INTEGRATED SOLUTIONS FOR ENERGY RETROFIT

Convegno KlimaKit – Fiera Klimahouse, 24 Gennaio 2019

Annamaria Belleri, Chiara Dipasquale, Jennifer Adami
Eurac Research

Principale partner associato del progetto

CONTEXT

1%
Building renovation rate in South Tyrol

70%
of local building stock was built before 1976

Buildings are responsible for the 40% of energy consumption

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Barriers to energy retrofit

KlimaKit proposed solutions

Organizational barriers: multi-property buildings → KlimaKit analysis tool to support building manager and the **participative process** in decision making

Technical barriers: missing tools to evaluate retrofit intervention cost-benefit → systemic approach to evaluate interactions among energy measures through **building energy simulations**

Financial barriers: risk assessment, user behavior impact → post-retrofit **monitoring** and user impact assessment

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KLIMAKIT ANALYSIS TOOL: DATABASE

Building features

- Typology
- Climate zone
- Floor number
- Apartment number
- Pre-retrofit envelope efficiency
- Roof type

Building geometry

- Net condit… area
- Heat transfer surfaces
- Volume
- WWR
- S/V
- Available surface for PV

Pre-retrofit

- Envelope efficiency pre-retrofit
  - •Uvalue of components
  - •Air tightness
  - •Heating need
- DHW/space heating
  - •Type
  - •Capacity
  - •Generation system
  - •Distribution system

Post-retrofit

- Klimakit retrofit packag…
- Envelope performance level
- Heating need
- Thermal and electricity consumption
- Energy production
- Thermal comfort
- Operative costs
- Equivalent CO2 emissions

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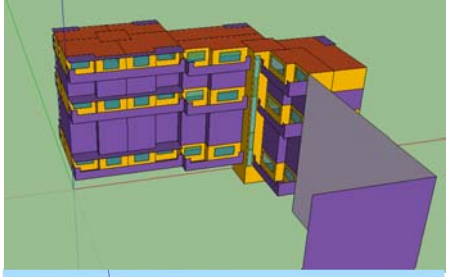
REFERENCE BUILDINGS

ID	Typology	Climate zone	Heating Degrees	Construction period	Apartment nr
1	Small multifamily house	E	2894	1976-91	8
2	Big multifamily house	E	2894	1976-91	24
3	Small multifamily house	E	2894	1946-75	6
4	Small multifamily house	E	2921	1976-91	16
5	Small multifamily house	F	3223	1976-91	10

1

2



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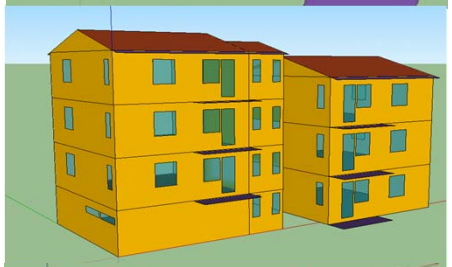

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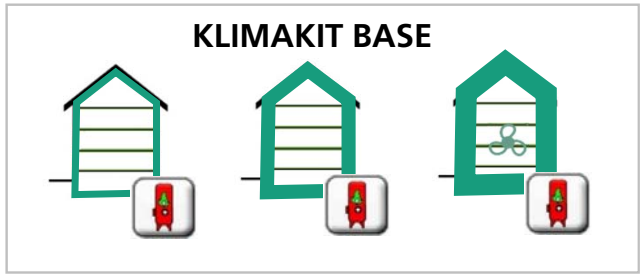
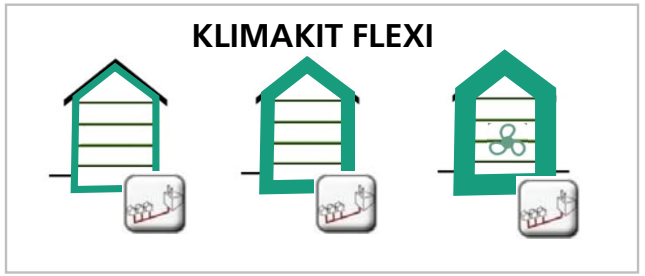
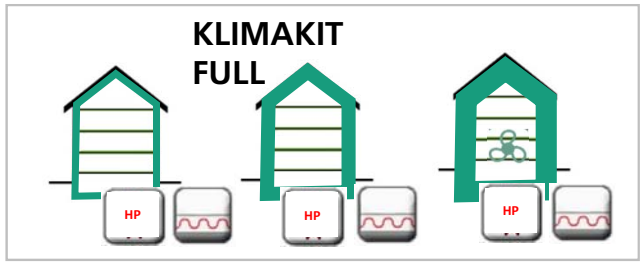
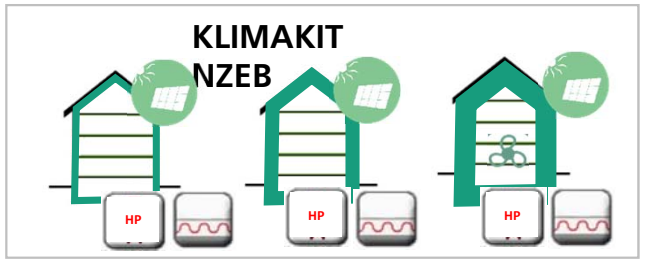
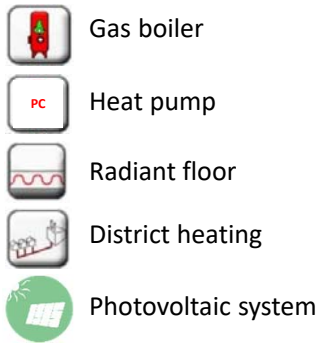
RETROFIT PACKAGES











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Technical requirements for envelope retrofit

Level 1: comply with minimum requirements of national and local regulation for buildings undergoing retrofit intervention;

Level 2: comply with minimum requirements of national and local regulation to access for incentives;

Level 3: have performance that allow to reach the target of nearly zero energy. In this case mechanical ventilation is installed to keep acceptable IAQ levels.

Uwall [W/m²K]	Uroof [W/m²K]	Ufloor [W/m²K]	Uwindow [W/m²K]	Air tightness [n50]	Mech. Vent. with HR
≤ 0.33	≤ 0.29	≤ 0.32	≤ 2.20 (double glazing)	3 (CasaClima R)	-
≤ 0.22	≤ 0.19	≤ 0.23	≤ 1.30 (double glazing)	1.5 (CasaClima A e B)	-
≤ 0.15	≤ 0.15	≤ 0.20	≤ 1.00 (triple glazing)	0.6 (CasaClima Gold)	0.6 vol/h HR 70%

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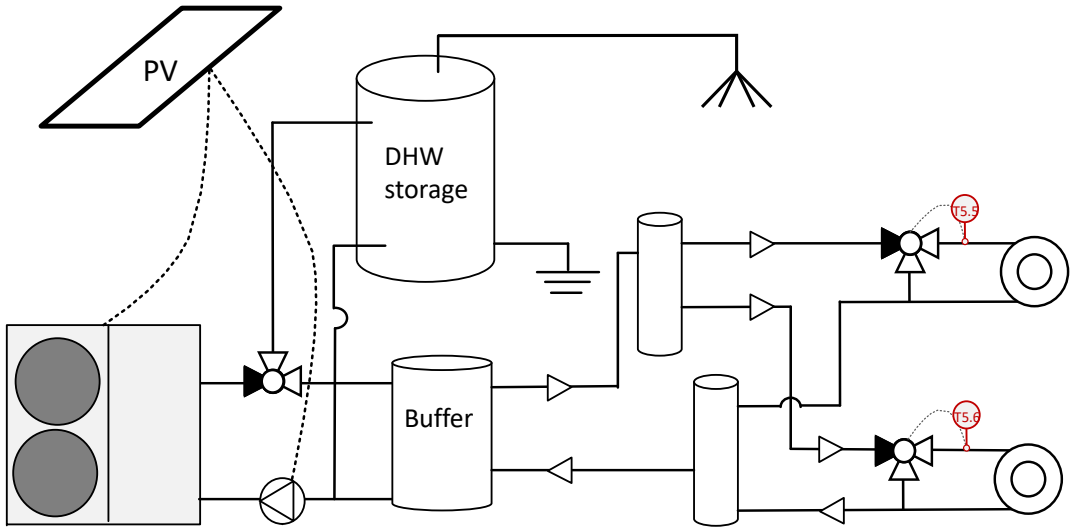
HEATING AND DOMESTIC HOT WATER (DHW) SYSTEM MODEL



Space heating set temperature	20 ±0.5 °C
Supply DHW temperature	45 °C
Supply temperature to radiators	45 °C
Supply temperature to radiant panels	35 °C

	System efficiency
Pre-retrofit generation system (gas boiler)	0.8
Condensation gas boiler	0.9
District heating	0.95

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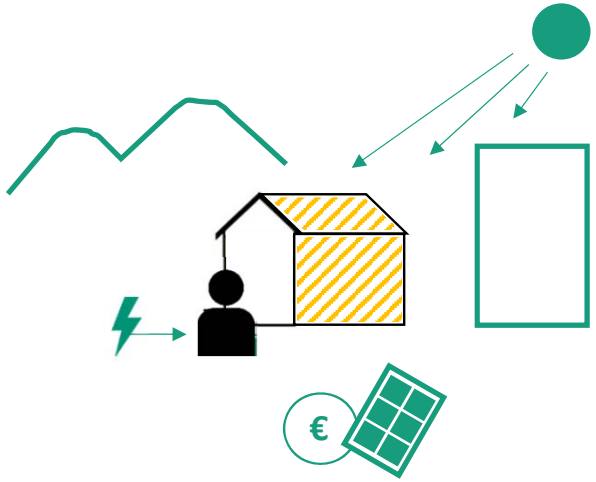
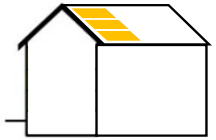
PHOTOVOLTAIC SYSTEM OPTIMIZATION

- 3D model
- Available surfaces for PV installation
- Solar radiation (climate conditions, shadings)
- Electricity demand (hourly)
- Tecno-economical inputs (cost variance, PV degradation)



PV modules position and capacity



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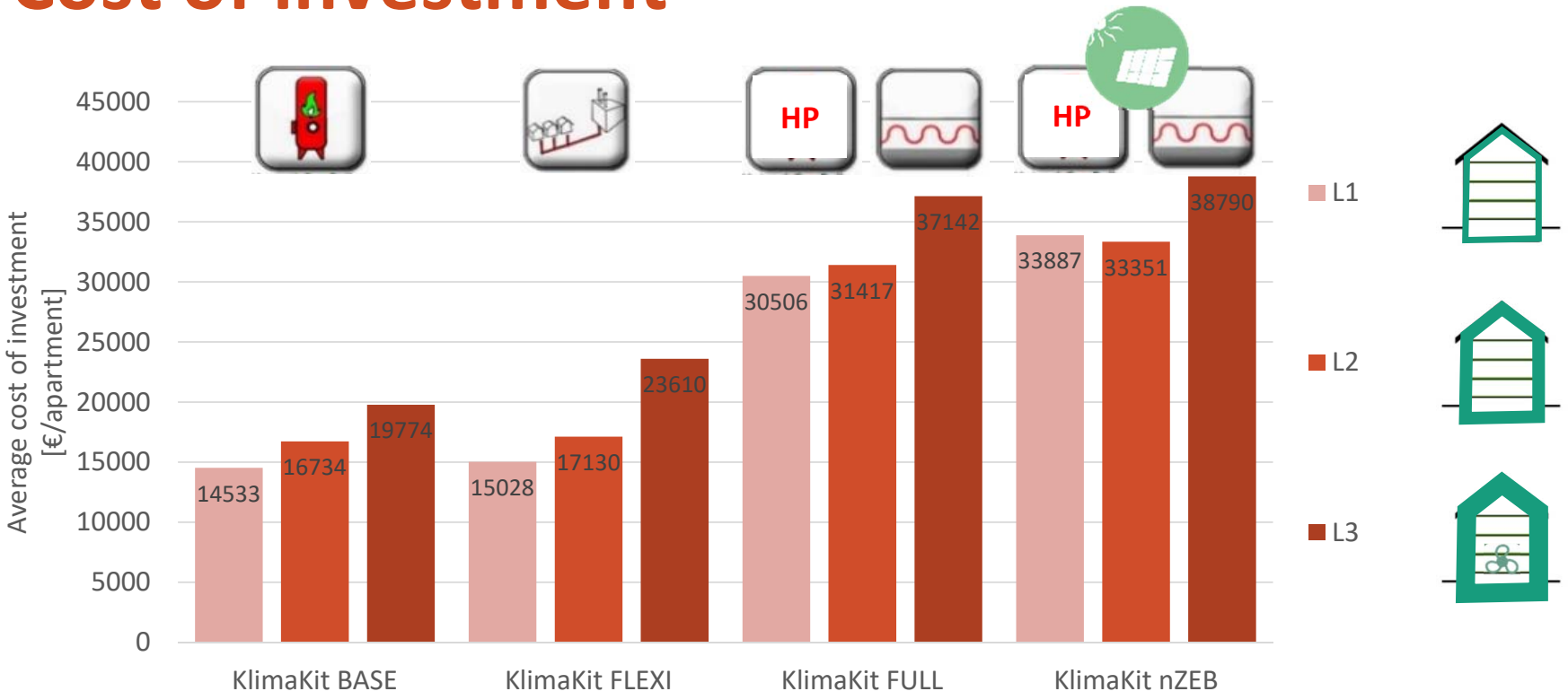
Cost of investment



Average cost of investment for retrofit solutions over reference buildings

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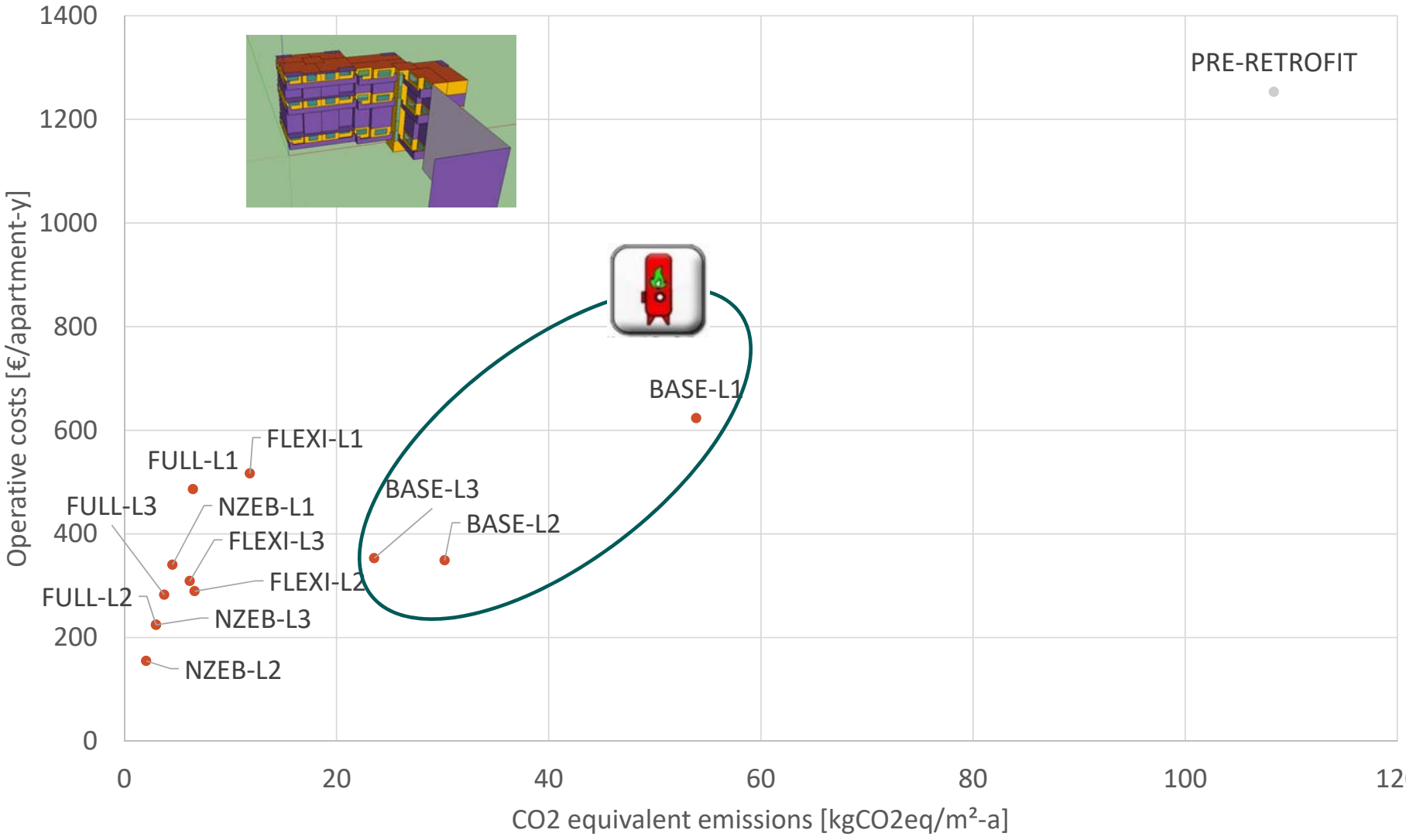
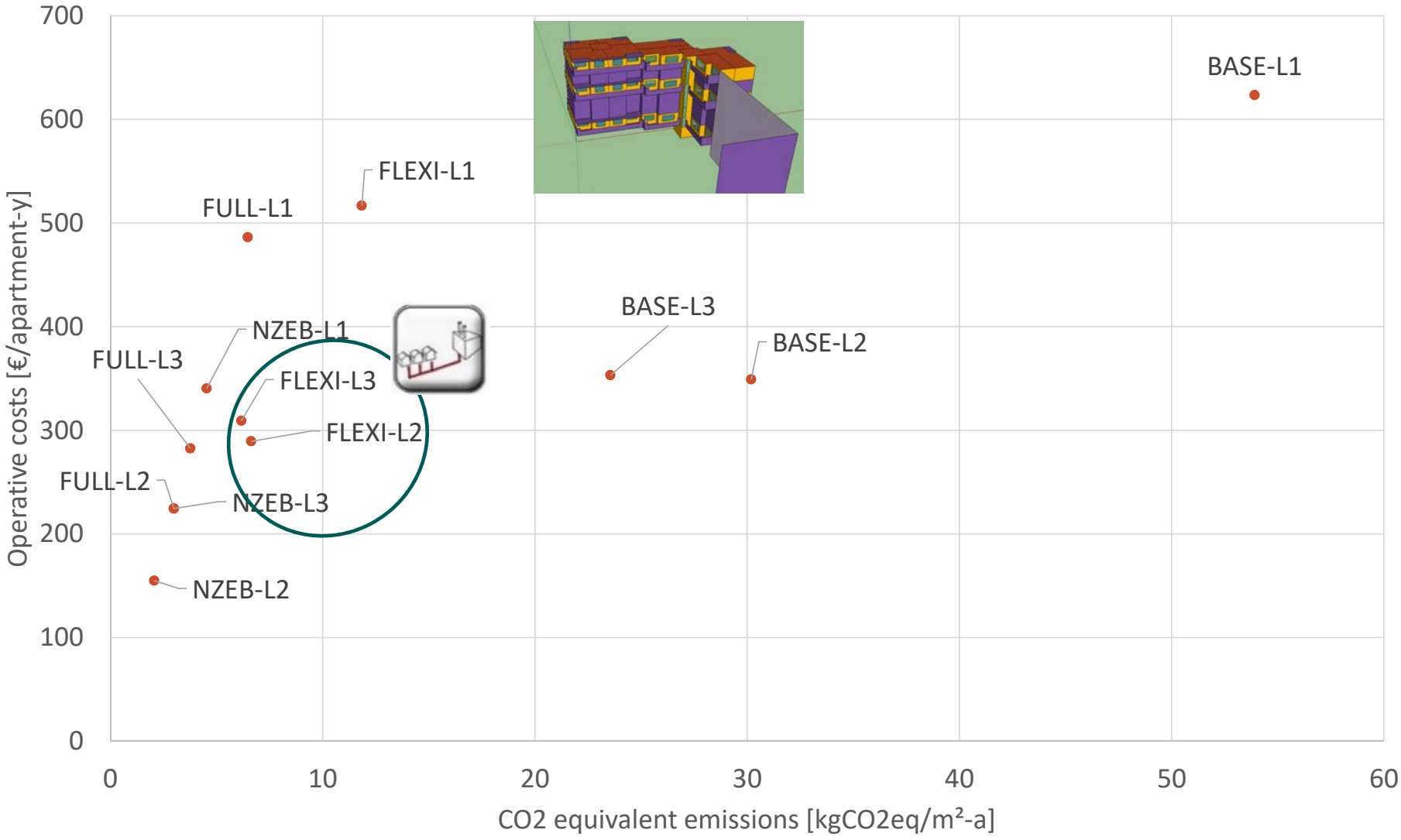
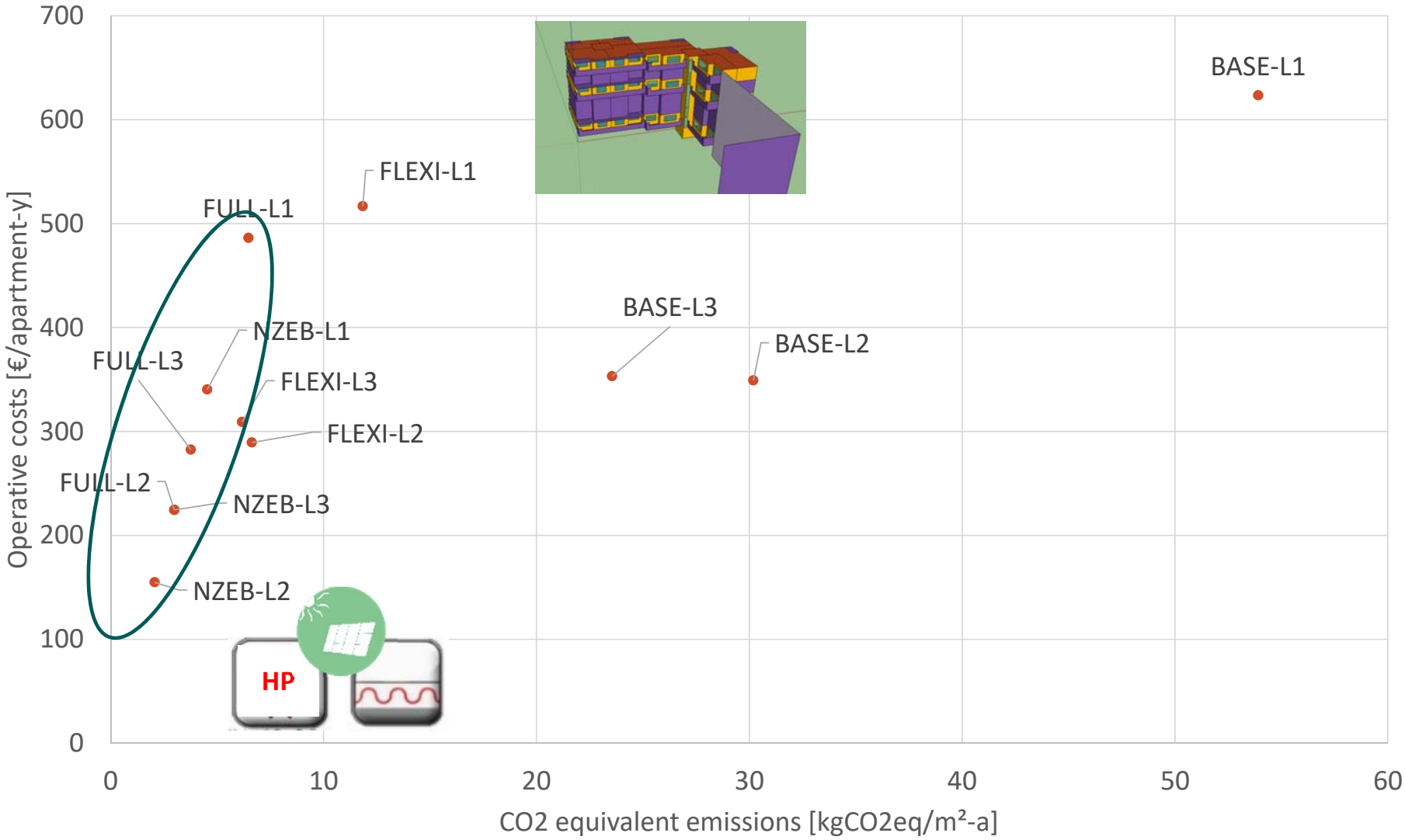
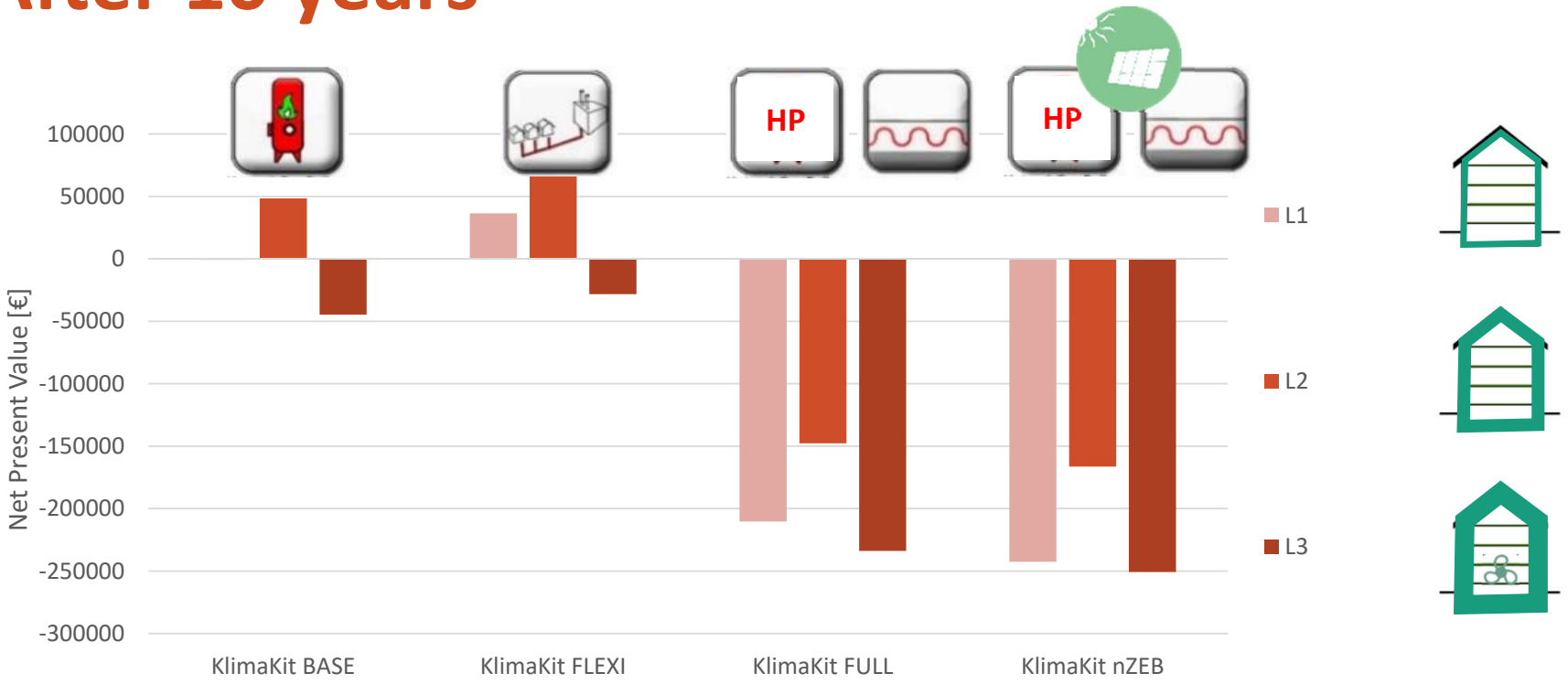

1400
1200
1000
800
600
400
200
0
Operative costs [€/apartment-y]
0
20
40
60
80
100
120
CO2 equivalent emissions [kgCO2eq/m²-a]
PRE-RETROFIT
BASE-L1
BASE-L2
BASE-L3
FLEXI-L1
FULL-L1
FULL-L3
NZEB-L1
FLEXI-L3
FLEXI-L2
FULL-L2
NZEB-L3
NZEB-L2


700
600
500
400
300
200
100
0
Operative costs [€/apartment-y]
0
10
20
30
40
50
60
CO2 equivalent emissions [kgCO2eq/m²-a]
BASE-L1
FLEXI-L1
FULL-L1
BASE-L3
BASE-L2
NZEB-L1
FULL-L3
FLEXI-L3
FLEXI-L2
FULL-L2
NZEB-L3
NZEB-L2


700
600
500
400
300
200
100
0
Operative costs [€/apartment-y]
0
10
20
30
40
50
60
CO2 equivalent emissions [kgCO2eq/m²-a]
BASE-L1
FLEXI-L1
FULL-L1
BASE-L3
BASE-L2
NZEB-L1
FULL-L3
FLEXI-L3
FLEXI-L2
FULL-L2
NZEB-L3
NZEB-L2
HP

After 10 years



Net Present Value of retrofit intervention after 10 years

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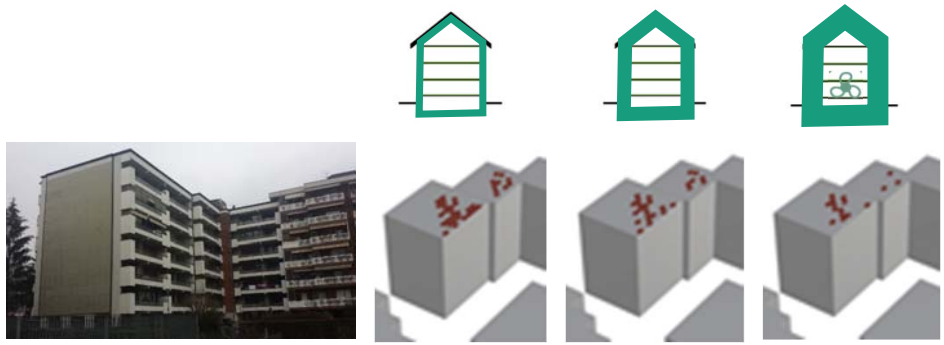
Optimized PV



PV capacity (kWp)	4	3.4	2.6
El. loads coverage (%)	30	31	31

PV capacity (kWp)	35	21.3	18
El. loads coverage (%)	27	28	29

PV capacity (kWp)	13.3	7.8	6.6
El. loads coverage (%)	28	30	31

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Barriers to energy retrofit		KlimaKit proposed solutions
Organizational barriers: multi-property buildings	→	KlimaKit analysis tool to support building manager and the **participative process** in decision making
Technical barriers: missing tools to evaluate retrofit intervention cost-benefit	→	systemic approach to evaluate interactions among energy measures through **building energy simulations**
Financial barriers: risk assessment, user behavior impact	→	post-retrofit **monitoring** and user impact assessment

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KlimaKit monitoring system: showing the way with data

User behaviour can:

- have same impact of retrofit passive solutions (es. heating setpoint)
- mitigate or nullify positive impact of passive solutions (es. window opening)

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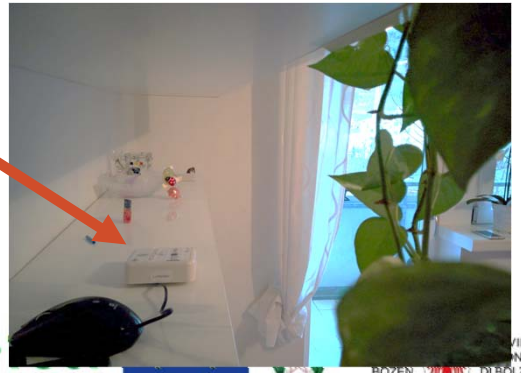

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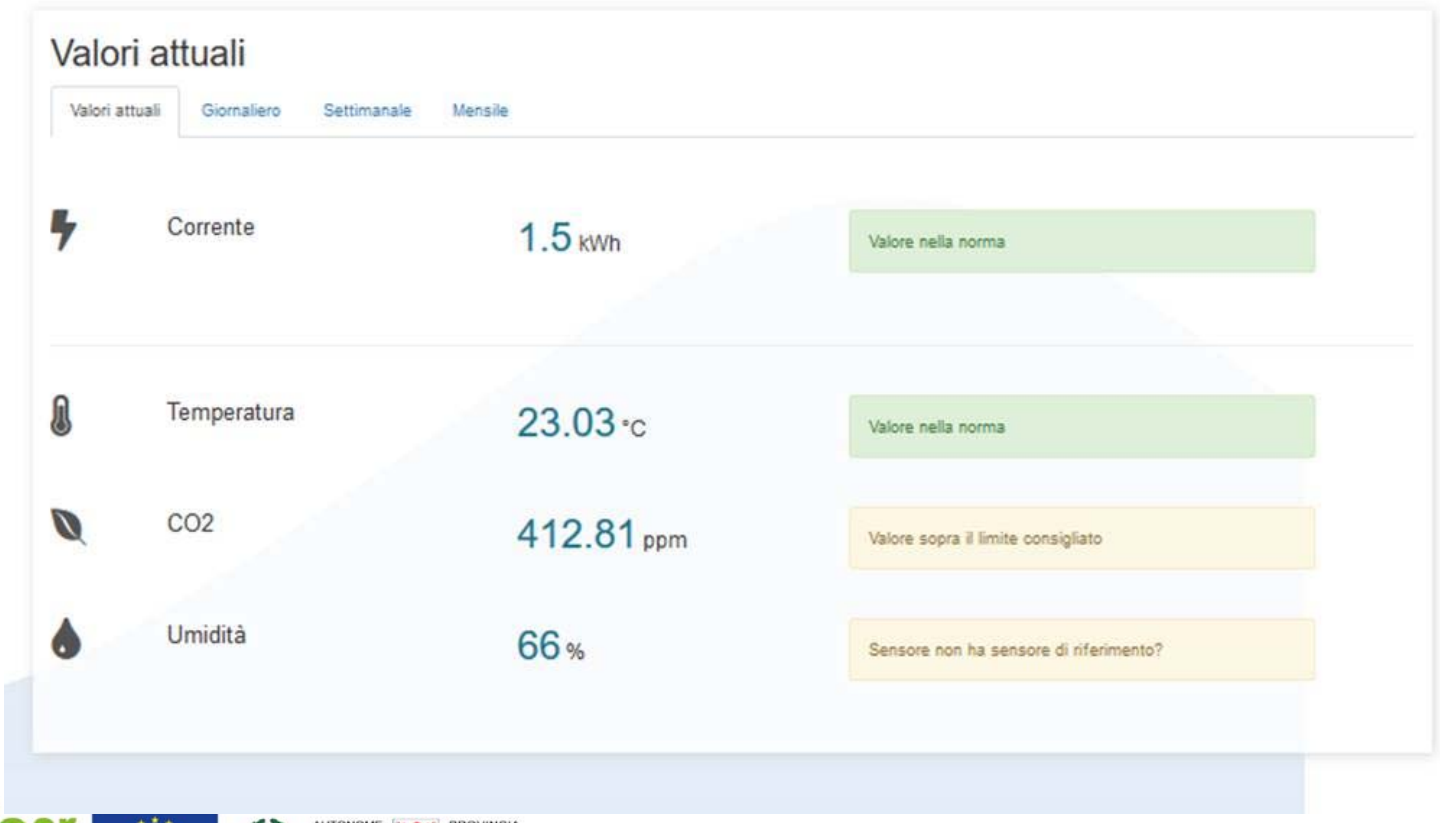
User web interface



To guide and stimulate users

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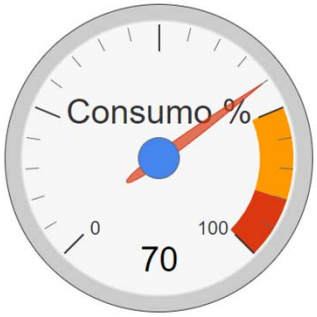
Energy consumption target

Consumo corrente elettrica mese in corso

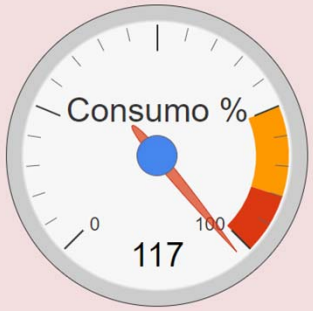


Obiettivo mensile: 100 kWh

70 kWh consumati

30 kWh residui

Consumo corrente elettrica mese in corso



Obiettivo mensile: 100 kWh

117 kW consumati

Attenzione:
obiettivo superato di 17 kWh

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CONTACT US

annamaria.belleri@eurac.edu

Eurac Research
Drususallee/Viale Druso 1
39100 Bozen/Bolzano
T +39 0471 055 055
info@eurac.edu
www.eurac.edu

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Drivers for HVAC replacement

	GENERATION SYSTEMS					DISTRIBUTION SYSTEMS		
Technical requirements	DISTRICT HEATING	GAS BOILER	BIOMASS BOILER	AIR TO WATER HEAT PUMP	WATER TO WATER HEAT PUMP	FAN COILS	RADIATORS	RADIANT PANELS
District heating grid	■							
Gas grid		■						
Small technical room		■		■	■			
Technical room		■	■					
Ground digging authorization					■			
Cold external temperatures (<-5°C)		■	■					
Mild external temperatures (>- 5°C)		■	■	■	■			
Occupied dwellings		■	■	■	■	■	■	
Empty dwellings		■	■	■	■	■	■	■
High peak load for space heating		■	■			■	■	
Low peak load for space heating				■	■	■	■	■
Air dehumidification				■	■	■		

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OUTPUT

	Cost	Conversion factor
gas	0.08 €/kWh	0.249 kg/kWh
elettricita'	0.2 €/kWh	0.647
teleriscaldamento	0.07 €/kWh	0.15

Fonte fattori di conversione: http://lexbrowser.provinz.bz.it/all/all.ashx?path=Allegato%203%20-%20167405.pdf&mimetype=application/pdf

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