TIMEPAC Academy

In-class training

Utilizzo degli APE per la pianificazione energetica locale, regionale e nazionale

29 maggio 2024
Politecnico di Torino

Politecnico di Torino 1859

EDILCLIMA ENGINEERING & SOFTWARE

REGIONE PIEMONTE

TIMEPAC Academy

Analisi statistica per la generazione di edifici rappresentativi (archetipi)

Matteo Piro
Politecnico di Torino

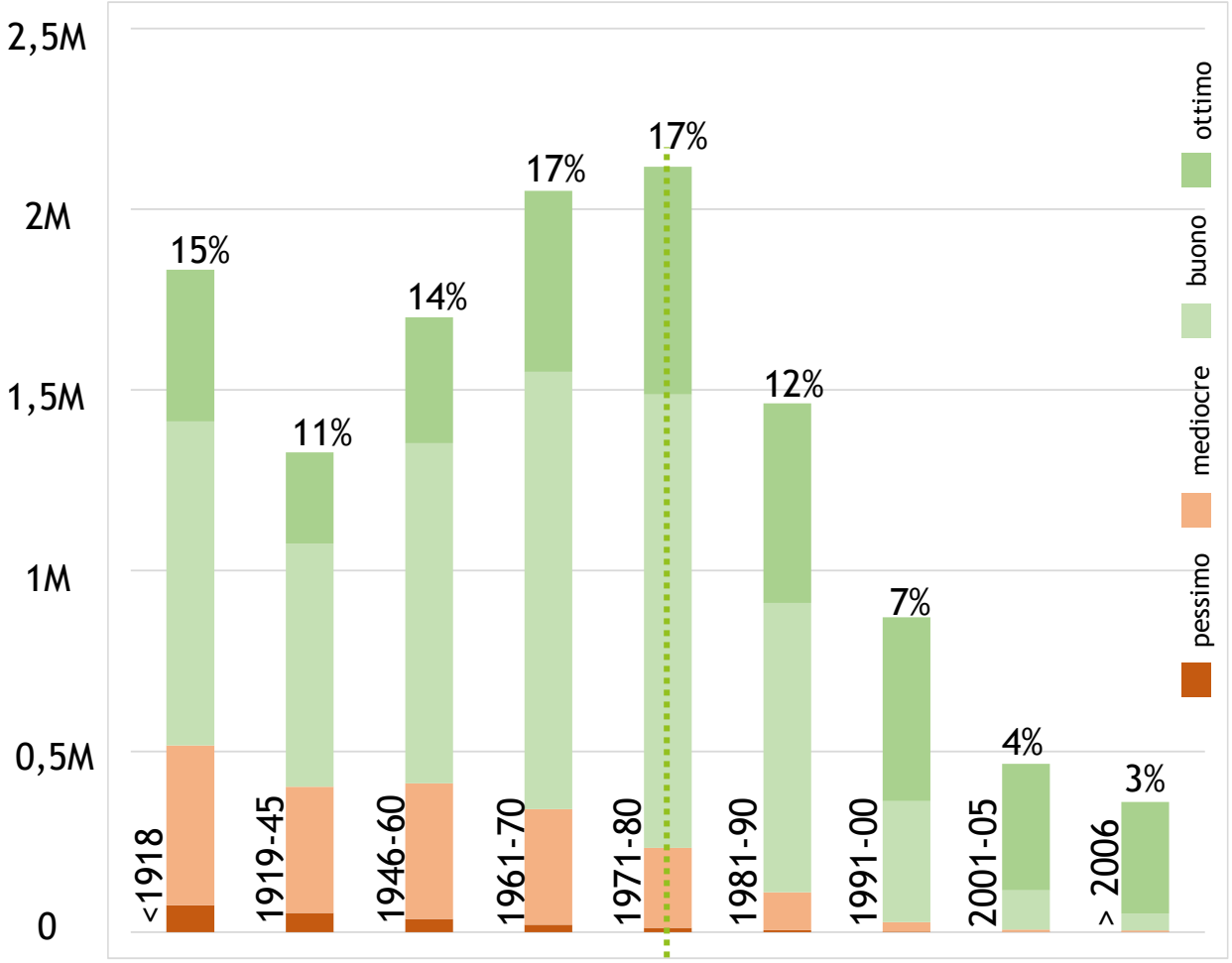
Politecnico di Torino 1859

EDILCLIMA ENGINEERING & SOFTWARE

REGIONE PIEMONTE

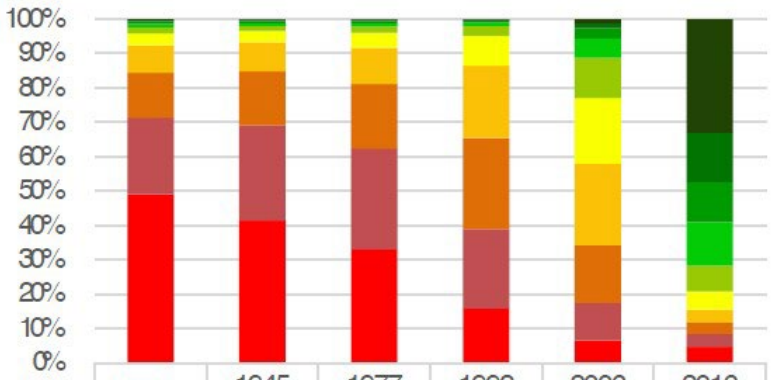
Prestazione energetica patrimonio edilizio italiano

EDIFICI RESIDENZIALI
Stato di conservazione per epoca di costruzione (ISTAT, 2011)



Legge 373/76

Prestazione energetica edifici per epoca di costruzione

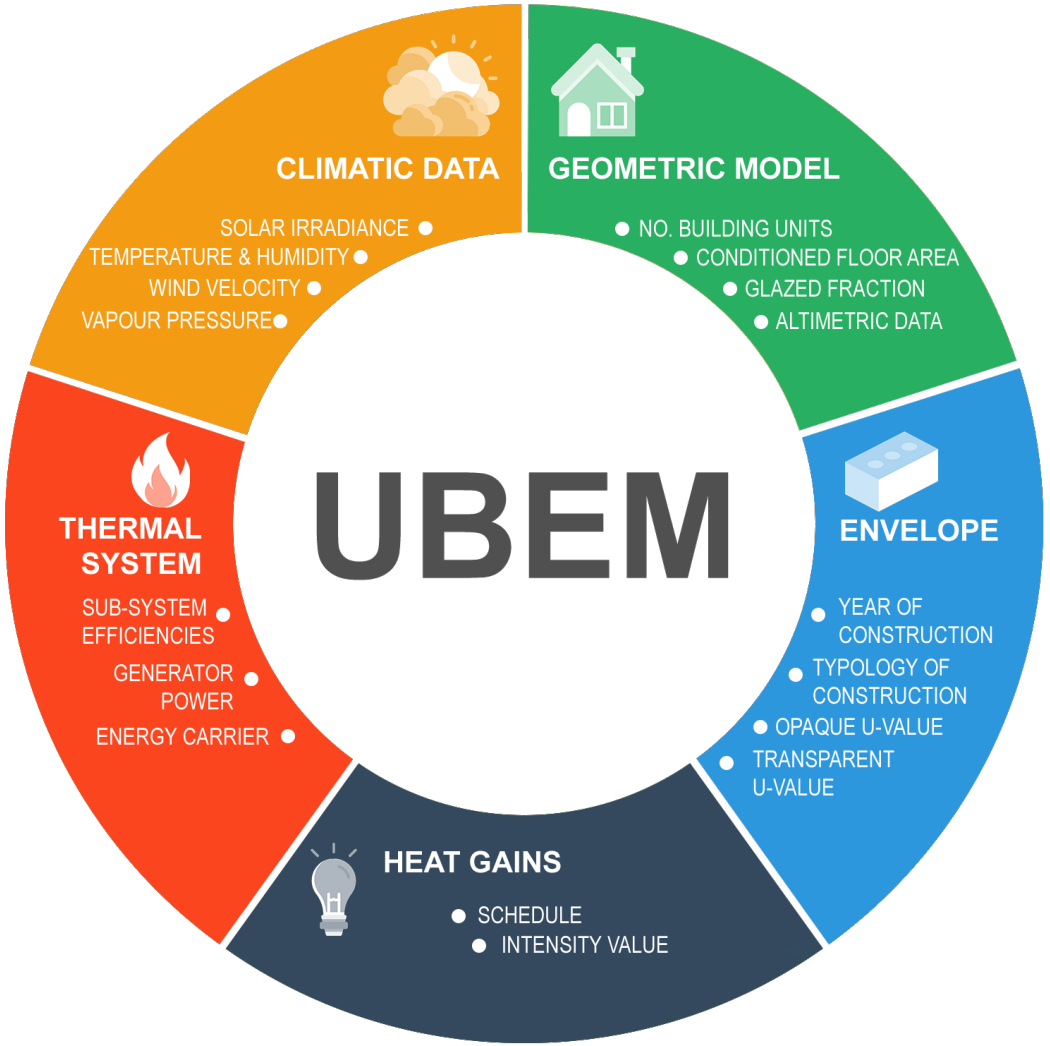


	<1945	1945 1976	1977 1991	1992 2005	2006 2015	2016 2020
A4	0,3%	0,3%	0,2%	0,2%	1,2%	33,1%
A3	0,4%	0,3%	0,4%	0,3%	1,5%	14,3%
A2	0,7%	0,6%	0,6%	0,6%	3,0%	11,7%
A1	1,0%	0,9%	0,9%	1,0%	5,6%	12,6%
B	1,7%	1,4%	1,8%	2,8%	11,6%	7,4%
C	3,5%	3,3%	4,3%	8,6%	19,2%	5,3%
D	7,9%	8,4%	10,6%	21,2%	23,7%	3,9%
E	13,2%	15,7%	18,7%	26,4%	16,6%	3,2%
F	22,1%	27,5%	29,3%	23,1%	11,0%	3,8%
G	49,1%	41,6%	33,0%	15,9%	6,6%	4,6%

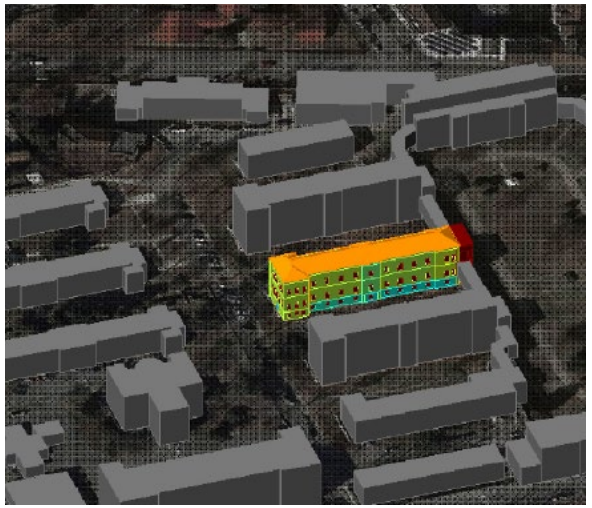
Fonte: ENEA & CTI. (2021). La certificazione energetica degli edifici: Rapporto annuale 2021. p. 38. ISBN 978-88-8286-421-7.

Urban Building Energy Modelling (UBEM)

- **UBEM** per la valutazione energetica ed ambientale ad ampia scala.
- **UBEM** come **strumento** di **supporto** a pubbliche amministrazioni, agenzie dell'energia e pianificatori urbani per incoraggiare lo sviluppo di **piani nazionali di ristrutturazione degli edifici**.

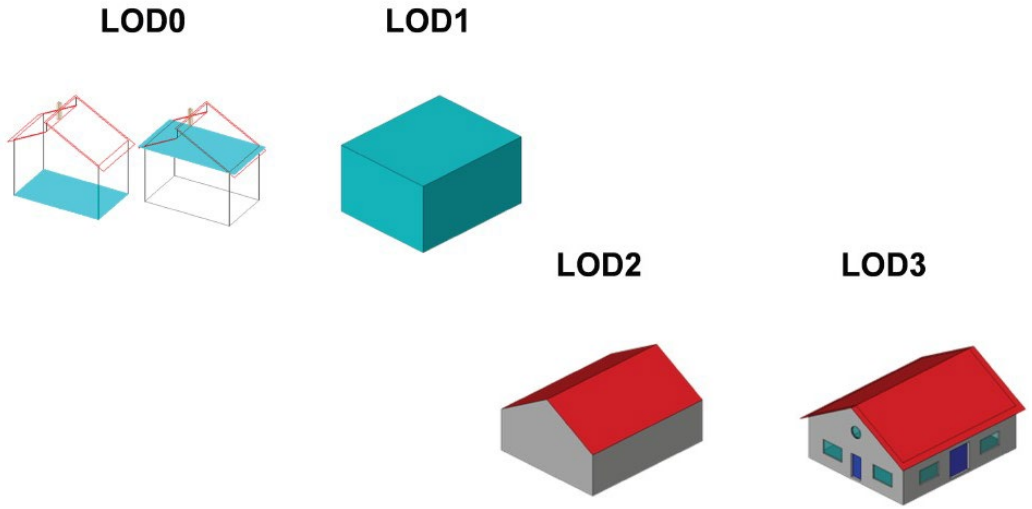


Dal BEM all'UBEM (1)



BEM

- **modello geometrico**
- involucro edilizio
- *zoning*
- apporti termici interni
- sistemi tecnici

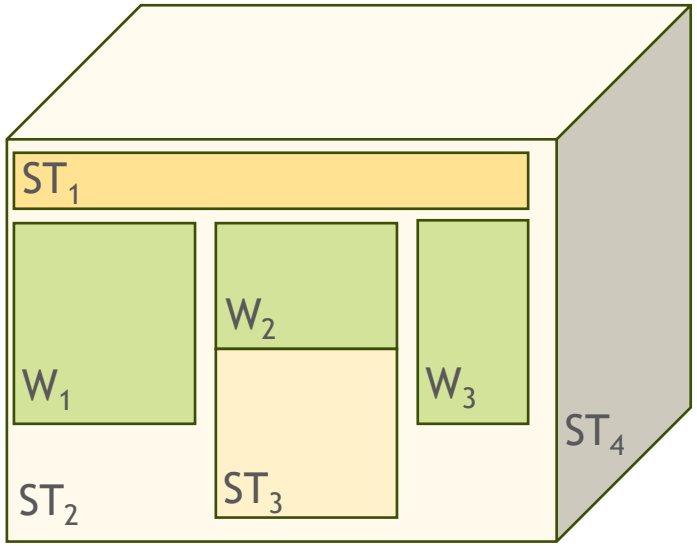


UBEM

Fonte: Kolbe, T. H., Kutzner, T., Smyth, C. S., Nagel, C., Roensdorf, C. and Heazel, C. (2021). OGC City Geography Markup Language (CityGML) Part 1: Conceptual Model Standard - Open Geospatial Consortium, p. 36.

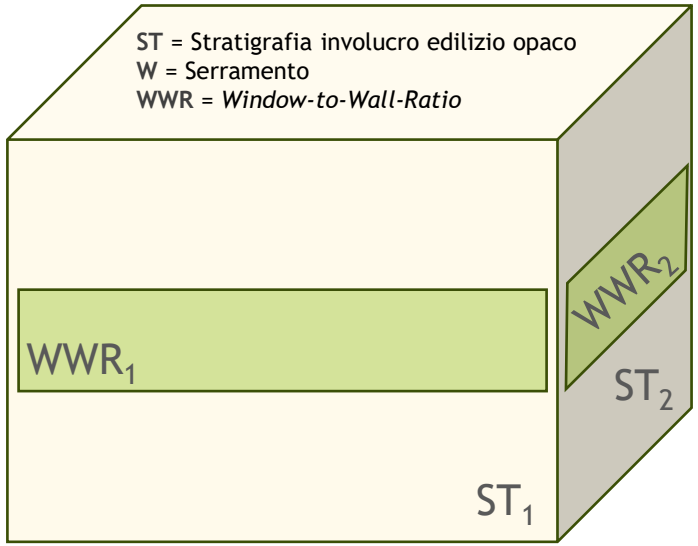
Piro, M., Ballarini, I., and Corrado, V. (2023). From Building Energy Models (BEM) to Urban Building Energy Models (UBEM): input data and modelling approaches.

Dal BEM all'UBEM (2)



BEM

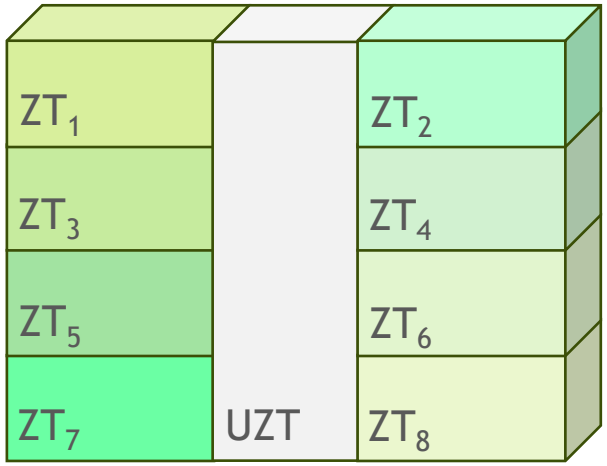
- modello geometrico
- **involucro edilizio**
- *zoning*
- apporti termici interni
- sistemi tecnici



UBEM

Piro, M., Ballarini, I., and Corrado, V. (2023). From Building Energy Models (BEM) to Urban Building Energy Models (UBEM): input data and modelling approaches.

Dal BEM all'UBEM (3)

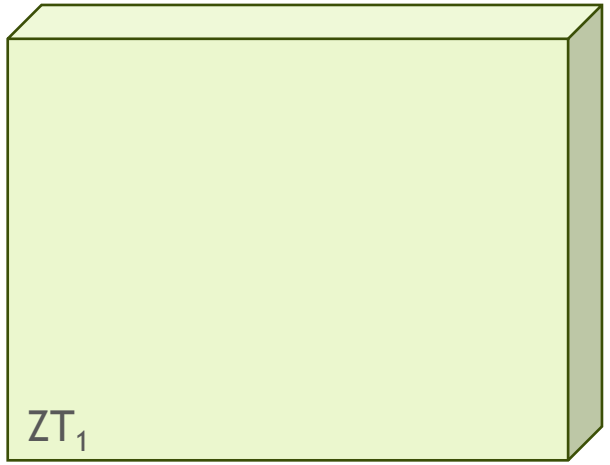


BEM

- modello geometrico
- involucro edilizio
- ***zoning***
- apporti termici interni
- sistemi tecnici

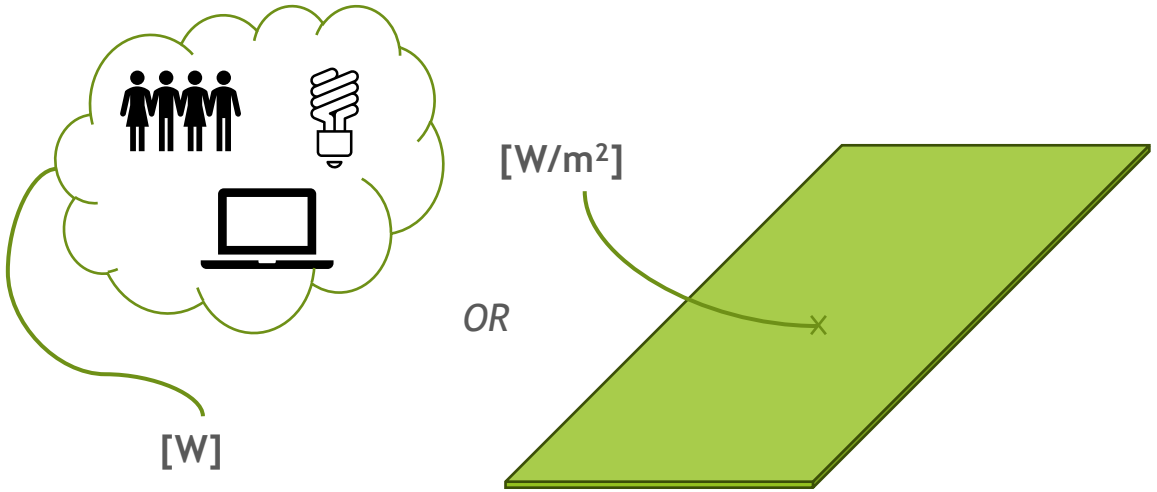
(*) **TZ** = Zona termica **UTZ** = Ambiente non climatizzato

UBEM



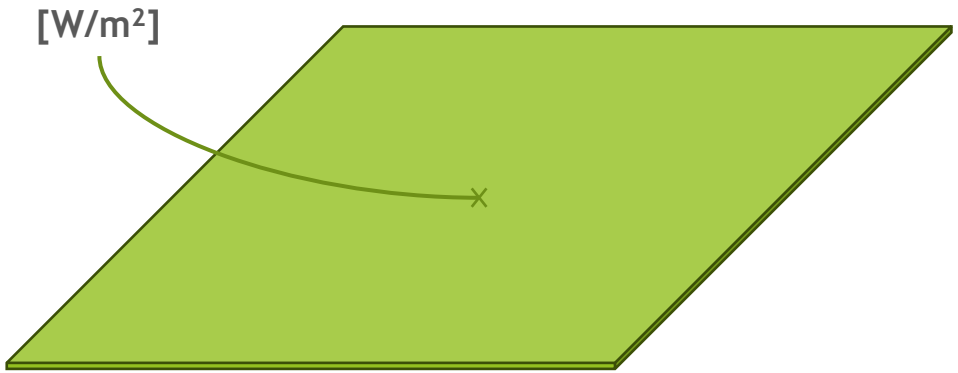
Piro, M., Ballarini, I., and Corrado, V. (2023). From Building Energy Models (BEM) to Urban Building Energy Models (UBEM): input data and modelling approaches.

Dal BEM all'UBEM (4)



BEM

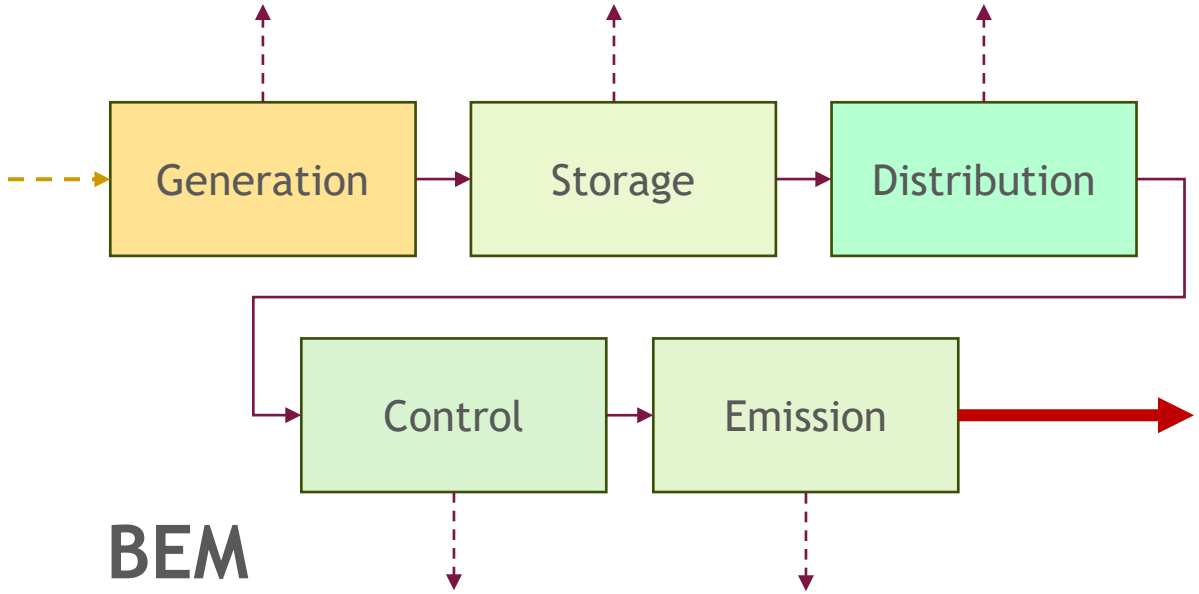
- modello geometrico
- involucro edilizio
- *zoning*
- **apporti termici interni**
- sistemi tecnici



UBEM

Piro, M., Ballarini, I., and Corrado, V. (2023). From Building Energy Models (BEM) to Urban Building Energy Models (UBEM): input data and modelling approaches.

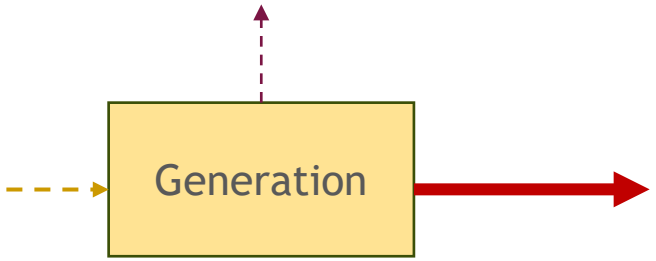
Dal BEM all'UBEM (5)



- modello geometrico
- involucro edilizio
- *zoning*
- apporti termici interni
- **sistemi tecnici**

BEM

UBEM



Piro, M., Ballarini, I., and Corrado, V. (2023). From Building Energy Models (BEM) to Urban Building Energy Models (UBEM): input data and modelling approaches.

UBEM *tool*

UBEM.IO

EUReCA

CityBES

O/I

TEASER

Tool for Energy Analysis and Simulation for Efficient Retrofit

City Energy Analyst

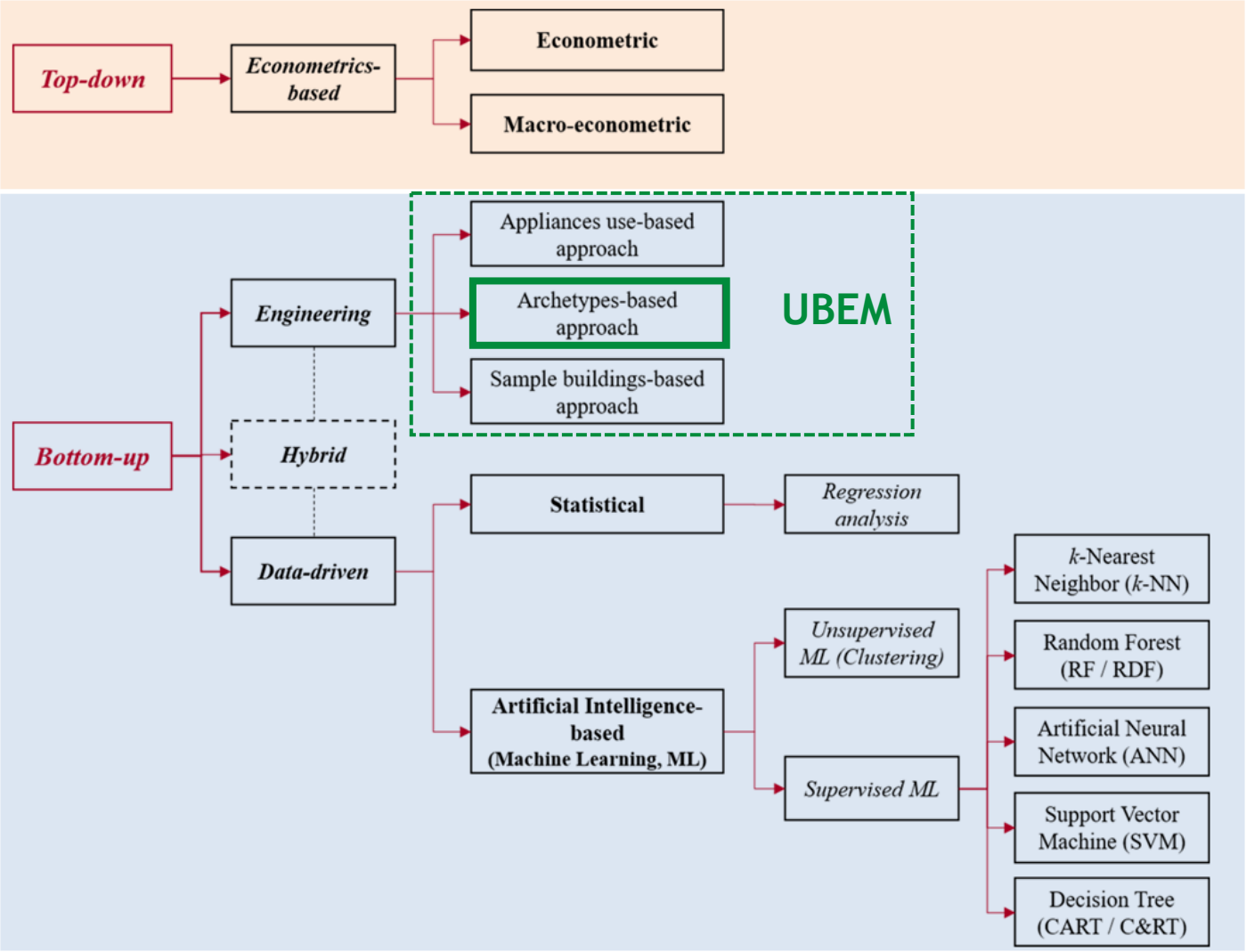
umi

URBAN OPT

Modelli energetici a larga scala

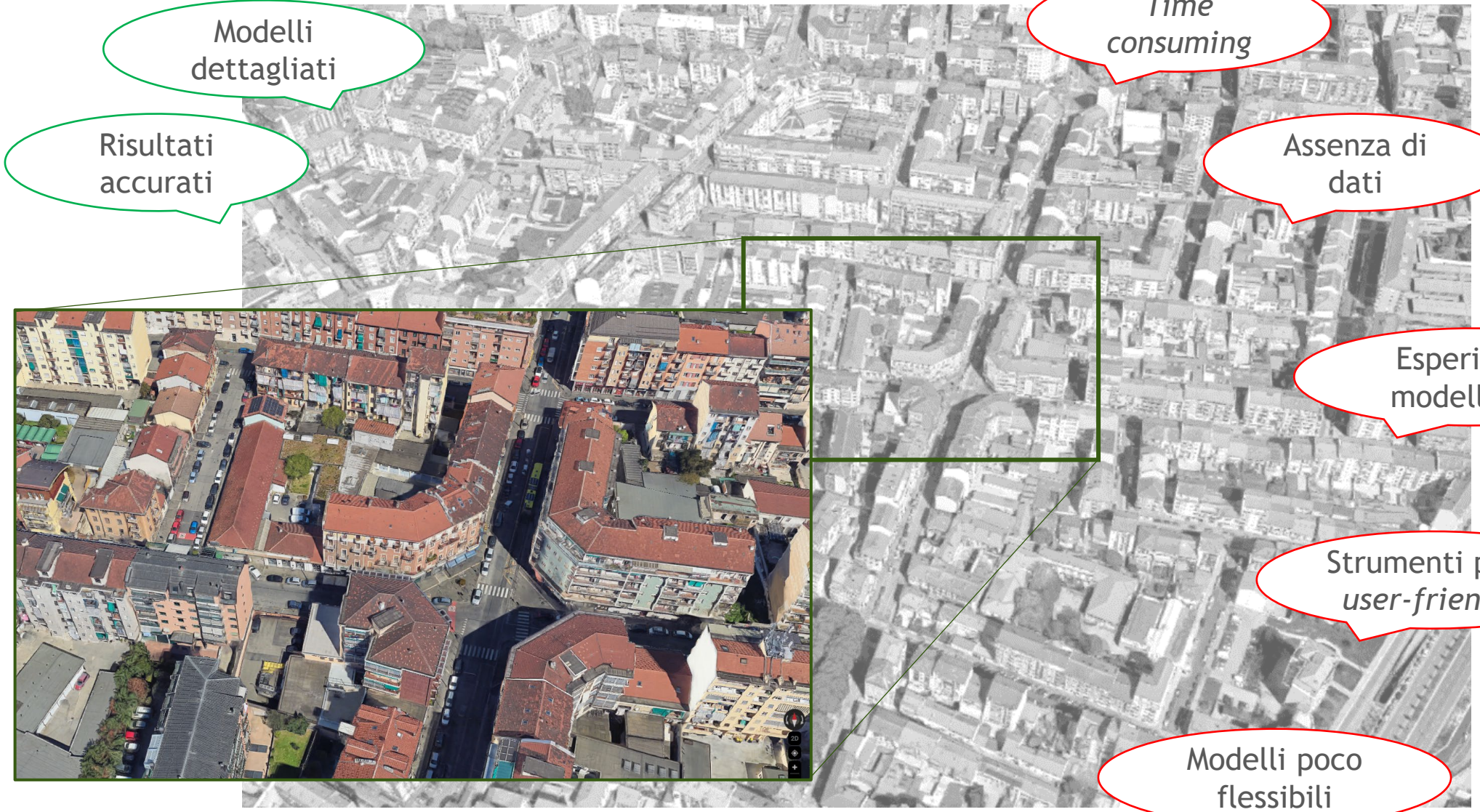
*The **building archetype** is a **statistical composite** of the features found within a category of buildings in the stock (IEA-ECBCS, Annex 31, 2004).*

*The archetype is not a real building, it is a **"virtual" building** characterized by a set of properties statistically detected in a building category (Sartori et al., Energy Policy 37, 2009; Caputo et al., Energy Policy 55, 2013; Ballarini et al., Energy Policy 68, 2014).*



Fonte: Ballarini, I., Corrado, V., & Piro, M. (2021). Building Stock Energy Models and ICT Solutions for Urban Energy Systems. In M. Del Giudice, A. Osello (Eds.), Handbook of Research on Developing Smart Cities Based on Digital Twins (pp. 490-514). IGI Global.

Come sviluppare un UBEM?



Modelli dettagliati

Risultati accurati

Time consuming

Assenza di dati

Esperienza modellatori

Strumenti poco *user-friendly*

Modelli poco flessibili

Fonte: Google Maps

Edifici rappresentativi

ESEMPIO

EDIFICI RAPPRESENTATIVI

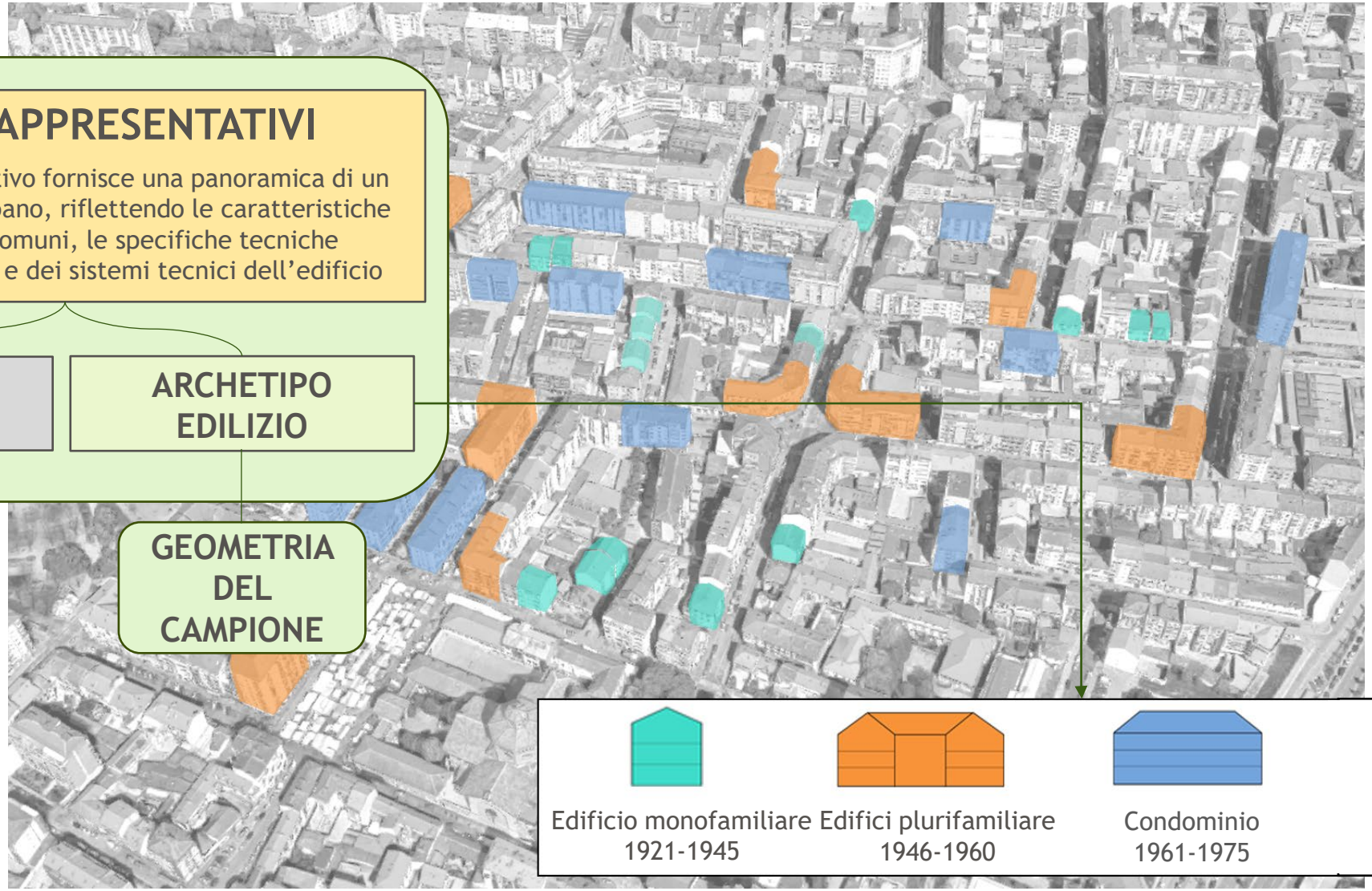
L'edificio rappresentativo fornisce una panoramica di un particolare tessuto urbano, riflettendo le caratteristiche geometriche più comuni, le specifiche tecniche dell'involucro edilizio e dei sistemi tecnici dell'edificio

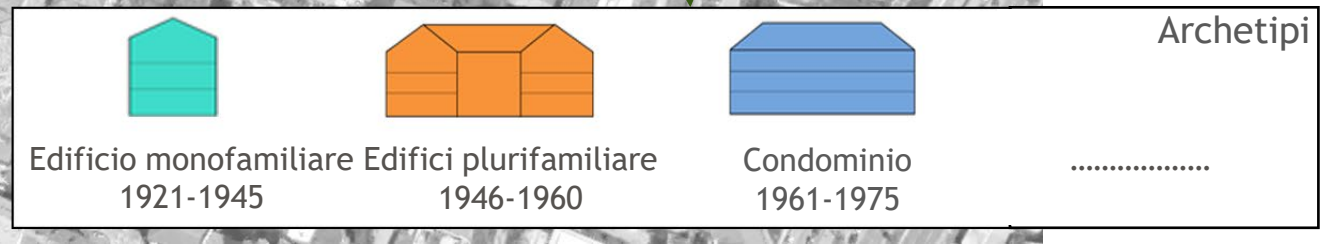
EDIFICIO REALE

ARCHETIPO EDILIZIO

GEOMETRIA REALE

GEOMETRIA DEL CAMPIONE



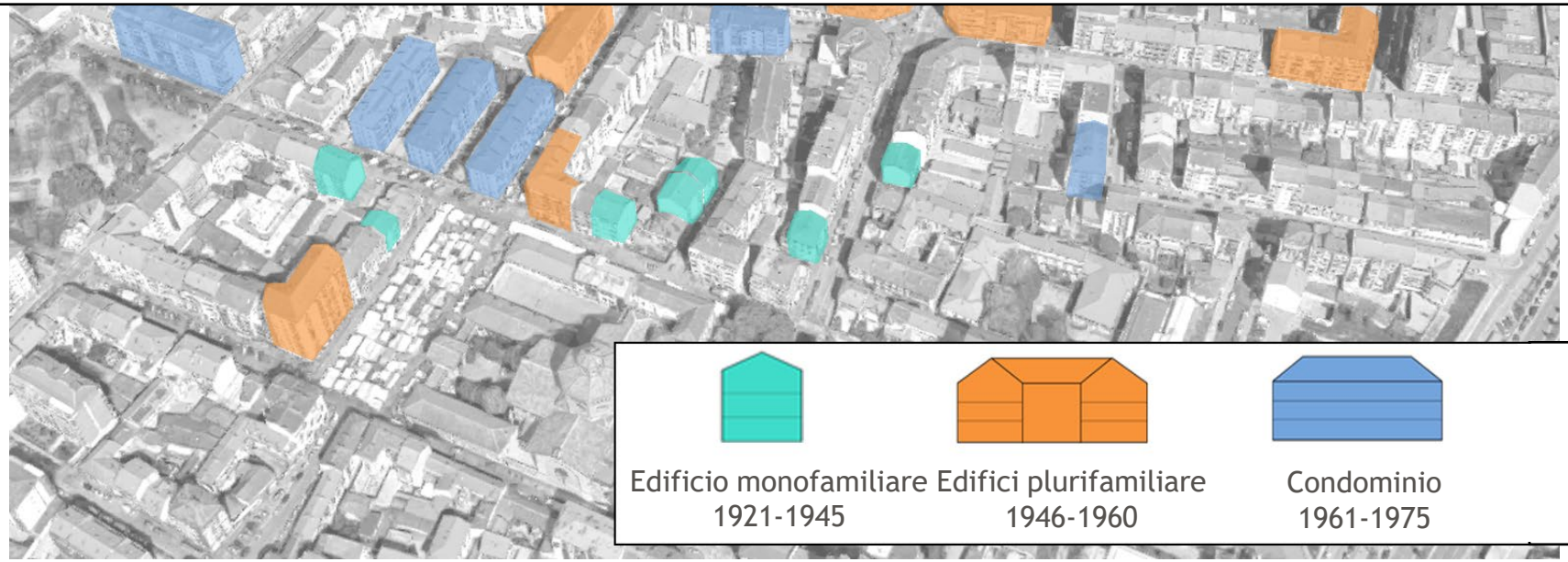


Fonte: Google Maps

Bottom-up UBEM archetype-based approach

ESEMPIO

Prestazione energetica tipologie edilizie X Consistenza statistica di edifici reali → Prestazione energetica del patrimonio edilizio (stato di fatto e scenari futuri)



Archetipi

Edificio monofamiliare 1921-1945 | Edifici plurifamiliare 1946-1960 | Condominio 1961-1975 | .....

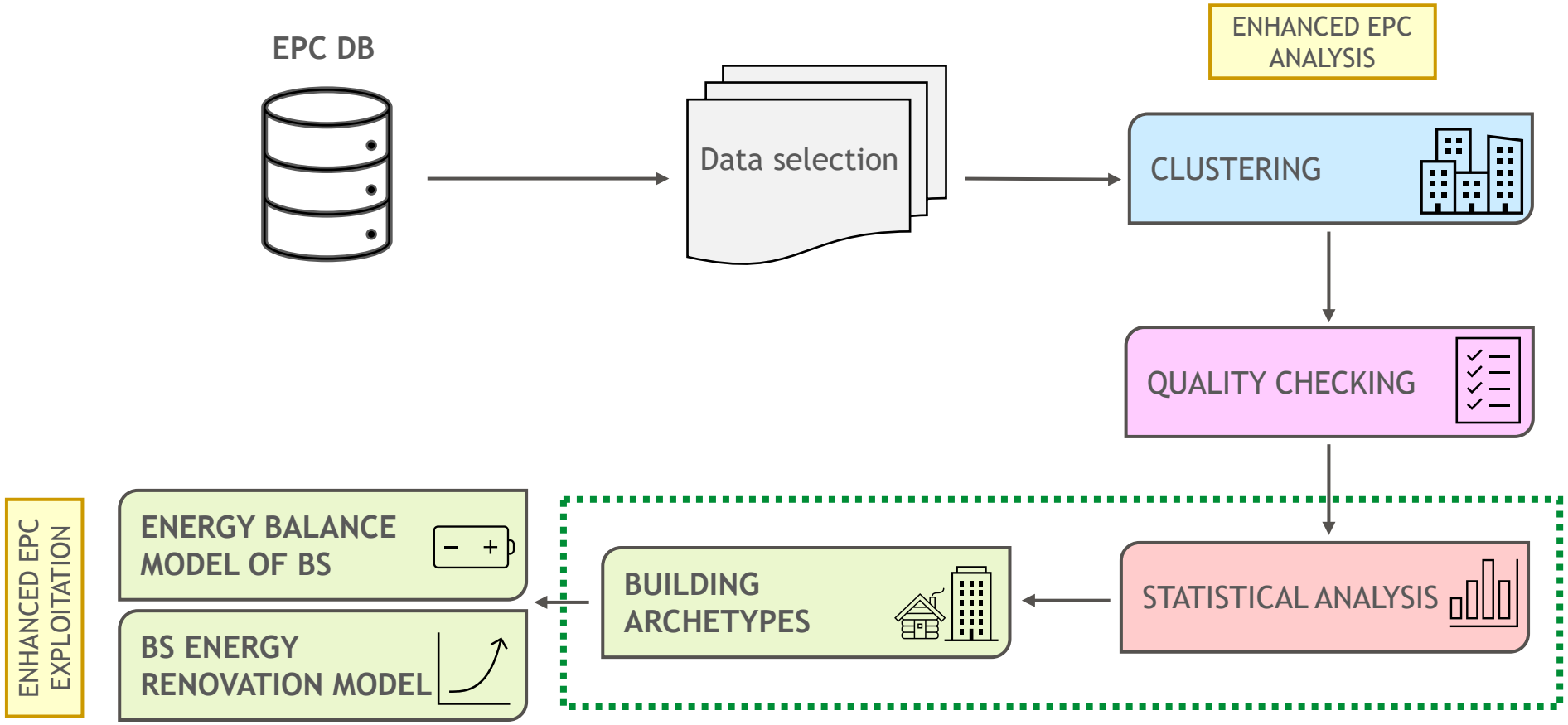
Fonte: Google Maps

Dati UBEM

Description	Symbol	Unit	Standard reference
Thickness of the material layer in the component	d	m	EN ISO 6946:2017
Design thermal conductivity	λ	W/(m·K)	EN ISO 6946:2017
External surface resistance	R_{se}	$(m^2 \cdot K)/W$	EN ISO 6946:2017
Internal surface resistance	R_{si}	$(m^2 \cdot K)/W$	EN ISO 6946:2017
Hemispherical emissivity of the surface	ε	–	EN ISO 6946:2017
Emissivity of the inside surface		–	
Emissivity of the external surface		–	
Density of building component	ρ_m	kg/m^3	EN ISO 13786:2017
Specific heat capacity of building component	c_m	J/(kg·K)	EN ISO 13786:2017
Solar absorption coefficient of external opaque surfaces	$\alpha_{sol;k}$	–	EN ISO 52016-1:2017
Visible absorption coefficient of external opaque surfaces		–	
Water vapour resistance factor	μ	–	EN ISO 10456:2007
Roughness of building component			ISO 4287-1:1984
[illegible]	λ	W/(m·K)	EN ISO 10077-1:2017
[illegible]dow	U_W	$W/(m^2 \cdot K)$	EN ISO 10077-1:2017
[illegible]ce of the transparent part of [illegible]	$g_{gl;wi}$	–	EN ISO 52016-1:2017
[illegible] side of the glazing facing the [illegible] indent radiation	ρ_e	–	ISO 52022-1:2017

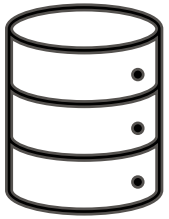
Stralcio di dati necessari per caratterizzare i componenti di involucro opachi

Metodologia TIMEPAC

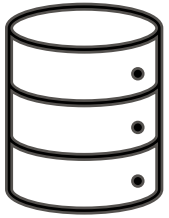


Selezione dati da APE

XML ridotto



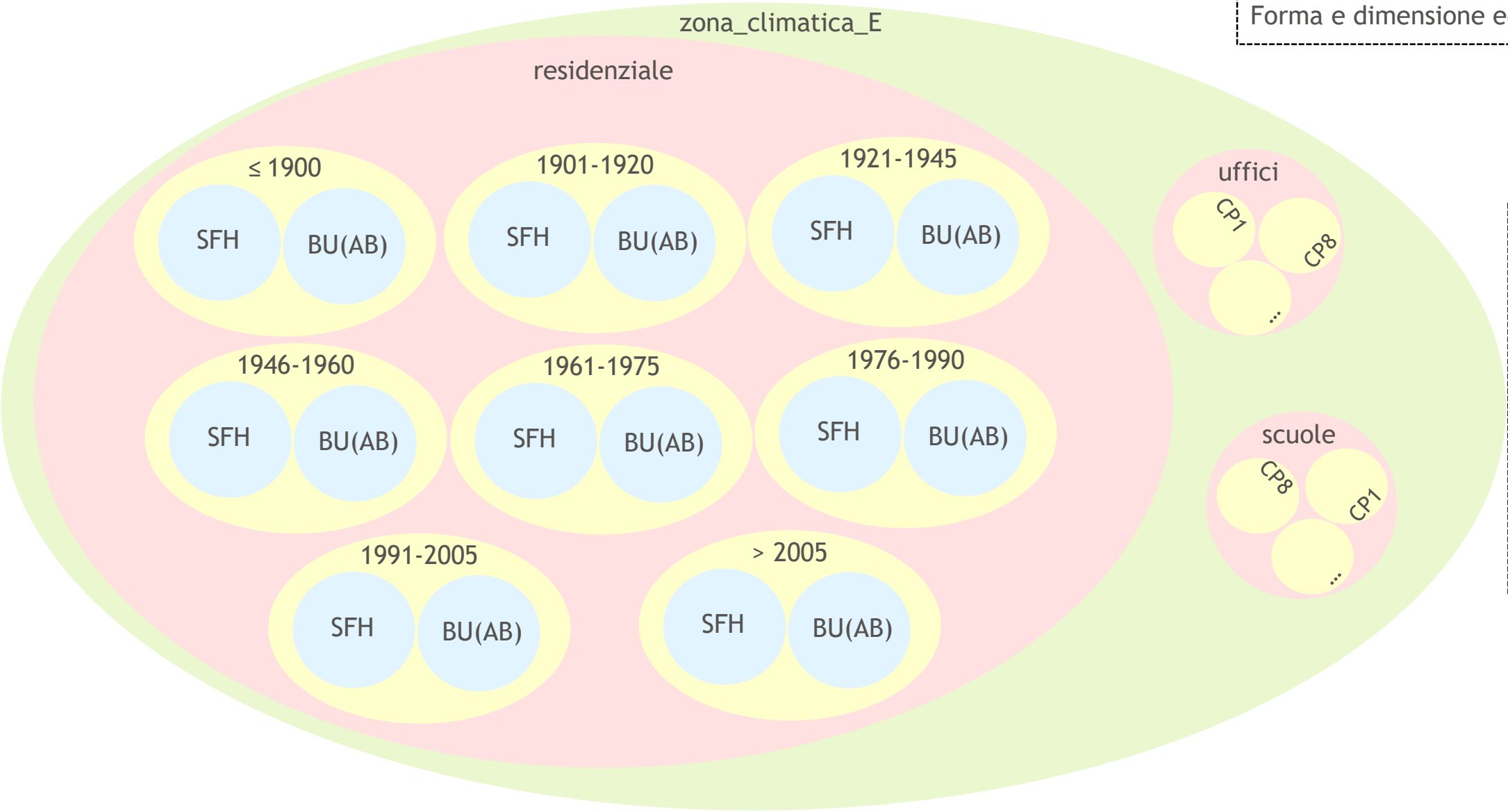
XML esteso



Oggetto attestato	Motivazione	APE ID	Comune
Destinazione d'uso	n. di unità immobiliari	**Tipologia edilizia**	Tipologia costruttiva
Anno di costruzione	Anno di ultima ristrutturazione	n. di piani	**Zona climatica**
Gradi giorno	**Fattore *S/V***	**Superficie di pavimento riscaldata/raffrescata**	**Volume lordo riscaldato/raffrescato**
Area disperdente	H'_T	**Area disperdente opaca**	**Area disperdente trasparente**
Trasmittanza termica media involucro edilizio	**Trasmittanza termica media involucro opaco**	**Trasmittanza termica media involucro trasparente**	**Servizi energetici**
Tipo di generatore per servizio energetico	**Vettore energetico per servizio energetico**	**Efficienza media stagionale dell'impianto per servizio energetico**	**Rendimenti dei sottosistemi per l'impianto di riscaldamento**
$EP_{H,nd}$	$EP_{C,nd}$	$EP_{W,nd}$	$EP_{H,nren}$
$EP_{C,nren}$	$EP_{W,nren}$	$EP_{gl,nren}$	$EP_{gl,ren}$
EP_{nren} per servizio energetico	Energia consegnata per vettore energetico	**Misure di efficienza energetica (raccomandazioni)**	**$EP_{gl,nren}$ con misure di efficienza energetica**

Raggruppamento APE

Zone climatiche: n = (1)
Destinazioni d'uso: m = (1, 3)
Periodi di costruzione: l = (1, 8)
Forma e dimensione edifici: o = (1, 2)



Legenda

- Zona climatica
- Destinazione d'uso
- Periodo di costruzione
- Forma e dimensione edificio

Rappresentazione statistica dati APE

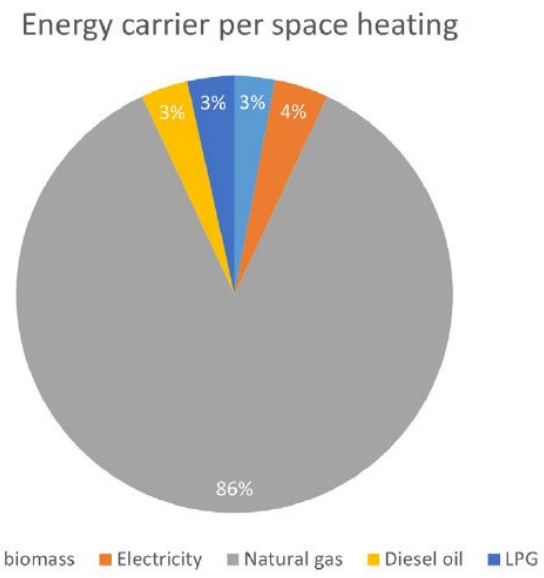
Data name	Qualitative or quantitative	Statistical representation
Number of building units	quantitative	boxplot or relative frequency
Building typology	qualitative	relative frequency
Building construction typology	qualitative	relative frequency
Heating degree days	quantitative	not needed
Thermally heated/cooled floor area	quantitative	boxplot
Thermally heated/cooled gross volume	quantitative	boxplot
Compactness ratio	quantitative	boxplot
Thermal envelope area	quantitative	boxplot
Opaque/transparent thermal envelope area	quantitative	boxplot
Mean thermal transmittance of the total building envelope	quantitative	boxplot
Mean thermal transmittance of the opaque building envelope	quantitative	boxplot
Mean thermal transmittance of the transparent building envelope	quantitative	boxplot

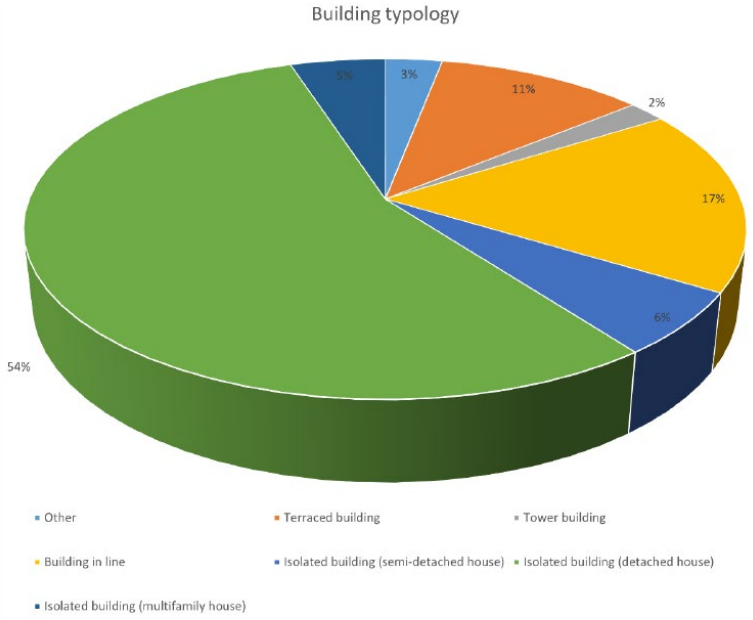
Data name	Qualitative or quantitative	Statistical representation
Heating/cooling/domestic hot water energy service	qualitative	relative frequency
Energy carrier per heating/cooling/domestic hot water	qualitative	relative frequency
Main technical building system (TBS) type of space heating generator	qualitative	relative frequency
Overall mean seasonal efficiency of the heating/cooling/domestic hot water system	quantitative	boxplot
Mean seasonal efficiency of the heating generation	quantitative	boxplot
Mean seasonal efficiency of the heating distribution/control/emission sub-system	quantitative	boxplot
Energy need for space heating	quantitative	boxplot
Energy need for space cooling	quantitative	boxplot
Overall non-renewable energy performance	quantitative	boxplot

Rappresentazione statistica dati APE

Dati qualitativi

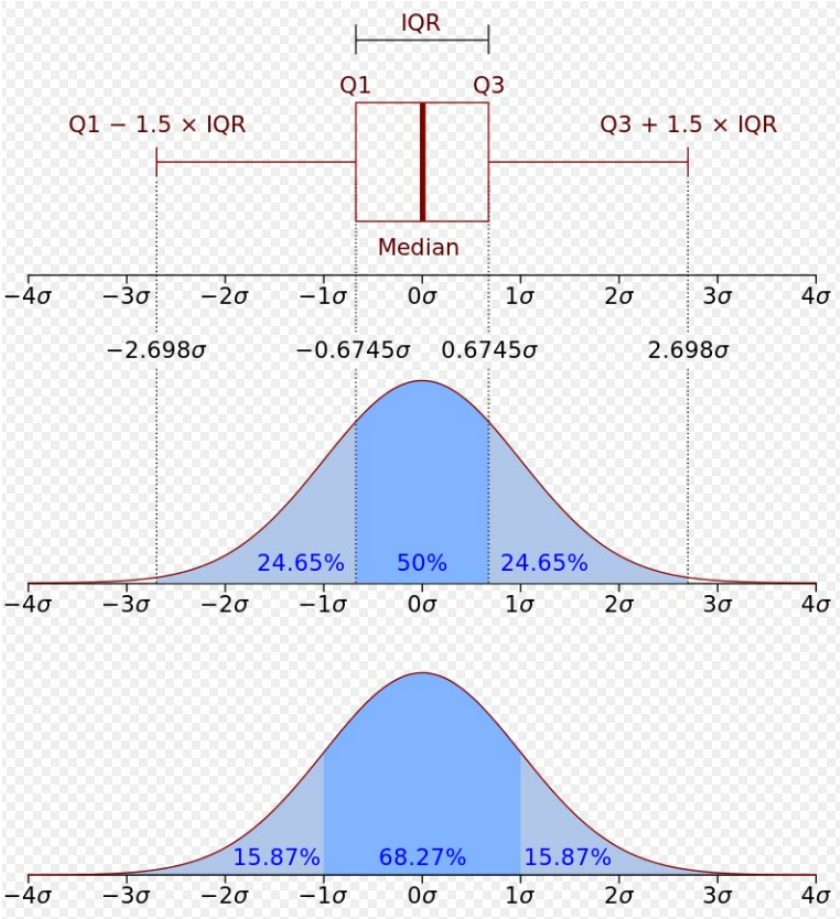
	SFH							
	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8
	≤ 1900	1901-1920	1921-1945	1946-1960	1961-1975	1976-1990	1991-2005	> 2005
Altro	1%	1%	1%	1%	1%	1%	1%	1%
Struttura in acciaio (con chiusure in muratura)	0%	0%	0%	0%	0%	0%	0%	0%
Struttura in acciaio (con chiusure in pannelli prefabbricati)	0%	0%	0%	0%	0%	0%	0%	0%
Struttura in acciaio (con facciate continue in vetro)	0%	0%	0%	0%	0%	0%	0%	0%
Struttura in c.a. (con chiusure continue in vetro)	0%	0%	0%	0%	0%	0%	0%	0%
Struttura in c.a. (con chiusure in laterizi)	2%	3%	4%	21%	50%	56%	58%	49%
Struttura in c.a. (con chiusure in pannelli prefabbricati)	0%	0%	0%	0%	0%	0%	0%	1%
Struttura in legno	0%	0%	0%	0%	0%	1%	1%	5%
Struttura in muratura portante	89%	90%	86%	66%	34%	28%	27%	30%
Struttura mista (acciaio e muratura	0%	0%	0%	0%	0%	0%	0%	0%
Struttura mista (altro)	5%	3%	4%	3%	3%	3%	2%	3%
Struttura mista (c.a. e acciaio)	0%	0%	0%	0%	0%	0%	0%	0%
Struttura mista (c.a. e laterizi)	3%	3%	5%	7%	10%	10%	10%	10%
Struttura mista (muratura e legno)	0%	0%	0%	0%	0%	0%	0%	1%
Struttura prefabbricata in c.a.	0%	0%	0%	0%	0%	0%	0%	0%

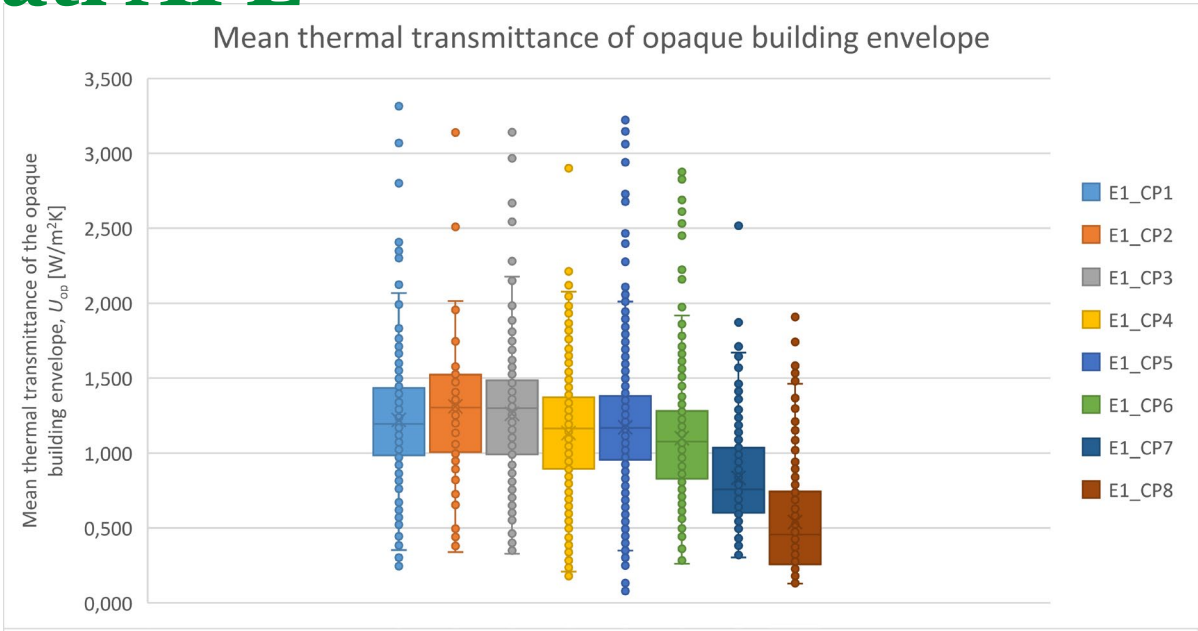


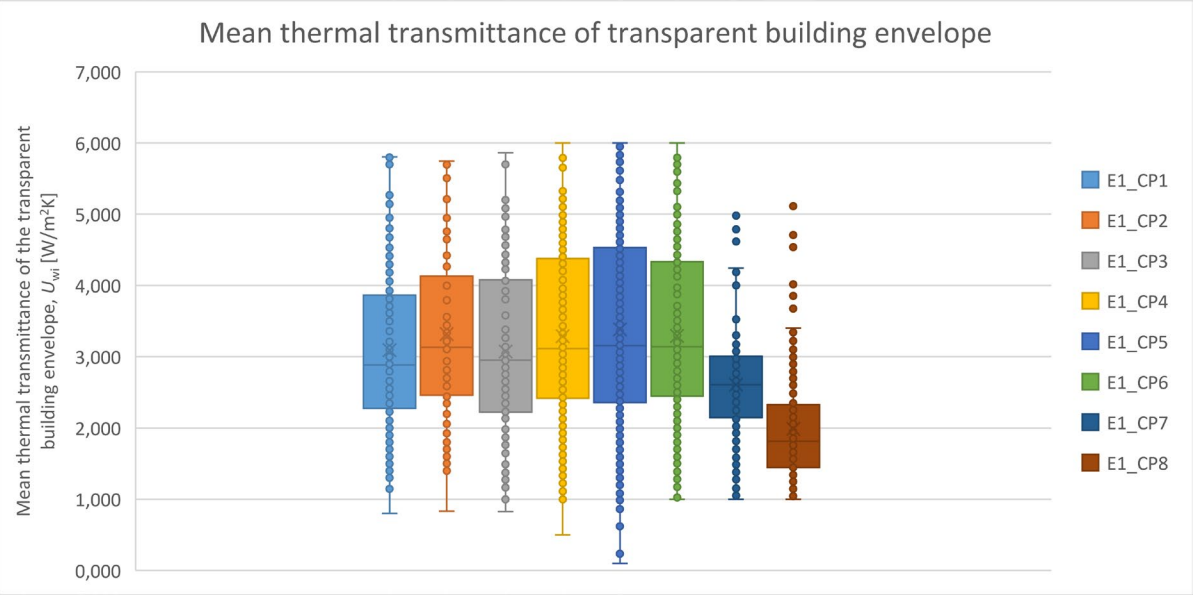


Rappresentazione statistica dati APE

Dati quantitativi







Schema archetipo edilizio

PIEMONTE REGION EPC DATABASE - E_RES_SINGLE_CP1						
	Data	Symbol	Unit of measure	Median	$(Q_3 - Q_2)$	$(Q_2 - Q_1)$
Geometry	Compactness ratio	CR	m^{-1}	0,754	0,128	0,114
	Thermally heated gross volume	$V_{H;g}$	m^3	457	+196	145
	Thermally heated floor area	$A_{H;use;ztc}$	m^2	110	47	35
	Transparent thermal envelope area on thermal envelope area	A_{wi}/A_{env}	%	5%	2%	1%
Envelope	Mean thermal transmittance of opaque building envelope	U_{op}	$W/(m^2 \cdot K)$	1,295	0,221	0,262
	Mean thermal transmittance of transparent building envelope	U_{wi}	$W/(m^2 \cdot K)$	3,166	1,211	0,940
Technical building system	Energy carrier per space heating	Natural gas = 78%; solid biomass = 7%; others = 15% (of the analysed sample)				
	Energy carrier per space cooling	Electricity = 100% (of the analysed sample)				
	Energy carrier per domestic hot water	Natural gas = 72%; electricity = 17%; others = 11% (of the analysed sample)				
	Mean seasonal efficiency of the heating generation sub-system (natural gas)	$\eta_{H;gn}$	–	0,917	0,093	0,127
	Mean seasonal efficiency of the heating generation sub-system (solid biomass)	$\eta_{H;gn}$	–	0,750	0,186	0,290
	Utilisation energy efficiency	$\eta_{H;u}$	–	0,875	0,048	0,065
Energy indicators	Energy need for space heating	$EP_{H;nd;ztc}$	kWh/m^2	193,7	65,6	56,6
	Energy need for space cooling	$EP_{C;nd;ztc}$	kWh/m^2	7,3	6,7	4,4
	Energy need for domestic hot water	$EP_{W;nd;ztc}$	kWh/m^2	17,0	2,0	1,4
	Seasonal space heating energy efficiency	$\eta_{s;H}$	–	0,730	0,040	0,050
	Seasonal space cooling energy efficiency	$\eta_{s;C}$	–	1,190	1,440	0,470
	Seasonal domestic hot water energy efficiency	$\eta_{s;W}$	–	0,580	0,170	0,080
	Non-renewable energy performance per space heating	$EP_{H;nren}$	kWh/m^2	241,5	102,0	94,3
	Non-renewable energy performance per space cooling	$EP_{C;nren}$	kWh/m^2	6,6	8,5	4,1
	Non-renewable energy performance per domestic hot water	$EP_{W;nren}$	kWh/m^2	26,7	8,8	7,0
	Overall non-renewable energy performance	$EP_{gl;nren}$	kWh/m^2	270,8	105,7	98,0
	Overall renewable energy performance	$EP_{gl;ren}$	kWh/m^2	1,8	12,7	1,3
	Renewable Energy Ratio	RER	%	1%	5%	1%

Matrice di tipologie edilizie

Climatic zone E	Residential bldgs		Non-residential bldgs	
	SFH	BU(AB)	OFF	EDUC
CP1	E_RES_SINGLE_CP1	E_RES_BU(AB)_CP1	E_OFF_CP1	E_EDUC_CP1
CP2	E_RES_SINGLE_CP2	E_RES_BU(AB)_CP2	E_OFF_CP2	E_EDUC_CP2
CP3	E_RES_SINGLE_CP3	E_RES_BU(AB)_CP3	E_OFF_CP3	E_EDUC_CP3
CP4	E_RES_SINGLE_CP4	E_RES_BU(AB)_CP4	E_OFF_CP4	E_EDUC_CP4
CP5	E_RES_SINGLE_CP5	E_RES_BU(AB)_CP5	E_OFF_CP5	E_EDUC_CP5
CP6	E_RES_SINGLE_CP6	E_RES_BU(AB)_CP6	E_OFF_CP6	E_EDUC_CP6
CP7	E_RES_SINGLE_CP7	E_RES_BU(AB)_CP7	E_OFF_CP7	E_EDUC_CP7
CP8	E_RES_SINGLE_CP8	E_RES_BU(AB)_CP8	E_OFF_CP8	E_EDUC_CP8

CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8
≤ 1900	1901-1920	1921-1945	1946-1960	1961-1975	1976-1990	1991-2005	> 2005

Matrice di tipologie edilizie

In TIMEPAC più di 150 archetipi edilizi sono stati sviluppati:

- 21 per la Spagna (Catalogna)
- 48 per la Slovenia
- 32 per l'Italia (Piemonte)
- 8 per l'Austria (Salisburghese)
- 42 per la Croazia
- 3 per Cipro

	sidential bldgs		Non-residential bldgs	
		BU(AB)	OFF	EDUC
		E_RES_BU(AB)_CP1	E_OFF_CP1	E_EDUC_CP1
		E_RES_BU(AB)_CP2	E_OFF_CP2	E_EDUC_CP2
		E_RES_BU(AB)_CP3	E_OFF_CP3	E_EDUC_CP3
		E_RES_BU(AB)_CP4	E_OFF_CP4	E_EDUC_CP4
CP5	E_RES_SINGLE_CP5	E_RES_BU(AB)_CP5	E_OFF_CP5	E_EDUC_CP5
CP6	E_RES_SINGLE_CP6	E_RES_BU(AB)_CP6	E_OFF_CP6	E_EDUC_CP6
CP7	E_RES_SINGLE_CP7	E_RES_BU(AB)_CP7	E_OFF_CP7	E_EDUC_CP7
CP8	E_RES_SINGLE_CP8	E_RES_BU(AB)_CP8	E_OFF_CP8	E_EDUC_CP8

CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8
≤ 1900	1901-1920	1921-1945	1946-1960	1961-1975	1976-1990	1991-2005	> 2005

Matrice di tipologie edilizie

Climatic zone E	Residential bldgs	
	SFH	BU(AB)
CP1	E_RES_SINGLE_CP1	E_RES_BU(AB
CP2	E_RES_SINGLE_CP2	E_RES_BU(AB
CP3	E_RES_SINGLE_CP3	E_RES_BU(AB
CP4	E_RES_SINGLE_CP4	E_RES_BU(AB
CP5	E_RES_SINGLE_CP5	E_RES_BU(AB
CP6	E_RES_SINGLE_CP6	E_RES_BU(AB
CP7	E_RES_SINGLE_CP7	E_RES_BU(AB
CP8	E_RES_SINGLE_CP8	E_RES_BU(AB

PIEMONTE REGION EPC DATABASE - E_RES_SINGLE_CP1

	Data	Symbol	Unit of measure	Median	$(Q_3 - Q_2)$	$(Q_2 - Q_1)$
Geometry	Compactness ratio	CR	m^{-1}	0,754	0,128	0,114
	Thermally heated gross volume	$V_{H;g}$	m^3	457	+196	145
	Thermally heated floor area	$A_{H;use;ztc}$	m^2	110	47	35
	Transparent thermal envelope area on thermal envelope area	A_{wi}/A_{env}	%	5%	2%	1%
Envelope	Mean thermal transmittance of opaque building envelope	U_{op}	$W/(m^2 \cdot K)$	1,295	0,221	0,262
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Matrice di tipologie edilizie

Climatic zone E	Residential bldgs	
	SFH	BU(AB)
CP1	E_RES_SINGLE_CP1	E_RES_BU(AB
CP2	E_RES_SINGLE_CP2	E_RES_BU(AB
CP3	E_RES_SINGLE_CP3	E_RES_BU(AB
CP4	E_RES_SINGLE_CP4	E_RES_BU(AB
CP5	E_RES_SINGLE_CP5	E_RES_BU(AB
CP6	E_RES_SINGLE_CP6	E_RES_BU(AB
CP7	E_RES_SINGLE_CP7	E_RES_BU(AB
CP8	E_RES_SINGLE_CP8	E_RES_BU(AB

PIEMONTE REGION EPC DATABASE - E_RES_SINGLE_CP1

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Geometry	Compactness ratio	CR	m^{-1}	0,754	0,128	0,114
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	Renewable Energy Ratio	RER	%	1%	5%	1%

I dati contenuti nell'archetipo sono sufficienti per sviluppare un modello UBEM dettagliato?

Matrice di tipologie edilizie

Climatic zone E	Residential bldgs	
	SFH	BU(AB)
CP1	E_RES_SINGLE_CP1	E_RES_BU(AB
CP2	E_RES_SINGLE_CP2	E_RES_BU(AB
CP3	E_RES_SINGLE_CP3	E_RES_BU(AB
CP4	E_RES_SINGLE_CP4	E_RES_BU(AB
CP5	E_RES_SINGLE_CP5	E_RES_BU(AB
CP6	E_RES_SINGLE_CP6	E_RES_BU(AB
CP7	E_RES_SINGLE_CP7	E_RES_BU(AB
CP8	E_RES_SINGLE_CP8	E_RES_BU(AB

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	Renewable Energy Ratio	RER	%	1%	5%	1%

I dati contenuti nell'archetipo sono sufficienti per sviluppare un modello UBEM dettagliato?

NO

Matrice di tipologie edilizie

Climatic zone E	Residential bldgs	
	SFH	BU(AB)
CP1	E_RES_SINGLE_CP1	E_RES_BU(AB
CP2	E_RES_SINGLE_CP2	E_RES_BU(AB
CP3	E_RES_SINGLE_CP3	E_RES_BU(AB
CP4	E_RES_SINGLE_CP4	E_RES_BU(AB
CP5	E_RES_SINGLE_CP5	E_RES_BU(AB
CP6	E_RES_SINGLE_CP6	E_RES_BU(AB
CP7	E_RES_SINGLE_CP7	E_RES_BU(AB
CP8	E_RES_SINGLE_CP8	E_RES_BU(AB

PIEMONTE REGION EPC DATABASE - E_RES_SINGLE_CP1

	Data	Symbol	Unit of measure	Median	$(Q_3 - Q_2)$	$(Q_2 - Q_1)$
Geometry	Compactness ratio	CR	m^{-1}	0,754	0,128	0,114
	Thermally heated gross volume	$V_{H;g}$	m^3	457	+196	145
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	Renewable Energy Ratio	RER	%	1%	5%	1%

I dati contenuti nell'archetipo sono sufficienti per sviluppare un modello UBEM dettagliato?

NO, ma sono uno strumento utile!

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TIMEPAC

Procedures and services to undertake large-scale statistical analysis of EPCs databases

Deliverable 2.5

This report summarizes to the work performed in Task 2.5 "TDS 5 - Large scale statistical analysis of EPC databases" of Work Package 2 "Transversal Deployment Scenarios". This work package...

Procedures and services to undertake large-scale statistical analysis of EPCs databases

Deliverable 2.5

Published November 16, 2023

This report summarizes to the work performed in Task 2.5 "TDS 5 - Large scale statistical analysis of EPC databases" of Work Package 2 "Transversal Deployment Scenarios". This work package is concerned with the creation of future scenarios with the aim of deploying and delivering...

Read more >

TIMEPAC

Report on improved certification with enhanced EPCs

Deliverable 3.1

This report provides a summary of the activities undertaken in Task 3.1 "Improving certification with enhanced EPCs" of Work Package 3 (WP3) "Verification Scenarios". The main goal of this work...

Report on improved certification with enhanced EPCs

Deliverable 3.1

Published May 20, 2024

This report provides a summary of the activities undertaken in Task 3.1 "Improving certification with enhanced EPCs" of Work Package 3 (WP3) "Verification Scenarios". The main goal of this work package is to validate the results of the Transversal Deployment Scenarios (TDSs) developed in Work...

Read more >

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Report on EPC exploitation through advanced analysis

Deliverable 3.2

This document provides a summary of the activities undertaken in Task 3.2 "EPC exploitation through advanced analysis " of Work Package 3 (WP3) "Verification Scenarios". The main goal of this...

Report on EPC exploitation through advanced analysis

Deliverable 3.2

Published May 20, 2024

This document provides a summary of the activities undertaken in Task 3.2 "EPC exploitation through advanced analysis " of Work Package 3 (WP3) "Verification Scenarios". The main goal of this work package is to validate the results of the Transversal Deployment Scenarios (TDSs) developed in...

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Report on building Renovation Passports from enhanced EPC data

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Report on improving building operation with enhanced EPCs

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Communication and Dissemination Plan

Deliverable 5.1

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Metodologia per la costruzione degli archetipi

Annex A - Guidelines to create archetypes of the building stock from EPC data

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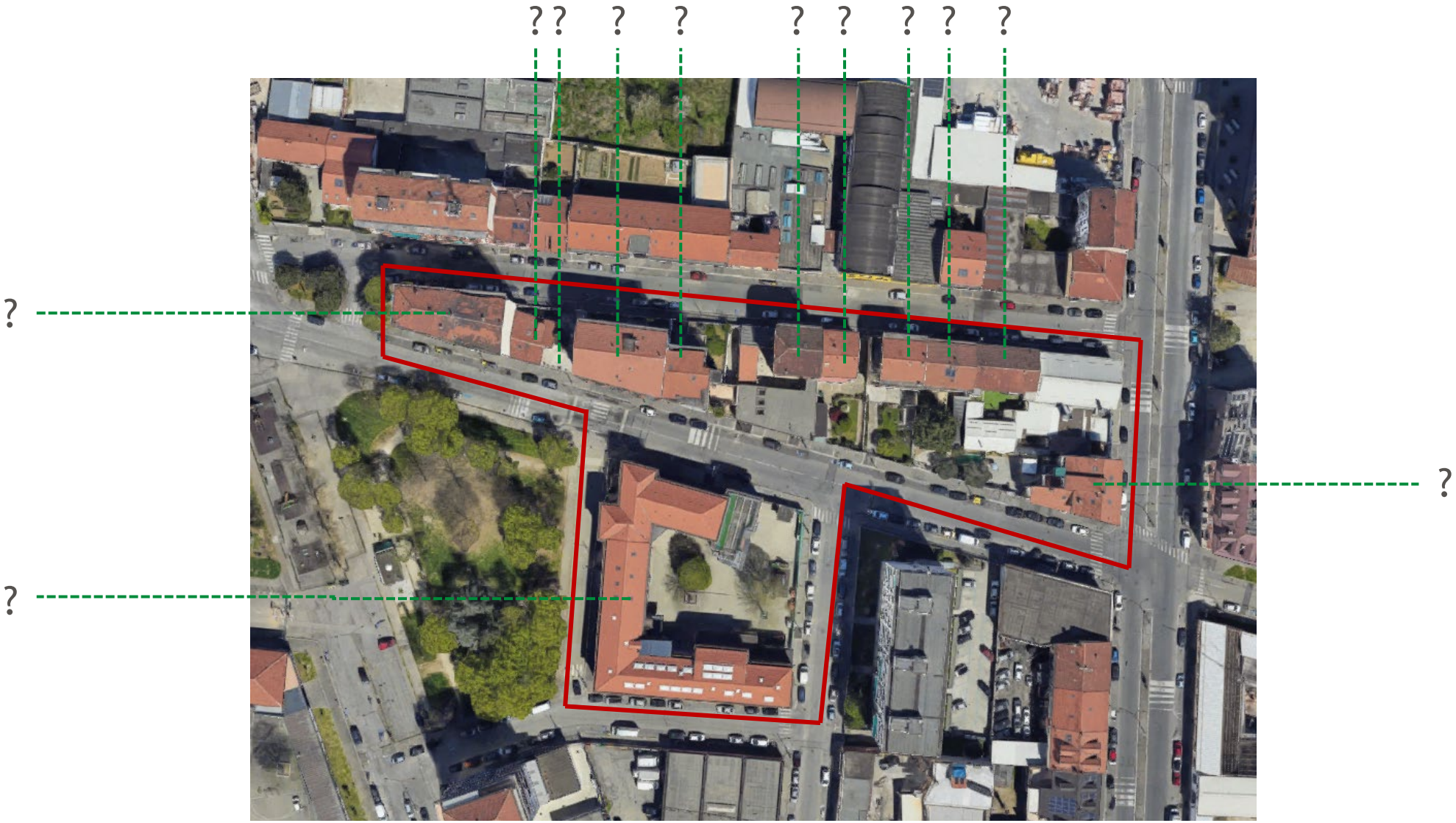
https://timepac.eu/reports/procedures-and-services-to-undertake-large-scale-statistical-analysis-of-epcs-databases/

Patrimonio edilizio torinese

Fonte: Google Maps (google.com/maps).

Patrimonio edilizio torinese



Fonte: Google Maps (google.com/maps).

Patrimonio edilizio torinese

Informazione oggetto

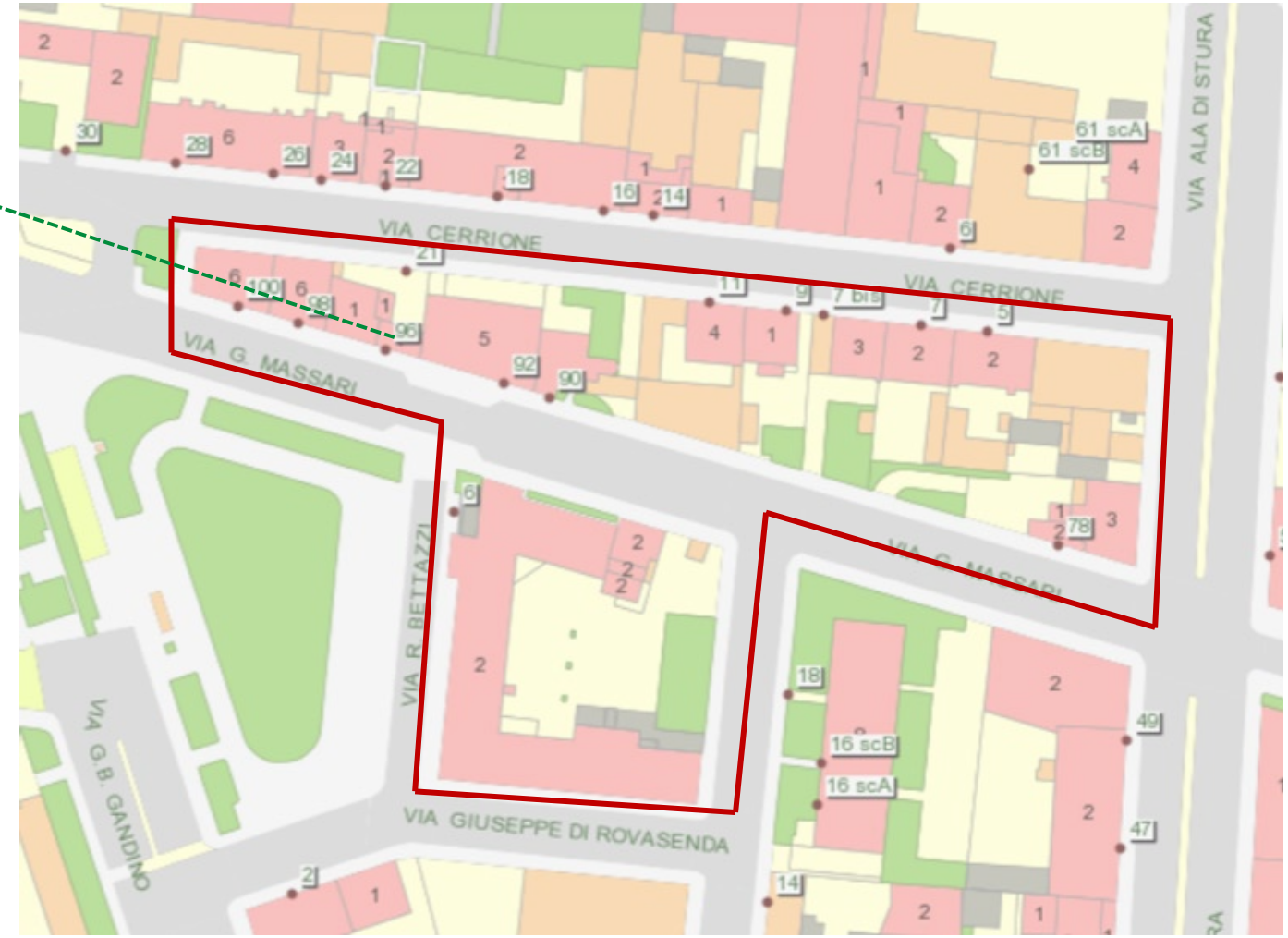
Carta Tecnica colori

Livello	Carta Tecnica
codice_intesa	020102
gruppo	EDIFICI PRINCIPALI
descrizione	generica
categoria_uso	residenziale
epoca_costruzione	1946 - 1960
numero_piani	1
altezza_edificio	4.4
valenza_storica	non monumentale
nome	
fondo	
materiale	
uso	

Zona climatica E

Edificio residenziale

1946-60



Fonte: Geoportale del Comune di Torino (geoportale.comune.torino.it).

Patrimonio edilizio torinese

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Livello	Carta Tecnica
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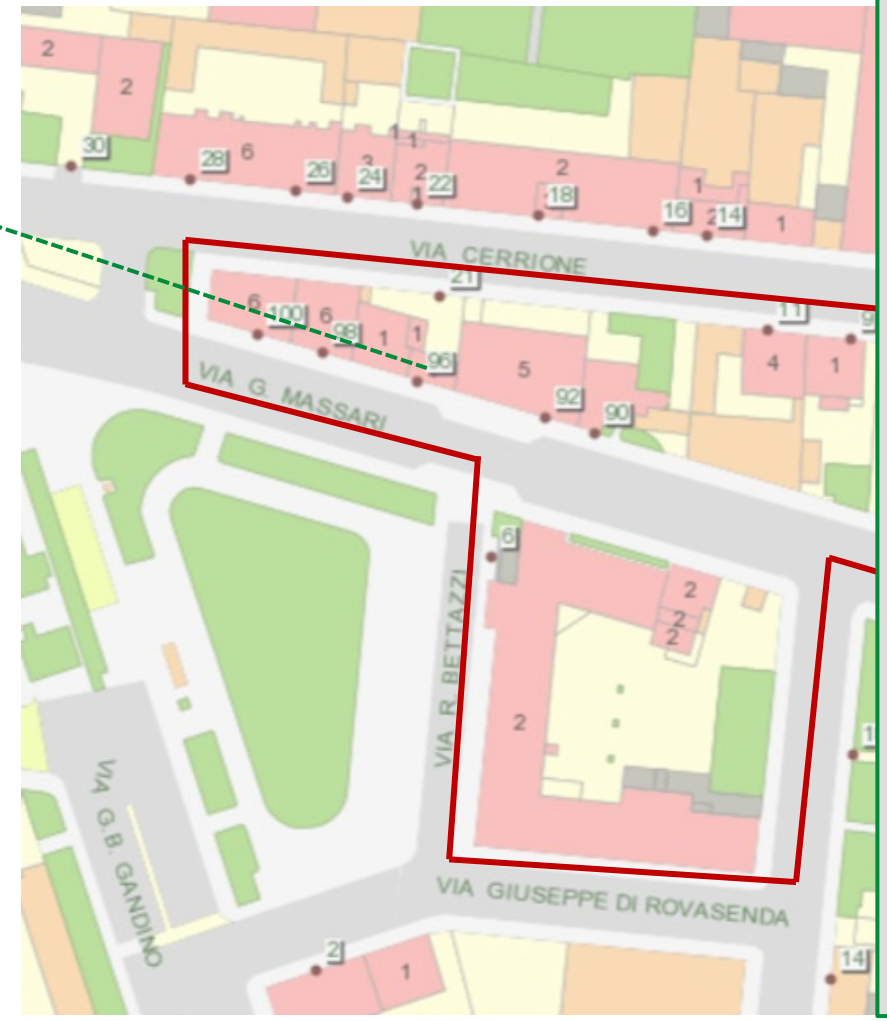
fondo	
materiale	
uso	

Zona climatica E

Edificio residenziale

1946-60

E_RES_SFH_CP4



Fonte: Geoportale del Comune di Torino (geoportale.comune.torino.it).

PIEMONTE REGION EPC DATABASE - E_RES_SINGLE_CP4

	Data	Symbol	Unit of measure	Median	$(Q_3 - Q_2)$	$(Q_2 - Q_1)$
Geometry	Compactness ratio	CR	m^{-1}	0,788	0,155	0,122
	Thermally heated gross volume	$V_{H;g}$	m^3	453	173	133
	Thermally heated floor area	$A_{H;use;ztc}$	m^2	110	43	31
	Transparent thermal envelope area on thermal envelope area	A_{wi}/A_{env}	%	5%	2%	1%
Envelope	Mean thermal transmittance of opaque building envelope	U_{op}	$W/(m^2 \cdot K)$	1,170	0,239	0,344
	Mean thermal transmittance of transparent building envelope	U_{wi}	$W/(m^2 \cdot K)$	2,907	1,212	1,024
Technical building system	Energy carrier per space heating	Natural gas = 78%; solid biomass = 7%; others = 15% (of the analysed sample)				
	Energy carrier per space cooling	Electricity = 100% (of the analysed sample)				
	Energy carrier per domestic hot water	Natural gas = 72%; electricity = 17%; others = 11% (of the analysed sample)				
	Mean seasonal efficiency of the heating generation sub-system (natural gas)	$\eta_{H;gn}$	–	0,917	0,093	0,127
	Mean seasonal efficiency of the heating generation sub-system (solid biomass)	$\eta_{H;gn}$	–	0,750	0,186	0,290
	Utilisation energy efficiency	$\eta_{H;u}$	–	0,875	0,048	0,065
	Energy need for space heating	$EP_{H;nd;ztc}$	kWh/m^2	174,7	69,8	61,3
	Energy need for space cooling	$EP_{C;nd;ztc}$	kWh/m^2	9,2	7,4	5,3
	Energy need for domestic hot water	$EP_{W;nd;ztc}$	kWh/m^2	17,0	1,6	1,4
Energy indicators	Seasonal space heating energy efficiency	$\eta_{s;H}$	–	0,730	0,070	0,050
	Seasonal space cooling energy efficiency	$\eta_{s;C}$	–	1,160	0,940	0,420
	Seasonal domestic hot water energy efficiency	$\eta_{s;W}$	–	0,670	0,110	0,120
	Non-renewable energy performance per space heating	$EP_{H;nren}$	kWh/m^2	215,9	108,2	93,0
	Non-renewable energy performance per space cooling	$EP_{C;nren}$	kWh/m^2	7,5	7,6	4,6
	Non-renewable energy performance per domestic hot water	$EP_{W;nren}$	kWh/m^2	24,0	7,8	5,1
	Overall non-renewable energy performance	$EP_{gl;nren}$	kWh/m^2	242,8	112,1	96,1
	Overall renewable energy performance	$EP_{gl;ren}$	kWh/m^2	1,9	11,3	1,0
	Renewable Energy Ratio	RER	%	1%	5%	0%

Patrimonio edilizio torinese

Informazione oggetto

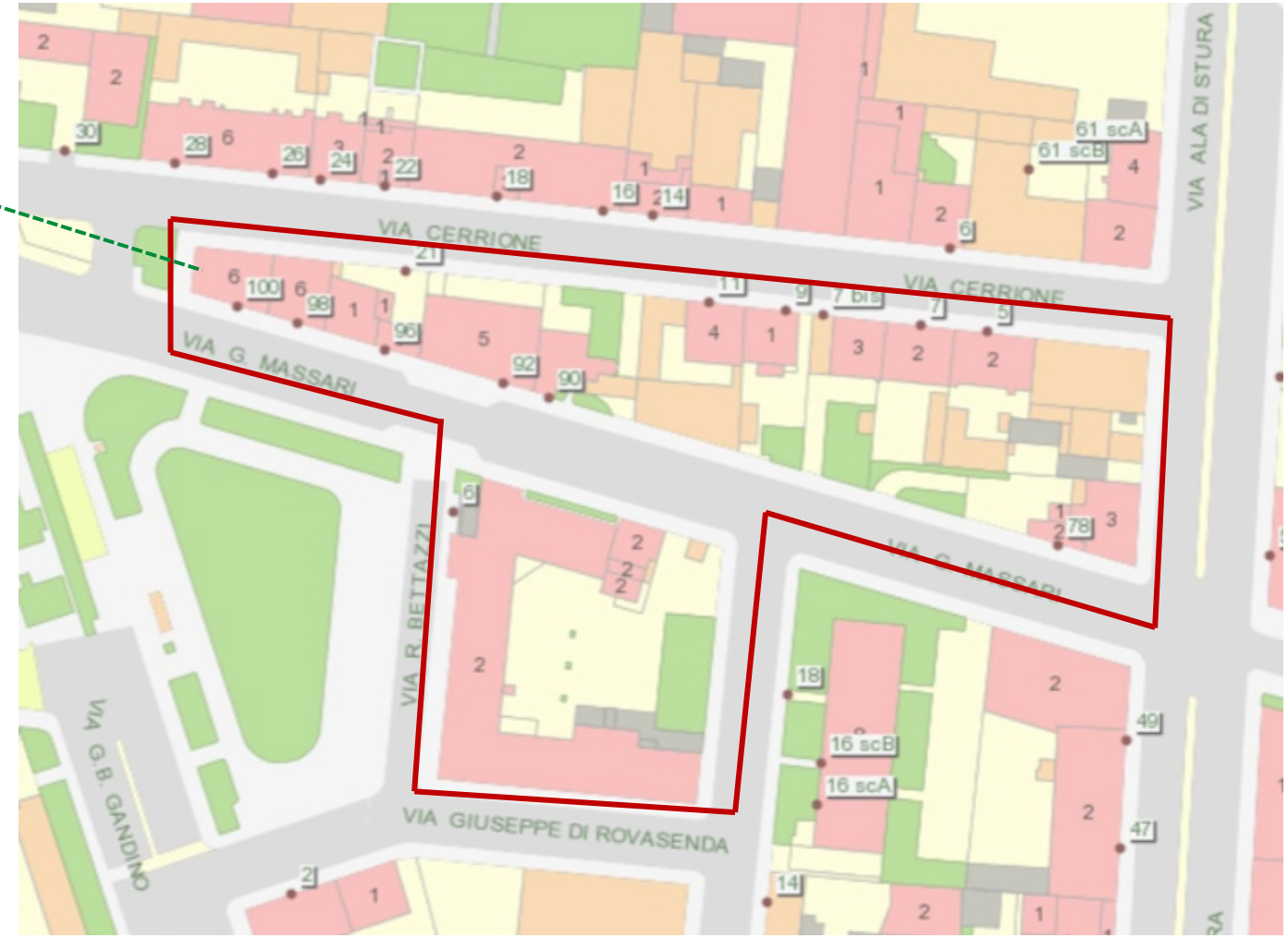
Carta Tecnica colori

Livello	Carta Tecnica
codice_intesa	020102
gruppo	EDIFICI PRINCIPALI
descrizione	generica
categoria_uso	residenziale
epoca_costruzione	1946 - 1960
numero_piani	6
altezza_edificio	21.35
valenza_storica	non monumentale
nome	
fondo	
materiale	
uso	

Zona climatica E

Edificio residenziale

1946-60



Fonte: Geoportale del Comune di Torino (geoportale.comune.torino.it).

Patrimonio edilizio torinese

Informazione oggetto

Carta Tecnica colori

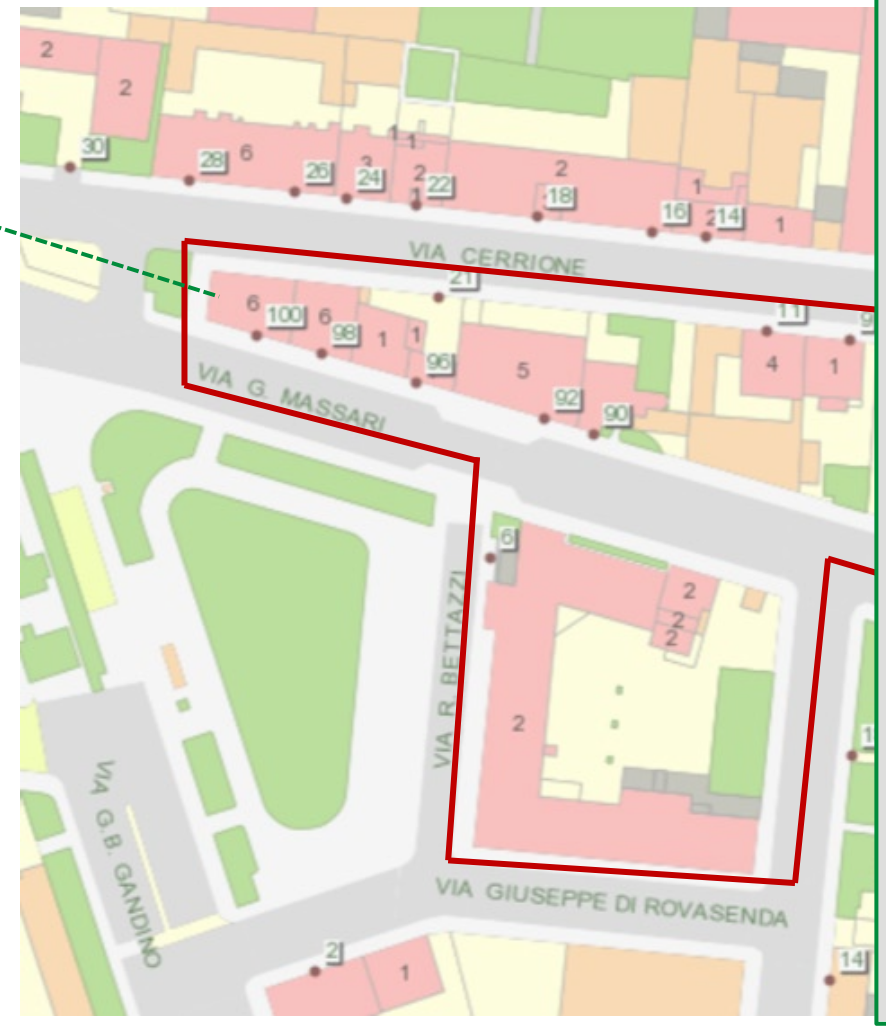
Livello	Carta Tecnica
codice_intesa	020102
gruppo	EDIFICI PRINCIPALI
descrizione	generica
categoria_uso	residenziale
epoca_costruzione	1946 - 1960
numero_piani	6
altezza_edificio	21.35
valenza_storica	non monumentale
nome	
fondo	
materiale	
uso	

Zona climatica E

Edificio residenziale

1946-60

E_RES_BU(AB)_CP4



PIEMONTE REGION EPC DATABASE - E_RES_BU(AB)_CP4

	Data	Symbol	Unit of measure	Median	$(Q_3 - Q_2)$	$(Q_2 - Q_1)$
Geometry	Compactness ratio	CR	m^{-1}	0,452	0,229	0,149
	Thermally heated gross volume	$V_{H;g}$	m^3	254	75	58
	Thermally heated floor area	$A_{H;use;ztc}$	m^2	65	19	15
	Transparent thermal envelope area on thermal envelope area	A_{wi}/A_{env}	%	10%	5%	4%
Envelope	Mean thermal transmittance of opaque building envelope	U_{op}	$W/(m^2 \cdot K)$	1,183	0,226	0,239
	Mean thermal transmittance of transparent building envelope	U_{wi}	$W/(m^2 \cdot K)$	3,124	1,356	0,810
Technical building system	Energy carrier per space heating	Natural gas = 78%; district heating = 15%; others = 7% (of the analysed sample)				
	Energy carrier per space cooling	Electricity = 99%; natural gas = 1% (of the analysed sample)				
	Energy carrier per domestic hot water	Natural gas = 74%; electricity = 21%; others = 15% (of the analysed sample)				
	Mean seasonal efficiency of the heating generation sub-system (natural gas)	$\eta_{H;gn}$	–	0,926	0,126	0,136
	Mean seasonal efficiency of the heating generation sub-system (district heating)	$\eta_{H;gn}$	–	0,960	0,040	0,263
	Utilisation energy efficiency	$\eta_{H;u}$	–	0,878	0,046	0,050
Energy indicators	Energy need for space heating	$EP_{H;nd;ztc}$	kWh/m^2	99,0	58,1	36,5
	Energy need for space cooling	$EP_{C;nd;ztc}$	kWh/m^2	16,2	11,3	8,6
	Energy need for domestic hot water	$EP_{W;nd;ztc}$	kWh/m^2	18,8	1,2	1,2
	Seasonal space heating energy efficiency	$\eta_{s;H}$	–	0,720	0,070	0,110
	Seasonal space cooling energy efficiency	$\eta_{s;C}$	–	1,000	0,360	0,340
	Seasonal domestic hot water energy efficiency	$\eta_{s;W}$	–	0,620	0,110	0,260
	Non-renewable energy performance per space heating	$EP_{H;nren}$	kWh/m^2	138,8	77,9	50,5
	Non-renewable energy performance per space cooling	$EP_{C;nren}$	kWh/m^2	13,6	12,5	7,3
	Non-renewable energy performance per domestic hot water	$EP_{W;nren}$	kWh/m^2	29,8	18,8	5,3
	Overall non-renewable energy performance	$EP_{gl;nren}$	kWh/m^2	177,0	77,4	51,2
	Overall renewable energy performance	$EP_{gl;ren}$	kWh/m^2	1,6	10,4	1,3
	Renewable Energy Ratio	RER	%	1%	4%	1%

Fonte: Geoportale del Comune di Torino (geoportale.comune.torino.it).

Patrimonio edilizio torinese

Informazione oggetto

Carta Tecnica colori

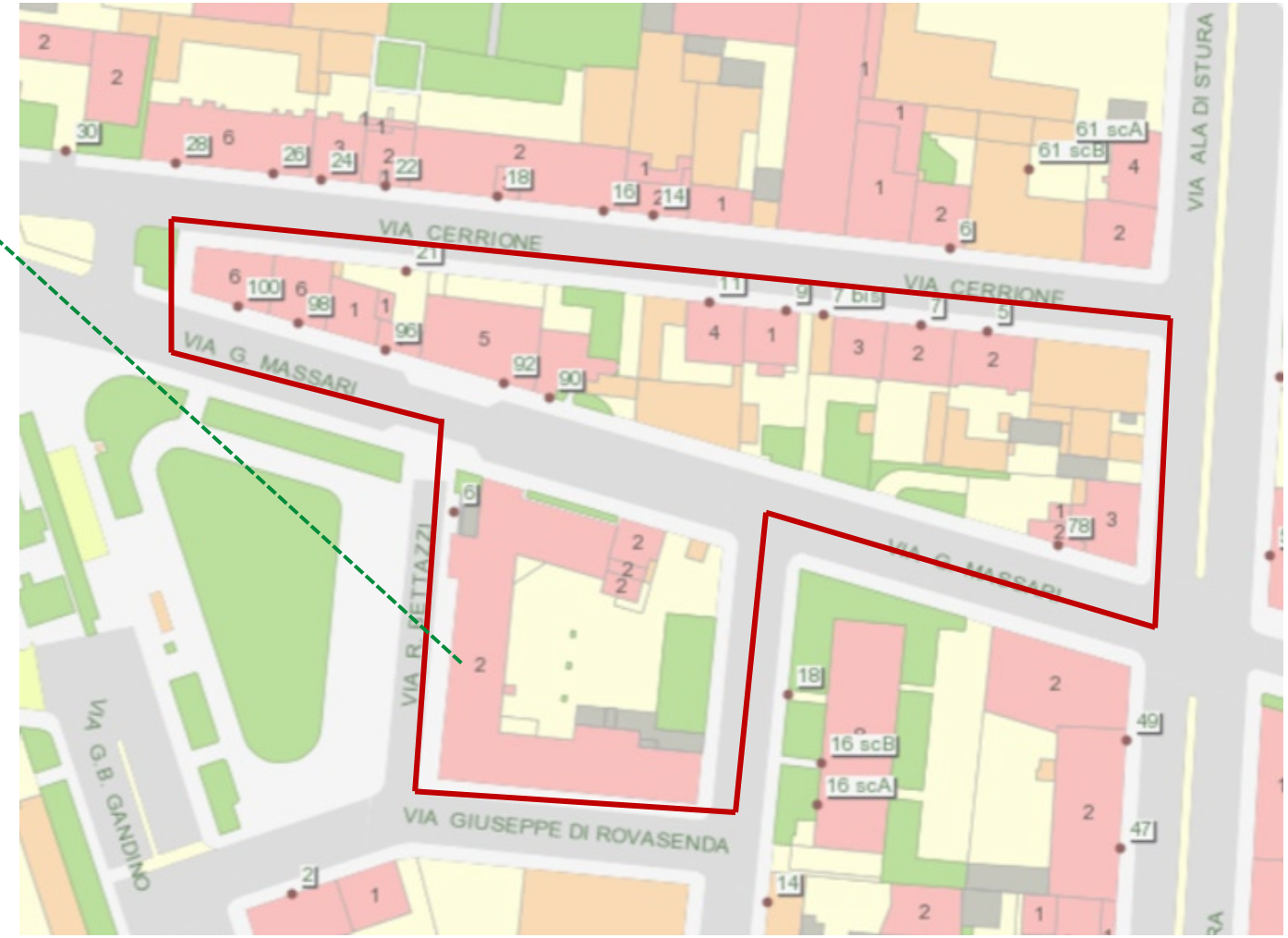
Livello	Carta Tecnica
codice_intesa	020102
gruppo	EDIFICI PRINCIPALI
descrizione	generica
categoria_uso	servizi - istruzione - sede di scuola
epoca_costruzione	non conosciuto
numero_piani	2
altezza_edificio	5.17
valenza_storica	non conosciuto
nome	SCUOLA D'INFANZIA E PRIMARIA
fondo	
materiale	
uso	

Zona climatica E

Scuola

???

???



Fonte: Geoportale del Comune di Torino (geoportale.comune.torino.it).

Patrimonio edilizio torinese

Informazione oggetto

Carta Tecnica colori

Livello	Carta Tecnica
codice_intesa	020102
gruppo	EDIFICI PRINCIPALI
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categoria_uso	servizi - istruzione - sede di scuola
epoca_costruzione	non conosciuto
numero_piani	2
altezza_edificio	5.17
valenza_storica	non conosciuto
nome	SCUOLA D'INFANZIA E PRIMARIA
fondo	
materiale	
uso	

Servizionline

SIPEE Sistema Informativo Prestazione Energetica Edifici

sei in: sistema piemonte » energia » sipee sistema informativo prestazione energetica edifici

- home del servizio
- » ricerca A.P.E.
- » ricerca certificatore
- Guida al servizio
- Contatti

Risultato ricerca A.P.E.

Un risultato trovato. pagina 1

	Codice A.P.E.	Indirizzo	Data Invio	Data Scadenza	Stato
○	2013 307558 0008	VIA RODOLFO BETTAZZI, 6 - TORINO - (TORINO)	16/03/2014	16/03/2024	Inviato

Un risultato trovato. pagina 1

stampa report

nuova ricerca

vedi sostituzioni

Dettaglio A.P.E.

Descrizione	Valore
DATI ANAGRAFICI IMMOBILE	
Codice A.P.E.	2013 307558 0008
Provincia	TORINO
Comune	TORINO
Zona climatica	E
Gradi giorno	2617
Indirizzo	VIA RODOLFO BETTAZZI,6

DATI TECNICI GENERALI	
Destinazione d'uso	E7
Tipo impianto	Autonomo
Tipologia dell'edificio	
Caratteristiche dell'edificio	
Edificio pubblico o ad uso pubblico	Si
Anno costruzione	1965

Zona climatica E

Scuola

1965

Fonte: SIPEE Sistema Informativo Prestazione Energetica Edifici (servizi.regione.piemonte.it).

Patrimonio edilizio torinese

Informazione oggetto

Carta Tecnica colori

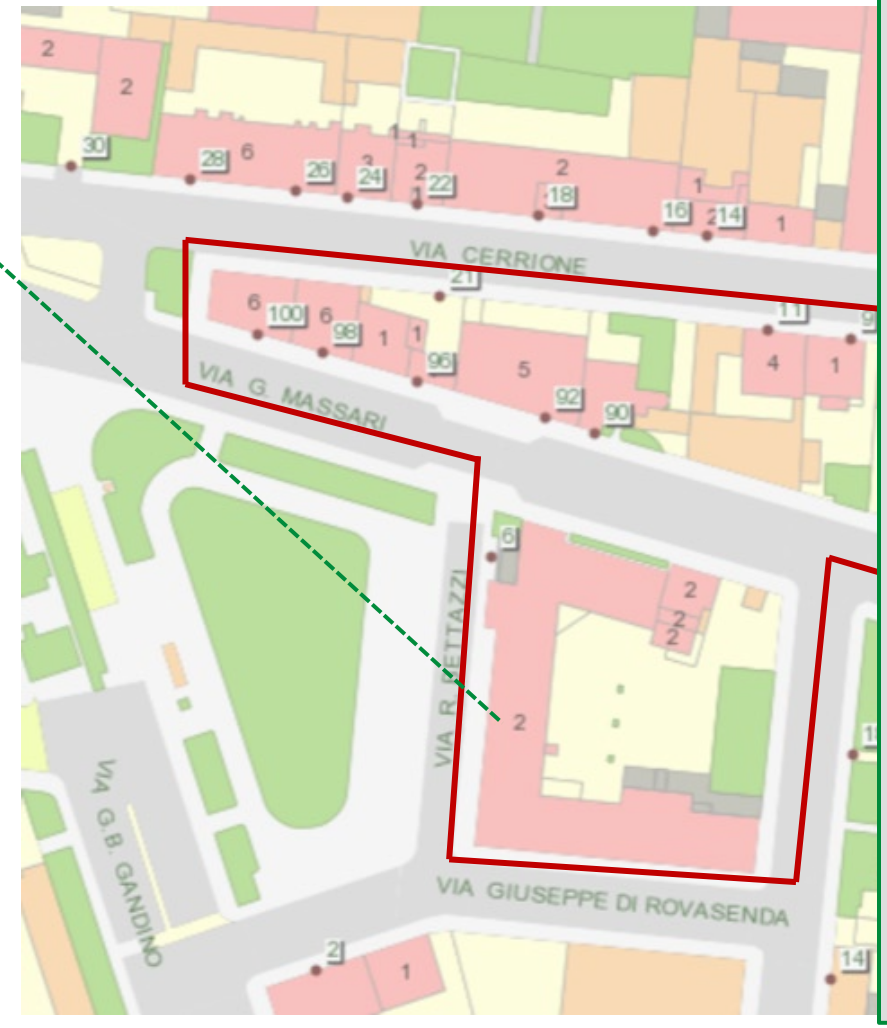
Livello	Carta Tecnica
codice_intesa	020102
gruppo	EDIFICI PRINCIPALI
descrizione	generica
categoria_uso	servizi - istruzione - sede di scuola
epoca_costruzione	non conosciuto
numero_piani	2
altezza_edificio	5.17
valenza_storica	non conosciuto
nome	SCUOLA D'INFANZIA E PRIMARIA
fondo	
materiale	
uso	

Zona climatica E

Scuola

1965

E_EDUC_CP5

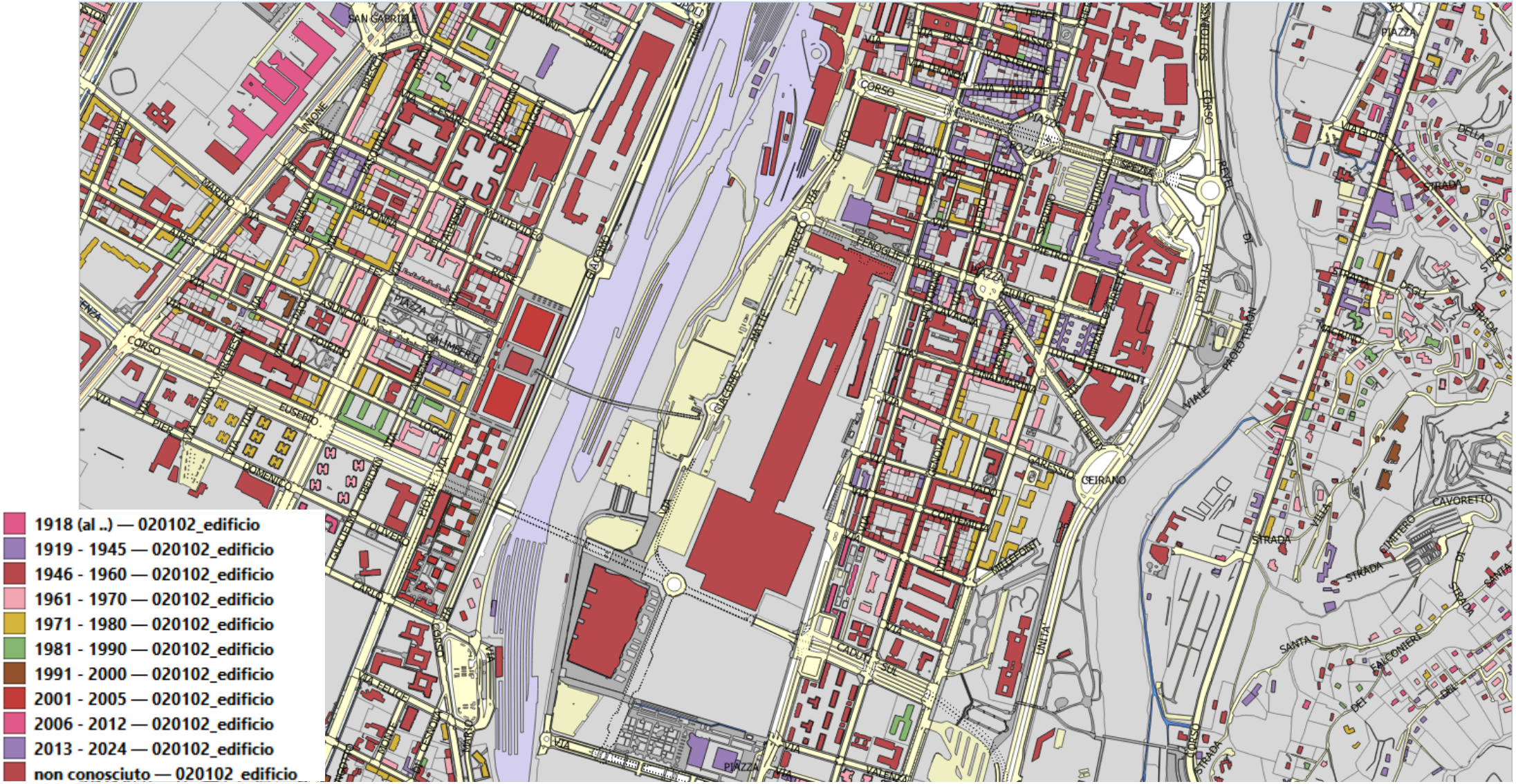


Source: Geoportale del Comune di Torino (geoportale.comune.torino.it).

PIEMONTE REGION EPC DATABASE - E_EDUC_CP5

	Data	Symbol	Unit of measure	Median	$(Q_3 - Q_2)$	$(Q_2 - Q_1)$
Geometry	Compactness ratio	CR	m^{-1}	0,451	0,119	0,060
	Thermally heated gross volume	$V_{H;g}$	m^3	8486	5710	4495
	Thermally heated floor area	$A_{H;use;ztc}$	m^2	1868	1294	930
	Transparent thermal envelope area on thermal envelope area	A_{wi}/A_{env}	%	10%	2%	3%
Envelope	Mean thermal transmittance of opaque building envelope	U_{op}	$W/(m^2 \cdot K)$	1,072	0,244	0,296
	Mean thermal transmittance of transparent building envelope	U_{wi}	$W/(m^2 \cdot K)$	3,219	1,043	1,261
Technical building system	Energy carrier per space heating	Natural gas = 79%; district heating = 14%; others = 7% (of the analysed sample)				
	Energy carrier per space cooling	Electricity = 98%; district cooling = 2% (of the analysed sample)				
	Energy carrier per domestic hot water	Electricity = 48%; natural gas = 44%; others = 8% (of the analysed sample)				
	Mean seasonal efficiency of the heating generation sub-system (natural gas)	$\eta_{H;gn}$	–	1,000	4,930	0,123
	Mean seasonal efficiency of the heating generation sub-system (district heating)	$\eta_{H;gn}$	–	0,980	2,763	0,022
	Utilisation energy efficiency	$\eta_{H;u}$	–	0,802	0,079	0,802
Energy indicators	Energy need for space heating	$EP_{H;nd;ztc}$	kWh/m^2	168,9	45,9	36,9
	Energy need for space cooling	$EP_{C;nd;ztc}$	kWh/m^2	4,6	19,0	4,0
	Energy need for domestic hot water	$EP_{W;nd;ztc}$	kWh/m^2	0,4	2,1	0,1
	Seasonal space heating energy efficiency	$\eta_{s;H}$	–	0,760	0,070	0,100
	Seasonal space cooling energy efficiency	$\eta_{s;C}$	–	0,875	0,235	0,293
	Seasonal domestic hot water energy efficiency	$\eta_{s;W}$	–	0,290	0,133	0,000
	Non-renewable energy performance per space heating	$EP_{H;nren}$	kWh/m^2	232,3	59,7	73,4
	Non-renewable energy performance per space cooling	$EP_{C;nren}$	kWh/m^2	18,5	0,9	17,9
	Non-renewable energy performance per domestic hot water	$EP_{W;nren}$	kWh/m^2	1,2	4,0	0,6
	Overall non-renewable energy performance	$EP_{gl;nren}$	kWh/m^2	258,8	68,7	60,7
	Overall renewable energy performance	$EP_{gl;ren}$	kWh/m^2	9,4	5,4	2,8
	Renewable Energy Ratio	RER	%	4%	2%	1%

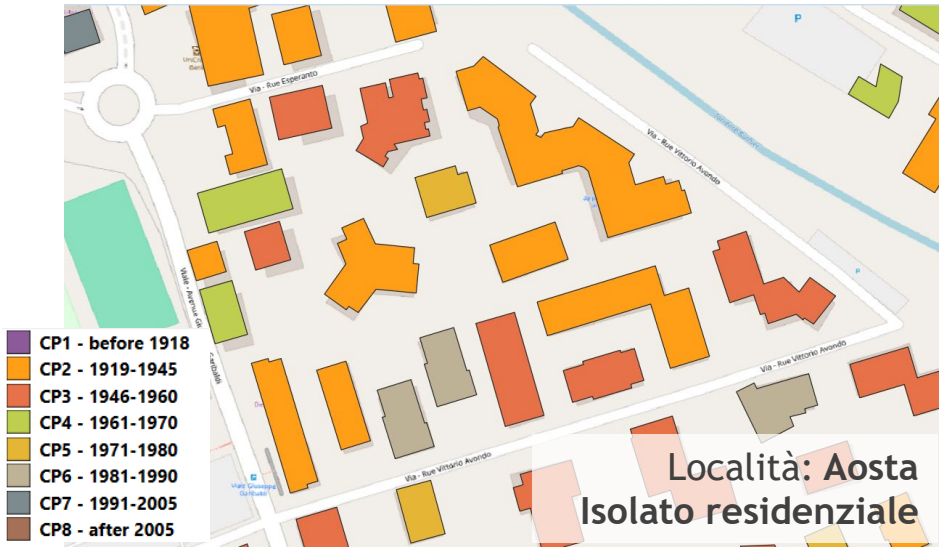
Patrimonio edilizio torinese



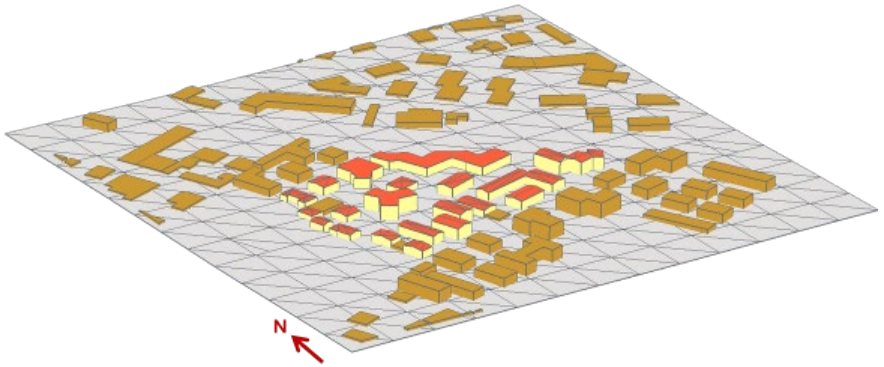
Fonte: Geoportale del Comune di Torino (geoportale.comune.torino.it).

… con un APE migliorato (1)

Regione Valle d'Aosta



*D'Alonzo et al. (2020). Energy and Buildings **206**.*



climatic zone E					
U_w [W m^{-2} K^{-1}]	1919 - 1945	1946 - 1961	1962 - 1971	1972 - 1981	1982 - 1991
Single glazing					
First quartile (Q_1)	3.958	3.926	4.178	4.317	4.232
Second quartile (Q_2)	4.514	4.670	4.764	4.970	4.619
Third quartile (Q_3)	4.920	4.980	4.980	5.000	4.980
Double glazing					
First quartile (Q_1)	2.543	2.541	2.600	2.667	2.570
Second quartile (Q_2)	2.726	2.728	2.777	2.838	2.786
Third quartile (Q_3)	2.870	2.933	3.000	2.931	2.901
Double glazing with gas					
First quartile (Q_1)	2.267	2.331	2.061	2.078	1.300
Second quartile (Q_2)	2.588	2.604	2.542	2.584	1.320
Third quartile (Q_3)	2.736	2.718	2.688	2.717	2.580
Double glazing with low-emissivity gas					
First quartile (Q_1)	1.400	1.385	1.401	1.363	1.390
Second quartile (Q_2)	1.603	1.609	1.630	1.599	1.480
Third quartile (Q_3)	1.810	1.899	1.850	1.842	1.655

Piro, M., Ballarini, I., and Corrado, V. (2024). Building archetypes supporting the national building renovation plan.

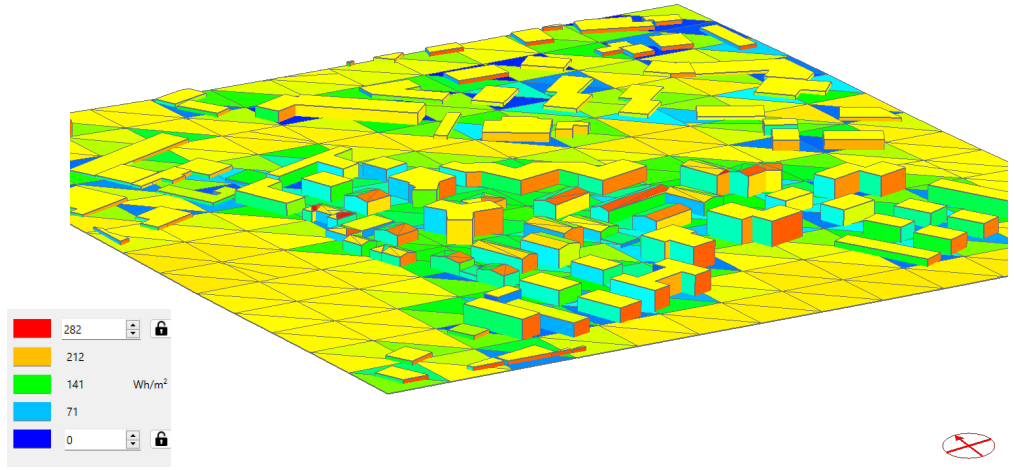
… con un APE migliorato (2)

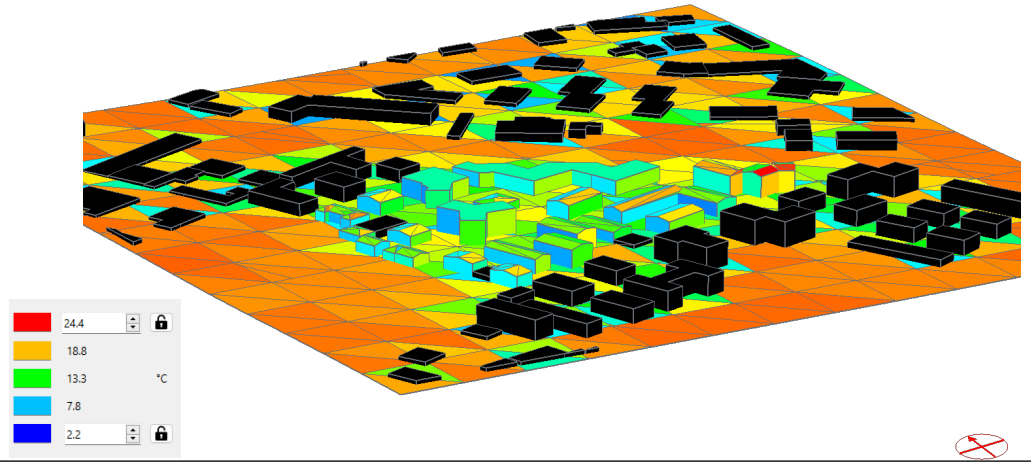
Regione Valle d'Aosta

SW irradiation

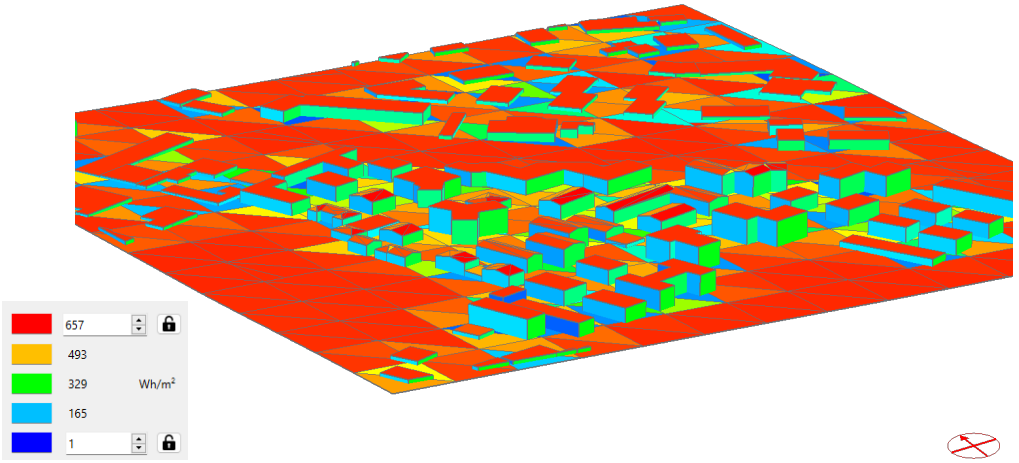
Surface temperature

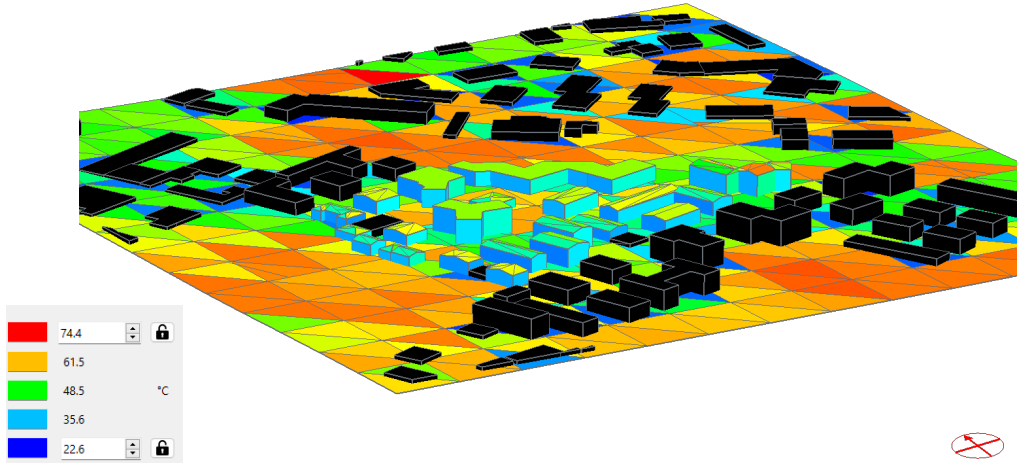
21 dicembre ore 12:00





21 luglio ore 12:00





Piro, M., Ballarini, I., and Corrado, V. (2024). Building archetypes supporting the national building renovation plan.

Pro

- **Migliorare** la **qualità delle informazioni energetiche** riguardanti il parco immobiliare pubblico e privato.
- ***Benchmark*** per definire la prestazione energetica ed ambientale del patrimonio edilizio.
- Archetipi edilizi come strumento per **monitorare** l'implementazione, il recepimento e l'aggiornamento di **piani di sviluppo nazionali** e **regionali**.

Contro

- L'APE è un documento con **limitate informazioni** energetiche e di **scarsa qualità**.
- Gli **archetipi edilizi** sono interamente costruiti a partire **dagli APE**.
- Il solo utilizzo dei dati estratti dagli **APE** non è sufficiente per soddisfare la mole di **input** necessari **richiesti da UBEM**. Pertanto, è necessario combinare diverse fonti informative: locali, regionali e nazionali.

Conclusioni

- Sviluppo di una **metodologia robusta** per valutare e utilizzare i dati degli APE a larga scala.
- L'**obiettivo** del progetto **TIMEPAC** è quello di creare l'APE di futura generazione che incrementerà l'affidabilità degli **archetipi edilizi**.
- La matrice di **tipologie edilizie** rivestirà un ruolo fondamentale nello sviluppo di **piani nazionali di ristrutturazione degli edifici**.

TIMEPAC The new EPC for Europe

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

matteo.piro@polito.it

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