TIMEPAC Academy

Session
Data collection and verification – case study office building

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21 May 2024

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EDILCLIMA ENGINEERING & SOFTWARE

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE, PODNEBJE IN ENERGIJO

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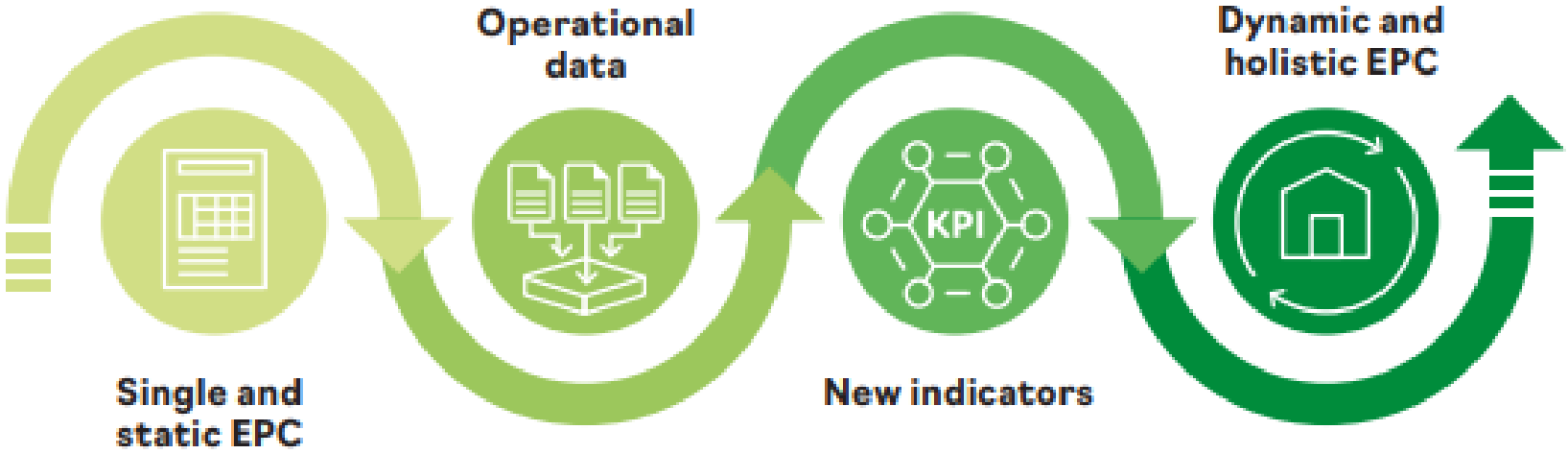
Objective of the presentation

To show the data collection process for the building performance analysis through a case study approach by:

- Listing the data able to analyse the overall building performance
- Providing tips for gathering data collection from various fields
- Showing example for enhancing the participation of the building experts and occupants
- Showing example for data visualization and elaboration for the subsequent analysis

TIMEPAC concept



Purpose of data collection

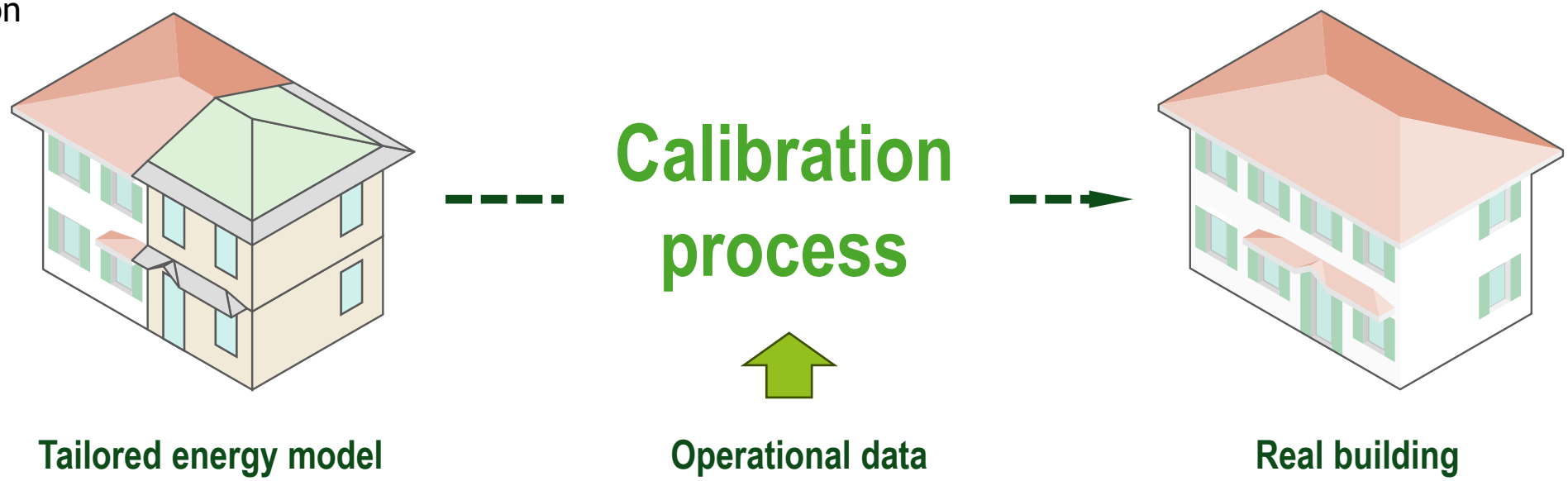
Data for Energy Performance Certificate

- Geographical and climatic data (standard)
- Geometrical characteristic
- Building components' characteristic
- Technical building systems' characteristics

Purpose of data collection

Data for the building calibration

- Geographical and climatic data (standard and real)
- Geometrical characteristic
- Building components' characteristic
- Users' information (real)
- Technical building systems' characteristics
- Energy consumption



Purpose of data collection

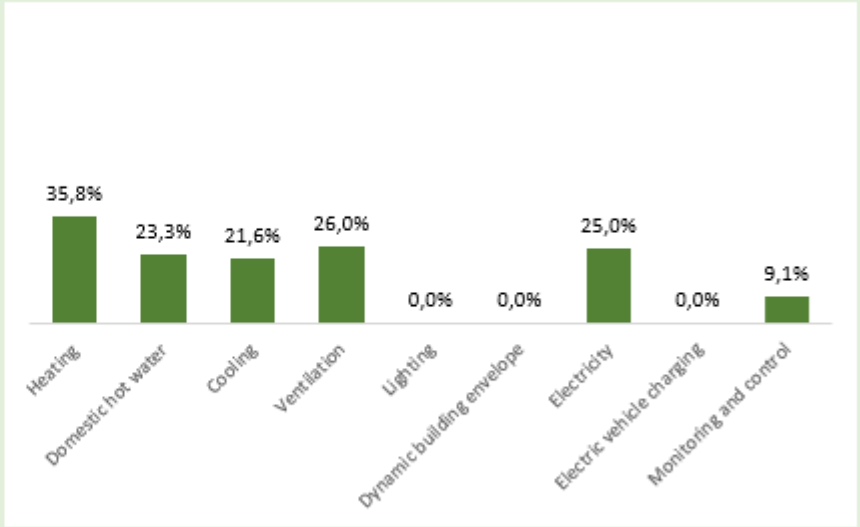
Data for the Smart Readiness Indicator (SRI) elaboration

- Technical building systems' characteristics
- Users' information
- Other

TOTAL SRI SCORE	19,3%	SRI CLAS	Lower than 20%

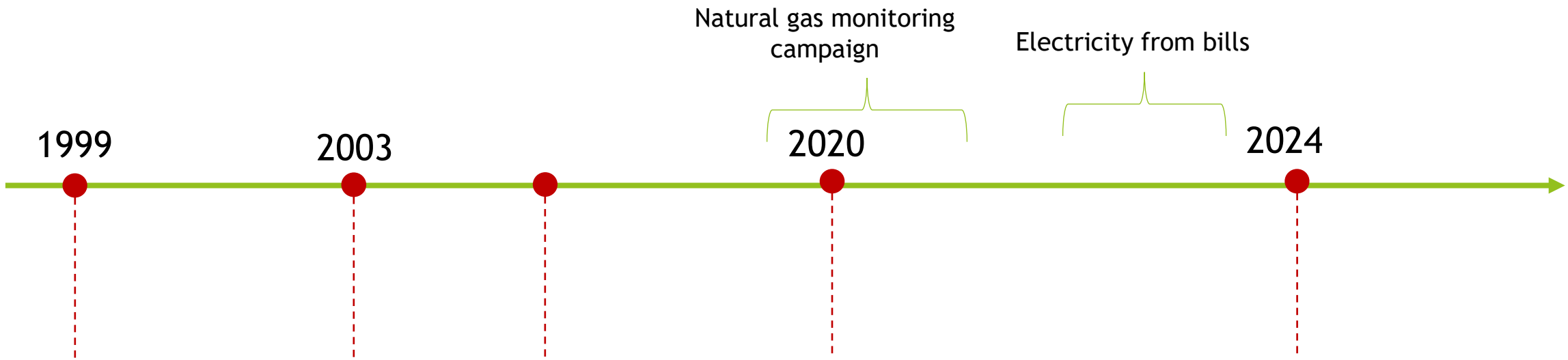
DOMAIN SCORES

Heating	35,8%
Domestic hot water	23,3%
Cooling	21,6%
Ventilation	26,0%
Lighting	0,0%
Dynamic building envelope	0,0%
Electricity	25,0%
Electric vehicle charging	0,0%
Monitoring and control	9,1%



Purpose of data collection

Documents that can be archived for a building logbook



1999 — Building envelope and plants design

- Building envelope and air conditioning system design (.doc; .dwg)
- Electrical system design (.doc; .dwg)
- Energy model (.E0001)

2003 — Refurbishment activity

BIM architectural model

- Archicad file (.ifc; .pln)

2020 — Creation of a calibrated energy model (natural gas)

- Calibrated energy model (.E0001)

2024 — Creation of a calibrated energy model (natural gas and electricity)

- Calibrated energy model (.E0001)

Case study: office building in Novara province

General information

Building use: Office building

Location: Borgomanero (NO)

In field site inspection

Which stakeholders were involved?

- Building owner: during the data collection phase
- Building and plants designer: during the data collection phase
- Building occupants (employees): during the calibration process phase

Which data have been collected?

List of data to be collected

- Geographical and climatic data
- Geometrical characteristics
- Building components’ characteristics
- Users’ information
- Technical building systems’ characteristics
- Energy consumption
- Data for SRI evaluation
- Document analysis and data archiving

Geographical and climatic data

External shading obstacles – data sources

- Presence of external shading obstacles (surrounding buildings, trees, etc.)
    1. City (or district) plans
    2. Web mapping platforms
    3. Provided documentation
    4. In site inspection
- Height and distance from the analysed building
    1. Provided documentation
    2. City (or district) plans
    3. In field measurements

Geographical and climatic data

Climatic data – data sources

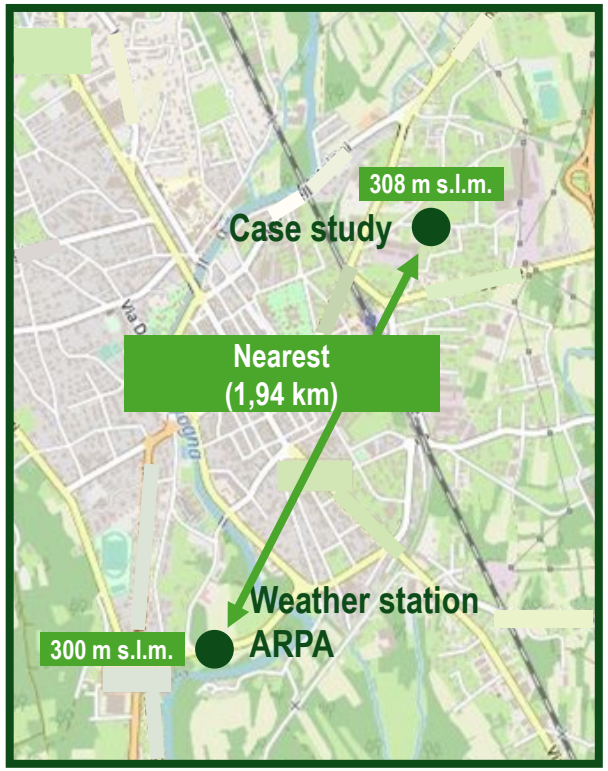
Generally, the required climatic data are outdoor air temperature, solar irradiance (horizontal and vertical for each orientation), relative humidity, wind speed and direction

1. In field measurements (real data recorded on building site)
2. Meteorological stations (nearby the building)
3. Technical standards (standard climatic data for the building location)

Climatic data

Case study

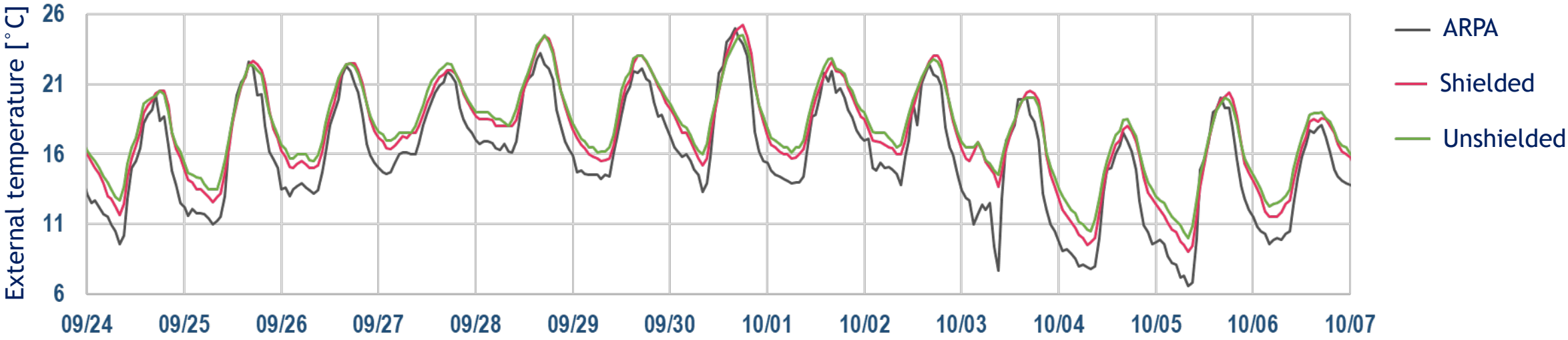
Data	Source	Objective
Solar radiation Wind speed Air temperature Dew point temperature Relative humidity	UNI 10349	Standard energy performance assessment Tailored energy performance assessment
Solar radiation Wind speed	ARPA Piemonte climatic station	Calibration
Air temperature Dew point temperature Relative humidity	In field measurement	Calibration



Climatic data

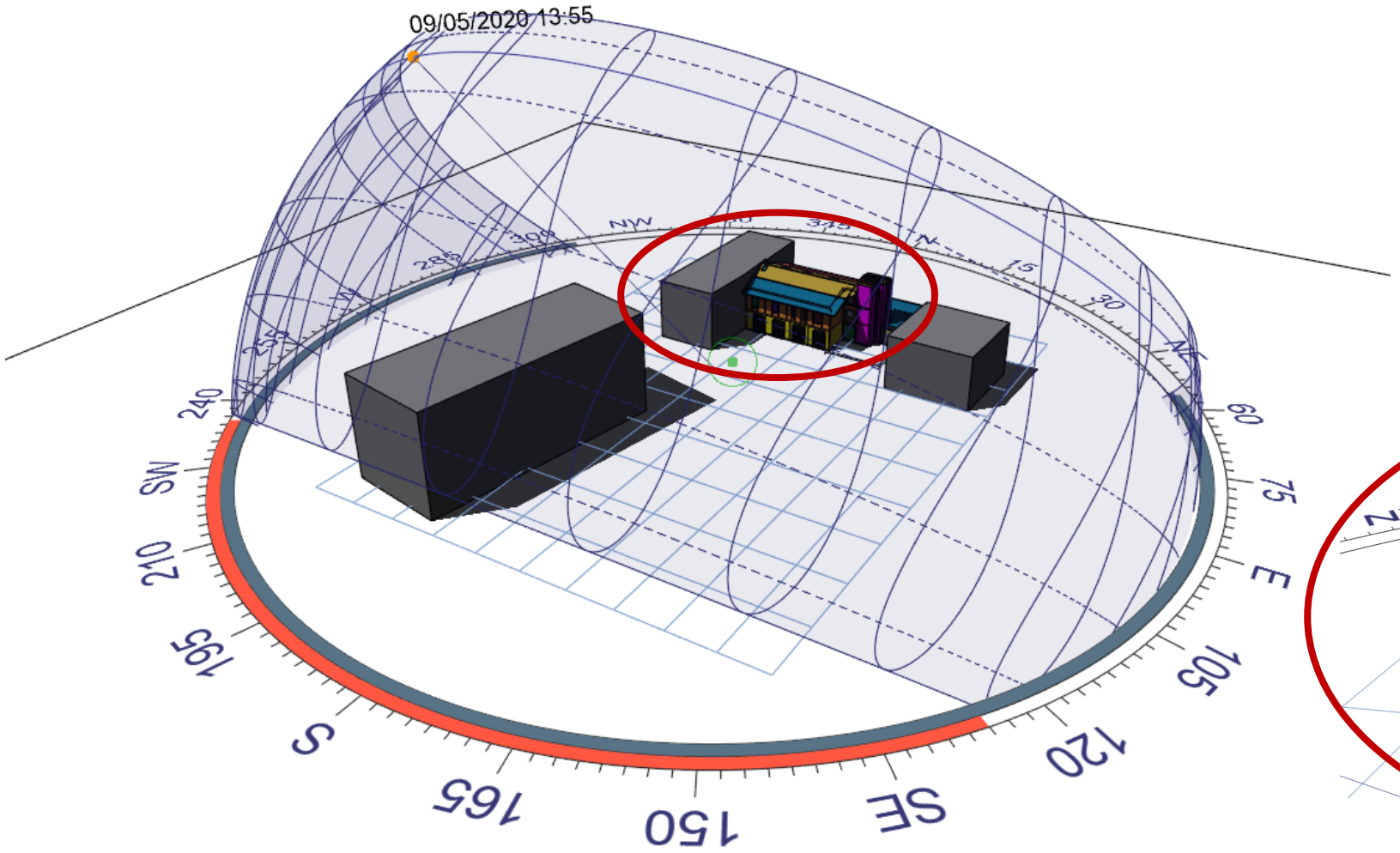
Case study

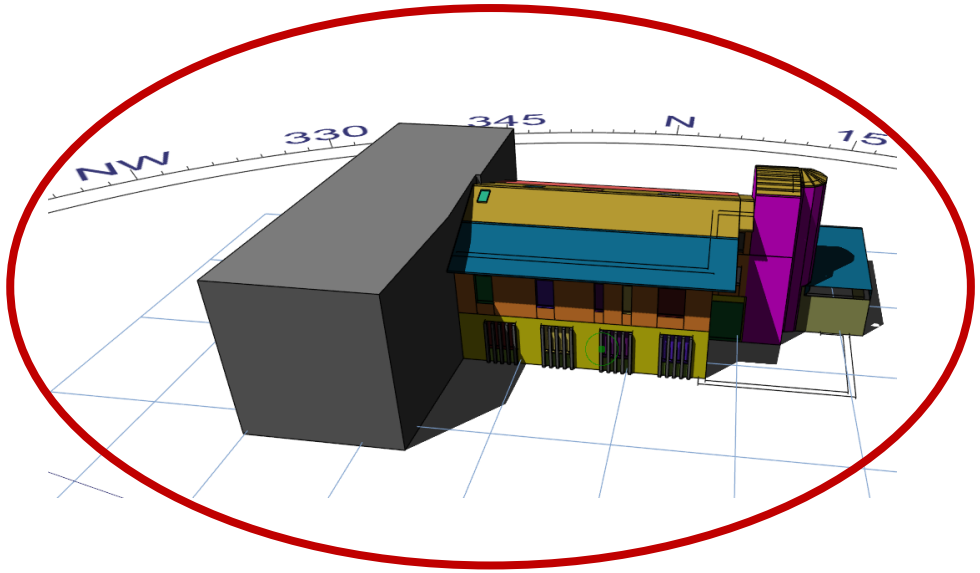
The on-site monitoring of external temperature was conducted using a sensor shielded from the extra-flow towards the celestial vault and one unshielded. By comparing the data collected with the ARPA meteorological station, it was decided to consider the temperatures monitored by the sensor shielded from the extra-flow.



Geographical data

Case study





Geometrical characteristics

Required to define the geometrical features of the building

- Overall and net floor area (at least for each thermal zone)
- Floor-to-ceiling height
- Overall heating space volume
- Envelope area
- Envelope components dimensions (for each opaque and transparent component)
- Envelope components orientation (for each opaque and transparent component)
- Presence of fixed solar shading devices, such as overhangs or side fins (for each opaque and transparent building envelope component

Geometrical characteristics

Data sources and data collection procedure

Generally, the required geometrical characteristics can be determined by

1. In field measurements (real data recorded on building site)
2. Building documentation (building plans, EPC, BIM, etc.)

According to the calculation procedure, the geometrical characteristics can be defined as

- Gross external dimensions
- Gross internal dimensions
- Net internal dimensions

Geometrical characteristics

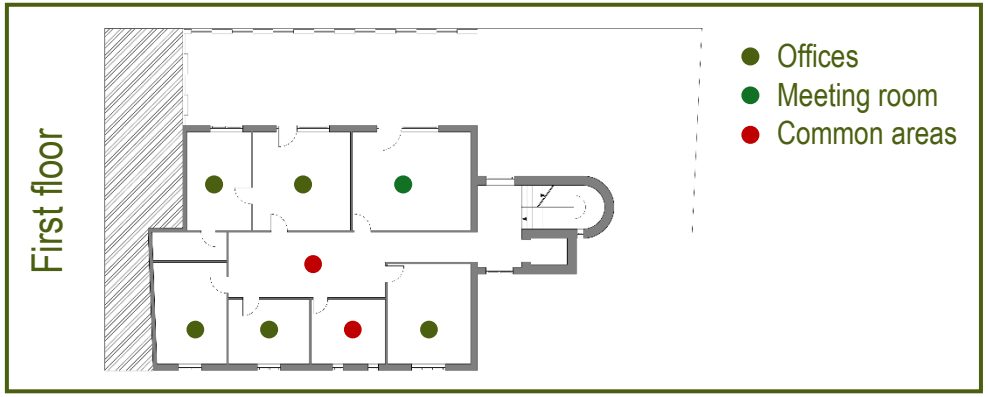
Case study

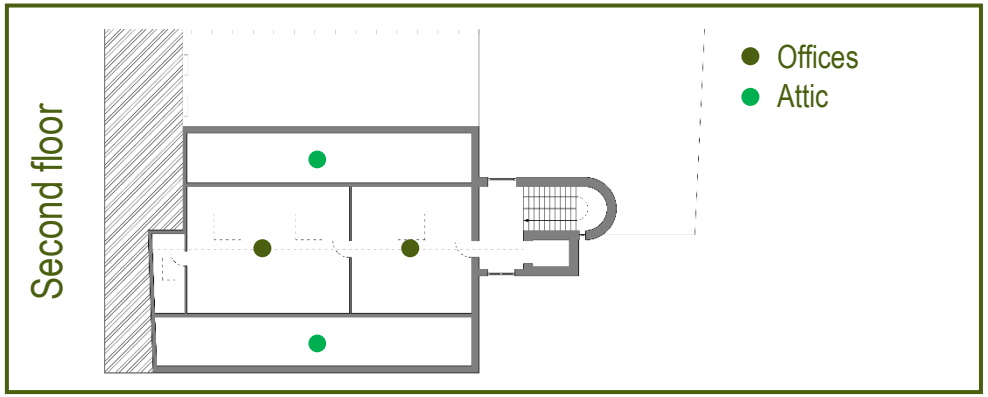
- Dimensions of spaces
- Interfloor heights

Building documentation
In field measurement

- Windows
- Uses of spaces

In field measurement





Geometrical characteristics

Case study

- Dimensions of spaces
- Interfloor heights

} Building documentation In field measurement

- Windows
- Uses of spaces

} In field measurement

Window			Window dimensions									
ID.	Floor	Type	L	H	A	B	C	D	NO	E	NV	F
	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[-]	[m]	[-]	[m]
FI01_DEP01	GF	Vertical	1.64	1.60	0.12	0.10	0.11	0.11			1	0.15
FI01_UFF01	GF	Vertical	1.90	1.60	0.12	0.10	0.11	0.11			1	0.15
FI01_UFF02	GF	Vertical	1.72	1.60	0.12	0.10	0.11	0.11			1	0.15
FI01_DEP02	GF	Vertical	2.14	1.60	0.12	0.10	0.11	0.11			1	0.15
FI01_UFF03	GF	Vertical	2.14	1.60	0.12	0.10	0.11	0.11			1	0.15
FI02_UFF03	GF	Vertical	2.14	1.60	0.12	0.10	0.11	0.11			1	0.15
PF01_COM01	GF	Vertical	2.18	2.59	0.01	0.15	0.07	0.07			1	1.23
FI01_UFF04	GF	Vertical	2.02	2.04	0.46	0.10	0.11	0.11			1	0.15
FI01_UFF05	GF	Vertical	2.06	2.03	0.44	0.10	0.11	0.11			1	0.15
FI01_UFF06	GF	Vertical	2.05	2.03	0.44	0.10	0.11	0.11			1	0.15
FI01_UFF07	GF	Vertical	2.02	2.04	0.45	0.10	0.11	0.11			1	0.15
FI01_COM02	FF	Vertical	0.30	8.20	0.07	0.07	0.07	0.07			1	0.48
FI02_COM02	FF	Vertical	1.37	1.17	0.11	0.10	0.10	0.10				
FI03_COM02	FF	Vertical	1.33	1.33	0.09	0.08	0.09	0.09	1	0.06	1	0.06
PF01_DEP03	FF	Vertical	3.10	2.35	0.11	0.18	0.12	0.12	1	0.11	1	0.17
PF01_UFF08	FF	Vertical	1.11	2.36	0.12	0.18	0.13	0.13	1	0.12		
FI01_UFF08	FF	Vertical	1.48	1.47	0.12	0.14	0.12	0.12				
FI01_UFF09	FF	Vertical	1.59	1.45	0.12	0.14	0.11	0.11			1	0.14
FI01_UFF10	FF	Vertical	1.13	0.95	0.11	0.14	0.13	0.13			1	0.14
FI01_UFF11	FF	Vertical	1.13	1.94	0.11	0.14	0.13	0.13			1	0.14
FI01_COM03	FF	Vertical	0.57	1.95	0.11	0.13	0.10	0.10				
FI02_COM03	FF	Vertical	0.57	1.95	0.11	0.13	0.10	0.10				
FI01_UFF12	FF	Vertical	1.64	1.96	0.13	0.13	0.12	0.12			2	0.15
FI01_COM04	SF	Vertical	1.33	1.34	0.10	0.08	0.09	0.09	1	0.06	1	0.06
FI02_COM04	SF	Vertical	1.37	0.91	0.10	0.10	0.10	0.10				
FI01_UFF13	SF	Skylight	1.31	1.34	0.11	0.06	0.07	0.07				
FI01_UFF14	SF	Skylight	1.29	1.34	0.11	0.06	0.07	0.07				
FI02_UFF14	SF	Skylight	1.29	1.34	0.11	0.06	0.07	0.07				
FI01_COM05	SF	Skylight	0.62	1.14	0.11	0.06	0.07	0.07				

Building components characteristics

Opaque components characterization – data sources

- Thermophysical parameters of each opaque component
    1. Calculation (EN ISO 6946)
    2. Provided documentation or technical sheets
    3. Inference rules (reference structures similar to the one to be described)
    4. In field measurements (calorimeter method or thermoflowmeter method)
- Layers and materials composing each opaque component
    1. Provided documentation or technical sheets
    2. Inference rules (reference structures similar to the one to be described)
    3. In site inspection

Building components characteristics

Transparent components characterization – data sources

- Thermophysical parameters of each transparent component
    1. Calculation (EN ISO 10077-1)
    2. Provided documentation or technical sheets
    3. Technical standard
- Presence and characterization of solar shading devices (movable)
    1. Provided documentation or technical sheets
    2. In site inspection
    3. Technical standard

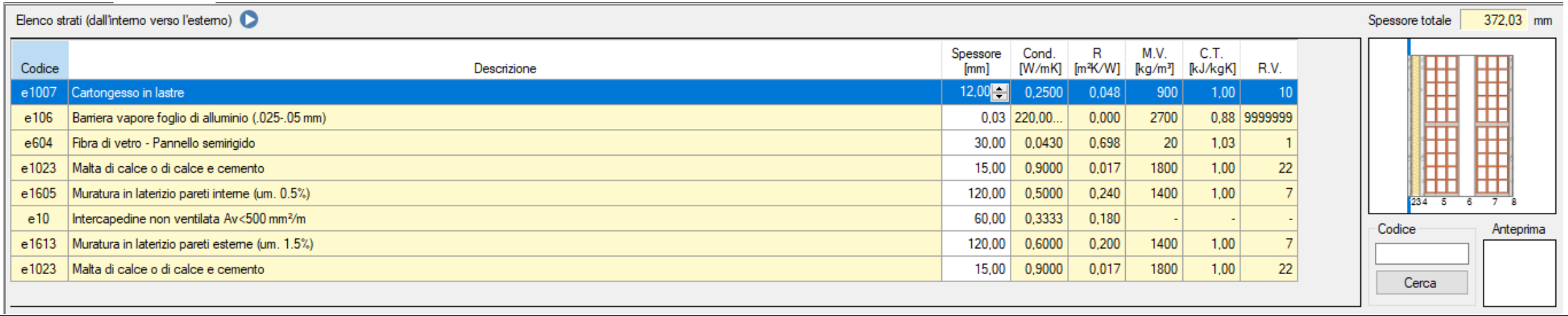
Building components characteristics

Case study

- **Opaque vertical components**
  Masonry cavity walls (10 different components)
  Internal insulation layer

- **Opaque horizontal components**
  Interfloor in brick-concrete with suspended ceiling
  Terraced roof and pitched roof

Building documentation



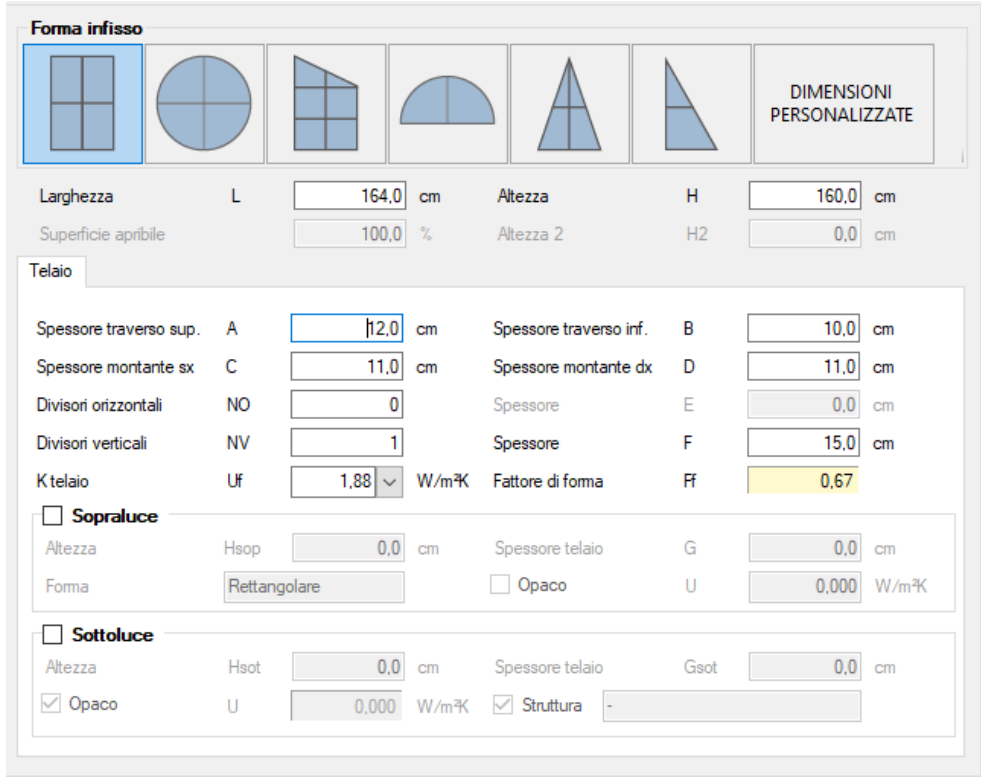
Building components characteristics

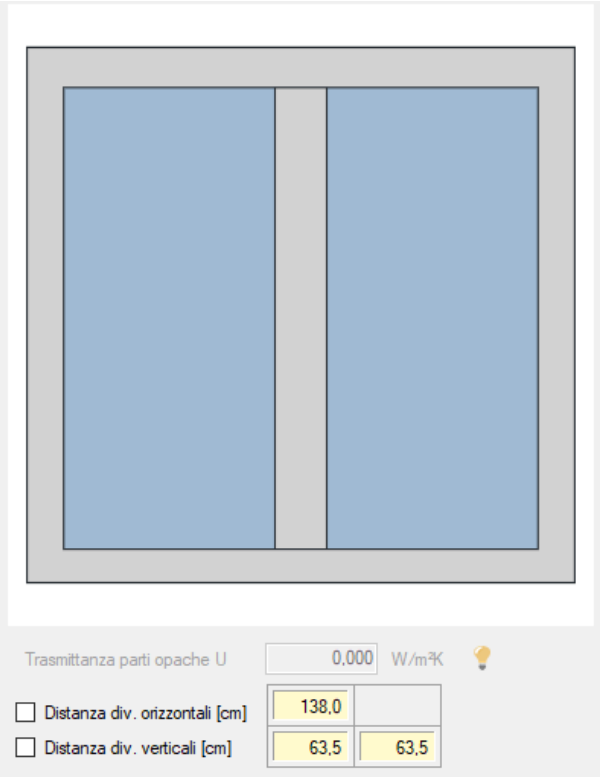
Case study

- **Transparent components**
- Double glazed windows
- Aluminium and wood frames
- Fixed brise-soleil or venetian blinds

Building documentation

In field analysis





Users information

Required to define the user behaviour in terms of presence in the building/room, control of the TBSs, use of appliances, windows openings, and use of solar shading devices, etc.

- Occupancy
- Natural ventilation
- Solar shading devices and shutters management
- Use of appliances (other internal heat gains)

Users information

Occupancy information – data sources

- Number of occupants (or occupant heat gains) for each room, thermal zone, or whole building
    1. Provided documentation
    2. Interviews with the users or the building energy manager
    3. Technical standard
- Occupancy schedule for each room, thermal zone, or whole building
    1. Provided documentation
    2. Interviews with the users or the building energy manager
    3. Technical standard

Users information

Natural ventilation – data sources

- Ventilation air flow for each room, thermal zone, or whole building
    1. Calculated from windows opening
    2. Provided documentation
    3. Technical standard (minimum air flow for indoor air quality)
- Windows opening schedule for each room, thermal zone, or whole building
    1. Interviews with the users or the building energy manager
    2. Technical standard
    3. Assumed equal to occupancy schedule

Users information

Solar shading devices and shutters management – data sources

- Activation of solar shading devices for each orientation (schedule of activation)
    1. Rule-based activation (e.g., incident solar irradiance on the window)
    2. Provided documentation
    3. Interviews with the users or the building energy manager
- Activation of external shutters (schedule of activation)
    1. Provided documentation
    2. Interviews with the users or the building energy manager
    3. Technical standard

Users information

Use of appliances – data sources

- Internal heat gains (from appliances) for each room, thermal zone, or whole building
    1. Calculated from number of appliances installed in the room
    2. Provided documentation
    3. Technical standard
- Use of appliances schedule for each room, thermal zone, or whole building
    1. Interviews with the users or the building energy manager
    2. Technical standard
    3. Assumed equal to occupancy schedule

Users information

Case study (entire building)

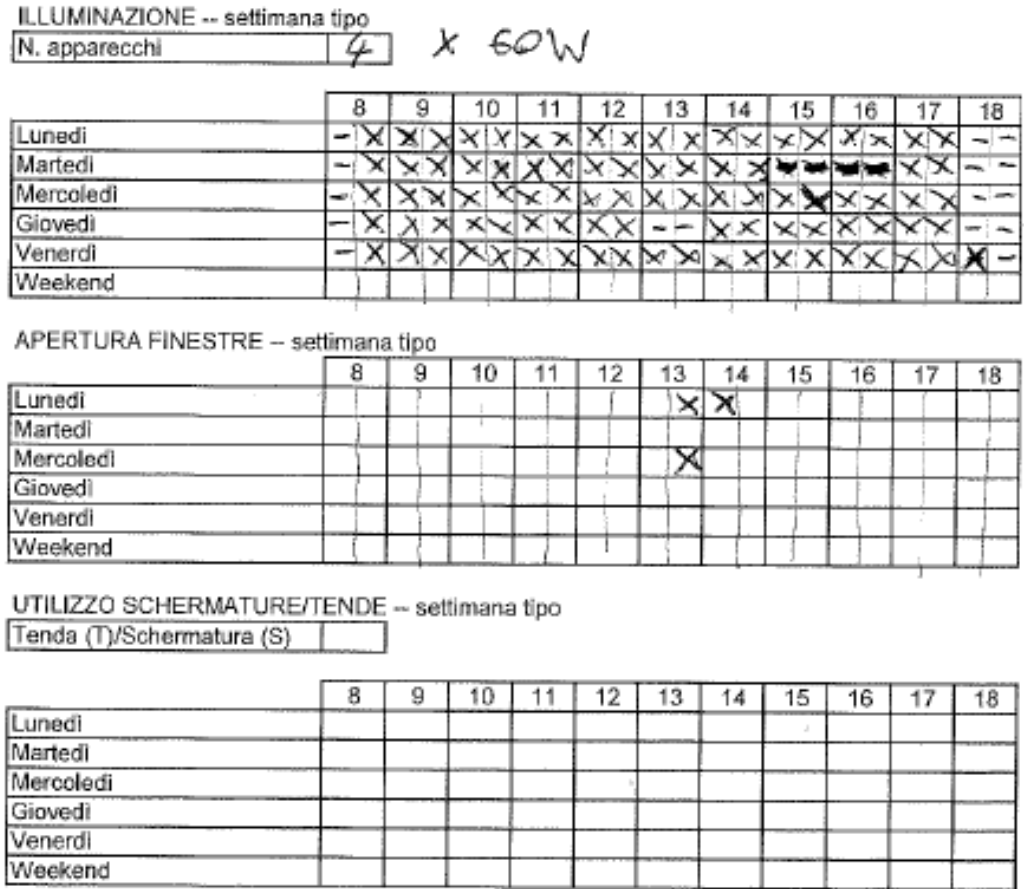
- Internal gains profile
- Specific gains
  - Occupants: 53 W/per
  - PC: 46 W/app
  - Monitor: 13 W/app
  - Lighting: 60 W/app
- Mechanical ventilation
  - 0,58 vol/h

Weekly monitoring sheet

ASHRAE Fundamentals «re-adapted» from calibration of a single office

Real feature and profile

Monitoring sheet



ILLUMINAZIONE -- settimana tipo

N. apparecchi: 4 x 60W

	8	9	10	11	12	13	14	15	16	17	18
Lunedì											
Martedì											
Mercoledì											
Giovedì											
Venerdì											
Weekend											

APERTURA FINESTRE -- settimana tipo

	8	9	10	11	12	13	14	15	16	17	18
Lunedì											
Martedì											
Mercoledì											
Giovedì											
Venerdì											
Weekend											

UTILIZZO SCHERMATURE/TENDE -- settimana tipo

Tenda (T)/Schermatura (S)

	8	9	10	11	12	13	14	15	16	17	18
Lunedì											
Martedì											
Mercoledì											
Giovedì											
Venerdì											
Weekend											

Users information

Case study (entire building)

Occupazione ed apporti interni (☐ utilizza profilo orario della zona)

Descrizione profilo orario

Categoria DPR 412/93: E.2 - Edifici adibiti a uffici e assimilabili.

Riferimento normativo

Apporti interni

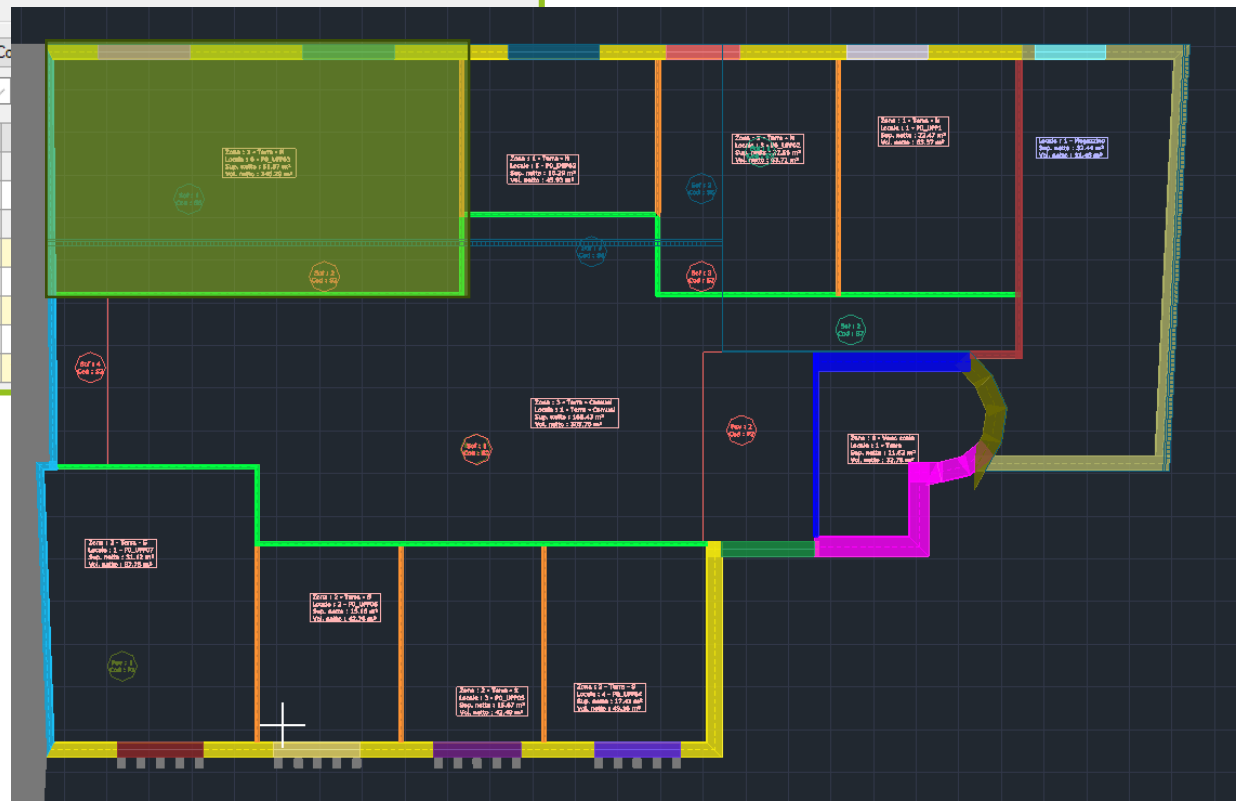
	Sensibili		Latenti	
Persone	6,50	W/m²	0,00	(g/h)/m²
Apparecchiature	9,50	W/m²	0,00	(g/h)/m²
Illuminazione	10,60	W/m²		

Profilo orario | Grafici

Copia su tutti i feriali | Copia su un periodo specifico | Nuovo periodo speciale | Duplica su periodo speciale | Elimina periodo speciale

Lunedì — Descrizione periodo: Lunedì — Periodo da 01/01/2020 a 31/12/2020

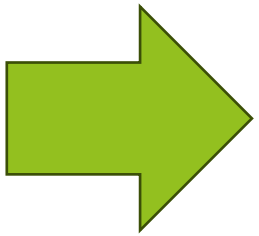
Ore del giorno	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
OCCUPAZIONE																
focc [-]	0,00	0,00	0,00	0,00	0,00	1,00	0,00	0,00	0,12	0,63	0,77	0,93	0,93	0,30	0,57	0,73
APPORTI INTERNI SENSIBILI																
ϕint,P [W/m²]	0,00	0,00	0,00	0,00	0,00	6,50	0,00	0,00	0,78	4,10	5,01	6,05	6,05	1,95	3,71	4,75
fint,A [-]	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,12	0,65	0,78	0,94	0,94	0,40	0,61	0,75
ϕint,A [W/m²]	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,14	6,18	7,41	8,93	8,93	3,80	5,80	7,13
fint,L [-]	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,50	1,00	1,00	1,00	1,00	1,00	1,00	1,00
ϕint,L [W/m²]	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,30	10,60	10,60	10,60	10,60	10,60	10,60	10,60



Users information

Case study (entire building)

- Internal gains profile
- Specific gains
  Occupants: 53 W/per
  PC: 46 W/app
  Monitor: 13 W/app
  Lightning : 60 W/app
- Mechanical ventilation
  0,58 vol/h



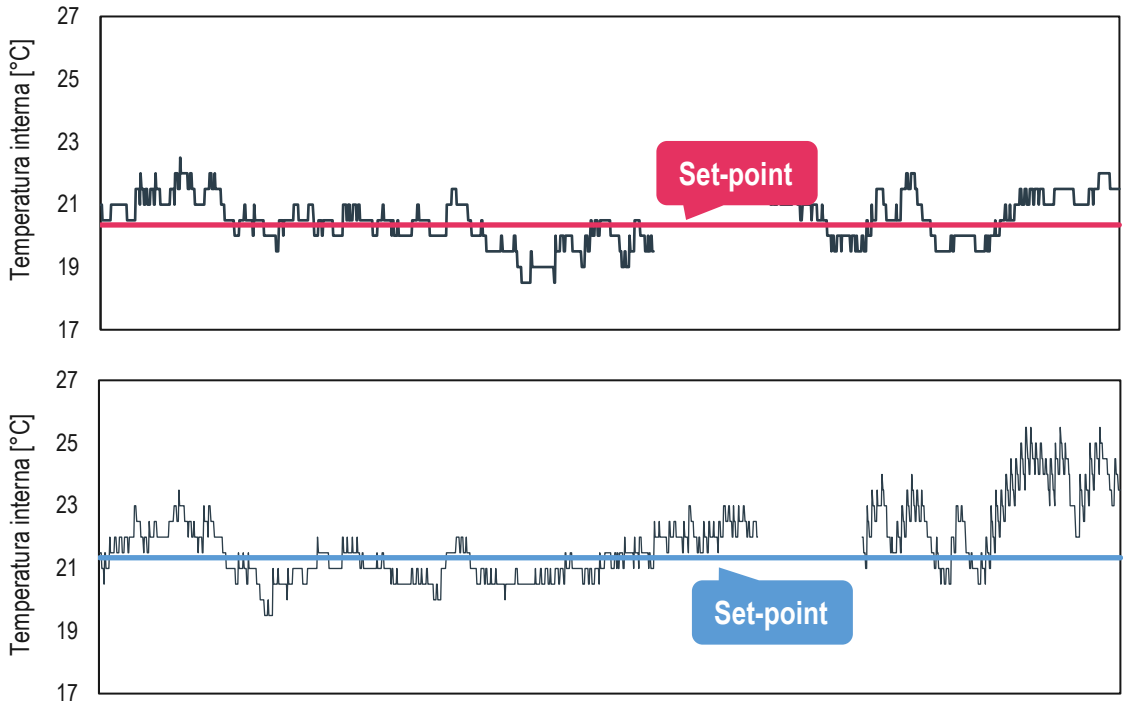
Creation of an internal gains profile for weekdays for:

- Occupants
- Device usage
  It is considered 1 PC and 1 monitor per occupant, considering a standby condition when occupants are in the office but not at their workstation (lunch break etc.)
- Artificial lightning usage
  It is considered that, even with only one occupant, the lightning system is on

Users information

Case study (entire building)

Set-point temperature evaluated based on internal temeperature monitoring (non occupancy hours) for each space



UFF01	20.3 °C
UFF02	21.1 °C
COM02	21.6 °C
UFF03	20.7 °C
UFF05	22.3 °C
UFF07	22.6 °C
UFF08	22.3 °C
UFF11	22.6 °C
UFF13	21.3 °C

Technical building systems (TBSs) characteristics

Required to define the typologies of TBSs available in the building and the specific properties of each sub-system

- Type of TBSs installed in the building
- Characteristics of the sub-systems for each TBS
- Operation time for each TBS

Technical building systems (TBSs) characteristics

Type of TBSs installed in the building - data sources

Generally, the required TBSs available in the building can be determined by

1. Inspection (visual analysis of the TBS components)
2. Building documentation (building plans, EPC, BIM, etc.)

The services can be divided in two macro-categories: the ones related to the hygrothermal control of the building (such as heating, cooling, domestic hot water, etc.) and the ones not related (e.g., lighting, people transport, etc.).

Technical building systems (TBSs) characteristics

Characteristics of the sub-systems for each TBS - data sources

Generally, the required TBS characteristics can be determined by

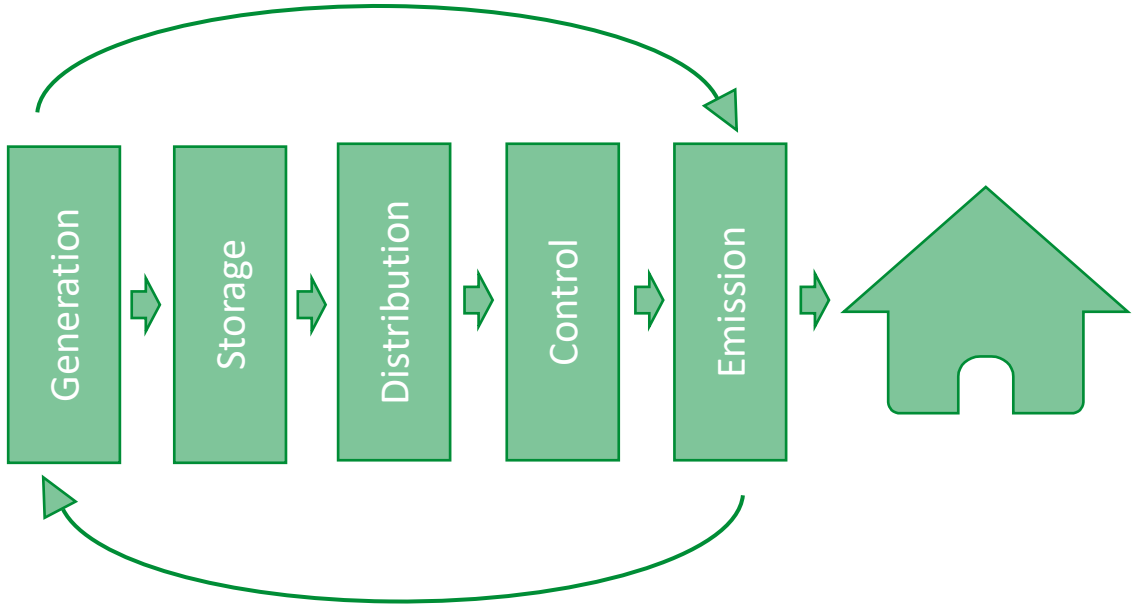
1. In field measurements (real data recorded on building site)
2. Inspection (visual analysis of the TBS components)
3. Building documentation (building plans, EPC, BIM, etc.)

In case the collected data only contains general information regarding the sub-system (such as the component name) the technician should obtain the technical sheets (e.g., through an internet research or asking directly to the producer)

Technical building systems (TBSs) characteristics

Characteristics of the sub-systems for each TBS - data collection procedure

- The analysis should be performd one TBS at time
- Starting from the generation sub-system and going to the emission one (or going in the other direction)
- Some TBS can have more than one sub-system per type
- Generation can be on-site, nearby, or off-site



Technical building systems (TBSs) characteristics

Operation time for each TBS - data sources

Generally, the required TBS operation time can be determined by

1. In field surveys (on the actual users)
2. Consumption analysis (e.g., on energetic bills)
3. International standards (EN 16798-1)

The TBS operation time should be collected, if possible, in a time-step format in accordance with the calculation procedure.

Technical building systems (TBSs) characteristics

Case study

Heating
The heating service is provided by a condensing boiler. The control system consists of thermostatic valves installed in each individual room and an external weather sensor that regulates the temperature of the heat transfer fluid. The distribution system is not insulated in compliance with current energy-saving regulations. The emission subsystem consists of radiators installed on insulated external walls.

Domestic Hot Water
Domestic hot water is produced by the same boiler that serves the heating system. Additionally, a thermal storage system is present.

Cooling
The cooling system consists of direct expansion heat pumps (split units) installed in each workspace.

Technical building systems (TBSs) characteristics

Case study

Ventilation system
The ventilation system is primary air and consists of an air handling unit installed in the technical room. The airflow supplied by the ventilation system is constant.

Lighting
The artificial lighting system consists of LED lamps. Switching on and off is manual in all areas.

Data centers

Picture of one of the two data centers

Technical building systems (TBSs) characteristics

Case study

Other

- People-moving system (elevator) that is used occasionally and therefore will not be analyzed within the data collection phase.
- Ventilation of data centers
- Central vacuum system
- Automatic gate
- Outdoor lighting

Technical building systems (TBSs) characteristics

Case study

Picture of the generator for heating and DHW production

Generation system for heating and DHW production

- Generation type: condensing gas boiler, installed in the boiler room
- Characteristics
  - Installed power 34,4 kW
  - Outside temperature compensated control
- Operation time
  - 24/24 h

Plant design
In field measurement

Technical building systems (TBSs) characteristics

Case study

Storage system for DHW

- Type: installed in the boiler room
- Characteristics
  - Volume
  - Thermal insulation level
- Operation time
  - 24/24 h
  - Recharging when the water temperature is lower than the set point temperature (45°C)

Plant design
In field measurement
Interview

Picture of the storage system fo DHW production

Technical building systems (TBSs) characteristics

Case study

Distribution sub system for heating and DHW production

- Characteristics
  - Distribution system with an insulation level below the actual standard
  - Lenght
- Circulation pump
  - Variable speed pump control

Plant design
In field measurement
Interview

Picture of the distribution pumps

Main features of hydronic piping

Tubazioni principali
I tronchetti ed i montanti saranno realizzati con tubazioni in acciaio aventi i seguenti diametri e quantità:
- tubazione da ¾" lunghezza 16 m;
- tubazione da 1" lunghezza 108 m;
- tubazione da 1 ¼" lunghezza 61 m;
- tubazione da 1 ½" lunghezza 33 m.

Per l'isolamento delle tubazioni in acciaio prevedere ARMAFLEX AC nei seguenti spessori:
- tubazione da ¾" IS 13 mm
- tubazione da 1" IS 13 mm
- tubazione da 1 ¼" IS 13 mm
- tubazione da 1 ½" IS 13 mm

Collettori
Sono previste 5 zone con i relativi collettori tipo xxxx della ditta xxxx.
Il tipo di collettore da utilizzare è il seguente:
- n. 1 collettore ∅ 1 ¼" 4 derivati;
- n. 2 collettori ∅ 1 ¼" 5 derivati;
- n. 1 collettore ∅ 1 ¼" 7 derivati;
- n. 1 collettore ∅ 1 ¼" 9 derivati;

Technical building systems (TBSs) characteristics

Case study

Emission sub system for heating

- Type: radiators installed adjacent insulated walls

Plant design
In field measurement

List of radiators with the main characteristics

N° Locale	Piano	Pot. Term. nominale (W)	Tipo	N. elemen t	Ø Valv. det.	Ø Tub.	Tipo Valvola
1	TERRA	1848	3/790	14	½"	14X1	Termostatica
2	TERRA	1188	3/790	9	½"	14X1	Termostatica
3	TERRA	1188	3/790	9	½"	14X1	Termostatica
4	TERRA	2112	3/790	16	½"	14X1	Termostatica
5	TERRA	642	2/871	6	½"	14X1	Termostatica
6 a	TERRA	2508	3/790	19	½"	14X1	Termostatica
6 b	TERRA	2508	3/790	19	½"	14X1	Termostatica
7	TERRA	1848	3/790	14	½"	14X1	Termostatica
8	TERRA	1980	3/790	15	½"	14X1	Termostatica
9	TERRA	2508	3/790	19	½"	14X1	Termostatica
10 a	TERRA	2376	3/790	18	½"	14X1	Termostatica
10 b	TERRA	2366	4/871	13	½"	14X1	Termostatica
11	TERRA	1452	3/790	11	½"	14X1	Termostatica
12	TERRA	1740	3/871	12	½"	14X1	Termostatica
13	TERRA	749	2/871	7	½"	14X1	Termostatica
14	TERRA	749	2/871	7	½"	14X1	Termostatica
15	PRIMO	2508	3/681	22	½"	14X1	Termostatica
16	PRIMO	870	4/681	6	½"	14X1	Termostatica
17	PRIMO	870	4/681	6	½"	14X1	Termostatica
18	PRIMO	1254	3/681	11	½"	14X1	Termostatica
19	PRIMO	1740	4/681	12	½"	14X1	Termostatica
20	PRIMO	1140	3/681	10	½"	14X1	Termostatica
21	PRIMO	2166	3/681	19	½"	14X1	Termostatica
22	PRIMO	3276	4/871	18	½"	14X1	Termostatica
23	PRIMO	1284	2/871	12	½"	14X1	Termostatica
24 a	SECONDO	1740	3/871	12	½"	14X1	Termostatica
24 b	SECONDO	1740	3/871	12	½"	14X1	Termostatica
24 c	SECONDO	1740	3/871	12	½"	14X1	Termostatica
24 d	SECONDO	1740	3/871	12	½"	14X1	Termostatica
25	SECONDO	856	2/871	8	½"	14X1	Termostatica

Technical building systems (TBSs) characteristics

Case study

Cooling system

- Type: split systems

Plant design
In field measurement

List of split units with the main characteristics

N° Locale	Piano	Pot. frigorifera totale (compresa a primaria)	Unità interna	Mandata diametro tubo e spessore isolamento	Ritorno diametro tubo gas e spessore isolamento	Diametro tubo e cavi elettrici	Diametro scarico condensa	Unità esterna collegata
1	TERRA	1788	FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	MA 90 CJV1
2	TERRA	1702	FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
3	TERRA	1702	FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
4	TERRA	2467	FT 35 G	Ø 6,4 mm IS = 10 mm	Ø 12,7 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
xxx	TERRA	---	FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 12,7 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
6 a	TERRA	3348/2	* FT 253	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	* MA 28 CV1
6 b	TERRA	3348/2	* FT 253	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
8	TERRA	1266	FT 18 G (o ft 25)	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	* MA 45 CV1 - b
9	TERRA	1385	FT 18 G (o ft 25)	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
11	TERRA	1502	FT 18 G (o ft 25)	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
15	PRIMO	1678	* FT 253	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	* MA 56 D7 V1 - a
18	PRIMO	1221	* FT 253	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
19	PRIMO	1401	* FT 253	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
20	PRIMO	1021	FT 18 G (o ft 25)	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	* MA 45 CV1 - a
21	PRIMO	1760	FT 18 G (o ft 25)	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
22	PRIMO	3338	* FH 35 FJ	Ø 6,4 mm IS = 10 mm	Ø 12,7 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
24 a	SEC.		FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	MA 56 D7 V1 - b
24 b	SEC.		FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
24 c	SEC.		FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	
24 d	SEC.		FT 25 G	Ø 6,4 mm IS = 10 mm	Ø 9,8 mm IS = 10 mm	Ø 20 mm 4x1,5 (3+T)	DN 20	

Technical building systems (TBSs) characteristics

Case study

Ventilation system

- Type: primary air ventilation system

Air Handling Unit (AHU) composed by

- filter, heating coil (10 kW capacity), variable speed fan, cooling coil (6.8 kW capacity)

Distribution

supply and exhaust ducts as per the project

Emission

16 ceiling diffusers and 7 wall diffusers

Regulation

Clock control

Plant design
In field measurement

Technical building systems (TBSs) characteristics

Case study

Lighting system

- Type of lamps: LED
- Type of regulation: manual on/off

Plant design
In field measurement

Luci	Potenza (W)	Utilizzo	Potenza (W)
Analisti	288	100%	288
Fabio	72	75%	54
Programmatori	288	70%	201,6
Ingrasso	144	100%	144
Corridoio	36	50%	18
Marketing	144	75%	108
Andrea	144	100%	144
Paola	144	75%	108
Commerciale	219	100%	219
Bagni	72	10%	7,2
Sala riunioni	144	20%	28,8
Amministrazione	144	35%	50,4
Donatella	144	25%	36
Corridoio	105	25%	26,25
Anna	144	50%	72
Bagni	36	10%	3,6
Mansarda	180	20%	36
TOT	**2.448**		**1.545**

Energy consumption

Required to define the actual building consumption in the calibration perspective

- Energy consumption for each energy carrier and energy service

Energy consumption

Energy consumption for each energy carrier and energy service - data sources

Generally, the energy consumption can be determined by

1. Meters readings (e.g., planned readings, maintenance reports, inspection reports, log-books and BACS records, etc.)
2. Invoice analysis
3. Other delivered energy estimation techniques

If the source is an invoice or delivery note, one shall verify the date of the reading or delivery, which may be different from date of the invoice, and that the invoice is based on an actual reading and not on a forecast.

Due to the purpose of this collection, the estimation techniques should be avoided.

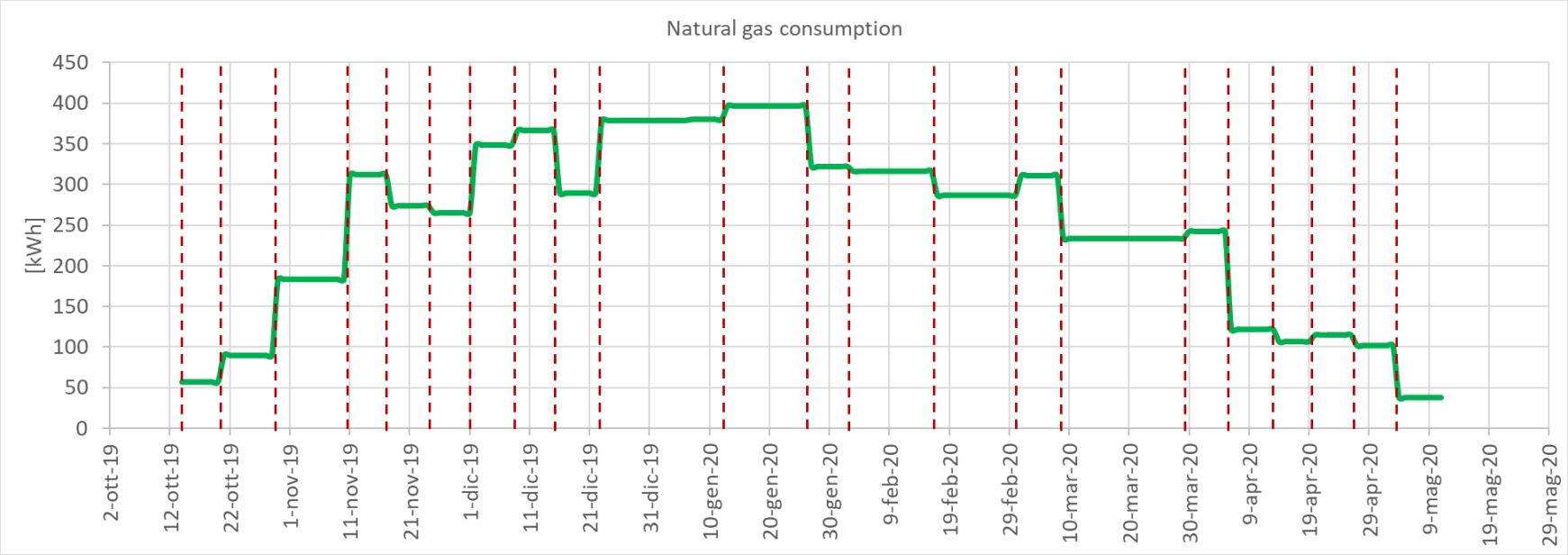
Energy consumption

Case study

Natural gas:

- Heating
- Domestic Hot Water Production

} Monitoring campaign



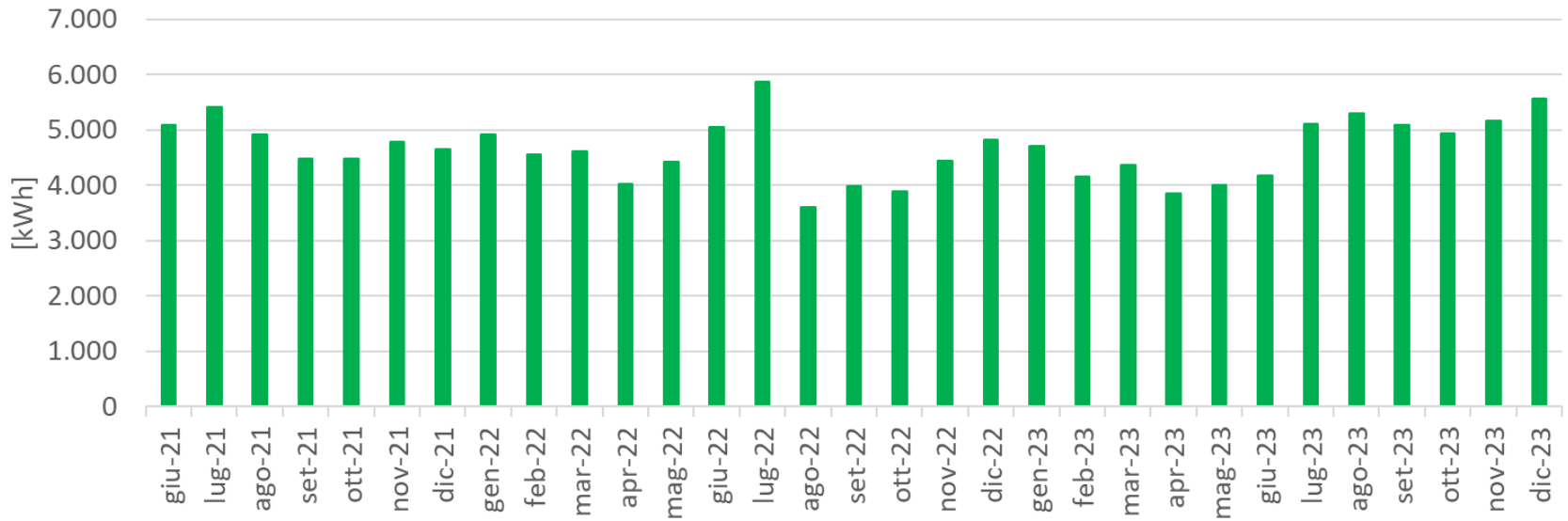
Energy consumption

Case study

Electricity:

- Data center (+ cooling data center)
- Data center cooling
- Ventilation
- Lighting
- PC
- Heating

} Bills



Data for SRI evaluation

Type of domains and impacts' categories

- Heating
- Domestic Hot Water
- Cooling
- Ventilation
- Lighting
- Dynamic building envelope
- Electricity
- Electric vehicle charging

Interview with the building expert

- Energy efficiency
- Energy flexibility and storage
- Comfort
- Convenience
- Health, well-being and accessibility
- Maintenance and fault prediction
- Information to occupants

Collection of data for SRI evaluation

Type of domains - data sources

- ✓ **Heating**
- ✓ Domestic Hot Water
- ✓ Cooling
- ✓ Ventilation
- ✓ Lighting
- ✓ Dynamic building envelope
- ✓ Electricity
- Electric vehicle charging

Collection of data for SRI evaluation

Type of domains - data sources

Heating	App	Functionality level 0	Functionality level 1	Functionality level 2	Functionality level 3	Functionality level 4
Heat emission control	1	No automatic control	Central automatic control	**Individual room control**	Individual room control with communication between controllers and BACS	Individual room control with communication and occupancy detection
Emission control for TABS	0					
Control of distribution fluid temperature	1	No automatic control	**Outside temperature compensated control**	Demand based control		
Control of distribution pumps in network	1	No automatic control	On/off control	Multi-stage control	**Variable speed pump control**	Variable speed pump control (external demand signal)
Thermal energy storage	0					

Collection of data for SRI evaluation

Heating	App	Functionality level 0	Functionality level 1	Functionality level 2	Functionality level 3	Functionality level 4
Heat generator control (all except heat pump)	1	Constant temperature control	**Variable temperature control depending on outdoor temperature**	Variable temperature control depending on the load		
Heat generator control (for heat pumps)	0					
Sequencing in case of different heat generator	0					
Report information regarding heating system performance	1	None	Central or remote reporting of current performance KPIs	**Central or remote reporting of current KPIs and historical data**	Central or remote reporting of performance evaluation including forecasting and/or benchmarking	Central or remote reporting of performance evaluation including forecasting and/or benchmarking. Also including predictive maintenance and fault detection
Flexibility and grid interaction	1	No automatic control	**Scheduled operation of heating system**	Self-learning optimal control of heating system	Heating system capable of flexible control through grid signals	Optimised control of heating system based on local predictions and grid signals

Tips and tricks for collecting data

For a comprehensive evaluation of the building, the data collection phase is very delicate. Here are some tips to optimize data collection for a holistic assessment of the building:

- Talk to the right people
- Prepare a checklist of data
- Gather building documents and store them appropriately
- Archive building documents in dedicated folders, paying attention to document coding

To conclude

A detailed data collection, combined with a subsequent phase of data archiving and processing, serves as a solid foundation to build a robust baseline for:

- Renovation activities (especially in view of a building renovation roadmap)
- Plans for ordinary and extraordinary maintenance
- Any re-commissioning activities
- others

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If you would like more information, please visit www.timepac.eu or contact us at

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Thanks for your attention!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033819