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Energy poverty in Italy

Marta Castellini, Phd. (UNIPD, dSEA)

GRINS - Spoke 6 - WP2: Improving energy efficiency

Finanziato dall'Unione europea NextGenerationEU
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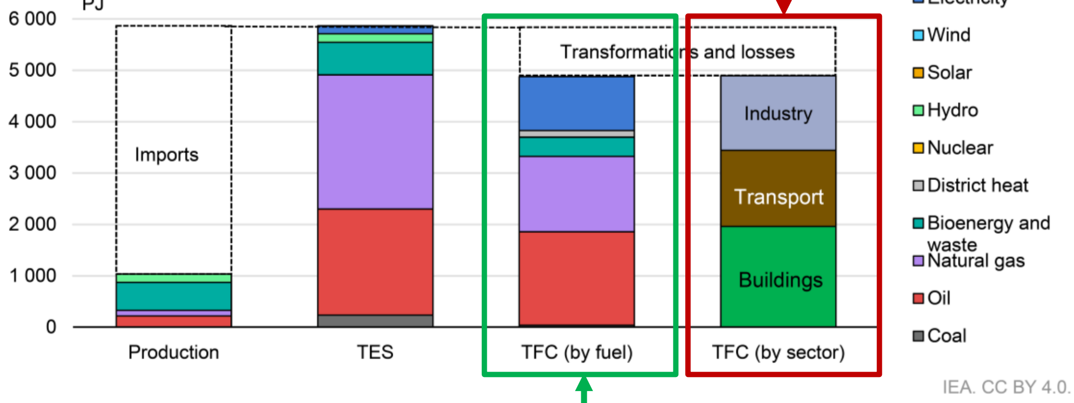
WP2 – Improving energy efficiency (greener building, energy poverty)

- **The total fuel consumption of buildings' sector in Italy was 40.1 % in 2021 (IEA, 2023).**

- It absorbs a **significant quota of total emissions** from energy use.

Energy production, supply and demand in Italy 2021



TES: total energy supply – TFC: total energy consumption

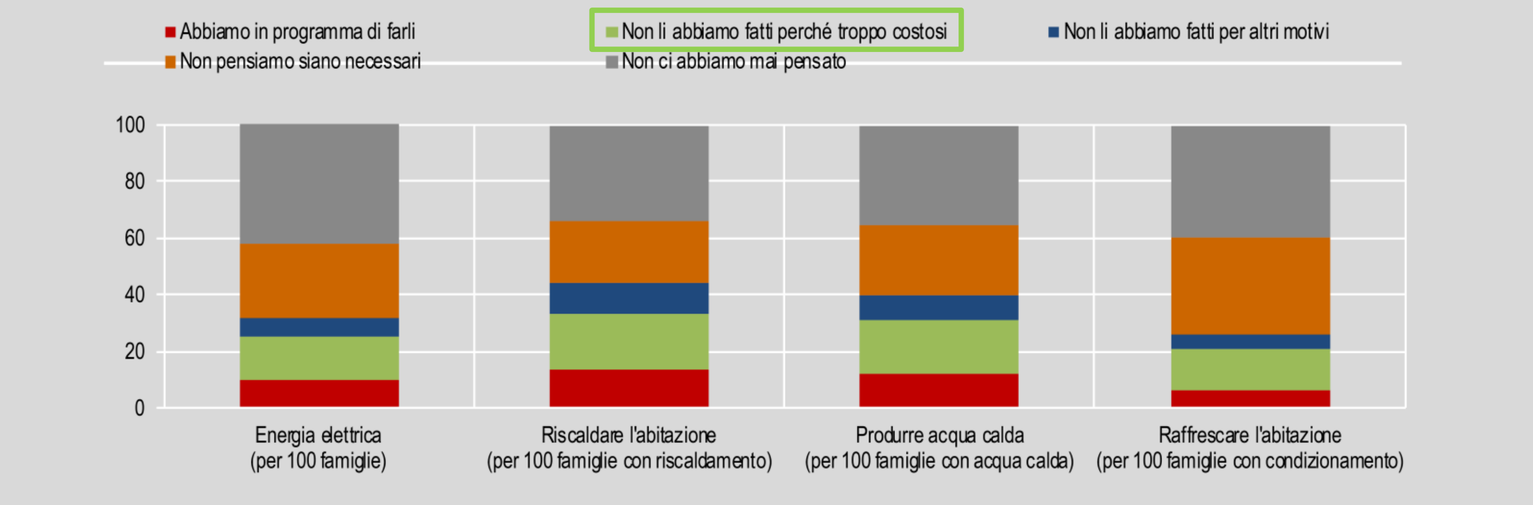
Fig. 2.1 Italy 2023 Energy Policy Review – International Energy Agency (May, 2023)

WP2 – Improving energy efficiency (greener building, energy poverty)

Improving building energy efficiency is key, but its costs could be **not always affordable**.

ISTAT 2022 Report CONSUMI ENERGETICI DELLE FAMIGLIE | ANNO 2021.

INTENZIONE DI EFFETTUARE INTERVENTI O INVESTIMENTI PER RIDURRE LE SPESE ENERGETICHE.



WP2 – Improving energy efficiency (greener building, energy poverty)

This is particularly true for **vulnerable households** being often **financially constrained**, **and/or** because they are **tenants of privately or publicly owned dwellings**.

Some figures on **Italy**:

- **Italians who own their homes in 2021: 71%** (Federproprietà & Censis, 2022) to more than **73%** (Eurostat).
- **Of 20% of households with the lowest economic resources**, **50% own the dwelling in which they live** (Federproprietà & Censis, 2022).
- EU-SILC Survey (Eurostat): by the application of the ***at-risk-of-poverty threshold filter*** when visualizing in the **EU-SILC survey** set "**Distribution of population by tenure status, type of household and income group**" for **Tenure status: Owner, the** share is **56.2%**.

WP2 – Improving energy efficiency (greener building, energy poverty)

The WP will focus on the design of win-win **building energy efficiency policies** that

- ✓ will reduce carbon emission and
- ✓ **will fight energy poverty**

Contribution of the research line of WP on energy poverty	
Visualization of indicators/measurements for energy poverty at different territorial levels	**Survey on vulnerable households living in public housing to test their willingness to pay for improving buildings' energy efficiency**

Energy poverty in Italy: definition

Energy Poverty can be defined as:

- the **difficulty** for a household of purchasing a **minimum set of energy goods and services** or **access to energy** services
- that implies **a diversion of resources**, in terms of expenditure or income, **higher than a normal value**

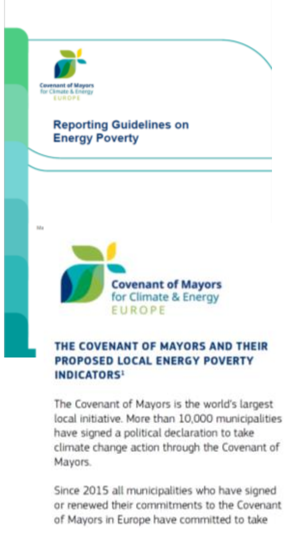
National Energy Strategy, 2017

National Energy and Climate Plan, 2019

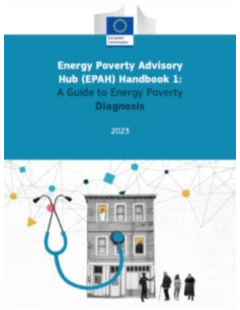
Photo: Energy Poverty in South East Europe - Surviving the Cold

Energy poverty in Italy: an overview

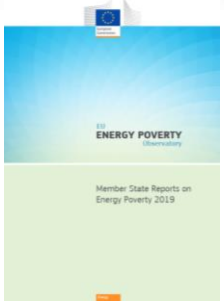
2008 – Unione dei Sindaci



2021 – PE Advisory Hub



2016 - Osservatorio Europeo PE



2014 – Banca d'Italia

2019 – Rapporto OIPE

- ISTAT -

2022

2023

Energy poverty in Italy: an overview

Policy measures change if these **vulnerable households are tenants** and if they are **living in private or public owned houses.**

Focus public residential building

- Design of a **survey** to understand the **willingness to adopt responsible energy-consumption** behaviors as well as for the **improvements in buildings' energy efficiency for vulnerable households living in public owned houses.**
- Interviews will be performed in **different areas across Italy**
- **Analysis** of outcomes and **policy recommendations**


Istat

INDAGINE
SUI CONSUMI ENERGETICI DELLE FAMIGLIE

Anno 2021

Guida al Questionario online

Italy Stakeholder Surveys
Italy Consumer Surveys
(132 questionnaire)

Popolazione 18 - 65 anni (1.228 interviste rappresentative della popolazione italiana Ottobre – Novembre 2021, Online)

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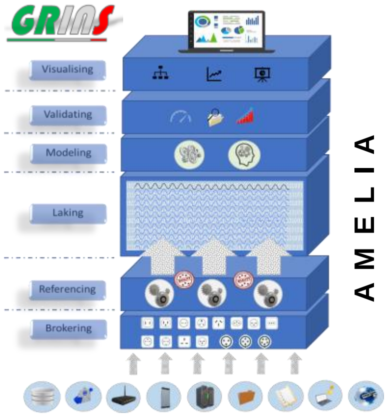
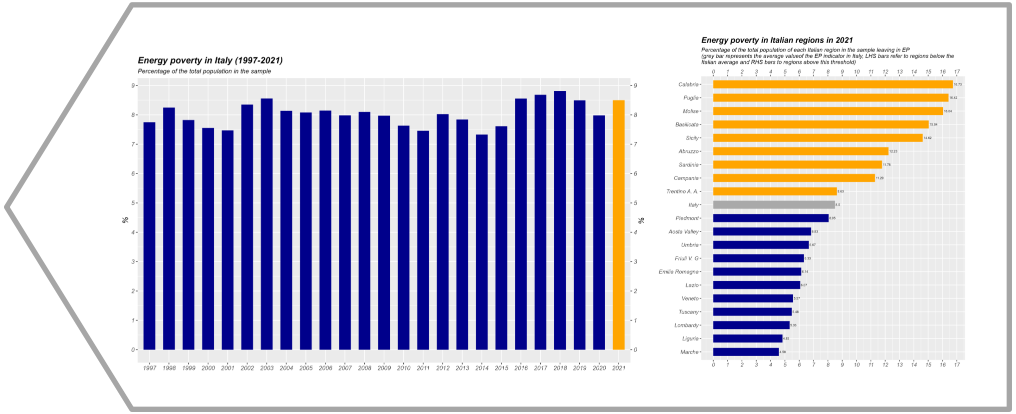
Energy poverty in Italy

- **From diagnosing energy poverty to planning** related targeted **interventions**, there is a need to harness **the effective use of indicators, also at local level.**
- Such **tools** and their **results** need to be **easily accessible to different audiences**.





Energy poverty in Italy: measurement

How can you fight it, if you can't measure it? *(quote from Faiella and Lavecchia, 2021)*

- The ***consensus-based measures* are widely used** due to the availability of data sources (i.e **EU-SILC survey data**).
- However, they can lead to **biased pictures** as they are based on data collected by asking questions about the **perceived adequacy** of the **home temperature**, so leading to **confusion** in terms of objective **needs** and **individual preferences**.
- **Questions** in the EU-SILC survey could be **too vague** to elicit conscious and effective feedback

Approach	Rationale	Energy Poverty Metrics		Strength / weakness
Expenditure-based	Expenditure-based metrics capture affordability of adequate energy services for those on low income. ('Adequacy' only captured if using 'required' expenditure)	Expenditure on household energy services above a share of total income after ensuring comparability e.g. household occupancy and 'after housing costs' to adjust household income	• Share of required expenditure on energy services relative to disposable income above twice the national median in the year, across the period of years, or fixed at 10% for the lowest income group • Actual[1] expenditure on energy services of disposable income above twice the national median in the year, across the period of years, or fixed at 10% for the lowest income group	✓ Captures key features of energy poverty ✓ Applied / tested in a number of MS ✓ Capture severity by use of different thresholds - Problematic to implement across all MS - Sensitive to energy price rises
Consensual-based	Self-reported indicators can provide an effective way of understanding perceived energy poverty and more explicit insights than quantitative metrics. This family of indicators could be a 'backstop' or complementary to other indicators.	Self-reported inability to adequately cool/ heat household, by income group	• Proportion of inhabitants unable to keep home adequately warm (HH050) per income quintile • Proportion of inhabitants who are living in a dwelling not comfortably cool in summer per income quintile • Population living in a dwelling with leaking roof or damp walls, etc. by income group per income quintile	✓ Main basis to date for assessment ✓ Can be used as a complementary indicator (FR, BE examples) ✓ Survey infrastructure in place, just needs improvement (see Thomson) - May not adequately allow for effective quantification - Survey may not have any associated income dimension
		Self-reported arrears	• HS020 Difficulty to pay utility bill per income quintile	
Outcome-based	This family of indicators provides a proxy for energy poverty based on outcomes. There are two possible approaches - using utility data or focus on health outcomes	Health outcomes (increased mortality)	• Cold related mortality (in lower income groups) per income quintile	✓ Measure of actual outcomes - Narrow proxy measure - Many different factors impact health outcomes in addition to energy poverty

Table1.1 Overview of energy poverty metrics
Selecting Indicators to Measure Energy Poverty- Annex 4, Trinomics (2014)
Pilot Project 'Energy Poverty – Assessment of the Impact of the Crisis and Review of Existing and Possible New Measures in the Member States

Energy poverty in Italy: selected measurement approach

- EP Measure based on **Faiella and Lavecchia (2014, 2015, 2021)** yearly estimated by **OIPE,** reported in SEN (2017) and PNIEC (2019), IEA-Italy assessment (2023).
- **Low-Income High Costs** (LIHC) approach designed for the UK by Hills (2011, 2012).
- It refers to the **energy vulnerability** as the condition in which "access to energy services means foregoing other resources (in terms of expenditure or income) to an abnormal extent".
- **Hidden energy poverty** is considered: zero heating expenditure and equivalent expenditure below the median value.
- **Database:** Istat data on family expenditure (year) (Indagine sulle spese delle famiglie: microdati)

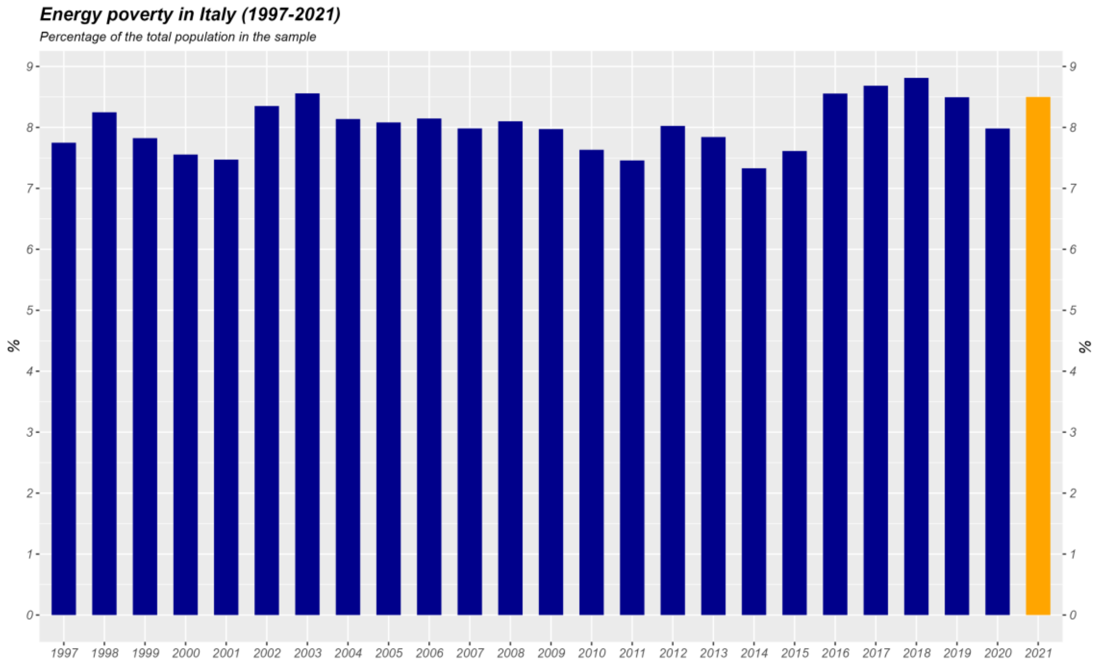
$$\eta_3 = \frac{1}{n}\sum_{i=1}^{n} w_i \left\{ \mathbb{I}\left[\frac{s_{ie}^{eq}}{S_i^{eq}} > 2 \left(\frac{\sum_{i=1}^{n} s_{ie}^{eq}}{\sum_{i=1}^{n} S_i^{eq}} \right) \right] \cdot \mathbb{I}\left[(s_i - s_{ie}) < s_J^* \right] \cup \left[\mathbb{I}\left(s_i^r = 0\right) \cdot \mathbb{I}\left(S_i^{eq} < P50_t\left(S_i^{eq}\right)\right) \right] \right\}$$

high energy costs incidence of energy expenditure more than twice the annual average

low expenditure when the energy expenditure of the household is subtracted from its total one, it spends less than the threshold on which the country's official measure of relative poverty is based.

hidden energy poverty: zero heating expenditure and equivalent expenditure below the median value

Energy poverty in Italy: results' visualization



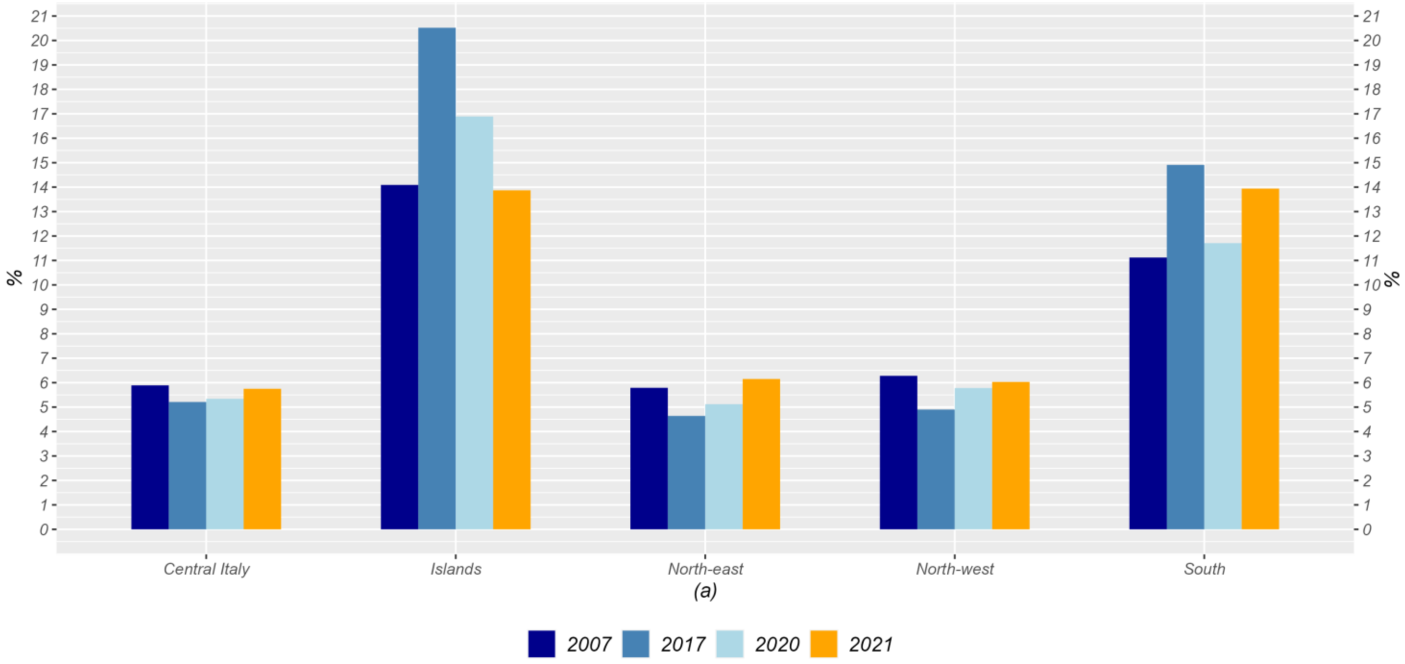
2021

- **2.2 million families** were in **energy poverty** (+125 thousand wrt 2020)
- **8.5% of Italian families**,
- an **increase** that completely **offsets the decrease** recorded in **2020**
- Vs Eurostat: 8.1% Italians unable to keep their homes adequately warm (EU-SILC survey)

Source: OIPE elaboration on Istat data on family expenditure (2021)

Energy poverty in Italy by area (a) and municipality type of municipality (b)

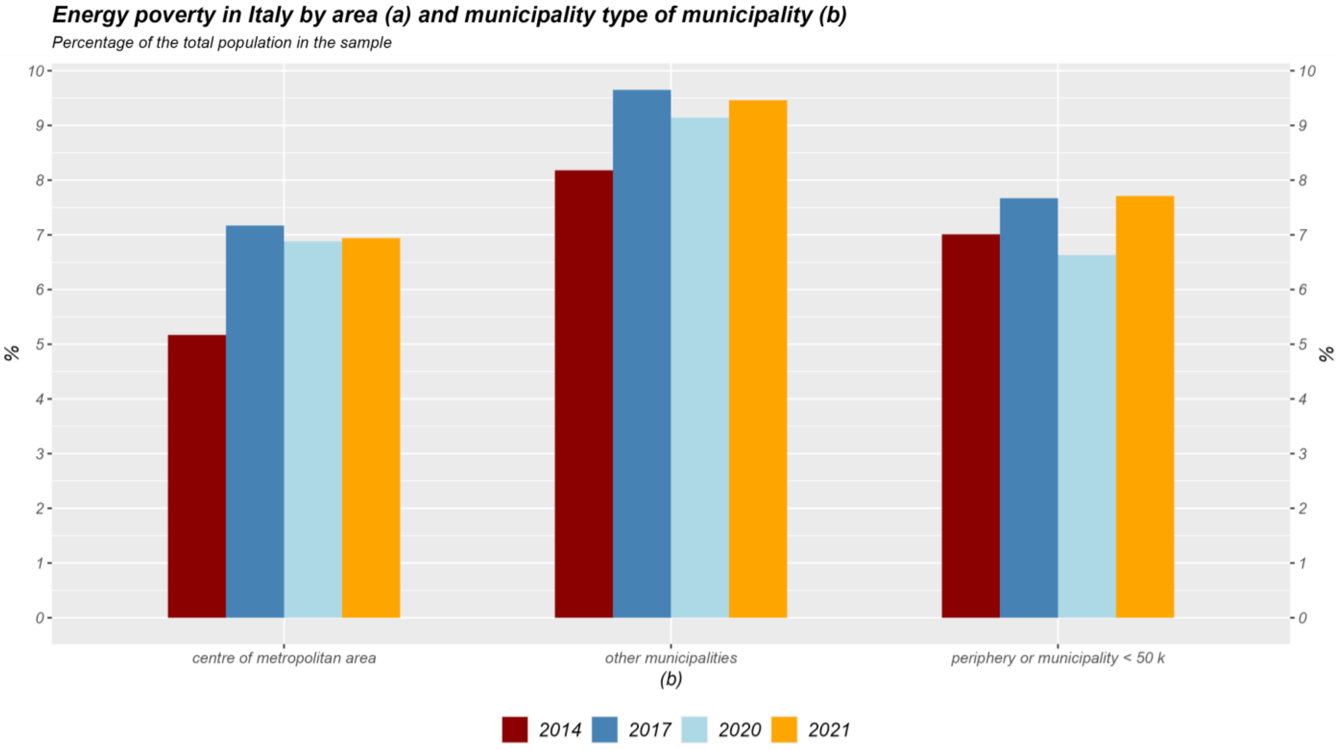
Percentage of the total population in the sample



2021

- **reduction in the Islands**, (mild winter compared to the past 30 years)
- **increase in other macro areas**, particularly in the south and north-east of Italy

Source: OIPE elaboration on Istat data on family expenditure (2021)



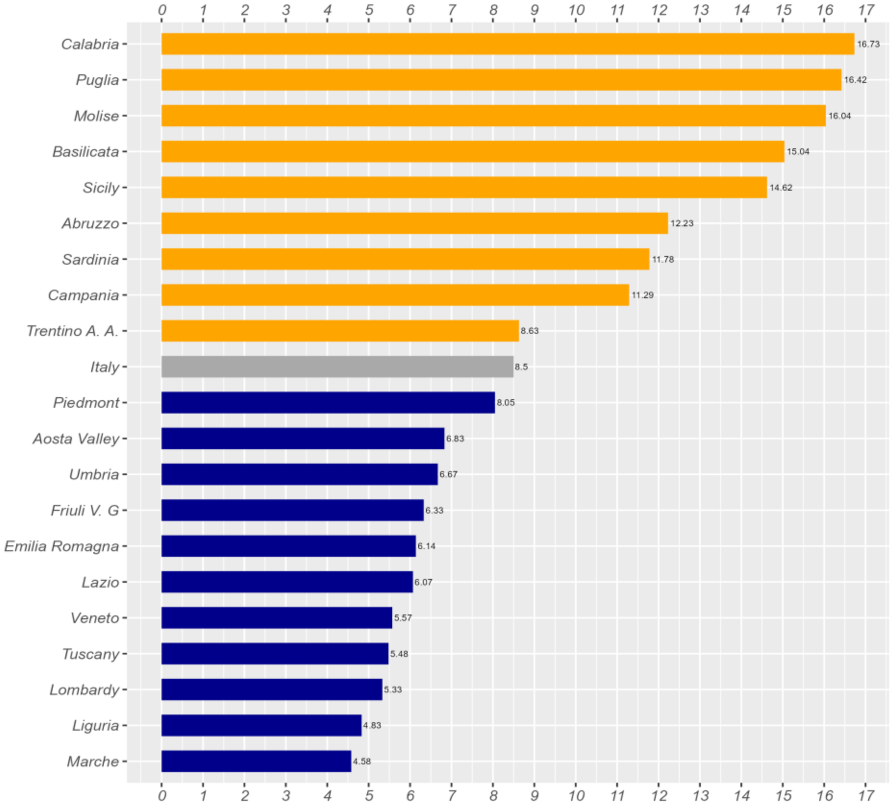
<u>2021</u>

- Households living in **small municipalities** (< 50 thousand inhab.) and **suburban areas** are the **most affected by EP**.
- In **large cities**, EP was **unchanged**

Source: OIPE elaboration on Istat data on family expenditure (2021)

Energy poverty in Italian regions in 2021

Percentage of the total population of each Italian region in the sample leaving in EP (grey bar represents the average valueof the EP indicator in Italy, LHS bars refer to regions below the Italian average and RHS bars to regions above this threshold)



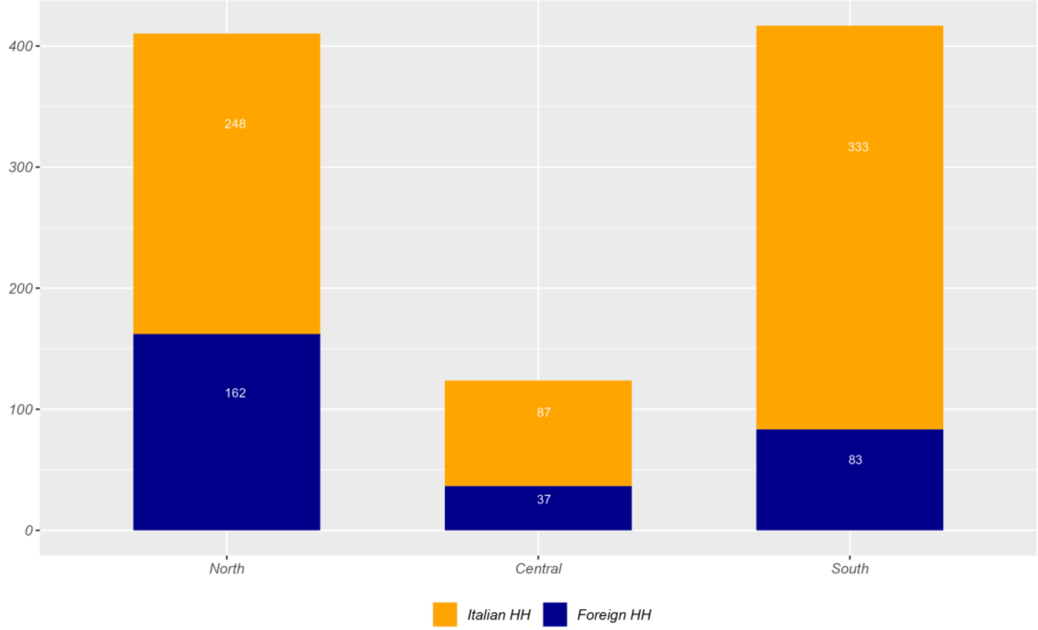
2021

- EP ranged from **4.6%** in the **Marche (min)** and **16.7%** in **Calabria (max)** regions
- The **greatest increase** with **respect to 2020** was **Puglia (+5.5%)**, followed by **Molise (+4.3%).**
- The islands recorded the sharpest **decrease** are **Sicily (-3.5%)** and **Sardinia (-1.8%),** due to a particularly mild winter.
- The grey bar is the **national average (8.5%)**

Source: OIPE elaboration on Istat data on family expenditure (2021)

Number of minors in energy poverty by citizenship of the head of the household (HH) and by area of residence (2021)

Source: processing of Istat data on family expenditure.



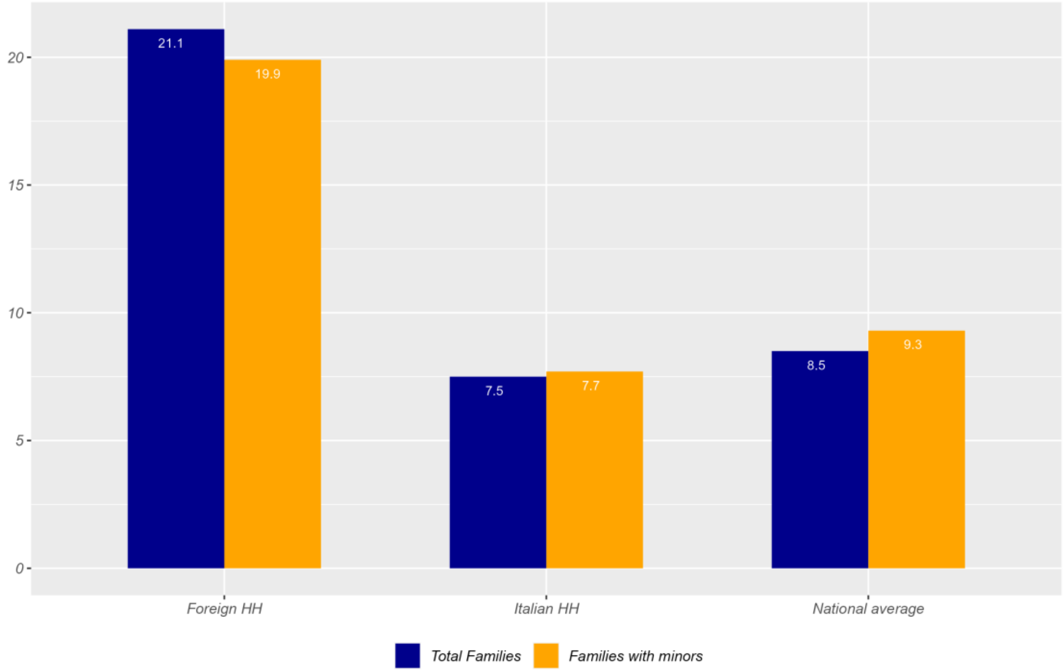
2021 – Thematic focus on minors and citizenship

- Over **a quarter of households in EP** had at least **one minor**
- **583 thousand households in EP** include **950 thousand minors**
- This minors live in unhealthy environments, with **poor heating/lighting and/or insufficient fresh air**.

Source: OIPE elaboration on Istat data on family expenditure (2021)

Families in energy poverty according to citizenship of the head of the household (HH) (2021)

Source: processing of Istat data on family expenditure



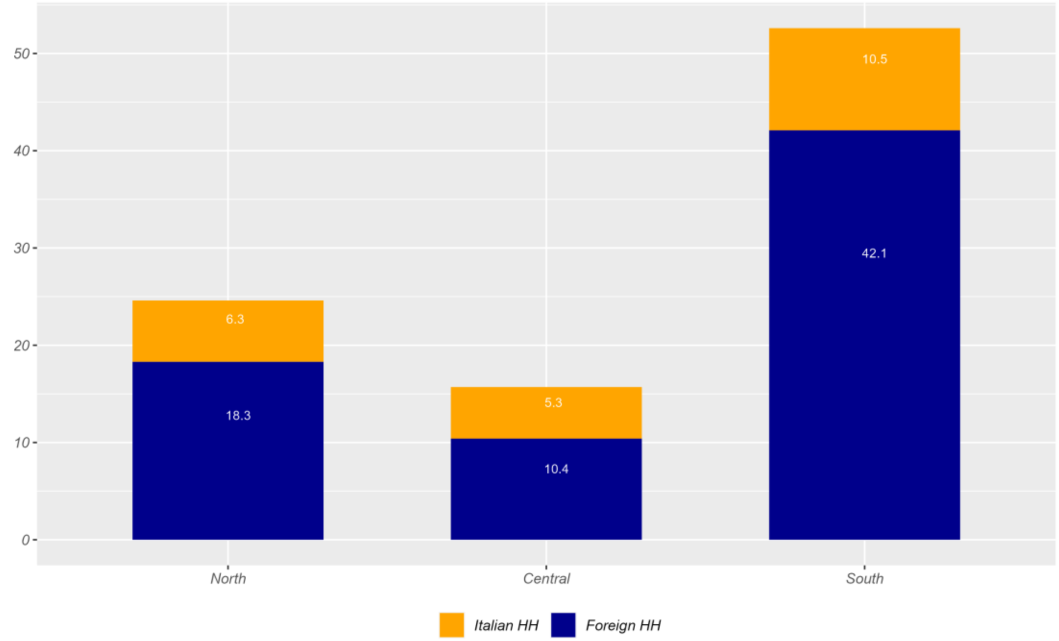
2021 – Thematic focus on minors and citizenship

- The **number of minors in EP** is significant **in families** with a **head of household** (respondent in the survey) who is **not an Italian citizen** ("foreign families" - about 1.9 million).
- the **EP rate in families with minors was 2.5 times higher in foreign households** (about 162 thousand families)

Source: OIPE elaboration on Istat data on family expenditure (2021)

Families with minors in energy poverty by citizenship of the head of the household (HH) and by area of residence (2021)

Percentage of families with minors in EP. Source: processing of Istat data on family expenditure



2021 – Thematic focus on minors and citizenship

- **The rate of families with minors in energy poverty and a foreign head of household is over 4 times higher in the south**

Source: OIPE elaboration on Istat data on family expenditure (2021)

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Energy poverty in Italy

Energy poverty in Italy in 2021:

- enters ***public debate***,
- ***increase in the phenomena***

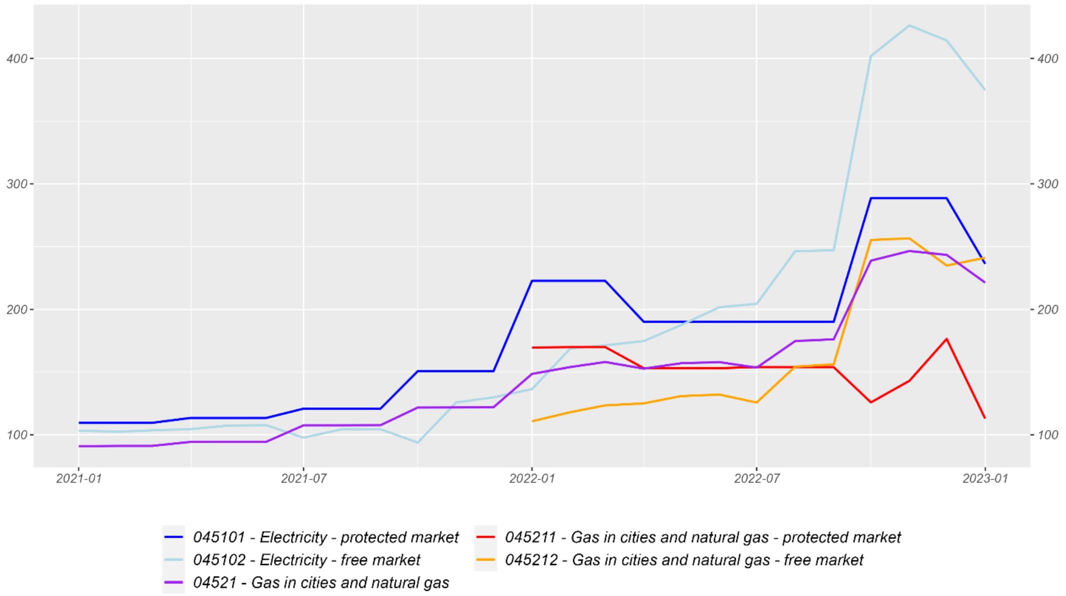
driven by the drastic increase in the Italian prices of electricity and gas beginning in the second half of 2021

Energy poverty in 2022:

analysis in progess, ISTAT data published on October, 18, 2023.

Trend in the consumer prices of electricity and gas

Index numbers 2015 = 100 - Source: Istat, consumer prices for the entire collectivity (National price index).Monthly data, Ecoicop classification (5 digits). There has been a distinction between the free market and the protected market for gas since January 2022.



Energy poverty in Italy: critical issues

- **Energy poverty in 2021 (8.5% of the Italian population)** to return to the level of 2019, after the improvement in 2020.
- The need for a **structured national policy recognized** at government level (NECP, 2023).
- Need of an **agreement on a national definition and measure**. This task has been assigned to the National Observatory on Energy Poverty (ONPE), established in 2022 (NECP, 2023).

Energy poverty in Italy: critical issues

Precondition 1 : availability of data for rigorous measurement and analysis of the phenomenon.

- Data on electricity and natural gas consumption of all Italian households and businesses are archived through the Sistema informativo integrato (SII) managed by Acquirente Unico, a public company, but ***access is currently not possible*** (Colabella et al. , 2023).

Precondition 2 : careful assessments of what measures can be promoted and developed.

- UK measure fuel poverty referring to the **Low Income Low Energy Efficiency (LILEE)** principle.
- In Italy databases collecting ***information contained in the Energy Performance Certificates (EPC) of buildings*** are managed in a heterogeneous way across regions and only few of them allow for the open access to these data.
- The aggregated database of EPC is managed by ENEA. At the time of writing***, it is not possible to access to it, even for research.***
- The availability of EPC data, combined with the matching of households' consumption ones with information in the national cadastre, could ***significantly improve the assessment of EP***.

Energy poverty in Italy: policy

Electricity and Gas Social Bonuses in 2021.

- More data are needed for their evaluation
- In 2021 significant ***changes were made concerning terms of eligibility*** (automatic eligibility in 2021 vs eligibility application to be submitted to obtain the contribution)
- The ***variation of ISEE criteria***, led to the exclusion of vulnerable households with ISEE higher of the threshold by few euros
- ***Households with district heating are excluded*** from the possibility of accessing to the gas bonus.

Final remarks

Data from **new survey** and **existing data** from the **national regulator**, **local authorities** and the **Italian Statistical Office** are needed to be merged **to study the effect of these bonuses**, and their better implementation (next steps in this research line).

Thank you for your time

This presentation contains contributions from the following authors:

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J. Vivian, A. Zarrella, M. Coppo L. Carnieletto, W. Pasut
Padova, 20/11/2023

UNIVERSITÀ DEGLI STUDI DI PADOVA

Università Ca'Foscari Venezia

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Calculating the energy consumption of the Italian residential building stock

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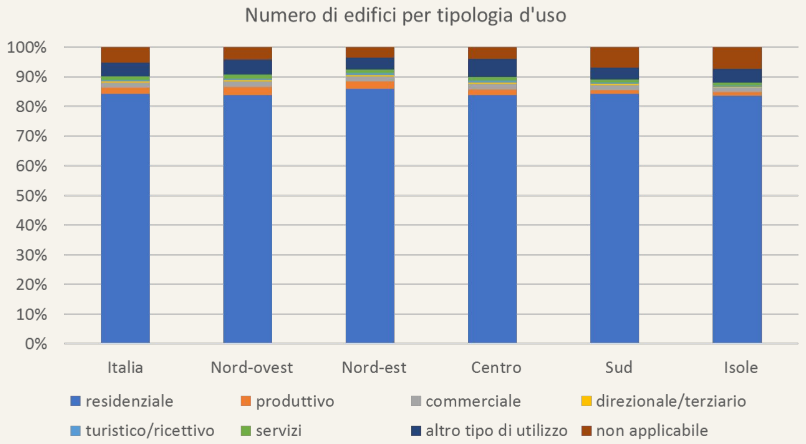
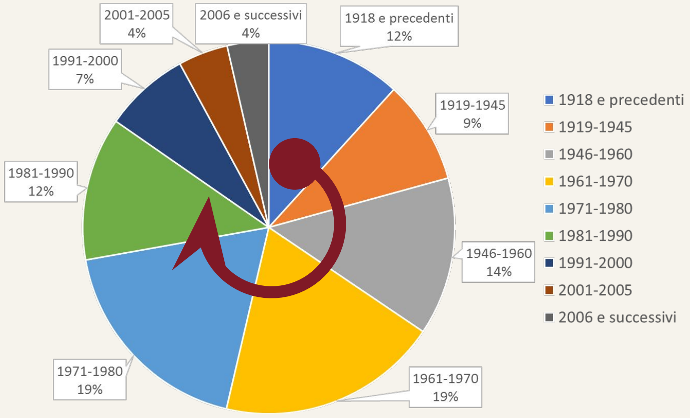
Context

Italian buildings in numbers





Objective

A tool for policy-makers


Servizio | Ue

Case green, direttiva verso l'accordo. Priorità ai lavori su 5 milioni di edifici

La novità più importante, in queste settimane, è arrivata sull'articolo 9 della cosiddetta Epbd (Energy performance of buildings directive). Nella versione del Parlamento qui veniva ipotizzato, per gli edifici residenziali, l'obiettivo di raggiungere la classe energetica E nel 2030 e D nel 2033. Questo approccio, adesso, viene superato. E si punta su un sistema di regole aperto, nel quale diventa fondamentale il ruolo dei paesi membri, che avranno maggiore discrezionalità

di Giuseppe Latour

19 novembre 2023

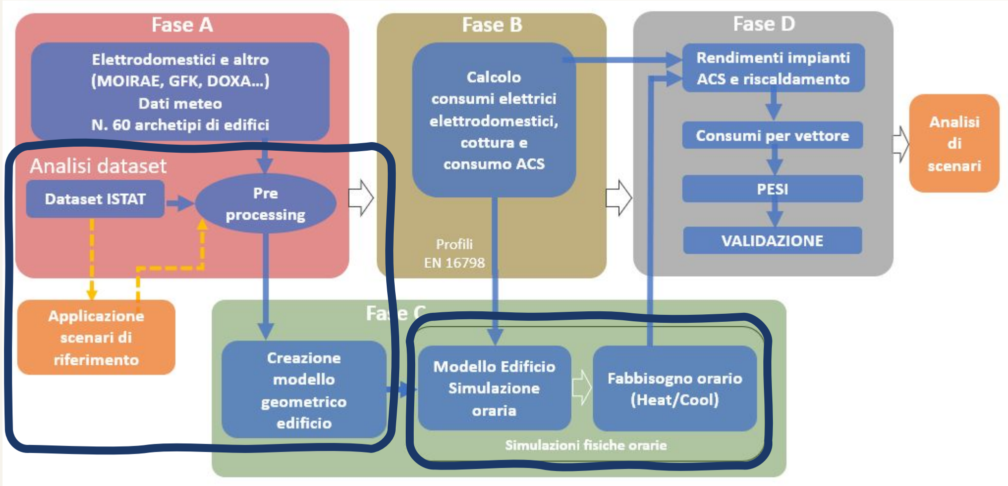
The **main objective** is to develop a tool to help evaluate building-related energy policy choices on a national level.

Some **research questions** are:

- How much do residential buildings contribute to the national energy consumptions and emissions?
- To what extent will climate change and user habits affect such energy consumption and emissions?
- To what extent do current and future energy policies (e.g., different incentives on building retrofits) help reduce such energy consumption and emissions and achieve energy efficiency targets?

Methods

A physics-based, bottom-up modelling approach



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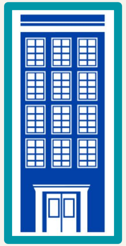
Methods

Archetype definition

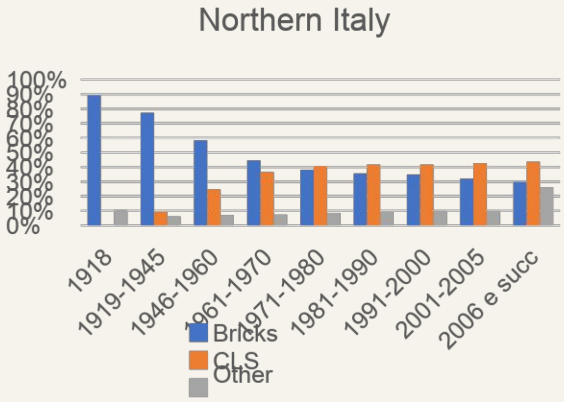


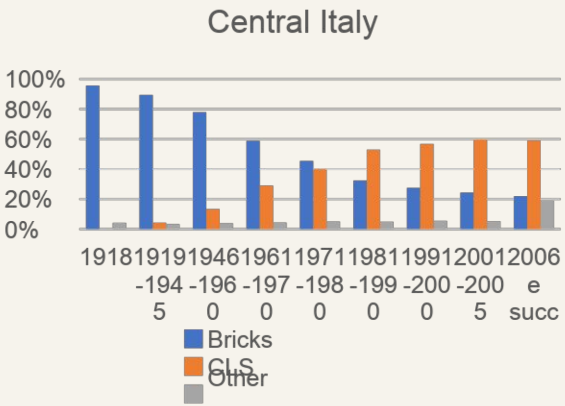
Multi family buildings (small apartment blocks)

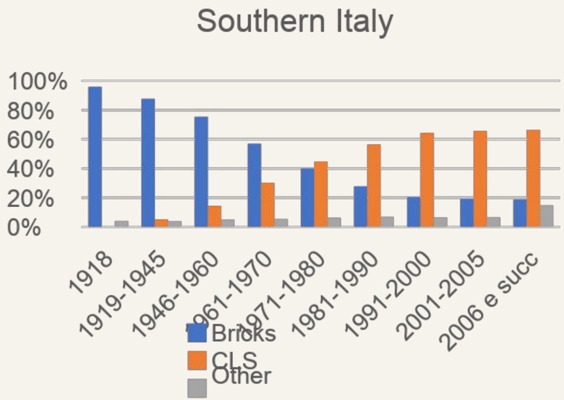
Single family houses

Methods

Archetype definition







Methods

Archetype definition

		Type of wall	Zona E	U-value W/(m2 K)	C (kJ/m2)
Before 1930		Roof	wood roof - non insulated	2.80	56.76
		External wall	Solid bricks/Stone walls	2.58	560.76
		Ground floor	Concrete ground slab	1.75	696.3
		Internal floor/Ceiling	beams-wooden slab	1.80	140.52
1930-1945		Roof	wood roof - non insulated	2.80	56.76
		External wall	Solid bricks	1.57	810.76
		Ground floor	Concrete ground slab	1.75	696.3
		Internal floor/Ceiling	beams-wooden slab	1.80	145.02
1945-1960	1	Roof	hollow bricks/wood	2.00	185.94
Traditional	1	External wall	llow wall, solid brick masonry (Mur.cassa vuota) or solid bricks (muratura a 3 teste)	1.57	624.76
Prefabricated	1	External wall	concrete blocks	0.90	600.76
	1	Ground floor	Concrete ground slab	1.75	696.3
	1	Internal floor/Ceiling	steel beams and hollow bricks (Tavelle e travetti)	1.72	188.52
1961-1970	1	Roof	Brick-concrete structure (20 cm) + tiles	1.93	226.68
Traditional	1	External wall	hollow wall (with hollow bricks) masonry	1.52	810.76
Prefabricated	1	External wall	cinder blocks	1.22	600.76
	1	Ground floor	Concrete ground slab, traditional screed	1.75	696.3
	1	Internal floor/Ceiling	conrete slab, no insulation	1.79	833.50
1971-1980	2	Roof	Brick-concrete structure (20 cm) + tiles	1.93	226.68
Traditional	2	External wall	concrete frame and brick masonry	1.45	604.76
	2	Ground floor	Concrete ground slab, lightweight screed	0.96	1240.30
	2	Internal floor/Ceiling	Predalles (30 cm)	1.19	155.50
1981-1990	2	Roof	Brick-concrete structure (24 cm) + tiles	1.67	322.68
Traditional	2	External wall	hollow wall (with hollow bricks) masonry	0.98	450.83
Prefabricated	2	External wall	concrete frame and brick masonry		
	2	Ground floor	Concrete ground slab, lightweight screed	0.85	1282.30
	2	Internal floor/Ceiling	brick-concrete ground slab (16 cm),no insulation	1.37	331.5
1991-2000	2	Roof	Brick-concrete structure (24 cm) + tiles	1.67	322.68
Traditional	3	External wall	hollow wall (with hollow bricks) masonry	0.62	696.83
Prefabricated	3	External wall	concrete frame and brick masonry		
	3	Ground floor	Concrete ground slab, traditional screed, low insulation (5 cm)	0.67	410.93
	3	Internal floor/Ceiling	brick-concrete ground slab, traditional screed (6 cm),no insulation	1.20	519.50
2000-2005	3	Roof	Brick-concrete structure (24 cm) + tiles, insulated (5 cm)	0.58	571.31
Traditional	3	External wall	hollow wall (with hollow bricks) masonry, low insulation (3 cm)	0.48	697.27
Prefabricated	3	External wall	concrete frame and brick masonry, low insulation (3 cm)		
	3	Ground floor	Concrete ground slab, traditional screed, low insulation (8 cm)	0.52	411.66
	3	Internal floor/Ceiling	brick-concrete ground slab, traditional screed (6 cm),low-insulation (5cm)	0.53	371.33
2005-2014	3	Roof	Brick-concrete structure (24 cm) + tiles, insulated (10 cm)	0.35	573.14
Traditional	4	External wall	hollow wall (with hollow bricks) masonry, medium insulation (8 cm)	0.38	603.32
Prefabricated	4	External wall	concrete frame and brick masonry, medium insulation (8 cm)		
	4	Ground floor	ventilated slab (vespaio areato) , insulated (10 cm)	0.39	412.76
	4	Internal floor/Ceiling	brick-concrete ground slab, lightweight screed (10 cm),low-insulation (5cm)	0.49	421.33
2015-2020	4	Roof	Brick-concrete structure (24 cm) + tiles, insulated (12 cm)	0.31	573.87
Traditional	4	External wall	Brick blocks, insulated (12 cm)		
Prefabricated	4	External wall	concrete frame and brick masonry, medium insulation (12 cm)	0.26	605.15
	4	Ground floor	ventilated slab (vespaio areato) , insulated (12 cm)	0.33	413.49
	4	Internal floor/Ceiling	brick-concrete ground slab, lightweight screed (6cm), insulated (8cm)	0.42	386.06
After 2020	4	Roof	Brick-concrete structure (24 cm) + tiles, insulated (15 cm)	0.25	574.97
Traditional	5	External wall	Brick blocks, insulated (15 cm)		
Prefabricated	5	External wall	concrete frame and brick masonry, high insulation (15 cm)	0.23	606.25
	5	Ground floor	ventilated slab (vespaio areato) , insulated (15 cm)	0.27	414.59
	53	Internal floor/Ceiling	brick-concrete ground slab, lightweight screed (6cm), insulated (8cm)	0.42	386.06

Period of construction

Type of structure

Layer definition

Thermophysical properties (U-value, Thermal capacity)

To be used as **input** for the **simulation tool** as representative of the climate zone E

Climate zones B,C,D: Work in progress

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Methods

Monitoring campaign

1 energy meter

2 smart plugs

2 temperature, Humidity and CO_2 sensors

1 IoT gateway

Methods

Monitoring campaign

Monitoraggio sui condomini per risparmiare energia

MOGLIANO

L'Associazione Nazionale Amministratori Condominiali Italiani (Anaci) e l'Università degli Studi di Padova hanno stretto un accordo con l'obiettivo di avanzare nella ricerca energetica per gli immobili. Questa partnership si concentra sullo sviluppo dei "Progetti di ricerca energetica su immobili", con particolare attenzione alla raccolta e all'analisi dei dati relativi ai consumi di gas degli edifici, un aspetto cruciale per affrontare le sfide dell'efficienza energetica.

L'INIZIATIVA

L'iniziativa, presentata ieri in un convegno a Villa Braida, ha preso forma il 18 maggio con la firma dell'accordo di riservatezza - protocollo d'intes
ci e l'Università di Pa
cessivamente, il 5 giu
Anaci ha consegnato
tori patavini dati dett
consumi di gas di tutti
a Padova nel 2020, nor
mazioni relative a 849
ni, comprendenti ul
volume, potenzialità
trale termica e consu
annuali per ciascuna
Questi dati costituis
base essenziale per il
Urbem, finanziato da
ro delle Università e d
ca, e affidato a divers
tà italiane, tra cui Pad
no, Firenze, Roma e
L'obiettivo primario
progetto è determinar

sogno energetico esatto degli appartamenti italiani. Ciò richiede

interne, come temperatura, umidità, CO2, e i consumi ener-

sare la spesa prevista per il consumo della centralina, i parteci-

Cercasi inquilini volontari per misurare la Co2 nelle loro case

Studio di Anaci con l'Università. E da Padova i primi risultati: troppi condomini con caldaie sovradimensionate

PADOVA Il 10% dei condomini di Padova è dotato di una caldaia che fornisce un livello di riscaldamento quattro volte superiore al fabbisogno, con ricadute importanti in termini di emissioni inquinanti. Emerge dalla ricerca condotta nel 2020 da Anaci Padova (l'associazione degli amministratori di condominio) sui consumi di gas di tutti gli edifici urbani via per via, civico per civico. Il dossier contiene inoltre i dati raccolti in due anni e mezzo relativi a 849 condomini, dei quali vengono indicati l'ubicazione, il volume, la potenzialità della centrale termica e gli annuali consumi di gas. «L'obiettivo è di capire quanta anidride carbonica producono i camini della città — spiega Giorgio Cambruzzi, presidente di Anaci Padova — e il primo indicatore emerso è che ci sono fabbricati con uguale volume ma con centrali termiche di diversa potenzialità. Le caldaie caratterizzate da potenza superiore quattro volte la reale necessità vanno cambiate. Il passo successivo è di calcolare esattamente i consumi di gas e trovare il sistema per contenerli».

849 condomini
di Padova sono stati analizzati per due anni e mezzo per capirne volume, e potenzialità della centrale termica

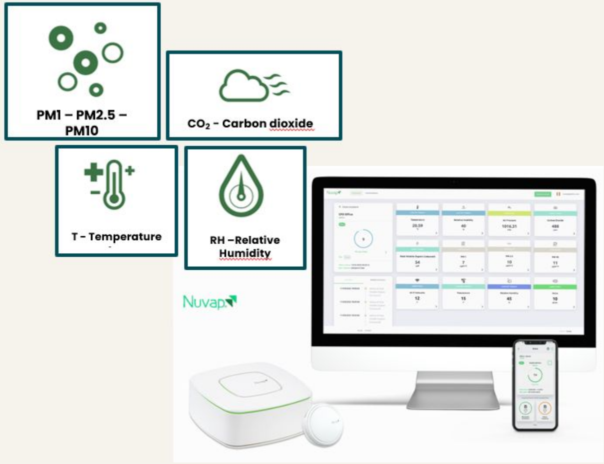
A tale scopo l'Anaci ha stretto una collaborazione con l'Università di Padova e lo scorso giugno, facendo seguito al protocollo d'intesa già in essere per la cooperazione in progetti di ricerca energetica sugli immobili, ha consegnato al professor Angelo Zarrella (Ingegneria) e al ricercatore Jacopo Vivian la documentazione raccolta. «L'abbiamo ceduta gratuitamente e rappresenta la base per avviare il Progetto URBEM, finanziato dal ministero dell'Università e della Ricerca e affidato agli Atenei di Padova, Milano, Firenze, Roma e Catania — illustra Cambruzzi — . Si propone di monitorare le condizioni di comfort termico e qualità dell'aria, i consumi di energia elettrica e gas in centinaia di unità residenziali in tutta Italia». Dal Pnrr è arrivato al Bo anche l'incarico di accertare l'esatto fabbisogno energetico degli appartamenti italiani nell'ambito del Progetto Europeo GRINS. E allora bisogna conoscere i dati reali sui consumi energetici (prevalentemente del gas per riscaldamento) e sulle abitudini delle persone. La mission dello studio curato da Zarrella e Vivian è di promuovere una campagna di monitoraggi sulle condizioni ambientali interne: temperatura dell'aria, umidità, CO_2, consumi energetici degli elettrodomestici, come lavatrice e lavastoviglie. Con l'elaborazione dei dati ottenuti sarà possibile condurre simulazioni energetiche su scala urbana più accurate, così da poter valutare l'impatto delle diverse soluzioni di efficientamento. «Vogliamo arrivare a indicatori reali, per creare un modello per il calcolo dei consumi dello stock edilizio italiano, che consiste per la maggior parte di complessi residenziali costruiti prima degli anni '90 — completa il presidente —. Per un anno nelle unità esaminate saranno installati l'energy meter, una centralina di raccolta dati, due "prese intelligenti" e altrettanti sensori ambientali per temperatura, umidità e CO_2. Verranno poi analizzate le bollette e somministrati questionari anonimi sulle abitudini di consumo dei partecipanti».

Giorgio Cambruzzi
È il presidente dell' Anaci Padova

I costi sono a carico dell'Università di Padova, che insieme all'Anaci cerca inquilini volontari per il monitoraggio. In cambio riceveranno un buono spesa da 50 euro spendibile su piattaforme on-line. Le candidature vanno inviate via mail all'indirizzo pnrrgreen@gmail.com, indicando indirizzo e telefono.

M.N.M.

Methods



Monitoring campaign and survey

Investigate *user behaviour* inside households

Extension of the monitoring campaign with compact and easy-to-install sensors

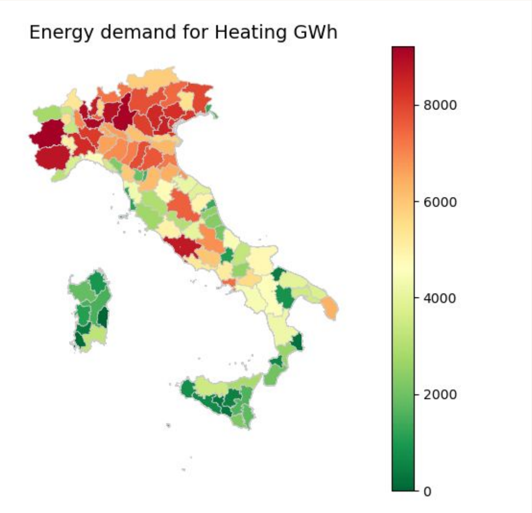
Development of a survey to be compiled by the monitored users (collection of habits and energy information from bills)

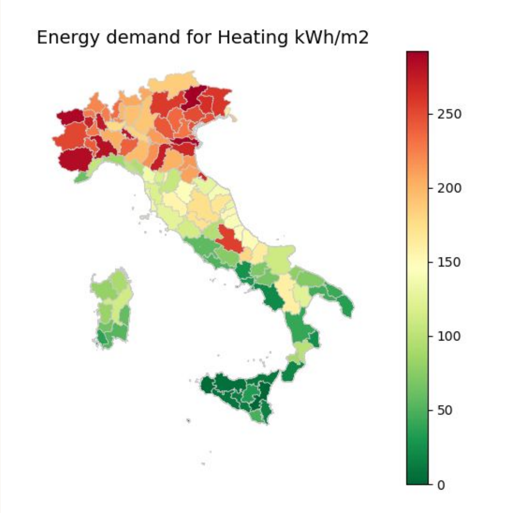
→

Evaluate the *impact* of the user on buildings' *energy consumption*

Define new strategies to avoid *energy gaps* between predictions an real operation, while maintaining indoor comfort

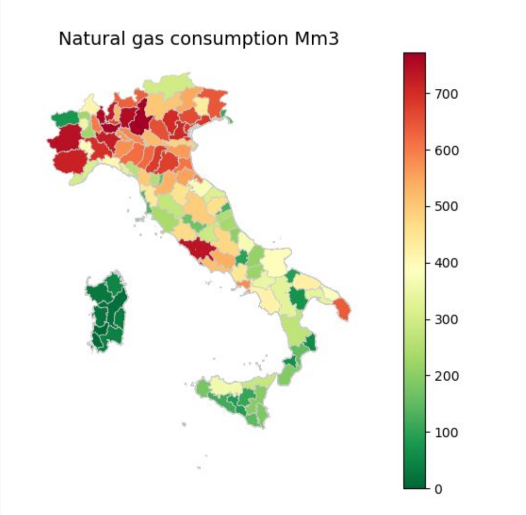
Preliminary results

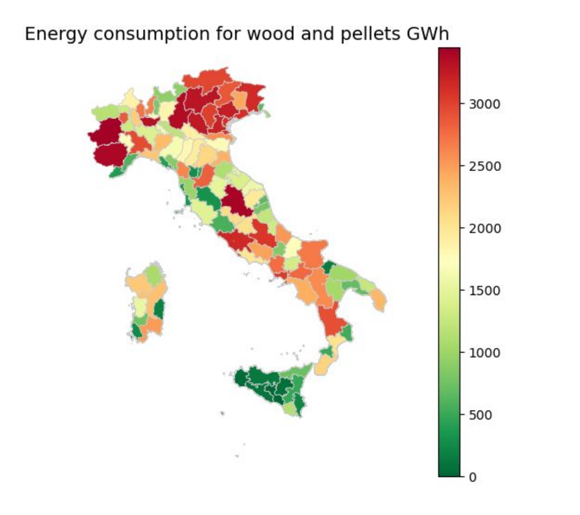




Energy end use for space heating, cooling, DHW, cooking, lighting, other electrical appliances

Preliminary results





Energy consumption from different energy carriers

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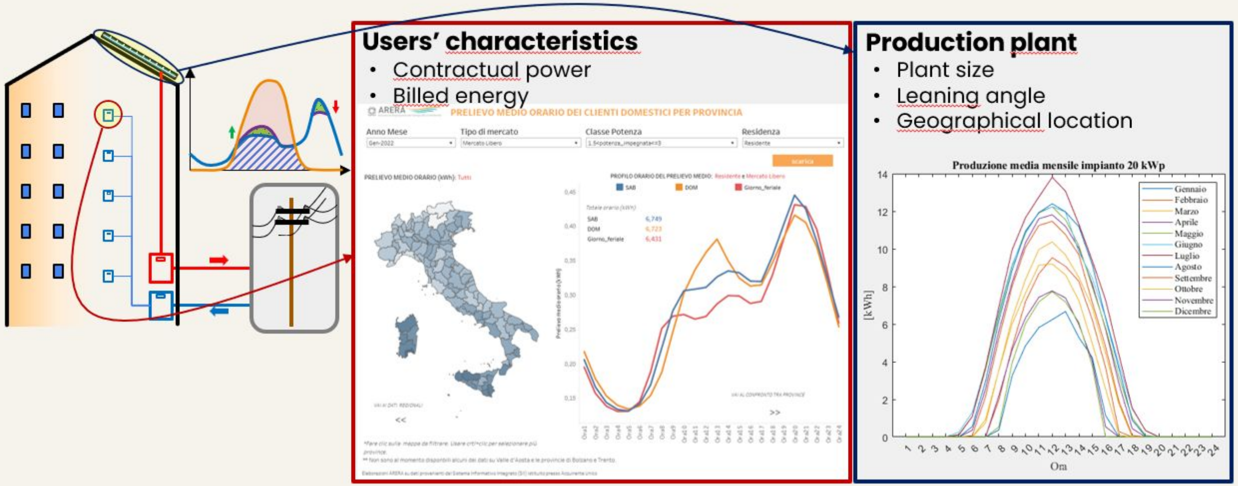
Other activities

Analysis of electrical consumption profiles



Thank you for your attention!

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Spoke 6: Low Carbon Policies

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

GRINS FOUNDATION

Electric and thermal energy consumptions of non-residential buildings: analysis of real data and modeling

Gian Luca Morini
Corrado Camponeschi
Maurizio Goni

DIN - Industrial Engineering Department - UNIBO

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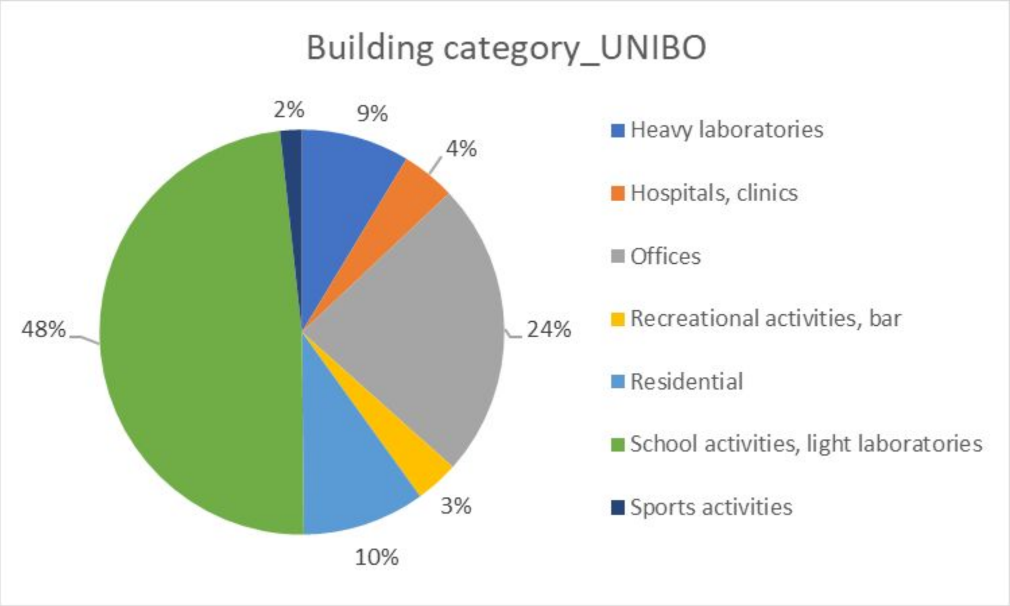
The **Alma Mater** manages **287 buildings** (>1 million square meters of covered area):

- 204 in Bologna
- 21 Ravenna
- 20 Cesena
- 24 Forlì
- 17 Rimini
- 1 Fano

District	Average value U wall [W/m²K]	Average value U roof [W/m²K]	Average value U window [W/m²K]	Percentage of insulated exterior walls [%]	Percentage of insulated roof [%]	Percentage of double glazing [%]
BOLOGNA						
Fanin	1,45	0,91	3,22	5	11	84
Navile	0,65	0,61	1,98	88	79	93
Nord Ovest	1,84	1,27	4,63	3	24,4	43,5
Risorgimento	1,6	0,72	4,19	0	64	22,6
Bertalia	1,28	1,06	3,09	0	58	100
S. Giacomo	1,86	0,89	3,8	0	55	41
Sud-Est	1,89	1,51	4,1	1	28	57
Zamboni-Poggi	1,8	0,87	4,8	0	45	16
Ozzano	0,94	1,56	3,15	30	8	93
Filippo Re	1,35	0,73	3,39	9	79	61
CESENA	1,14	1	2,1	14,7	24	93
FORLÌ	1,8	1,28	2,37	3	31	87
RAVENNA	1,4	1,31	3,38	20	36	59
RIMINI	1,6	0,71	2,83	13	59	78

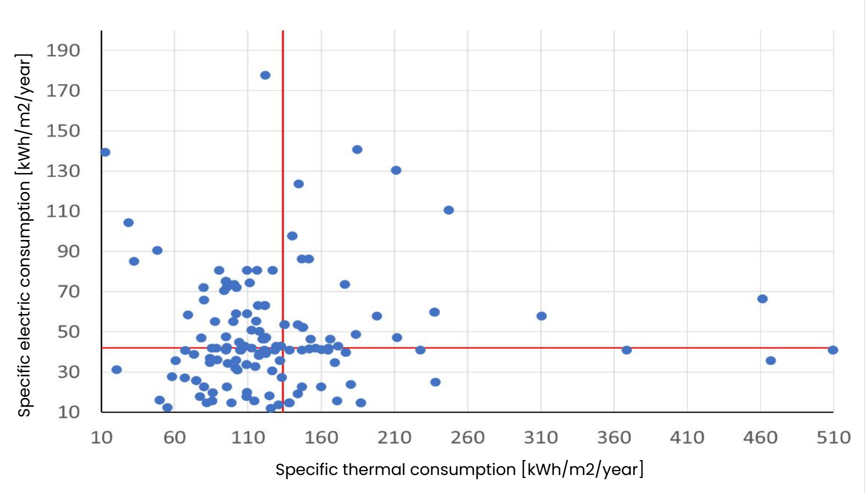
The main **categories for buildings** within the UNIBO **real estate portfolio** are:

- Buildings used for **school and light laboratories**
- **Office** and similar buildings
- Buildings used as **residences**
- Buildings used for **heavy laboratories**
- **Recreational** and similar buildings
- **Hospitals, clinics** and similar buildings
- Buildings used for **sporting activities**



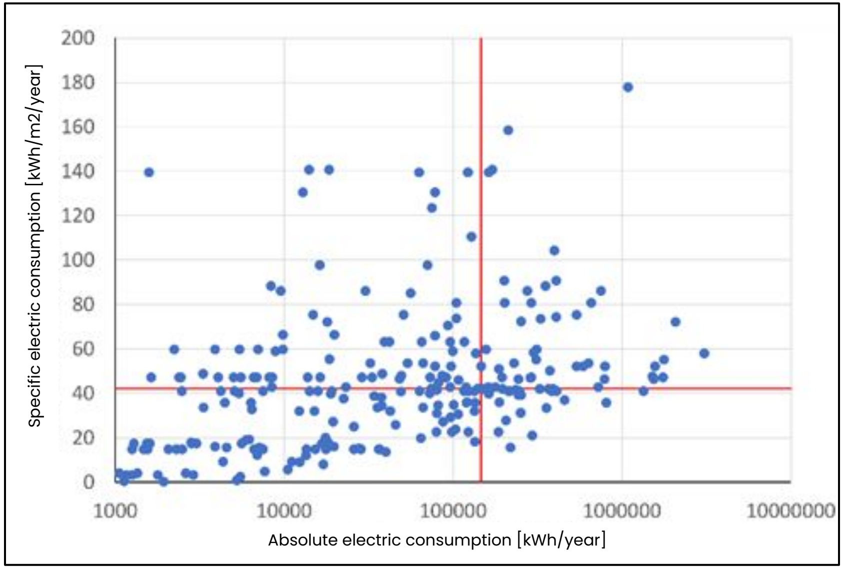
Annual analysis 2018–2022

Indicators of specific consumption		
CEStot	Specific primary energy consumption for unit of total area	kWh/m2/year
CESel	Specific electric consumption for unit of surface served	kWh/m2/year
CESth	Specific thermal energy consumption for unit of surface served	kWh/m2/year
CESth_gas	Specific thermal consumption of natural gas for unit of surface served	kWh/m2/year
CESth_tlr	Specific thermal energy consumption for district heating (TLR) per unit of surface served	kWh/m2/year
Indicators of energy expenditure		
CSTUD	Cost incurred for energy supplies for student	€/student
CSUP	Total cost incurred for unit of area served	€/m2
Environmental indicators		
Emtot	CO2 emissions into the atmosphere for unit of primary energy consumed	tCO2/tep



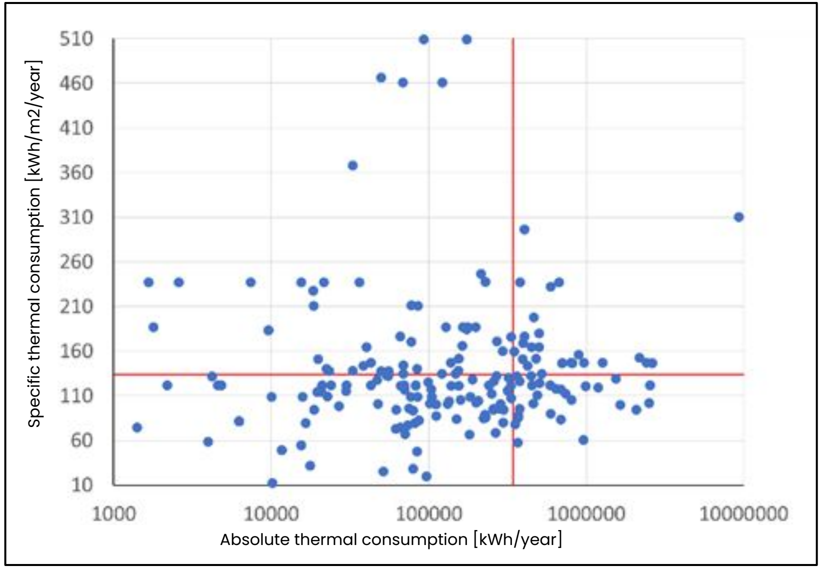
Priority map of the project. Distribution of University buildings according to specific thermal and electric consumption (data 2022).

Electric consumption



Priority map of the project. Distribution of University buildings according to absolute electric consumption and specific electric consumption (data 2022).

Thermal consumption



Priority map of the project. Distribution of University buildings according to absolute thermal consumption and specific thermal consumption (data 2022).

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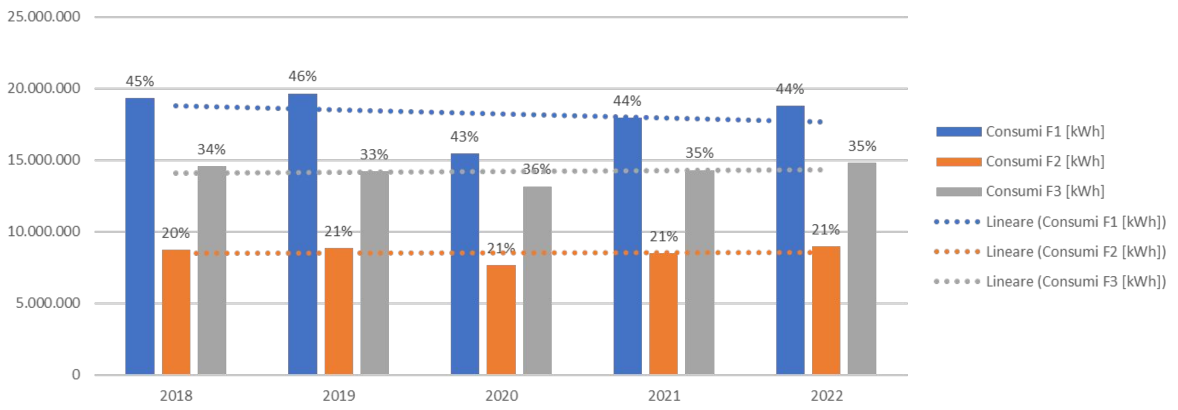
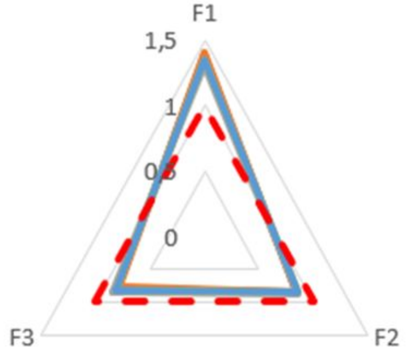
The **objective** is to generate **correlations for predicting consumption** (thermal and electric) across different uses.

The **approach** is based on the creation of **clusters** of buildings according to the prevailing use categories, by type of energy vector and diversification by consumption.

We're currently working on the creation of clusters analyzing the University's real estate assets and consumption from the year 2018 until today.

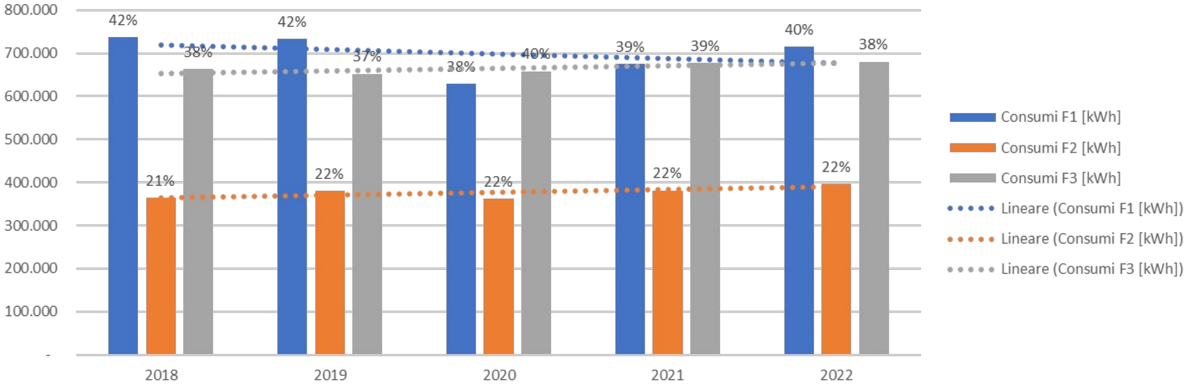
Consumption bands_UNIBO



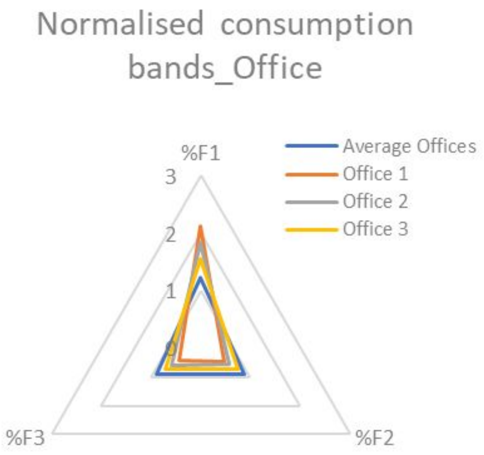


- **F1:** mon-fri, hours 8.00-19.00 (55h).
- **F2:** mon-fri, hours 7.00-8.00 and 19.00-23.00. Saturday, hours 7.00-23.00, excluding public holidays (41h).
- **F3:** mon-sat, hours 23:00-7.00; sunday and the public holidays 24/24h (72h).

Consumption bands_Office Cluster



Consumption from 2018 to 2022 by bands for buildings in the office cluster



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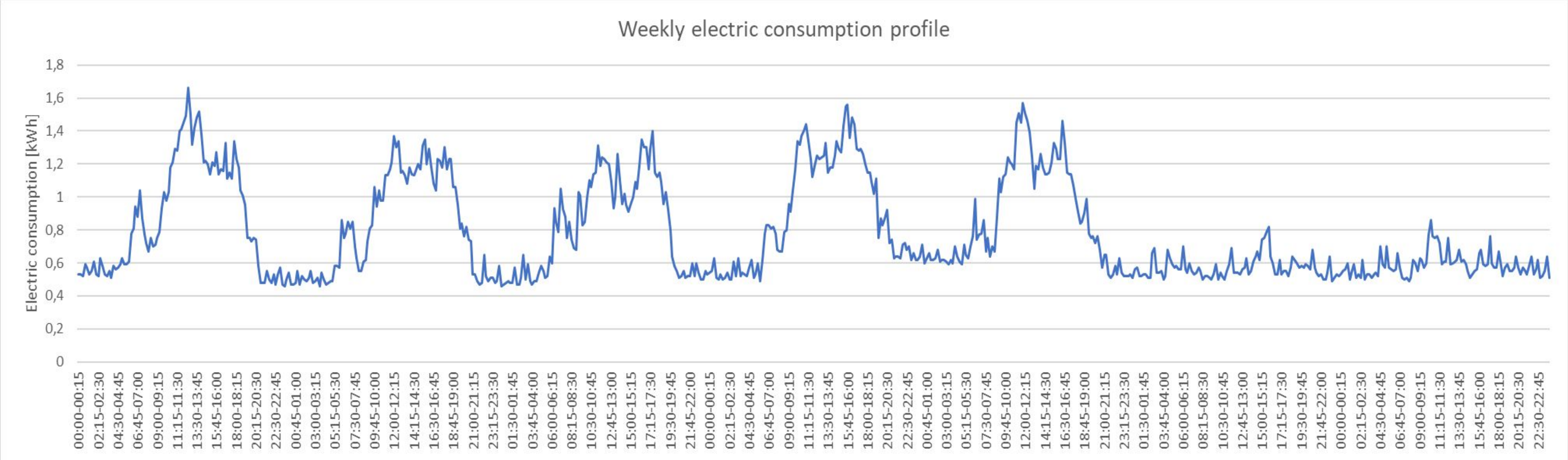
Hourly electric consumption profile_Office Cluster



Example of a weekly electric consumption profile for office cluster

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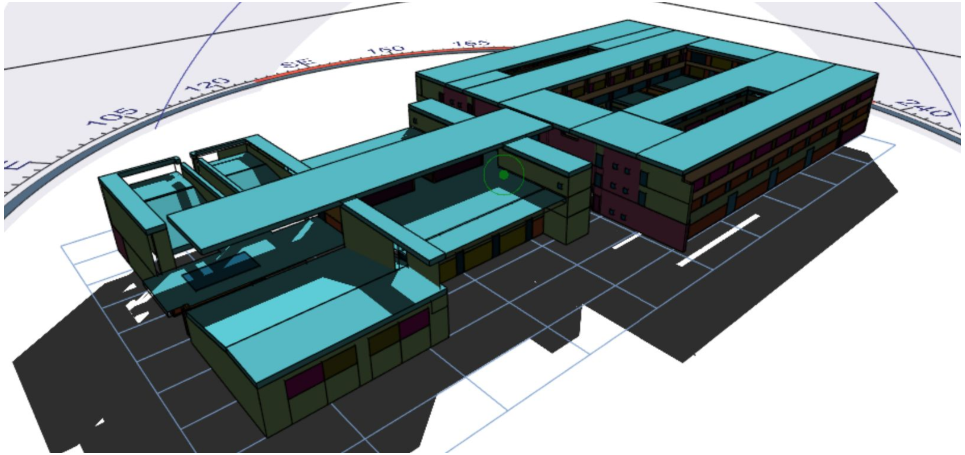
The Energy model of the building

Detailed analysis based on the energy modelling of the buildings of the University's real estate assets.

Evaluation (savings and costs) of energy efficiency **interventions** with a consequent **change of class**, using **20 EC700_Edilclima models** owned by the research group.

EDILCLIMA®
ENGINEERING & SOFTWARE

Bertalia district case study



EC700_Edilclima model of the Bertalia district case study

Focus on the realization of the energy model of the building 342_Bertalia.

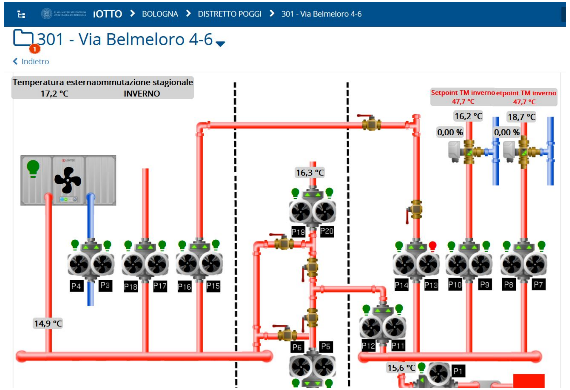
Calibration of the model thanks to the **installation of meters** (thermal and electrical) thanks to which it is possible to **divide the consumption** for each subcategory of use of the building.

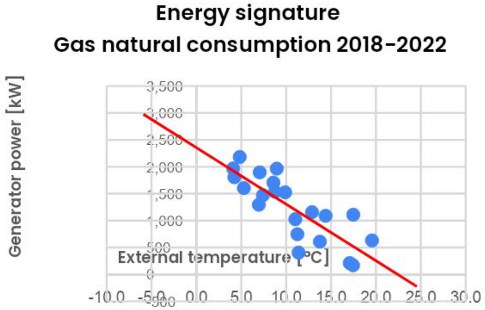
University building management system BMS

iOTTO is a **BMS platform** operating in the Internet-of-Things, which **manages sensors and actuators** in thermal and power plants.

It allows to:

- **collect data** from meters, **analyze** them and **control** "smart" devices remotely
- **compare** expected **energy consumption** with real value
- **remote control** of the installations
- **send alerts** in case of failure





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