

User's Manual

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1. Introduction

CYPETHERM FUJITSU is a program for the energy simulation and analysis of buildings featuring Fujitsu HVAC systems. The energy simulations are performed with the U.S. DOE's calculation engine EnergyPlus[™] version 9.0.

1.1 Minimum software requirements

The program is compatible with Microsoft OS Windows 7, 8 and 10 (64-bit versions).

Additional software requirements:

• A minimum of 1 GB of available space on the hard disk.

1.2 Capacities

In this section the elements that CYPETHERM Fujitsu is capable of simulating and its known limitations are detailed.

In general, the simulation limitations of CYPETHERM Fujitsu correspond to the EnergyPlus[™] functionalities (version 9.0) that have been implemented and are described in the EnergyPlus[™] 9.0 Input Output Reference manual. In some cases the limitations of the calculation engine have been overcome by means of equivalences and approximations of calculation.

Geometry

As for the geometric description of the building, there are no known limitations in the number of elements (zones, walls, openings, etc.), dimensions or shape.

Elements and constructive solutions

The description of the constructive solutions is different for the opaque part of the building envelope and the fenestration. In each of these categories, the program allows you to simulate the following elements:

Opaque envelopes:

- Walls: facades, dividing walls, partitions, underground walls.
- Slabs: floors in contact with the ground with optional peripheral insulation, floors between levels, overhangs and roofs.

The composition of the opaque envelopes is defined by layers. Each layer can be a solid material, an air gap (even ventilated) or a vapour barrier. There are no limitations in the number of layers, since CYPETHERM FUJITSU automatically groups the layers defined to adapt to the maximum limit of 10 layers per element that is allowed by EnergyPlus[™] 9.0.

Alternatively, a simplified description of the envelopes is allowed indicating the thermal properties of the set.

Therefore, it is possible to simulate all constructive solutions that can be assimilated to these definitions.

It is possible to define a single value for the air permeability of all the facades of the building, and a different one for the roofs.

Fenestration:

- Opaque: doors
- Glazed: windows and glazed doors, skylights
- Openings

The definition of the fenestration materials is limited to the definition of their global thermal properties, distinguishing between glass and opaque fraction in the case of glazed openings.

In the glazed openings, the definition of sun protection accessories (interior and exterior blinds) and their control, of shadow elements (cantilevers and side protections), and of the different elements of the windows (lintel, blind box, etc.) that produce plane thermal bridges are allowed.

It is allowed to define a value for the air permeability of each glazed opening. It is allowed to define a single value for the air permeability of all the doors of the building, and a different one for the openings.

Linear thermal bridges

The effect of the linear thermal bridges produced by the meeting of the different construction elements and the ground can be simulated.

Loads and thermal inertias

In each space of the building, the sensible and latent thermal loads due to occupancy (if the space is occupied), lighting, ventilation and internal equipment are considered. It is possible to edit the corresponding values and define usage profiles hour by hour.

Air infiltrations are defined at the thermal zone level. The value of the air flow rate can also be defined hour by hour.

Operational conditions and interior comfort

It is allowed to edit the set point temperatures of each thermal zone with hourly resolution, distinguishing between cooling and heating set points.

Air conditioning systems

The program enables the simulation of the following HVAC systems:

Stand-alone terminal units:

- Constant performance systems
- Electric heating transmitters (Joule heating)
- Heat and Energy Recovery Ventilators (HRV/ERV), single zone

Water HVAC systems:

- Heating by radiators and underfloor heating
- Fan-coils

That can be connected to the following types of hydraulic loops:

- o Hot-water systems, including conventional or condensing boilers
- Chilled-water systems, including chillers with air, water or evaporative condenser

Direct expansion HVAC systems:

- Fujitsu's Airstage variable refrigerant flow (VRF) systems
- Packaged air-to-air heat pump (PTHP) equipment. For simulation purposes this is equivalent to split equipment, not inverter.
- Packaged air conditioning units with electric, gas or water heating (PTAC).
- Water-loop heat pump systems (water-to-air heat pump).

Air HVAC systems:

- Constant air volume systems, single zone (rooftop units) and multizone (with terminal reheating).
- Variable air volume systems (VAV), with variable flow boxes with optional auxiliary fan.
- Dual-duct systems, constant air volume and variable air volume, with a single fan or with a fan per duct.
- Centralized ventilation systems (only handle the ventilation air flow):
 - Heat and Energy Recovery Ventilator (HRV/ERV)
 - Dedicated outdoor air system (DOAS)

The air handling units (AHUs) associated with these systems are configurable. The characteristics of the following elements can be defined:

- Cooling coil:
 - Water, connected to a chilled-water system using chillers.
 - Direct expansion, available in single-zone constant air volume systems, in variable flow systems with rooftop units and in the DOAS.
- Heating coil:
 - Water, connected to a hot-water system using boilers.
 - Electric
 - Gas
 - Direct expansion, available in single-zone constant air volume systems and in the DOAS.
- Supply fan
- Return fan
- Humidity control: dehumidification and humidifier
- Outdoor air intake, with the following functions:
 - Free cooling
 - Heat and energy recovery

Condenser water systems:

- For chillers, by cooling towers of 1 or 2 speeds.
- For reversible heat pumps, using cooling towers and boilers.

There are the following limitations regarding the simulation of HVAC systems:

• It is not allowed to define availability and activation schedules of the HVAC systems. In general, the HVAC systems are activated automatically to maintain the set point temperatures defined in the thermal zones. Air HVAC systems continuously drive air, except for centralized ventilation systems, which follow the defined use profile for the ventilation of the spaces of the thermal zones it serves.

• It is allowed to edit the performance curves of the boilers and the chillers. The rest of the generic systems are simulated with the default performance curves of the EnergyPlus[™] v9.0 template objects.

There are the following limitations regarding the number and type of HVAC systems that can be simulated in the same building:

- You can define any number of air and direct expansion HVAC systems.
- If only water, direct expansion or centralized ventilation systems have been defined in the building, it is possible to simulate any number of systems of these types. However, if any other type of HVAC system has been defined (other air HVAC systems or any condenser water system), only one hot-water and one chilled-water system can be defined in the building.
- Only one condenser water system of each type can be defined (for chiller and for reversible heat pump).
- If only water, direct expansion or centralized ventilation systems have been defined in the building, it is possible to define any number and type of terminal units in the same thermal zone. However, if any other type of HVAC system has been defined, in each thermal zone it is only possible to define a single terminal unit of the following types: air terminal units (ATU), water terminal units and the water-to-air heat pump (WAHP). These terminal units cannot be defined together with other types of units in the same thermal zone, with the exception of an electric emitter for heating, or a radiator or a radiant floor.
- If the building contains air HVAC systems (except centralized ventilation systems) or condenser water systems, it is possible to define several VRF terminal units (indoor units) in the same thermal zone, but they cannot be defined together with other types of terminal units with the exception of an electric emitter for heating, or a radiator or a radiant floor.
- Only one constant performance equipment per thermal zone can be defined. In this zone no other type of terminal unit can be defined.
- Only a terminal unit with ventilation function can be defined per thermal zone. All the ventilation air flow assigned to the spaces in the zone will enter through that terminal unit.
- It is allowed to define a maximum of 10 production devices within the same water system or condenser water system.

Domestic hot water (DHW) systems

The program does not perform the dynamic simulation of the DHW production. The energy consumption for this concept is calculated through the DHW demand and the average seasonal performance of the system that supplies it.

Maximum and minimum values

The following limits are known in the values of some properties, imposed by the EnergyPlus[™] v9.0 models that are used in CYPETHERM FUJITSU:

- Specific heat of solid materials. The minimum value is 100 J kg⁻¹K⁻¹. If a lower value is defined, the program will automatically assume the minimum value.
- Global heat transfer coefficient (U) of glazed openings. The maximum allowed value is 7 W $m^{\text{-2}}\text{K}^{\text{-1}}$

2. Getting Started

2.1 Initial window

When opening CYPETHERM FUJITSU the initial window will appear. This window is broken into 4 sections:

- **1.** File: The file section allows users to create a new file, open existing files with the file manager, or access the preloaded example files.
- 2. Recent files: The recent files section displays the most recently opened files
- **3.** Help: The helps section provides the user with access to program documentation and licensing information. Clicking "About..." will display the users current license code.
- **4. BIMserver.center:** This section displays the status of the user's connection to the BIMserver.center and provides a direct link to the website.

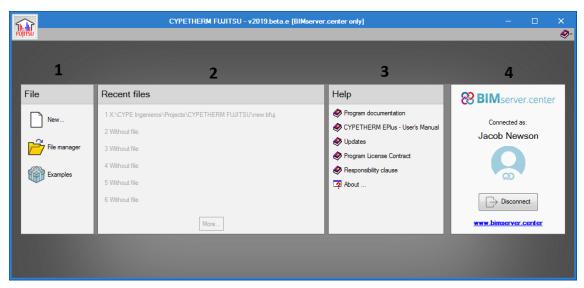


Figure 1: Opening window interface

2.2 Starting a new project

To start a new Project, click "New..." in the File section of the initial window. A prompt will open allowing users to designate a file name and an optional description.

File	New project	×
New	Project name X:\CYPE Ingenieros\Projects\CYPETHERM FUJITSU\ Browse]
File manager	File name new trfu	ij
Examples		
	Accept	cel

Figure 2: New file option

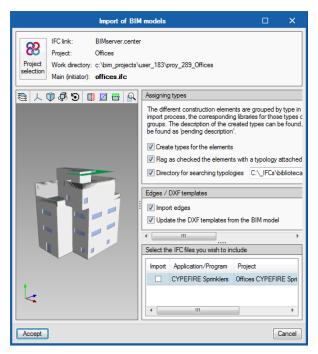


Figure 3: Importing BIM model

Opening an existing BIM project

To open an existing BIM project simply select the project in the window and the model will be loaded. Make sure to check that the BIMserver Synchronizer is activated and up-to-date. The BIM model will be imported and the configuration can be altered prior to starting the project. Clicking *Accept* will open the open the model in the software and commence the project.

After inputting the necessary details, clicking accept will open the next window.

With the window in Figure 4 users have the option to open an existing BIM project with its associated 3D model or to instead use the 3D model wizard to generate a 3D model separate from the BIMserver.

New project	×
☑ Link to a BIM project	
Connected as:	
Jacob Newson	
Select project	
Project:	
www.bimserver.center	
Accept	cel

Figure 4: New project window

New project	Generating a 3D model with the wizard
Eink to a BIM project BIM server.center Connected as: Jacob Newson	The alternative method for starting a project is to generate a 3D model using the inbuilt wizard. To use this method either untick the <i>Link to a BIM project</i> box or <i>Create a new project</i> in the BIMserver.center. From here users are able to launch the wizard with <i>Manua</i> <i>introduction</i> or to import an existing local file in either IFC or gbXML format.
Project:	
Accept	y importing a CAD/BIM file in IFC format y importing a CAD/BIM file in gbXML format

Figure 5: Linking to a BIM project

Automatic introduction from BIM files in gbXML format

The gbXML format (Green Building XML) has been developed to facilitate interoperability between design and development programs used in the building industry. Thanks to the gbXML format it is possible to exchange data between applications avoiding manual input and the possible errors that this entails.

The program facilitates the introduction of a building thanks to the import of all the information contained in a BIM file in gbXML format with all the constructive elements, the premises and the zones.

Automatic introduction from BIM files in IFC format

The IFC (Industry Foundation Classes) format is a 3D architectural file format used by the building industry to exchange and share information between programs.

The program facilitates the introduction of a building thanks to the import of all the information contained in a BIM file in IFC format with all the constructive elements, the premises and the zones.

This .ifc file can be generated by IFC Builder or by another BIM program capable of creating files in IFC4 format.

Units

After selecting *Manual introduction* or creating a new BIM project and *Accept*, the following prompt will appear allowing users to determine the system of units to be used for the project. This can be altered afterwards using the *General options* button.

Units	×			
I-P system				
International system				
Accept	Cancel			

Figure 6: Units systems

3D model wizard

The 3D model wizard will be launched once the units system has been selected. From here the user must complete 6 steps to generate a 3D model (Type, Location, Floors, Geometry, VRF system, and Ventilation).

Type of project

The first window of the definition wizard allows you to choose the type of building project. Depending on the chosen type, the default library typologies will be loaded to define the internal heat gains and the constructive solutions.



Figure 7: Type of project, 3D model wizard

Location

The following window allows you to choose the location of the project and its corresponding climatic data. Select a state first to see the locations whose climatic data are available in the program. For the state of California, the official climate data of the California Climate Zones, which are owned by the

California Energy Commission, are provided.

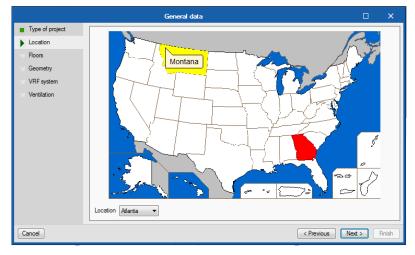


Figure 8: Location, 3D model wizard

The climatic data of the rest of localities are property of the National Renewable Energy Laboratory (NREL), and correspond with the TMY3 files recommended for energy simulation. If you cannot find the desired location, you can upload your own climatic data file .epw in the general interface of the program. Meteorological data of over 2100 world locations can be found on the EnergyPlus website (energyplus.net/weather).

Floors

Determine the number of floors of the building and its height, distinguishing between floors below ground (basements) and above ground. When adding a new floor, the option *number of floors in the group* allows the creation of several equal floors at the same time.

Geometry

Chose the geometry of the building among the proposed forms. The dimensions, the orientation of the building and the total area of windows must be defined. The assistant will create the 3D model of the building for the simulation with the form and number of defined floors. A single space will be created per floor, which will correspond to a thermal zone.

VRF system

Once the building has been defined, the wizard can add a Fujitsu Airstage variable (VRF) refrigerant flow air conditioning system. In the Indoor units section, you must define the indoor VRF units that you want to install on a building floor. These indoor units will be copied on all floors of the building. In the Outdoor unit section, you must select the outdoor unit VRF to which the defined indoor units will be connected. The Single OU option will create a single

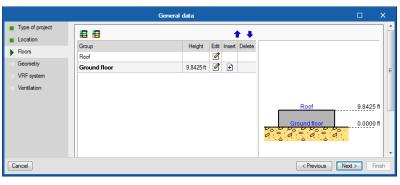


Figure 9: Floors selection, 3D model wizard

	General data	□ ×
 Type of project Location 		m
 Floors Geometry 		
VRF system Ventilation	Length 16.0000 ft Width 16.0000 ft	
	Orientation 0.00 degrees Total window area 196.85 ft ²	
Cancel	< Previous	Next > Finish

Figure 10: Geometry, 3D model wizard

	General data 🛛 🗸
 Type of project Location 	☑ Create VRF air conditioning system
Roors Geometry VRF system	AIRSTAGE
Versigned	Indoor unts Define the VRF indoor unts (IU) that serve each floor of the building.
	Outdoor unit Define the VRF outdoor unit (DU) connected to the indoor units. • Single OU • One OU per floor Equipment Heat pump (2 pipe) • Aintage V-II (230 V) • AOUA72RLBV1 (72000 Btu/h) • Nominal cooling capacity: 72000 Btu/h Nominal cooling capacity: 72000 Btu/h Nominal cooling capacity: 72000 Btu/h Nominal heating input power: 5.31 kW
Cancel	<previous next=""> Prink</previous>

Figure 11: VRF system, 3D model wizard

outdoor unit (OU) to which all the building's indoor units will be connected. The One OU per floor option will create as many outdoor units (OU) as the building's floors. The indoor units of a floor will be connected to each OU.

Ventilation

Finally, the option of creating a ventilation system for the building offered. The is equipment that will allow the entrance of the air to the building can be a heat / energy recovery ventilator (HRV / ERV) or a direct-expansion dedicated outdoor air system (DX-DOAS). In this window, you must define characteristics of the the chosen equipment. The blue arrow button restores the default values. The Single unit option will create a centralized

	General data	o x
 Type of project Location 	Create ventifation system	
 Roors Geometry 	Single unit One unit perfloor	
 VRF system 		
Ventilation	HRIVERV DOAS	
	Energy recovery ventilator	
	Heat exchanger	• ا
	Sensble effectiveness 70.00 %	
	Fans	
	Outdoor air bypass	
	Mirimum temperature 68.00) 'F Maximum temperature 75.20) 'F	
Cancel	< Previous	Next > Finish

Figure 12: Ventilation, 3D model wizard

system that will serve all the floors of the building. The *One unit per floor* option will create a ventilation system for each floor of the building.

Once the wizard is finished, the 3D thermal model of the building appears in the main window of the program.

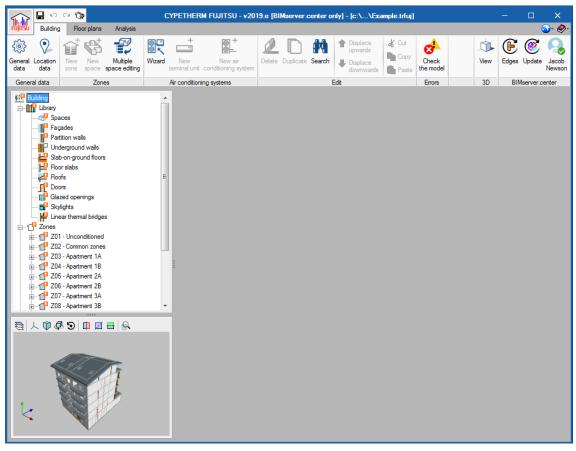


Figure 13: Main window, CYPETHERM FUJITSU

2.3 Interface

The interface of the main window of the program is broken into three tabs: Building, Floor plans, and Analysis. The three tabs are structured in the same format and can each be broken into four sections.

Primary toolbar: Consists of the primary tools used to interact with the project.

Project tree: A library of all elements and operations within the project.

3D model viewer: The standard 3D model viewer contained within all CYPE software. The window's dimensions can be adjusted and also contains a tool bar for useful functions such as viewing properties, layers and rotation of the model.

Configuration window: The main window of the interface is reserved for adjusting settings of any selected components in the project tree.

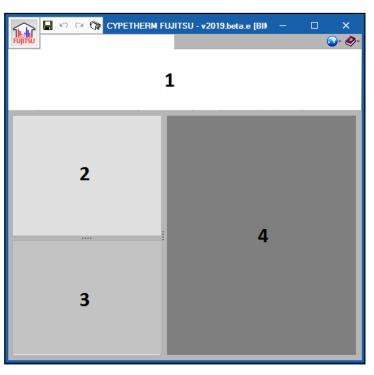


Figure 14: Interface structure

2.3.1 Auxiliary tools

The auxiliary toolbars located within the interface are very similar to those found in all CYPE software and serve to complete and configure the basic commands of the program.

File button

In the top left corner of the window is the File button used to access the most basic commands alongside four shortcuts (Save, undo, redo, and drawings). Clicking the button opens a drop down menu containing the following options:

- New file
- Open file
- Save
- Save as
- Alter job description
- Produce drawings
- Recent files
- Exit

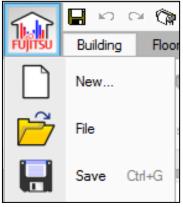


Figure 15: File button drop-down menu

General configuration

In the top right hand corner of the screen the user has access to two buttons: configuration, and help.

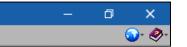


Figure 16: General configuration buttons

Configuration: The configuration tool is used to change a number of basic settings for the program, such as the unit system, drawing settings, and background colour.

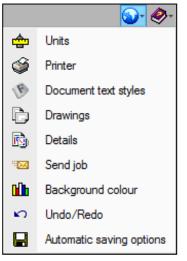


Figure 17: Configuration drop-down menu

Help: The help tool is used to access the program documentation, user manuals, and licensing information.

	🌖 - 🏈
٨	Program documentation
۲	CYPETHERM EPlus - User's Manual
٨	Updates
۲	Program License Contract
	Responsibility clause
<u></u>	About
2	License information

Figure 18: Help drop-down menu

General toolbar

The general toolbar is found in every configuration window. The tools on the left are used to add, delete, copy, and edit items listed. The tools on the right are used to import and export the elements of the list as library files, for use with other projects.

Ŧ	💋 🗈 🖻 🖓 🖓 🥵
	Reference

Figure 19: General toolbar

3. Building tab

The general data, the building location data and the thermal model of the building are defined in the Building tab.

The thermal model of the building is organized in a tree scheme with four main branches:

• Library

In the library the user can define the types of spaces and elements (walls, floors, windows...) that make up the building.

Zones

Each thermal zone will include several spaces of the building, which will be made of different elements (walls, floor, windows...), and also the terminal units of the HVAC system. The operational conditions of the HVAC system are defined at the zone level.

• Air conditioning systems This section is used to define the supply side (central plant) of the HVAC systems of the building. These will serve the terminal units defined in the zones.

• DHW systems

This section is used to define the domestic hot water systems of the building.

3.1 General data

The first section of the Building tab is the General data section. From here the user has access to two tools used to assign the general parameters of the project: General data, and Location data.



3.1.1 General data

The General data window is broken into 4 sections:

Condensation: The program includes the option for verification of the existence of surface and interstitial condensations according to the UNE-EN ISO 13788 standard, offering results for each constructive solution.

Daily DHW demand:

The parameters to calculate the energy consumption associated with domestic hot water (DHW) production can be defined for each thermal zone, in the Zone panel, or for the entire building, in this panel.

General data		×
Condensation		
Check for the existence of surface and interstitial condensation in accordance	with ISO 1	3788
Energy conversion factors		Ò
Air permeability of the building envelope		d
Daily DHW demand		
Total demand of the building Demand by thermal zone		
Daily DHW demand 0.0 I/day		
Reference temperature 140.00 °F		
Solar contribution distribution		
Constant Monthly		
Percentage of DHW demand satisfied using solar energy 0.0 %		
Accept	(Cancel

Figure 21: General data window

The daily DHW demand in litres/day must be defined and the temperature at which that amount of water is produced (reference temperature).

To consider solar thermal installations for DHW, you can define the percentage of DHW demand satisfied using solar energy, as a total annual value or month by month. This value is subtracted from the energy expenditure for the production of DHW.

Figure 20: General data

Energy conversion factors:				×
The user defines the energy		Primary energy / Final energy	% Non-renewable	kg·CO2 / kWh Final energy
conversion factors from	Bectricity	2.368	82.52	0.331
different sources. These	Natural gas	1.195	99.5	0.252
factors take into account the	Diesel	1.182	99.74	0.311
origin of the energy consumed	LPG	1.204	99.75	0.254
in the building.	Carbon	1.084	99.81	0.472
			7.63	0.018
Energy conversion factors X			3.27	0.018
Energy sources			0	0
Energy conversion factor			0	0
Final electrical energy generated and auto-consumed Defined				Cancel
Accept		Cancel		

Figure 22: Energy conversion factors windows

There is the option for including any electrical energy that is generated (such as by solar panels) and subtracting that value from the energy expenditure.

Air permeability:

The air permeability of the different envelopes of the building can be configured using the following window.

Air permeability of the building envelope X					
Air permeability of the building envelope					
Air leakage rate for a reference pressure of 100 Pa					
Façades	6.54	gpm/ft ²			
Roofs	6.54	gpm/ft²			
Doors	24.54	gpm/ft²			
Openings	4.09	gpm/ft²			
Accept					

Figure 23: Permeability of the air

3.1.2 Location data

The icon "Location Data" opens the window for defining the weather data. The program runs the energy simulation using the data in the Weather Data File loaded (epw format).

The blue arrow icon opens the US map for location selection. Accepting this pop-up window will load the corresponding Climate data file and update the Location Data. The charts in the right hand side show the data of outdoor temperatures, wind speed and direction and solar irradiation contained in the .epw file loaded.

If you cannot find the desired location, you can upload the corresponding weather data file in epw format in the section Climate data file. Meteorological data of over 2100 world locations can be found on the EnergyPlus website (energyplus.net/weather).

The data in the sections Orientation, Undisturbed temperature of the soil, Solar contribution of domestic hot water and Condensation must be specified by the user.

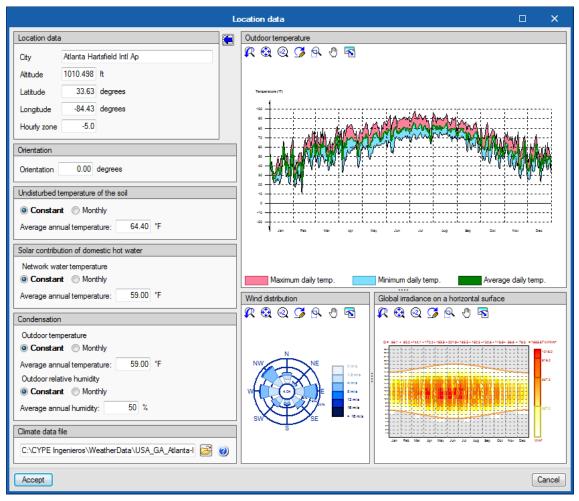


Figure 24: Location data window with visualization of climate data

3.2 Library

Once the work has been created and the general data and the location have been defined, the types of enclosure and constructive elements present in the building must be defined.

If the work has been created from BIM files and the directory for the typology search has been indicated, the elements that appear in the library will be already defined. The elements present in the model that are not in the library will be pending to be defined.

The way to create and manage each element of the library is identical in all cases:

- Manual introduction: Creation of a new element.
- Import of the library: Import of elements saved in a database previously defined by the user.

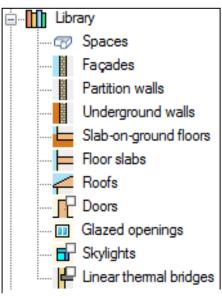


Figure 25: Library section of the project tree

Spaces

- Occupied: Indoor enclosure intended for the use of people. The data of the heat gains corresponding to ventilation, lighting, occupancy and internal equipment are customizable. For each type of heat gain, the blue arrow icons allow to import values from ASHRAE standards and manuals. The right-hand side blue arrow icon fills in all the heat gains at a time, depending on the type of space selected.
- Not occupied: Interior enclosure not intended for the permanent use of people, and hence without cooling or heating needs. The user

Space typ	es (Type 1)		×
Reference Office			-
Occupied Not occupied			4
Ventilation 18.01 cfm/person -	☑ Lighting	(
🖉 Schedule 🛛 🔂 Mon-Fri 8h	Installed light power 2.79 Btu/(h ft?) -		
	Radiant fraction 0.97		
	Space fraction 0.18		
	Schedule Mon-Fri 8h		
✓ People 215.28 ft²/person ▼	Internal equipment		
Activity level 443.58 Btu/h/person	Image: A marked and A marked		
Sensible fraction	Name		
Radiant fraction 0.58	Office equipment		
Schedule Mon-Fri &	b		
Accept			ance

Figure 26: Space types window

can define internal gains due to ventilation, lighting and internal equipment.

Construction elements

The introduction of the construction elements comprises the definition of the opaque building envelopes (walls, partitions and slabs) and the fenestration (windows, skylights and opaque doors).

Walls and partitions

- Facades: Vertical enclosures in contact with the external environment or in contact with another building (dividing wall).
- **Partitions:** The partitions are arranged to separate the interior of the building in different enclosures.
- Underground walls: These vertical enclosures in contact with the ground are used to build floors below ground.

The detailed input of walls and partitions implies specifying each of their layers. The materials that form the walls can be defined by the designer or imported from different libraries of materials. Alternatively, the

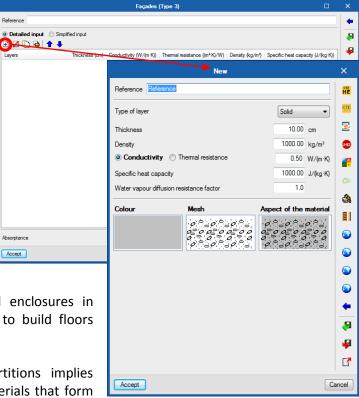


Figure 27: Creating a new facade

simplified input allows for defining a wall with its total thickness and its average relevant properties. In this option, the properties labeled as "thermal description" are just information and do not take part in the energy simulation.

Slabs

Once the walls and partitions are defined, the slabs are defined, which are classified as:

- **Roofs:** Superior enclosures in contact with the external environment.
- Floor slabs: The floors connecting levels. Horizontal or slightly inclined lower enclosures existing between one floor and another.
- Slab-on-ground floors: The enclosures that are in contact with the ground.

As in the definition of walls and partitions, slabs can also be introduced as generic walls or by defining their layers.

Doors, windows and skylights

The fenestration makes an important contribution to the thermal load of an enclosure. That is why the definition of doors, windows and skylights must be adjusted enough to allow the introduction of both predefined parameters and values provided by manufacturers (in accordance with the applicable regulations).

In the windows and skylights the following elements can be detailed:

- Glazed fraction
- Opaque fraction
- Accessories
- Shadow elements
- Plane thermal bridges

In the case of doors, the definition does not need to be so exhaustive and, therefore, only the thermal transmittance and the absorption coefficient are indicated.

Glazed openings (Type 5)	×		
eference	8		
lazed fraction 🔽 Opaque fraction Accessories 🖾 Shading elements 🔽 Plane thermal bridge			
Heat transfer coefficient	2		
Solar heat gain coefficient 0.70			
Glazed openings (Type 5)	×		
Reference	4		
Glazed fraction 🔽 Opaque fraction Accessories 🔽 Shading elements 🔽 Plane thermal bridge			
Heat transfer coefficient 2.00 W/(m ² K)			
Opening opaque fraction 0.20			
Absorptance 0.60			
Glazed openings (Type 5)		×	
Reference		1	
Glazed fraction 🔽 Opaque fraction Accessories 🔽 Shading elements 🔽 Plane thermal brid	ige	₩	
With solar protection accessories		1	
Name			
Type Interior shade 💌			
Solar transmission coefficient 0.70			
Thickness 0.010 m			
	Conductivity 0.10 W/(m·K)		
Shading control type Always on			
Glazed openings (Type 5)		×	
A Reference		1 🖉	
Glazed fraction 🔽 Opaque fraction Accessories 🗹 Shading elements 🔽 Plane therm	al bridge	-	
Claze incluin (P) Opaque incluin (Accessories) (P) Should g oction (P) Plane inem (V) Overhang (Horizontal projection)	a bloge		
Overhang projection depth (PH) 1.000 m			
Vertical offset from fenestration top (RH) 0.005 m			
Angle 0.0 degrees			
A V Left fin (Left vertical projection)			
Fin projection depth (PV) 1.000 m			
Horizontal offset from fenestration edge (RW) 0.100 m			
V Right fin (Right vertical projection)			
Fin projection depth (PV)			
Horizontal offset from fenestration edge (RW) 0.100 m			
0 ^w wo` '			
Ar leakage rate for a reference pressure of 100 Pa 20.00 m ² /(hm ²)			

Figure 28: Definition of the glazed openings

Linear thermal bridges

The loss of heat through thermal bridges has a considerable impact on the results of energy demand. For this reason, the correct definition of the characteristics of the thermal bridges is essential for an accurate calculation of the building's energy consumption.

	Linear thermal bridges (Type 20)			×
			î	9
Reference	1		<table-cell-rows> CTE DB-HE</table-cell-rows>	•
Description		*	4 ISO 14683	÷
			4 ISO 10211	ľ
		-	年 RT Existant	
Psi	0.50 W/(m·K)		年 RT 2012	
Value	Not defined	•		
Accept			Ca	ancel

The data that defines a thermal bridge:

- Linear thermal transmittance (psi)
- Value
- Type of meeting

This data can be customized or can be imported from three assistants implemented in the program:

- CTE DB-HE (thermal bridge Atlas of supporting document DA DB-HE / 3)
- ISO 14683
- ISO 10211

When the work has been created from a BIM model generated in IFC Builder, the library of thermal bridges contains all the edges of the building (purely geometric entities obtained from the intersection between the different construction elements) although part of these edges does not intervene in the calculation.

For the detection of linear thermal bridges it is recommended that the building be completely defined (zoning, description of the spaces, etc.) and the option Edge Processing (see section Edge Processing) be used for the program to show only the types of thermal bridges used in the work. In this way it is much easier to modify, if necessary, the values of the types of thermal bridges proposed by the program.

BIM Model

In the case where the model was imported from a BIM model there will be the following error messages in the library to signal that the elements have not been defined.

🔢 Building	ŧ	💋 🗈 🖻 🦊 🦊 🖗	<u>6</u>	
		Reference	In use	
		RESIDENTIAL		8
	2	2 UNCONDITIONED		8
Underground walls	1	CORRIDOR		8
Slab-on-ground floors	4	LIFT		8
💾 Floor slabs 		GARAGE		8
FIOOTS				

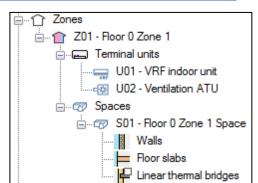
Figure 30: BIM model definition error

All of these elements/operations must be defined for the analysis to be completed successfully.

Figure 29: Definition of linear thermal bridges

3.3 Zones

The thermal zones group the spaces of the building, which are defined each by a space type and the corresponding construction elements from the library. By clicking in each of these elements, the user can see and change the definition of the element by selecting an existing type from the library. Element types can also be created and edited from these windows with the buttons close to the option Library.



Each of this group of spaces will be served by one or

more HVAC terminal units, which are specified as well inside the thermal zones.

Figure 31: Zones, Project tree

Zone		
Reference		Z01
Name		Floor 0 Zone 1
Classificatio	on of the zone	Occupied
Operational	conditions and	indoor comfort
V Heating	🕒 Heati	ng 📝 Cooling 🔂 Cooling
Ventilation a	nd infiltration	B
Ventilation Infiltrations		
Condensatio	n	•
		Psychrometric diagram

Each zone contains the definition of the following parameters:

Figure 32: Window for the definition of Zones

Classification of the zone: Occupied or Not occupied. All the spaces inside the zone must have this same classification.

Operating conditions and indoor comfort: set point temperatures for the air inside the zone for cooling and heating, defined for the whole year in an hourly basis.

Ventilation and infiltration: the ventilation needs of the zone are automatically calculated from the specifications made in the Spaces. In this menu, the user must choose whether the ventilation air flow will be enter the zone as Natural ventilation, Mechanical ventilation (allows for defining fan consumption) or Via the air-conditioning system (e.g. by means of a DOAS or an ERV). Optionally, the user can activate the calculation of the air infiltration.

Condensation: parameters for performing calculations of condensation in the constructive elements.

Once the zones of the building have been defined, the spaces are introduced, indicating the geometrical characteristics and subsequently the constructive elements.

Reference	Z01_S01
Name	Floor 0 Zone 1 Space
Library	1: Office 🔻 🛃 🔛
Area	200.00 m ²
Volume between the floor and suspended ceiling	600.00 m ³
Lighting	
Personalised values:	

Figure 33: Window for the definition of Spaces, Zones

Each space in the building is defined by its typology within the library, its geometric characteristics and its constructive elements. The user can define the specific lighting power value of the space. If defined, this value will override the value defined in the corresponding space typology from the library.

Enclosure elements

In each space the user can visualize and manage the enclosure elements that make it up and the associated thermal bridges. The user can access the openings and associate linear thermal bridges by clicking on the walls in which they are embedded.

Doors	Walls Adjace	nt						
Glazed openings	🗄 💋 🗋 🕇	• •						
🔂 Skylights	Reference	Туре	Library	Area	Adiacency	Fenestration	Checked	
Linear thermal bridges	Z01_S01_W01	Façade	WALL-1	618.75 ft ²				Ξ
⊡	Z01_S01_W02	Façade	WALL-1	610.38 ft ²	-			
Terminal units	Z01 S01 W03	Façade	WALL-1	408.23 ft ²	-			
	Z01_S01_W04	Partition wall	PARTITION-2	127.57 ft ²	Corridor			
S01 - Garage	Z01 S01 W05	Partition wall	PARTITION-1	99.83 ft ²	Storage 8	1		
🚰 Walls 💾 Floor slabs	Z01 S01 W06	Partition wall	PARTITION-1	97.64 ft ²	Storage 7	1		-
📛 Floor stabs	<	T dittion wai		07.0411	otorago /		4	
	Data							
🕀 🐨 🚽 S03 - Lobby	Reference	Z01_S01_W0	5					
	Туре			~ -				-
	type	🔘 Façade	Party wall	Partitio	n wall 🔘	Basement wall	0	-
	Library	1: PARTITIO	N-1 🔻 🕂 🖉					
	Adjacent space	Another space	e 👻 Stora	ge 8 (Uncon	ditioned)			=
🔁 人 🗘 🖗 🔊 📋 🖉 🖶 🖳								-
	Vertices	l Ca						
1 Dillion	Fenestration							
		🖻 🕇 🖊						U,
	Reference		Туре	Libr	ary	Area	0	2
< Caster	Z01_S01_W05	_G1	Door	DOORS	SIMPLE	18.08 ft²		Ŧ
w.	•						•	

Figure 34: Enclosure elements, Zones

3.4 Domestic Hot Water (DHW) systems

In this section, the systems in charge of producing the domestic hot water (DHW) of the building are defined. The definition of the DHW systems depends on the option chosen in Daily Demand of DHW within General Parameters. If you have chosen 'Total building demand', you can define a single DHW system that meets this demand. If 'Demand by thermal zone' has been chosen, it is allowed to define more than one system and select the zones served by each one. A zone can only be served by one DHW system.

To define a generic DHW system, the user must indicate the type of production equipment, the energy vector it uses, its seasonal energy performance and its nominal power. The nominal power does not affect the DHW calculations, it is only used for reporting purposes. The blue arrow icon opens a window to calculate the seasonal performance of combustion boilers, according to the EN 15378 standard.

1	Systems		
im III Library	Reference DHW		
⊕… ☆ Zones ⊫A DHW systems			
Air conditioning systems	Type (a) Generic (C) Not defined		
Own shade	Type of energy vector	Electricity -	
Remote shadows	Туре		
	Average seasonal energy performance	0.75 🖕	
	Rated capacity	600.00 W	
+			

Figure 35: DHW systems

3.5 HVAC systems

The HVAC systems of the building are defined in two sections of the scheme:

- **Terminal units (within each Zone):** these are the equipment found in the enclosures that come into contact with their air.
- Air conditioning systems: they are the centralized production equipment and air conditioning units that serve terminal units or other air conditioning systems. Together with the centralized equipment, the relevant characteristics of the distribution network of the working fluid are also defined.

Generally, a complete HVAC system consists of one or more terminal units connected to a centralized system, which in turn may need other production systems. For example, in an all-air system, the air terminal units (ATU) are the terminal units and the air handling unit (AHU) is the centralized system. If the AHU contains a chilled water coil, it will be necessary to define an additional production system that generates the chilled water.

There may also be HVAC systems composed only of terminal units: this is the case of electric radiators or split 1x1 equipment.

In the program, the air conditioning systems and their terminal units have been classified according to the type of fluid that combats the thermal load of the enclosure. Thus, it distinguishes between and water, direct expansion and air terminal units and air conditioning systems. In addition, the program includes the definition of other autonomous terminal units and condenser water systems for chillers and reversible heat pumps.

The program includes the possibility of defining any type of HVAC system, knowing its average seasonal performance of production of cold and / or heat and the type of energy it consumes, through the terminal unit *Constant performance equipment*.

The user can define the building's HVAC systems using the inbuilt wizard. Depending on the type of system chosen, the wizard successively displays the definition panels corresponding to the different equipment of the HVAC system.

3.5.1 Centralized production systems

To add a new centralized production system you must select the branch of the HVAC Systems tree and press the button *New air conditioning system* on the primary toolbar. A pop-up window will appear in which to select the type of production system. The user can choose between the water, direct expansion and air HVAC systems or the condenser water system.

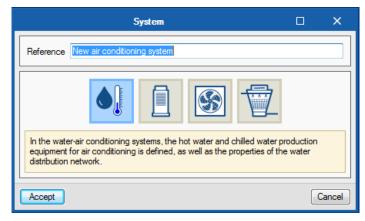


Figure 36: Centralized production systems

When choosing a general typology, a new window will open in which the specific system type is selected and its characteristics are defined. The systems included in the program within each typology are listed below according to the icons that represent them, from left to right:

Water HVAC systems:

- Chilled-water systems, with chillers.
- Hot-water systems, with boilers.

Direct expansion systems:

• Outdoor unit of variable refrigerant flow systems (VRF) Airstage by Fujitsu

Air HVAC systems:

- Centralized ventilation system:
 - Centralized heat/energy recovery ventilator (HRV/ERV).
 - Dedicated Outdoor Air System (DOAS).

- Constant air volume system
 - Rooftop unit (DX coils).
 - Air-handling unit (water coils).
 - Air-handling unit, single zone system, configurable.
- Variable air volume system (VAV)
 - Rooftop unit (DX cooling coils.
 - Air-handling unit (water coils).
- Constant air volume system, dual duct
- Variable air volume system (VAV), dual duct

Condenser water systems:

- For reversible heat pump, with cooling towers and boilers.
- For chiller, with cooling towers.

When selecting the type of equipment, the editing panel is updated to show its characteristics.

The characteristics of the Fujitsu's Airstage equipment are completely defined within the program, so that the user should only indicate the characteristics related to their installation.

In the generic HVAC equipment edition panels, in addition to the list and library management tools, the following general utilities are offered:

- A show and edit advanced system features.
- Restore the default values proposed by the program.

If a value is not specified for certain equipment characteristics, such as its rated capacity or the air flow of a fan, the *autosize* function of EnergyPlusTM is used. This function calculates the values not defined by the user from the thermal loads of the associated zones and the design characteristics of the equipment.

3.5.2 Terminal units

The addition of the terminal units of the HVAC systems is analogous to that of the centralized production equipment. To add a new terminal unit you must select the branch of the tree *Terminal units* within the *Zone* where you want to add a new terminal unit. When clicking on the primary toolbar button *New terminal unit*, a pop-up window will appear in which to select the type of terminal unit, between constant performance equipment, water terminal units, direct expansion terminal units, air terminal units, electric emitter for heating and energy recovery ventilator (HRV/ERV).

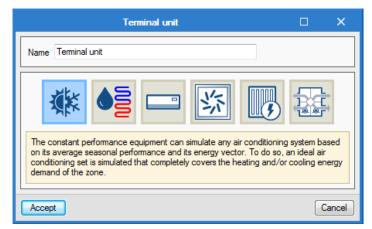


Figure 37: Terminal unit window

When choosing a general typology, a new window will open in which the type of terminal unit is selected and its characteristics are defined. The systems included in the program within each typology are listed below according to the icons that represent them, from left to right:

Constant performance equipment

It is an ideal piece of equipment capable of instantly overcoming the thermal loads of the area where it is located (infinite power equipment). For this reason, it is not allowed to define this type of terminal unit together with any other unit in the same zone. In practice, this equipment can be used to represent any HVAC system based on its heating and/or cooling seasonal performance and the type of energy it consumes (energy vector). It is allowed to define the function of heat recovery, for which the user must activate in the panel of the Zone the option *Ventilation via the air conditioning system*. Three types of constant performance equipment are offered:

- Heating only
- Cooling only
- Heating and cooling

Terminal unit				
Constant performance equipment				
	9			
	4			
Heating Cooling				
Average seasonal performance 0.92 Average seasonal performance 2.00				
Type of energy vector Natural gas Type of energy vector Electricity				
Heat recovery				
Sensible effectiveness 70.00 %				
Latent effectiveness				
Accept	Cancel			

Figure 38: Terminal unit window, Constant performance equipment

Water terminal units

They must be connected to a water system.

- Radiator
- Radiant floor, for heating only
- Fancoil, for heating and cooling

Direct expansion terminal units

- Indoor unit of variable refrigerant flow system (VRF) Airstage by Fujitsu. It must be connected to a direct expansion system of the same type (outdoor unit).
- Packaged terminal unit. It is an autonomous terminal unit. If you define a water heater, you must connect it to a water heating system.
 - PTAC: Packaged terminal air conditioner with gas, water or electric heating.
 - PTHP: Packaged terminal heat pump (direct expansion heating). For simulation purposes, it is equivalent to the split-system equipment.
- Water-to-air heat pump (WAHP). It must be connected to a condenser water system for a reversible heat pump.

Air terminal units (ATUs)

They represent the supply outlets (diffusers, nozzles, registers) and boxes into which the ducts of the all-air systems open. In the program, they must be connected to an HVAC system (that is, to an air handling unit), depending on their type:

- Air supply outlet. It must be connected to a system of constant air flow or centralized ventilation, according to the chosen option:
 - For rooftop equipment or single-zone AHU.
 - For AHU with water coils. The difference with the previous type is that it allows the option of terminal reheating.
 - For centralized ventilation system. The difference with the previous types is that it does not allow the flow of supply air to be defined, since this will come automatically determined by the needs of ventilation defined in the spaces of the zone.
- Air supply outlet, dual duct. It must be connected to a dual duct, constant air volume system.
- Variable air volume (VAV) box. It must be connected to a VAV system.
- Variable air volume (VAV) box, dual duct. It must be connected to a dual duct VAV system.

If the air terminal unit is connected to an air system with an outside air intake or to a centralized ventilation system, the option of Ventilation through the air conditioning system must be activated in the zone panel.

Electric emitter for heating

This element represents electric heating equipment (electric radiator, fan heater, etc.). It is an autonomous terminal unit, that is, it does not need a connection with any system.

Heat/Energy recovery ventilator (HRV/ERV)

It is an autonomous terminal unit, that is, it does not need a connection with any system. To use this terminal unit, the option of *Ventilation via the air conditioning system* must be activated in the zone panel.

As with the centralized part of the climate control systems, when selecting the type of terminal unit, the editing panel is updated to show its characteristics. For the indoor units of VRF systems, the user can select the units in the Airstage by Fujitsu commercial catalog. The characteristics of the Airstage indoor units are completely defined within the program, so that the user should only indicate the outdoor VRF unit they are connected to. In the generic equipment edition panels, the following utilities are offered:

- Show and edit advanced features of the equipment.
- Restore the default values proposed by the program.

If a value is not specified for certain equipment characteristics, such as its nominal power or the flow rate of a fan, the *autosize* function of EnergyPlusTM is used. This function calculates the values not defined by the user from the thermal loads of the associated zones and the automatic sizing options.

• System

This section appears on the panels of the non-autonomous terminal units. The centralized system to which the equipment is connected must be selected. The dropdown will only offer the systems compatible with the terminal unit defined in the work. The list management buttons to the right of the drop down allow:

- E Define a new centralized production system, of any type.
- \circ \blacksquare Edit and select a centralized production system defined in the building.
- Solution of the selection made in the drop-down is empty or is incorrect.

Terminal unit	×
VRF	
FUĴĨTSU	9 9 1
System	
Variable refrigerant flow system (VRF)	
Indoor unit	
Equipment Cassette Compact cassette AUUA4TLAV1 (4000 Btu/h)	
Total cooling capacity: 4000 Btu/h Sensible cooling capacity: 3000 Btu/h Heating capacity: 4400 Btu/h	
Accept	Cancel

Figure 39: Terminal unit window, direct expansion terminal unit

At the end of the creation of a new terminal unit, it will appear as an element in the section *Terminal Units* of the scheme, within each *Zone*. When clicking on the element, its editing panel appears on the screen.

Management of terminal units and automatic sizing options

The *Terminal units* panel allows managing the operation of the terminal units defined in each zone and defining the EnergyPlusTM automatic sizing options.

III Building	Teminal units
i Library	Heating
E Zones	Automatic sizing options
201 - Ground floor - Dining	
ieminal units	
U02 - Ventilation ATUs	Activation sequence
	1 Ventilation ATUs
- CP Spaces	2 Fancoil units
S01 - Dining room	
E Z02 - Ground floor - Office space	
Erren Terminal units	
😥 U01 - Fancoil units	
UD2 - Ventilation ATUs	
B-CP SD1 - Hall	
B-07 S02 - Office 1	
E-1 Z03 - Offices - South	Cooling
🖃 📻 Teminal units 🗸 👻	
	Automatic sizing options
毫人 ♥ ❹ ᠑ □ ☑	↑ ↓
	Activation sequence
	1 Ventilation ATUs
	2 Fancol units
	During the simulation, the terminal units that are present in the same zone will be activated sequentially, in the order in which they appear defined,
	until the themal load of the zone is defeated, considering the following exceptions:
	-If the project contains air or water condensation air conditioning systems, "Radiator", "Radiant floor" and "Electric emitter for heating" terminal
*	units will always be activated last. -The unit terminals in charge of ventilating the zone, if present, will always be activated first.
	The one common in orange of commonly proceeds, in proceeds, the oracy's to doubting the common many states and the common states and

Figure 40: Terminal units panel

During the simulation, the terminal units present in the zone will be activated sequentially until the thermal load of the zone is overcome, according to the order defined in the sections *Activation sequence*, distinguishing between heating and cooling. The following exceptions are considered:

- If the building contains air HVAC systems or condenser water systems, the Radiator, Radiant Floor and Electric Emitter for heating terminal units will always be activated last.
- The terminal unit responsible for ventilation of the zone, if any, will always be activated first.

The automatic heating / cooling sizing options are advanced functions that allow editing the parameters that $EnergyPlus^{TM}$ uses to determine the characteristics of the HVAC equipment that the user has not specified (autosize function):

- Zone heating / cooling sizing factor: scaling factor on the thermal load calculated in the zone. The capacity of the HVAC equipment will be determined from the thermal load of the area multiplied by this factor.
- Zone cooling/heating design supply air temperature input method: the air flow rates that must be driven by the equipment to overcome the thermal load are calculated according to a design supply temperature defined by the user. Three options are offered:
 - Supply air temperature: the design air flow temperature for heating / cooling must be defined.
 - Temperature difference: the temperature difference between the supply air and the temperature of the zone must be defined.
 - System supply air temperature: only valid for air HVAC systems. The cooling/heating design set point defined in the panel of the air HVAC system will be taken as "supply air temperature".

3.5.3 HVAC systems wizard

In the HVAC systems section, the Wizard button allows you to define in a guided way a complete HVAC system, including systems for both HVAC and DHW, or add terminal units to already defined systems.

In the first window of the Wizard, the new system should be named and its typology should be chosen between water HVAC systems, direct expansion systems, air HVAC systems or constant performance equipment.

	Wizard	×
New air conditioning system	Reference	
Type of air conditioning system	Reference	
Select zones	Select the type of system to be added.	
Terminal units		
Air-conditioning unit		
Supply system		
🖉 Condenser water system	The water-air conditioning systems include the boilers, chillers and aerothermal equipment,	
Domestic hot water system	connected to radiators, the radiant floor for heating and fan coils.	
Cancel	< Previous Next > Fir	nish

Figure 41: HVAC systems wizard

On the left side of the window are the steps by which the wizard will guide the user to complete the definition of the HVAC system. The different sections light up in black if it is necessary to define them according to the chosen options. The buttons on the lower bar allow you to navigate in the wizard.

In the second step of the wizard, the user must choose the type of HVAC system according to the category chosen above.

	Wizard		×
New air conditioning system	Select the type of water terminal unit.		
Type of air conditioning system			
Select zones			
Terminal units		<u>)~~</u> {	
Air-conditioning unit	Radiator Radiant floor F	ancoil	
Supply system			
🖉 Condenser water system	Select the type of hot water supply equipment.		
Domestic hot water system	Boiler		
Cancel	< Previous Neo	xt >	Finish

Figure 42: Type of air-conditioning system, HVAC wizard

In the third step, the user must select the zones of the building that will be associated with the HVAC system. The wizard will automatically create the terminal units of the system defined in each of the selected zones and connect them to a centralized production system if necessary. The following options are offered:

• Replace the previously introduced systems

If this option is selected, the terminal units that already exist in the selected zones will be eliminated. When erasing terminal units it is possible that the air conditioning systems of the building are no longer connected to any terminal unit. In this case, at the end of the wizard, you will be asked if you want to delete the unused systems.

• Add one air handling unit per zone

If this option is selected, as many AHUs as selected zones will be added, each one connected to the air terminal units defined in each zone.

• Add a supply system per zone

If this option is selected, as many supply systems as selected zones will be added, each one connected to the equipment defined in each zone. Depending on the type of system chosen, such equipment can be directly the zone terminal units or AHUs with water coils.

, n	Wizard	□ ×
New air conditioning system		
Type of air conditioning system		
Select zones	Mark	Unmark
Terminal units		
Air-conditioning unit	Select the	e zones served by the new air conditioning system.
Supply system	Selectio	Z01 Ground floor - Dining
🐖 Condenser water system		Z02_Ground floor - Office space
Domestic hot water system		Z03_Offices - South
		Z04_Offices - North
		lace the systems introduced previously a supply system per zone
Cancel		< Previous Next > Finish

Figure 43: Selecting the zones, HVAC wizard

The following steps of the wizard run through the different elements that make up the type of HVAC system chosen, so that the user can define their characteristics. In general, the definition panels corresponding to the terminal units and to the HVAC systems available in the program will be shown as necessary.

To describe the rest of the options available in the wizard, the next figures show the definition of an HVAC system that consists of fan-coils connected to a water-condensed chiller and a boiler for heating and DHW.

Then, the next step offered by the wizard is the definition of the terminal units, fan-coil type. The terminal units defined in this step will be added to all the zones selected in the previous step. It is allowed to create more than one terminal unit of the same type in the zone by means of the panel list (according to the limitations of the systems detailed in the Capabilities section).

	Wizard		×
New air conditioning system Type of air conditioning system Select zones Terminal units Air-conditioning unit. Supply system Condenser water system. Domestic hot water system	Redictor Define the properties of the terminal unit or units associated with each zone. The defined terminal units will be created in all the zones that have been selected in the	previous	e step.
Cancel	< Previous Next		Finish

Figure 44: Defining the terminal units, HVAC wizard

The next step is to define the centralized supply equipment, or the air-handling units in the case of the air systems, to which the terminal units will be connected. In this example, the wizard shows the hot- and chilled-water systems.

	Wizard	□ ×
New air conditioning system	Hot-water system	♦↓ Chilled-water system
 Type of air conditioning system Select zones 	Add Select Define the hot water production equipment and the properties of the distribution network.	Add Select Define the cold water production equipment and the properties of the distribution network.
Terminal units An-conditioning unit Supply system Condenser water system Domestic hot water system	With domestic hot water production Hot water production equipment C C C C C C C C C C C C C C C C C C C	Cold water production equipment Cold water cooled chiller Cold water distribution
	Hot water distribution Design parameters Design setpoint temperature 82.0 °C Design deta temperature 11.1 °C Ruid type Water Circulating pump Operating parameters Design system configuration	Design parameters Image: Constraint temperature 7.2 °C Design defa temperature 6.7 °C Build type Water Image: Constraint of the second
Cancel	<u>الم</u>	∫ n Anish

Figure 45: Defining the supply systems, HVAC wizard

For each system the following options are offered:

- *Add*: allows you to define a new HVAC system.
- Select: allows you to select a HVAC system of the corresponding type, among those defined in the building. If in the third step of the wizard the option Add a production system / climate unit per zone was selected, a system must be selected for each selected zone.
- *With DHW production*: This option is exclusive to hot-water systems. It allows the definition of a hot-water system for heating and DHW.

In this example, a new hot-water system has been defined with the option With DHW production, and a new chilled-water system containing a water-cooled chiller. The wizard detects the needs of the selected equipment, and in the next step proposes the definition of the condenser water system for the chiller.

	Wizard		×
New air conditioning system	Condenser water system for chiller		
Type of air conditioning system	Add Select		
Select zones	Define the properties of the water condensation network.		
Terminal units	Equipment		
 Air-conditioning unit 			
 Supply system 	Name		
Condenser water system	1 Tower		
Domestic hot water system	Water loop Design parameters Design setpoint temperature 294 "C Circulating pump Operating parameters Pping system configuration		9 9 7
Cancel	< Previous Ne	sat >	Finish

Figure 46: Condenser water system, HVAC wizard

Finally, the wizard shows the definition of the DHW system to be added, based on the characteristics of the previously defined hot-water system supply equipment. In the case of having defined several boilers, it must be specified which one produces DHW in order to calculate its characteristics. The user can accept the proposal of the wizard or edit it.

		Wizard		×
New air conditioning system	Itot-water system			
Type of air conditioning system	* Revise la definición del sistema de ACS.			
Select zones	Hot water production equipment			
Terminal units	Name		Produce /	
 Air-conditioning unit 	Boiler		Produce /	46.5
Supply system	Doller		•	
Condenser water system				
Domestic hot water system				
	Equipo genérico de ACS			
	Type of energy vector	Electricity		
		Hot water boiler		
	Average seasonal energy performance	0.800		
	Rated capacity	0.00 W		
	hated capacity			
	El rendimiento medio estacional de calor factor de carga parcial de 1 y una temper	propuesto se ha obtenido a partir de la eficiencia nominal y la curva de comportamiento del equipo seleccionado, consi ratura de 60%.	derando un	
Cancel		< Previous New	t> [F	inish

Figure 47: Defining the hot water system, HVAC wizard

At the end of the wizard, the different elements of the defined system are added to the scheme of the building and the necessary ventilation options at the zone level are chosen. If you have added a DHW system with the wizard, its definition depends on the selection previously made in General Parameters for the Daily Demand of DHW. If the total Building Demand was defined, the wizard will create a single DHW system for the building. If the Demand was defined by thermal zone, the wizard will create by default a single DHW system that serves the zones selected in step 3 of the wizard. In the latter case, if the option "Add a supply system by zone" has been selected in the wizard, a DHW system will be created for each zone.

3.6 Shadows

This section is used to configure the shadows cast onto the building by both the buildings own features (such as balconies) and the features of nearby buildings (remote shadows).

	Own shade
	Remote shadows

Figure 48: Shadows, Project tree

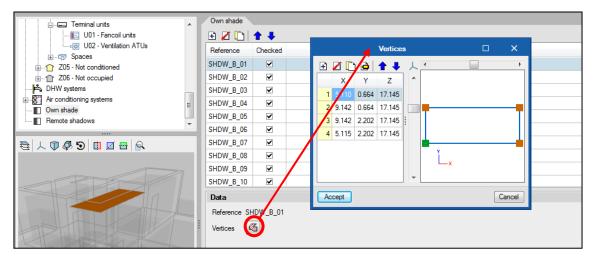


Figure 49: Configuration of the shadow cast by the buildings own feature

3.7 Edge processing

main

constructive

solutions are selected so that the corresponding

thermal transmittances

are calculated.

The IFC4 standard does not include the concept of linear thermal bridges, therefore CYPE has created an entity so that when an IFC4 file generated by IFC Builder is imported, the intersections of the constructive elements (edges) can be reflected for further treatment in CYPETHERM FUJITSU.

As mentioned in the section Thermal bridges, when the work has been created from a BIM model generated in IFC Builder, the library of thermal bridges contains all the edges of the building (purely geometric entities obtained from the intersection between the different constructive elements), although part of these edges does not intervene in the calculation. Once the building has been defined without errors, this tool can be used to obtain the linear thermal bridges present in the work through the *Edges* button on the ribbon.

										(@ • 📀
New air nit conditioning system	Delete	Duplicate	Search	 Displace upwards Displace downwards 	or Cut Cut Copy	Check the model		View	Edges	() Update	Jacob Newsor
oning systems		_		Edit		Errors		3D	BI	Mserver.c	enter
				Edges proces	ssing					;	×
	Ch Ti Co Ti te Ti St Co Co Co Co Co Co Co Co Co Co Co Co Co	haracterist his analys ode that h he import echnical in herefore, t ep, 'Edge onstruction	tics of the is will be of as been s of building formation to detect s' are imp n element ng into ac	e analysis to calcula adopted construct carried out taking in selected to calculat g information model is introduced using linear thermal bridg orted as purely geo ts. In the second st scount the building	ion solutions. to account the the the thermal s (BIM) focus s specific soft es, the progra metric entities ep "Edges predesered description fro	ne specificati transmittanc es on the ge ware. am must camy s, obtained fr occssing' line	ons that are ap e in linear then ometric descrip vout a two-step om the intersed ar thermal bridg	pplicable mal bridg ption of the pproces ction of v ges are o	dependi jes. he buildir s. For the various obtained	ng; their e first from the	ə —
	_				C	onfiguration					×
		Cod	e (ISO 146	83 🔹							
		EN	ISO 14683	. Thermal bridges in build	ding construction	n. Linear therma	transmittance. Sir	mplified me	thods and	default valu	Jes.
Accept				uggested in the code an Ig into account the confi					icient for th	ie different t	thermal
e program ar building by det geometric edge between upied space ar side, and an oc ce and an oc	tecting es that an nd the cupied		-] The insulat] Front of the Numerical a lodule devel the analysis CDTI)', and (he frame of the opening tion of the façade reach e slab with insulation analysis of linear thermal loped as part of the 'De' s of building energy dem co-financed by the 'Eur e Energética' of the 'Dep	es the frame of t bridges (EN ISC velopment of a s and investigatio opean Regional	he opening 10211) oftware tool for t n project, financ Development Fu	the integration of the integration of the control o	para el De arried out i	esarrollo Te n collabora	cnológico l ation with th	ndustrial e 'Grupo
ce. In <i>Configu</i>	•										
characteristics	of the	2									

Manual definition of the linear thermal transmittance coefficient
Accept
Cancel

Figure 50: Edge processing tool and configuration window

3.8 BIM model

If there have been any changes to the linked BIM model, the *Update* button on the Primary toolbar will flash and display a warning signal. When clicking on it, the panel *Update the BIM model* appears. Here various options are offered to manage the importation of the changes introduced in the model.

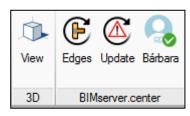


Figure 51: BIMserver.center section, Primary toolbar

3.9 Check the model

The *Check the model* button is available on the ribbon. This button analyzes the definitions made in the building and shows error messages in the lower part of the screen if there are incorrect or incompatible definitions. If there are potentially incorrect definitions that do not produce errors in the calculations, a warning message will be displayed.

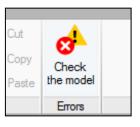


Figure 52: Check the model button, Errors section

As explained in section 4.2. Library, subsection BIM model, each icon that appears in the tree allows, through a small mark, the detection of the absence or non-definition of a typology.

4. Floor plans tab

This section contains the plans of every floor with the corresponding construction elements. From here it is also possible to edit the characteristics of the construction elements.

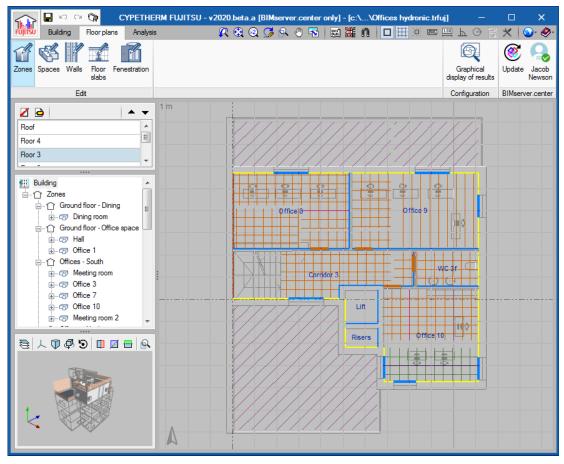


Figure 53: Floor plans tab

4.1 Without BIM model

Without a BIM model, you will be able to import plans with the buttons with 'DXF / DWG', or you will be able to create a new plan by placing yourself on previously entered objects.

4.2 With BIM model

If you created your project from the IFC file import, the plans, containing the construction elements and their typologies, will be imported directly into the 'Floor plans' tab. You can edit them by selecting corresponding tool in the primary toolbar and then selecting them in the window. Selecting elements in the Project tree will highlight them in the window.

4.3 Generation of plans

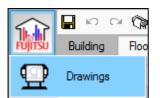


Figure 54: Drawings button, File

🔁 🗾 🗋 🔒 🕇 🦊

With textbox

✓

Draw

✓

Accept

Drawing selection

Title block

The printing of the plans is available via the menu 'File'> 'Drawings'.

In the drawing selection prompt, click new and add the desired floors to the drawing. Choose a PDF generator in 'Peripherals' used to import PDF. Click accept and the software will generate the drawings.

□ × You must click on 'Detail of all drawings' to display your plans.

Ŧ

Cancel



Save

Layers

Peripherals

				D	rawing	j compos	ition						×
New (drawing	Delete empty spaces	Centre all drawings	Centre selected drawings	Edit object	Move object	Drawing detail	Detail of all the drawings	ے Print all	Print selection	R Q @) 7 9	. 🖑 🗟	DXF -
(1\\\C	,											
	1)AC	,											
								3		a P 🏹 🦂 🥵			
						t		•					
				7	¥//.	·//////							
		200											
			Fi	gure	56: C	Drawin	g compos	itio	n prompt				
Group: DX	F												

5. Analysis tab

In this section the user can run the energy simulation and view the results.

	🛛 🖓						
FUJITSU	Building	Floor plans	Analysis				
÷			2	e			
Calculation options	n 3D Model	Analyse Energy file		Results file	Demand report	Consumption report	Complementary reports
	Analysis Reports						

Figure 57: Analysis tab, Primary toolbar

5.1 Analysis

Calculation options

In Calculation options, you can choose the simulation you want to run:

• Demand

Simulation of the building only (without the HVAC systems). Allows analyzing the thermal demand of each building zone separately.

Demand/Consumption Simulation of the building with and without the HVAC systems. For the consumption simulation, an ideal HVAC system will be automatically added to the zones with a cooling or heating temperature set point that do not contain any HVAC system, in order to keep the zone air at the defined temperature set points. This ideal system does not consume any energy.

Calculation options X
Simulation type Demand/Consumption
Vertical partition simplification With thermal bridge export
Simulation period
Accept Cancel



In large works, where calculation times can be very high, it is convenient to activate the option "Vertical partition simplification". The activation of this option consists in the calculation of a simplified option of the 3D calculation model where the vertical partitions, instead of sending them to EnergyPlus[™] separately, are grouped by "characteristics" and simulated as the internal mass of each zone. This option is advisable, above all, in large works, since it greatly reduces the complexity of the model and, consequently, the calculation times, offering results with hardly any differences with respect to those of the complete model.

The option "With thermal bridge export" includes the thermal bridges of the building in the simulation.

There is also the possibility to simulate a period of time instead of the full year, to check the validity of the calculation model or visualize the behavior of the building for a few specific days.

3D model

The 3D Model button shows all the elements of the calculation model of the building that will be used in the simulation with the calculation engine.

You can consult all the characteristics of each element in the information balloon that appears on the right.

	3D Model						o x			
Building elements	Z01_Ground_floor_Dining	,								
	Name	Z01_	Ground_floor_	Dining						
Project	Type of use	Hous	ehold							
	Hygrometric class	3								
Z01_Ground_floor_Dining	Area	50.51								
	Height	3.403								
	Volume	171.9		D::: (0	1.1.0	LL Mr. of				
	Activity tables	201_	Ground floor -	Dining (Occup	ancy, Lighting	and Infiltrati	ons) 🔅			
	Area									
	1. Z01_S01_W01		wall 12.96 m ²				4			
	2. Z01_S01_W02		ions 10.45 m ²				٩			
	3. Z01_S01_W03		ions 20 m²				٠			
External shade	Z01_S01_W03_G1	Door	3.65 m ²				٤			
	Z01_S01_W03_G2	Wind	ow 1.21 m ²				٤			
	Z01_S01_W03_G3	Wind	ow 1.21 m ²				Ū,			
	Z01_S01_W03_G4 Window 1.21 m ²									
	4. Z01_S01_W05 Facade 28.5 m ²									
Object building	Z01_S01_W05_G1	Wind	Window 3.08 m ²							
K 🕄 Q 📿 R 🖑 🗟	T Z01_S01_W05_G2 Window 3.08 m ²									
	Z01_S01_W05_G3	Wind	Window 3.08 m ²							
	5. Z01_S01_W06 Façade 15.43 m ²									
Ŷ	Z01_S01_W06_G1	Z01_S01_W06_G1 Window 1.04 m ²								
	Z01_S01_W03 ×									
	C07_Simple_partition									
	Material		Thickness (cm)	Conductivity (W/(m·K))	Unit weight (kg/m³)	Specific heat capacity (J/(kg·K))	Thermal resistance ((m²-K)/W)			
	1. M11_G01_16_mm_gyp_t	ooard	1.59	0.16	800.9	1088				
	2. M01_F04_Wall_air_spac		4.50	0.40		1000	0.15			
	3. M11_G01_16_mm_gyp_t	board	1.59	0.16	800.9	1088				
	Accept									

Figure 59: 3D model prompt, Analysis tab

Analyse

Run the simulation and/or update the reports, being able to modify the options defined in "Calculation options".

EnergyPlus[™] file

Using this option, the software generates the .idf file of the building data. This is the file which is used as the input data for EnergyPlusTM.

Warnings file

Through this option you can consult the .err file with warnings and errors returned by $EnergyPlus^{TM}$.

Results file

Through this option you can consult the .html file with a summary of the output of results generated by $EnergyPlus^{TM}$.

5.2 Results

In this section the calculation options are defined, the simulation is launched and the results are viewed.

	CYPETHERM FUJITSU - v2019.e [BIMsen	er.cente	er only] ·	- [c:\\	Offices	hydronia	e.trfuj]							-	٥
Building Floor plans Analysis															<u></u>
Image: Second state Image: Second state	Demand Consumption report Complementary														Improve meas
Analysis	Reports														Бф
14 M	Building														
Building	Object building(Demand)														•
Z02_Ground_floor_Office_space	Heating energy and minimum temperatures														
[], Z03_Offices_South [], Z04_Offices_North	Zone				Surface (m ^a)	lan Feb	Mar Ap	or May	Jun Ju	Aug S	iep Oct	Nov D	ec Total		
Z05_Not_conditioned	Z01_Ground_floor_Dining					cWh/m²	50.51 4	.65 2.62	0.37 0.0	14 -		•	- 0.1	0.78 2.	05 10.61
Z06_Not_occupied	Z02_Ground_floor_Office_space					⟨Wh/m²	71.52 3	.16 1.82	0.11 0	-		1.0	- 0.04	0.22 1.4	41 6.77
	Z03_Offices_South					cWh/m²	117.82 7	.28 4.18	0.47 0.0	12 -			- 0.18	0.88 3.	35 16.36
	Z04_Offices_North					⟨Wh/m²	143.72 5	27 2.91	0.2 0	-			- 0.09	0.61 2.	74 11.82
	Z05_Not_conditioned					°C		6.4 8.4	16.4 19	4 22.5	24.9 24.	5 26.1	22 17	14.7 11	.6
	Z06_Not_occupied					°C	1	2.4 2.5	11.9 13.	7 18.6	21.9 22.	3 25 2	0.3 13	8.9 6	6
	Total					cWh/m²	383.57 5	.41 3.06	0.29 0.0)1 -			- 0.11	0.64 2.	59 12.11
	Cooling energy and maximum temperatures														
	Zone			Surl (n	iace Jan 1²)	Feb Ma	ar Apr I	May Ju	in Jul	Aug S	iep Oct	Nov D	ec Total		
	Z01_Ground_floor_Dining	Z01_Ground_floor_Dining							2 2.43	4.69 7.3	22 7.93	8.27 4	.97 2.11	0.25 0.	08 38.89
	Z02_Ground_floor_Office_space				kW/	n/m² 71	.52 -	0.29 0.7	78 2.08	4.05 6.	1 7.12	7.52 4	.78 2.2	0.42 0.	07 35.43
	Z03_Offices_South				kW/	n/m² 113	7.82 0.01	0.7 1.5	67 4.21	8.04 12	33 14.02	14.83 9	28 4.39	0.98 0.3	21 70.56
	Z04_Offices_North				kW/	n/m² 143	3.72 -	0.16 0.	9 3.06 (6.16 8.3	78 10	10.21 6	.12 2.31	0.15 0.	04 47.91
	Z05_Not_conditioned				1	C	19.4	23.5 25	1 26 3	28.1 29	.4 31.6	31.3 2	9.2 26.1	23.2 2	2
	Z06_Not_occupied				1	C	15.2	20.1 22	.9 24.3	26.1 28	.7 30.7	30 2	7.6 23.6	20.1 18	.2
	Total				kW	n/m² 383	3.57 0	0.36 1.0	6 3.15 (6.15 9.1	17 10.43	10.87 6	.69 2.9	0.47 0	1 51.35
\$ @ © 8 0 1 1	Results														
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	Minimum external temperature	°C	-6.7	-12.6	1.3	0.4	8	11.5	17.2	18.7	11.9	2.2	-3.3	-5.4	
	Maximum external temperature	°C	20.9	25	27.8	28.9	30.6	34.2	36.7	35	31.7	29.6	24.2	22.8	
	Average external relative humidity	%	65	58	55	62	67	63	71	73	72	74	63	64	
	Minimum internal operative temperature	°C	2.4	2.1	11.9	13.7	18.6	21.9	22.3	24.6	20.3	13	8.9	6.6	
	Maximum internal operative temperature	°C	23.6	25.4	26.9	27.5	29.6	31.1	33.6	33	30.7	27.4	25.3	24.4	
	Internal mean air temperature	°C	14.1	16.3	20.4	22.6	24.5	26.5	27.3	27.3	25.2	21.7	19.2	16.1	
	Average internal relative humidity	74	37	37	39	44	51	52	58	60	56	52	43	40	
	Heating demand	kWh	2075.88	1173.27	109.82	4.78					-	42.7	246.52	993.82	4646.77
	Cooling demand	kWh	1.1	137.81	407.09	1207.2	2359.81	3516.4	3999.17	4170.37	2566.48	3 1113.05	180.75	38.58	19697.8
	Energy contribution: Opaque elements	kWh	1993.55	1552.6	1287.62	1082.2	819.49	834.4	956.02	849.77	703.71	1183.81	1445.09	1688.39	14396.6
	Energy loss: Opaque elements	kWh	3492.17	2767.16	2258.79	1851.8	1494.72	1209.93	1138.31	1020.94	1029.02	1975.28	2431.92	2824.2	23494.3
	Energy contribution: Openings, total			1219.89											

Figure 60: Analysis tab window

Throughout the work process, it is only necessary to re-launch the simulation if the definitions made in the Building and Floor plans tabs have altered the EnergyPlusTM input data files with respect to the last calculated simulation. In this case, the work not calculated notice will appear on the screen. If the EnergyPlusTM input data has not been altered, the calculation results will be displayed directly. In any case, it is necessary to click on the *Analyse* button to generate the reports.

5.2.1 Reports

Demand report

In this report the results of the calculation of the energy demand of the building are detailed.

		Demand report					
👌 Page preview 🛞 Setup 🕒 Print 🗰 Search 🔹	$\triangleleft \triangleright$			P	Share 🛱 Export 🕶 🔯		
	E	nergy dem	and				
1 ENERGY DEMAND C	ALCULATI	ON SUMMA	RY.				
The table below summarises the rest zone, as well as the total energy dem			the heating and co	oling energy dema	and of each occupied		
Habitable zones	s			D _{cool}			
Habitable zones	(m²)	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)		
Ground floor - Dining	50.51	536.12	10.61	1964.33	38.89		
Ground floor - Office space	71.52	484.09	6.77	2533.94	35.43		
Offices - South	117.82	1927.40	16.36	8313.41	70.56		
Offices - North	143.72	1699.17	11.82	6886.12	47.91		
Not conditioned	57.53	-	-	-	-		
	441.10	4646.77	10.53	19697.80	44.66		
where: S _u : Useful surface area of the habitab		_					
D _{heat} : Calculated value of the heating en							
D _{cool} : Calculated value of the cooling en	ergy demand, kWh/m	·year.					
2 MONTHLY RESULTS							
	التنام مطعلهم						
2.1 Annual energy balance		-					
The following bar chart shows the end							
to thermal transmission via opaque a	and light elements	(Q _{op} and Q _w , re	espectively), the ene	ergy interchange d	lue to ventilation and		

Figure 61: Demand report

Consumption report

In this report are detailed the results of the calculation of the energy consumption of the building HVAC and DHW systems.

					C	onsumpti	on report								o x
🖻 Page preview 🍪 Setup 兽 Pirst 🇰 Search < 🗁 👘 Export 🖛 😭 Export 🕶 🥘											🕶 🔯 Debug				
						- 91				-					~
1 ENERGY CONSUMPTION CALCULATION RESULTS															
1.1 Mon	thiv re	sults.													
1.1.1 Annual energy consumption of the building.											-				
11111 7000	iui cherg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ye	ar
		(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)	(kWh·year) (k	Wh/m²·yea
BUILDING (S _u	= 441.10 n	n²; V = 1	546.78	m³)											
	Heating	2075.9	1173.3	109.8	4.8						42.7	246.5	993.8	4646.8	10.
Energy deman	d Cooling	1.1	137.8	407.1	1207.2	2359.8	3516.4	3999.2	4170.4	2566.5	1113.0	180.7	38.6	19697.8	44.
	TOTAL	2077.0	1311.1	516.9	1212.0	2359.8	3516.4	3999.2	4170.4	2566.5	1155.7	427.3	1032.4	24344.6	55.
	EF _{heat}	598.7	382.7	237.6	86.3	12.6	0.5			1.2	126.3	293.8	428.6	2168.3	4
	EP _{heat}	1417.8	906.3	562.5	204.4	29.9	1.2			2.8	299.1	695.8	1014.9	5134.6	11
	EP _{nr,heat}		747.9	464.2	168.7	24.7	1.0			2.3	246.8	574.2	837.5	4237.1	9.
	EF _{cool}	0.9	59.5	184.2	477.5	938.3	1509.4	1785.3	1934.7	1088.5	486.3	94.6	23.1	8582.4	19
Electricity (free = 1.954)	EP _{cool}	2.1	140.9	436.2	1130.7	2221.9	3574.4	4227.5	4581.4	2577.7	1151.5	224.1	54.8	20323.2	46
(Topp - 2100-1)	EP _{nr,cool}	1.7	116.3	360.0	933.1	1833.5	2949.6	3488.6	3780.5	2127.1	950.2	184.9	45.2	16770.7	38.
	EFdhw														
	EP _{dhw}														
	EP _{nr,dhw}														
	EFheat		867.4	43.9	0.5						18.8	128.2	654.5	3265.1	7
		1854.3	1036.5	52.5	0.6						22.4	153.2	782.1	3901.7	8 .
•		•												1	•

Figure 62: Consumption report

Complementary reports

Complementary	×	
	Ŕ	
Description of materials and construction elements	Condensation	
Internal comfort		
Accept		Cancel

Figure 63: Complementary reports

Description of materials and construction elements

This report shows the different elements present in the work together with their materials, quantities, transmission coefficients, etc.

Condensation

This report is available if the option Condensation has been selected in the General data window. The report shows the justification of the calculations carried out by the program following the guidelines of the ISO 13788 standard.

Internal comfort

This list allows the visualization, through graphs and tables, of the evolution of the indoor air temperature of the zones, comparing it with the outdoor air temperature and counting the number of hours that the comfort temperature defined in each zone is exceeded.

5.2.2 Export results

The *Improvement measure* button will export the results from CYPETHERM FUJITSU to CYPETHERM Improvements Plus, a program designed for the energy and economic analysis of the building.

First, the simulation of the building in its current state must be run with CYPETHERM FUJITSU. This case will be defined as the initial solution for the Improvement measure exportation.

Subsequently, the desired modifications of the building will be made in the Building tab. It is recommended to save the work in a different file so as not to lose the definition of the initial situation. The modified building will be simulated and, in the improvement measure wizard, this case will be defined as an Improvement Measure, specifying its associated costs.



Figure 64: Improvement measure export tool