4 Export data from iCIM model to iVN project	TO3.3	09/02/22	09/02/22
TO3.5 Setup iVN project parameters	TO3.4	09/02/22	09/02/22
TO3.6 iVN baseline network model (inc. virtual and physical networks, simulation and export of results)	TO3.5	10/02/22	11/02/22

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TO3.7 iVN network model scenario #1 (inc. virtual and physical networks, setup of custom installation script, simulation and results visualisation)	TO3.6	14/02/22	14/02/22
TO3.8 iVN network model scenario #2 (inc. virtual and physical networks, setup of custom installation script, simulation and results visualisation)	TO3.7	15/02/22	15/02/22
TO3.9 iVN network model scenario #3 (inc. virtual and physical networks, setup of custom installation script, simulation and results visualisation)	TO3.8	16/02/22	16/02/22
TO3.10 Comparison against baseline results (inc. export of simulated results for baseline and scenario network models)	TO3.5 to TO3.8	17/02/22	17/02/22
TO4 - Identification of plan for exploitation of WH/C resource and for use of SO WHAT tool (including TO2)	***cf. D1.6 report & T4.2_TechnologyDatabaseImplementationD1.9_PythonBasicTemplatePrepData_v3***	***31/01/22***	***03/02/22***
TO4.1 Review and share list of WH/C recovery/exploitation technologies (D1.6 report), as well as overview on assessment of potential WH/C resource with relevant stakeholders	-	31/01/22	01/02/22
TO4.2 Meet with stakeholders to identify plan for exploitation of potential WH/C resource, and to select relevant WH/C recovery/exploitation technologies	TO4.1/TO1	03/02/22	03/02/22
TO5 - Setup of existing DHN (baseline) for exploitation of WH resource and integration of RESs	***cf. WP4_IESRD.pptx (GA6)***	***03/02/22***	***11/02/22***
TO5.1 Develop and calibrate iCD building model (demo-site buildings and relevant buildings located in DHN/DCN area of interest)	TO8	03/02/22	04/02/22
TO5.2 Export data from iSCAN to iCD	TO5.1	07/02/22	07/02/22
TO5.3 Synchronisation of iCD data with iCIM model	TO5.2	07/02/22	07/02/22
TO5.4 Export data from iCIM model to iVN project	TO5.3	08/02/22	08/02/22
TO5.5 Setup iVN project parameters	TO5.4	08/02/22	08/02/22
TO5.6 iVN baseline network model (inc. virtual and physical networks, simulation and setup of custom installation script)	TO5.5	09/02/22	10/02/22
TO5.7 Export and visualisation of simulated results for baseline model	TO5.6	11/02/22	11/02/22

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TO6 - Identification of 3 to 5 relevant WH/C exploitation technologies	***cf. D1.6 report & T4.2_TechnologyDatabaseImplementationD1.9_PythonBasicTemplatePrepData_v3***	***31/01/22***	***03/02/22***
TO6.1 Review and share list of WH/C recovery/exploitation technologies (D1.6 report) with relevant stakeholders	-	31/01/22	31/01/22
TO6.2 Meet with stakeholders to select relevant WH/C recovery/exploitation technologies	TO6.1/TO1	03/02/22	03/02/22
TO7 - Setup of virtual network baseline model for exploitation of WH/C resource and integration of RESs (baseline and scenarios)	***cf. WP4_IESRD.pptx (GA6)***	***16/02/22***	***28/02/22***
TO7.1 Export data from VE to iSCAN for calibrated detailed VE model of demo-site buildings	TO11	16/02/22	16/02/22
TO7.2 Export data from iSCAN to iCD	TO7.1	17/02/22	17/02/22
TO7.3 Synchronisation of iCD data with iCIM model	TO7.2	17/02/22	17/02/22
TO7.4 Export data from iCIM model to iVN project	TO7.3	18/02/22	18/02/22
TO7.5 Setup iVN project parameters	TO7.4	18/02/22	18/02/22
TO7.6 iVN baseline network model (inc. virtual network, simulation and export of results)	TO7.5	21/02/22	21/02/22
TO7.7 iVN network model scenario #1 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	TO7.6	22/02/22	22/02/22
TO7.8 iVN network model scenario #2 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	TO7.7	23/02/22	23/02/22
TO7.9 iVN network model scenario #3 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	TO7.8	24/02/22	24/02/22
TO7.10 iVN network model scenario #4 (inc. virtual network, setup of custom installation script, simulation and results visualisation)	TO7.9	25/02/22	25/02/22
TO7.10 Comparison against baseline results (inc. export of simulated results for baseline and scenario network models)	TO7.5 to TO7.9	28/02/22	28/02/22

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TO8 - Development/estimation of (W)H/C resource time series on DHN supply/demand sides	***cf. D1.1 report §3.1***	***31/01/22***	***02/02/22***
TO8.1 Request and collect relevant data available and shareable	-	31/01/22	31/01/22
TO8.2 Data formatting, upload to iSCAN, mapping and/or pre-processing	TO8.1	01/02/22	01/02/22
TO8.3 Rough-cut profiling and/or data processing and/or upload to iSCAN	TO8.2	02/02/22	02/02/22
TO9 - Validation/calibration of WH/C recovery/exploitation technology model against currently installed technologies in DHN		***14/02/22***	***18/02/22***
TO9.1 Comparison and gap analysis between simulated results for WH/C recovery/exploitation technology models against real-life measured data	TO8/TO5	14/02/22	14/02/22
TO9.2 Iterations with adjustment of user input parameters for WH/C technlogy models, re-simulation, results comparison and gap analysis	TO9.1	15/02/22	17/02/22
TO9.3 Export and visualisation of simulated results for calibrated baseline model	TO9.2	18/02/22	18/02/22
TO10 - Detailed modelling of demo-site building(s)	***cf. SOWHAT_Demos site Data Checklist_Individual_v6.xlsx***	***31/01/22***	***15/02/22***
TO10.1 Review building data checklist and request relevant data available and shareable through buidling data checklist	-	31/01/22	31/01/22
TO10.2 Review and/or complete building data checklist, and provide relevant data available and shareable	TO10.1	01/02/22	07/02/22
TO10.3 Collect, review and pre-process relevant data available and shareable through buidling data checklist	TO10.2	03/02/22	03/02/22
TO10.4 Collect, review and pre-process relevant data available and shareable through buidling data checklist	TO10.2	08/02/22	08/02/22
TO10.5 Develop and calibrate detailed VE/iCD building model (demo-site buildings)	TO10.3/TO10.4	04/02/22	15/02/22

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