Energy poverty quantitative measurement: methodology and case studies in Italy

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Ricerca sul Sistema Energetico – RSE S.p.A.

RSE – Ricerca sul Sistema Energetico

MISSION

Research about energy system for the benefit of all consumers

PEOPLE

320 employees

2/3 M.Sc./Ph.D, 80% researchers;

Headquarter: Milano

PROPERTY

Private company owned by the Ministry of Economy and Finance and held by GSE, financed by Ministry for the Ecological Transition

ACTIVITIES

Research on Energy System

Energy Efficiency

Regulation and normatives

Technology

Industry

International activities

3 different approaches to EP quantitative measurement

1. **ENERGIA SU MISURA (2015-2018)** – project funded by the Italian Ministry of Economic Development:
   - Choice of EP users based on their income conditions → living in social housing;
   - Real time metering of their electricity consumption and comparison with «average» consumers.
2. **ASSIST PROJECT (2017-2020)** – project funded by the European Commission:
   - «Market» segmentation of EP consumers using statistics and national indicator;
   - Data on electricity and heating consumption from questionnaires;
   - Development of KPIs including comfort, monetary savings, awareness increase.
3. **Energy poverty and health (2019-ongoing)** – project funded by the Italian Ministry of Economic Development:
   - Proposal of a dedicated EP indicator, considering electricity, heating, other energy consumption;
   - «Market» segmentation of EP users based on the new indicator;
   - Implications for their health.

Energia su misura

ENERGIA SU MISURA – project funded by the Italian Ministry of Economic Development

Objectives:

- Characterization of energy consumption of Italian families with identification of the most relevant variables affecting it;
- Modelling of the energy consumption and evaluation of the effects of different energy efficiency measures on that (e.g. building retrofit, low cost measures, behavioural effects);
- Validation of the models through real measurements;
- Focus on energy poverty and vulnerability with analysis of the causes of different consumption levels wrt other consumers;
- Policy implications and recommendations.

Energia su misura

Monitoring campaign (electricity) on 24 households in social housing in Milan

Energia su misura

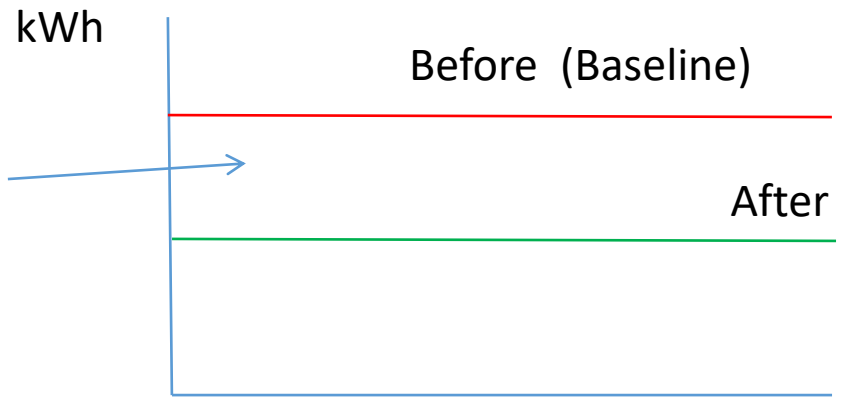
Monitoring of electricity consumption in both average households and vulnerable households:

- To build a typical load curve;
- To define consumption patterns of domestic users for the main electrical appliances (washing machine, dishwasher, TV, fridge…)

Goals:

<u>Energy Efficiency:</u> replacement of old appliances with more efficient ones

<u>Energy saving:</u> energy waste reduction.



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Energia su misura

Statistical analysis of Italian households (ISTAT)

Location
Household composition
Household income (budget)

Monitoring campaign on 67 households

55% North

37% Center

8% South

Average duration of monitoring campaign: 225 days

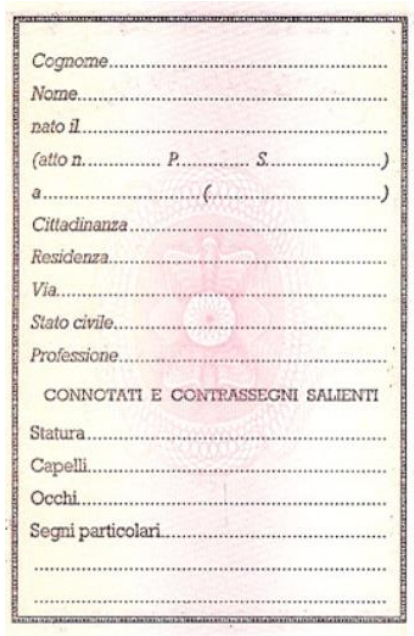
Energia su misura

Project video

RSE Progetto Energia su Misura - in Inglese

https://www.youtube.com/watch?v=gDUTHLNvZAw

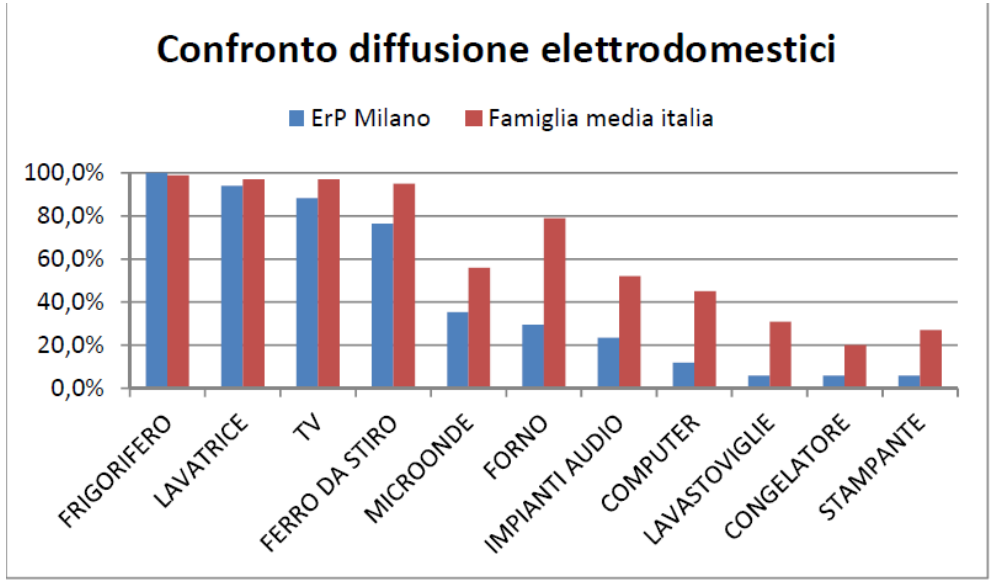
Energia su misura



Involved households:

- Houses smaller than 50 m^2, with 2 rooms and a bathroom;
- >70% are single people, most of them >70 y.o.;
- 65% are women;
- 23% are employed in the service sector, the others live on subsidies.

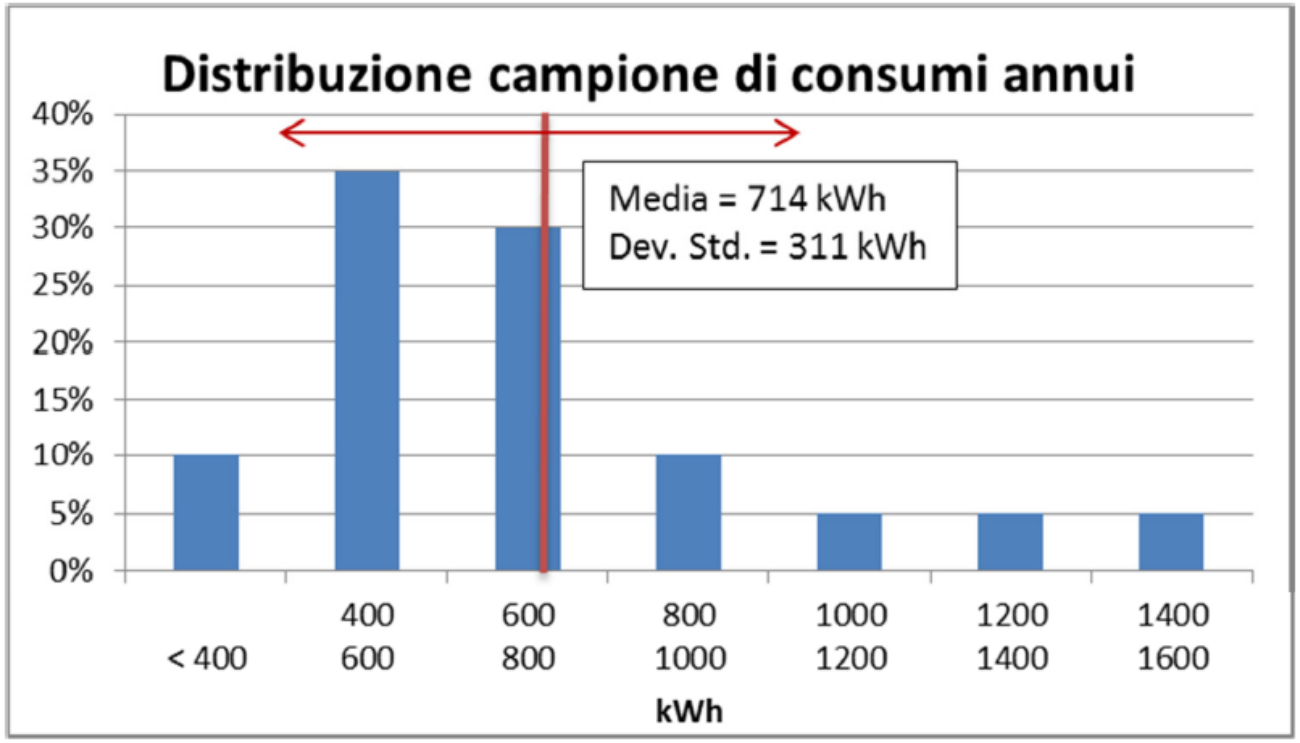
Energia su misura



Comparison between people in the social housing experiment (blue) and the average Italian families (red) (ISTAT)

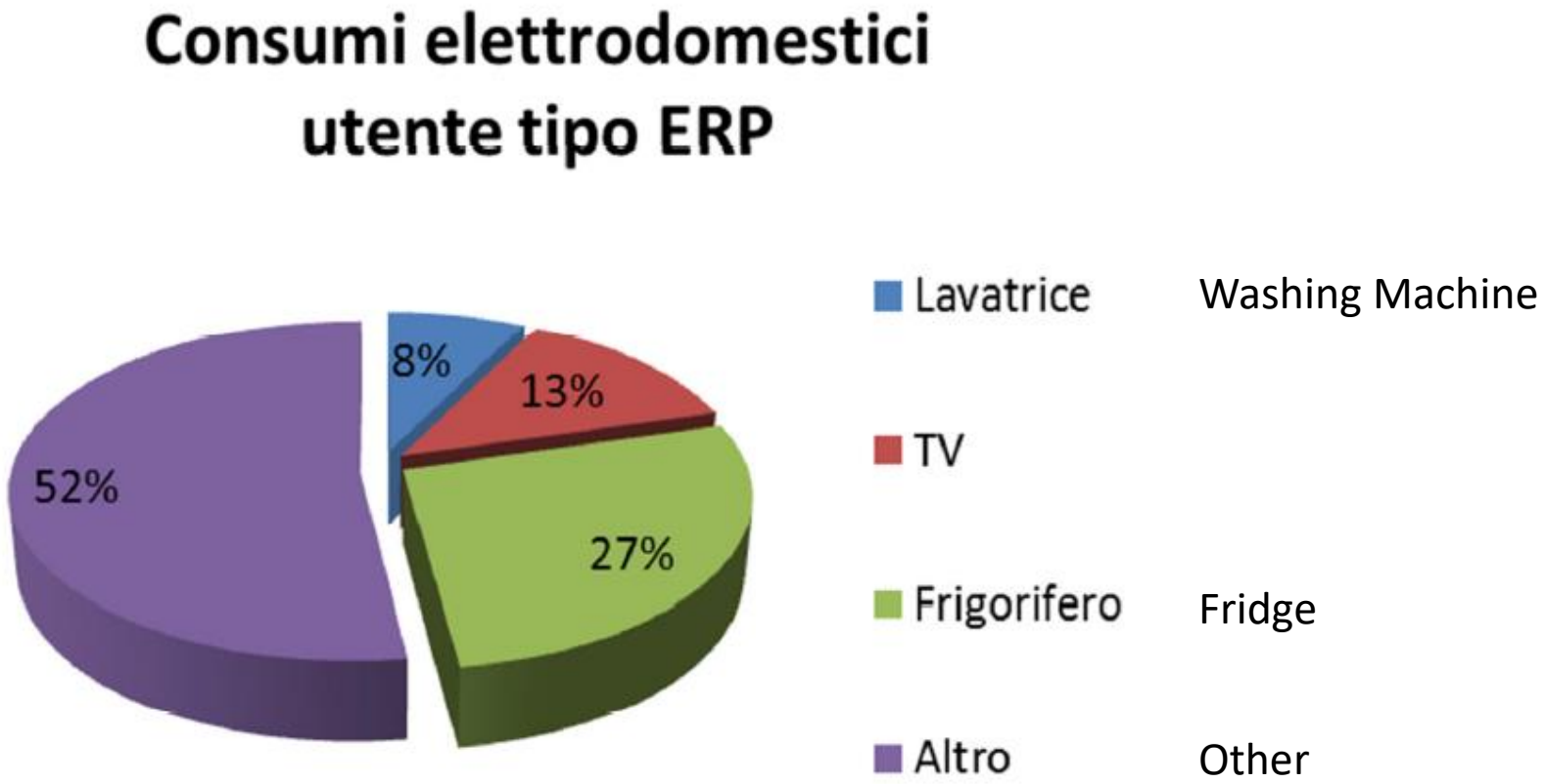
- All users have a fridge (200 – 260 kWh/y) and a TV (on average, on for 11 hr/day);
- 90% have a washing machine (used 1–3 times a week);
- 8% have a dishwasher;
- <35% have either an electric oven or a microwave;
- During home visits, it has been noted that all appliances are quite old and inefficient.

Energia su misura



The yearly consumption has been taken from direct metering during an average campaign of 225 days. There isn't any seasonal effect, since none of them had air conditioning nor was going on holiday during the summer.
The metered value has been compared to the one reported on electric bills and the correspondence was satisfactory.

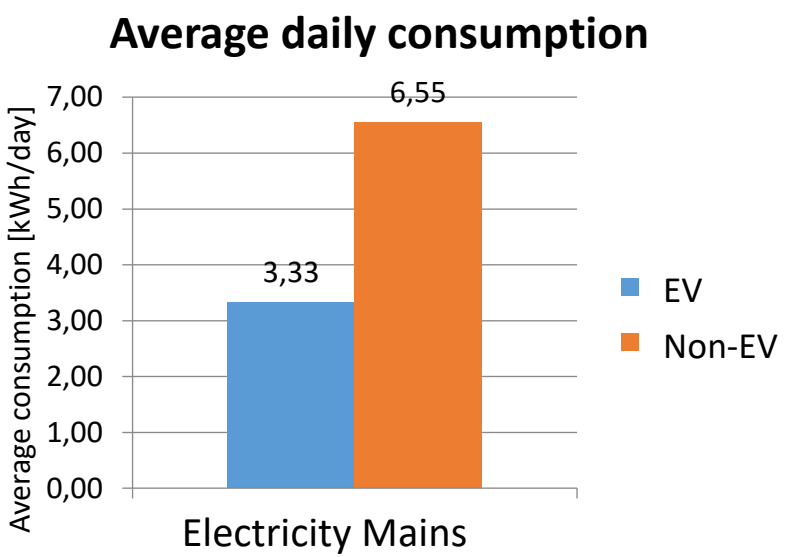
Energia su misura

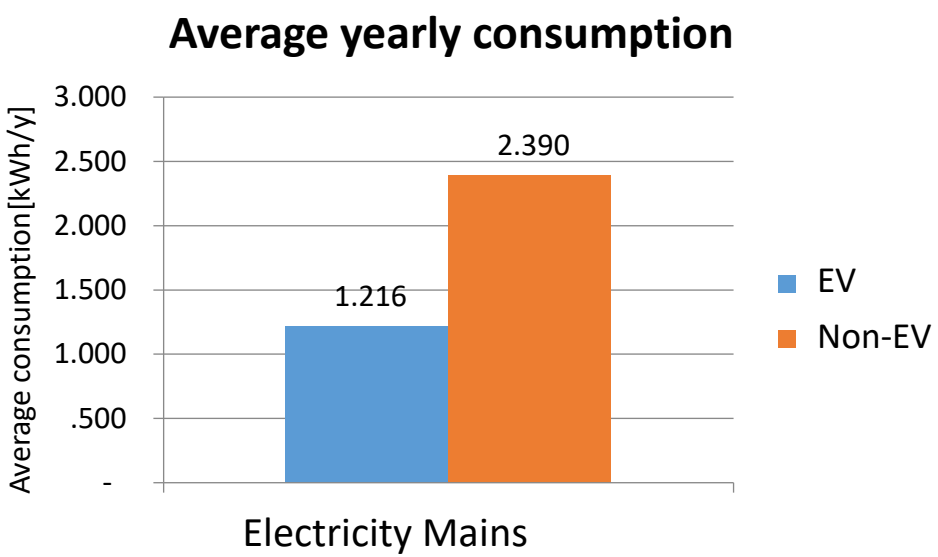


Example of a retired person

Yearly consumption approx. 580 kWh/y

Comparison with average users





Energy Vulnerable population, at the same demographic and building conditions (surface of the house, number of occupants) tend to consume less ➔ but often to pay more, due to bad energy contracts/not optimal use of energy.

NOT JUST ENERGY, BUT ALSO COSTS ARE AN ISSUE

It was more difficult to convince social housing inhabitants to be involved in electricity consumption measurements than other social classes (e.g. middle class professionals, teachers, etc…), but when available to be involved, the answer was enthusiastic

TRUST IS THE MAIN BARRIER

Energia su misura - Conclusions

Energia su misura has been the first approach to EP in Italy, with the aim to understand the type of EP consumers, their behaviour, their energy awareness and their consumption patterns.

The true challenge is to tackle the phenomenon at its root, by finding infrastructural solutions with a long-term effect: the aim is to reduce their bills through energy efficiency.

It is a complex issue, due also to the fact that most EP consumers are renting their apartments and/or don’t have access to financial resources to implement energy efficiency measures.

ASSIST2GETHER

ASSIST 2GETHER: aims to find best practices and recommendations to address Energy Poverty from the implementation of a series of pilot actions with a group of advisors (called HEAs – Home Energy Advisors); such advisors are specifically trained to implement the pilot actions by educating energy vulnerable consumers (VCs) to optimize (and, possibly, reduce) their energy consumption, mostly through behavioural changes.

RSE role:

- Coordinator of WP5:
  - Consumers segmentation;
  - Pilot action coordinator;
- Training course teacher (italian training).

ASSIST2GETHER

Call topic: Horizon2020 - EE-06-2016-2017 «Engaging private consumers towards sustainable energy»

Duration: 36 months (1 May 2017 – 30 April 2020)

Consortium: 12 partners: 6 countries + 1 European association

+ Steering committee composed by experts in each country and at European level

Partners	Country
AISFOR S.R.L. - RICERCA SUL SISTEMA ENERGETICO S.P.A. - ACQUIRENTE UNICO S.P.A.	Italy (3)
ASOCIACIÓN ECOSERVEIS - ALGINET DISTRIBUCIÓN ENERGÍA ELÉCTRICA S.l.	Spain (2)
SEVERN WYE ENERGY AGENCY LTD.	UK (1)
FEDERACJA KONSUMENTOW STOWARZYSZENIE - KRAJOWA AGENCJA POSZANOWANIA ENERGII SPOLKA AKCYJNA	Poland (2)
VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V. - EANDIS CVBA	Belgium (2)
VAASAETT Ltd AB OY	Finland (1)
EUROPEAN ANTI-POVERTY NETWORK - EAPN	European (1)

ASSIST2GETHER

- Market survey
- Analysis of ongoing / finished initiatives
- Analysis of existing economic support measures

In-depth analysis

HEA Training

- Definition of HEA profile and training needs
- Creation of training course (structure and material)
- Training of 75 HEA in each country

- Organisation and management of National HEA network

HEA Network

ASSIST Action

- Definition and implementation of National actions to support vulnerable consumers through the trained HEA and the network

ASSIST2GETHER – Energy Poverty Segmentation

DELIVERABLE D5.1

Boundaries definition – Belgium – indicators

3 Official indicators:

- Measured energy poverty (Boardman)
- Hidden energy poverty
- Subjective energy poverty

21%

Flanders region: 10,8%
Brussels region: 12,8%
Walloon region: 22%

Flanders region: 3%
Brussels region: 9,8%
Walloon region: 2,2%

Flanders region: 2,4%
Brussels region: 8,1%
Walloon region: 7,9%

ASSIST RSE 4

DELIVERABLE D5.1

Boundaries definition – Italy – EP risk

Clusters more at risk of energy poverty: 1, 3, 7, 11, 12

→ % of population: 32,5%

→ 1 indicator: 24,5%

→ 2 indicators: 12,0%

→ 3 indicators: 4,6%

People at risk of energy poverty: 12,0% – 24,5%

The same as in another study on EP in Italy (Faiella, Lavecchia, Borgarello 2017)

ASSIST RSE 10

DELIVERABLE D5.1

Boundaries definition – Spain – EP risk

Geographical area (being in the south or in the north) is not a constraint. More at risk: households with children under 18; Sigle-parental, large family, single person households; low level of education; people without a permanent job.

ASSIST RSE 17

DELIVERABLE D5.1

Boundaries definition – Finland – EP risk

- Financial situation 1 or 2 (Not enough money for primary needs (food and energy bills) OR Enough money for primary needs, but not for non-basic expenses).
- Retired, unemployed, student, unable to work, home-maker or inactive people in the household.
- Other variables are not important (household age, ability to maintain adequate temperature, marital status, type of heating system).

15%

CLUSTER	E/H costs > 10%	E/H costs > 20%	Average E/H costs	No ability to maintain adequate temp.	Social Benefits	Financial situation=1	Financial situation=2	% of esp.
C3	70%	28%	17%	100%	26%	14%	88%	1%
C4	44%	9%	11%	0%	10%	15%	85%	8%
C5	36%	12%	12%	20%	64%	4%	96%	1%
C1	35%	8%	10%	33%	35%	6%	94%	2%
C8	24%	4%	8%	3%	6%	0%	0%	25%
C2	17%	3%	6%	15%	23%	15%	85%	3%
C6	13%	3%	6%	4%	10%	0%	0%	2%
C9	10%	2%	5%	1%	4%	0%	0%	22%
C7	5%	1%	4%	4%	16%	0%	0%	32%

ASSIST RSE 8

DELIVERABLE D5.1

Boundaries definition – Poland – EP risk

Type of building

Construction date

Living space

Flat ownership

DELIVERABLE D5.1

Boundaries definition – UK – EP risk

	Fuel poor	Non-fuel poor	All households
Median income	£10,118	£23,147	£21,333
Median FPEER	58.1	65.5	64.6
Median fuel costs	£1,430	£1,197	£1,236

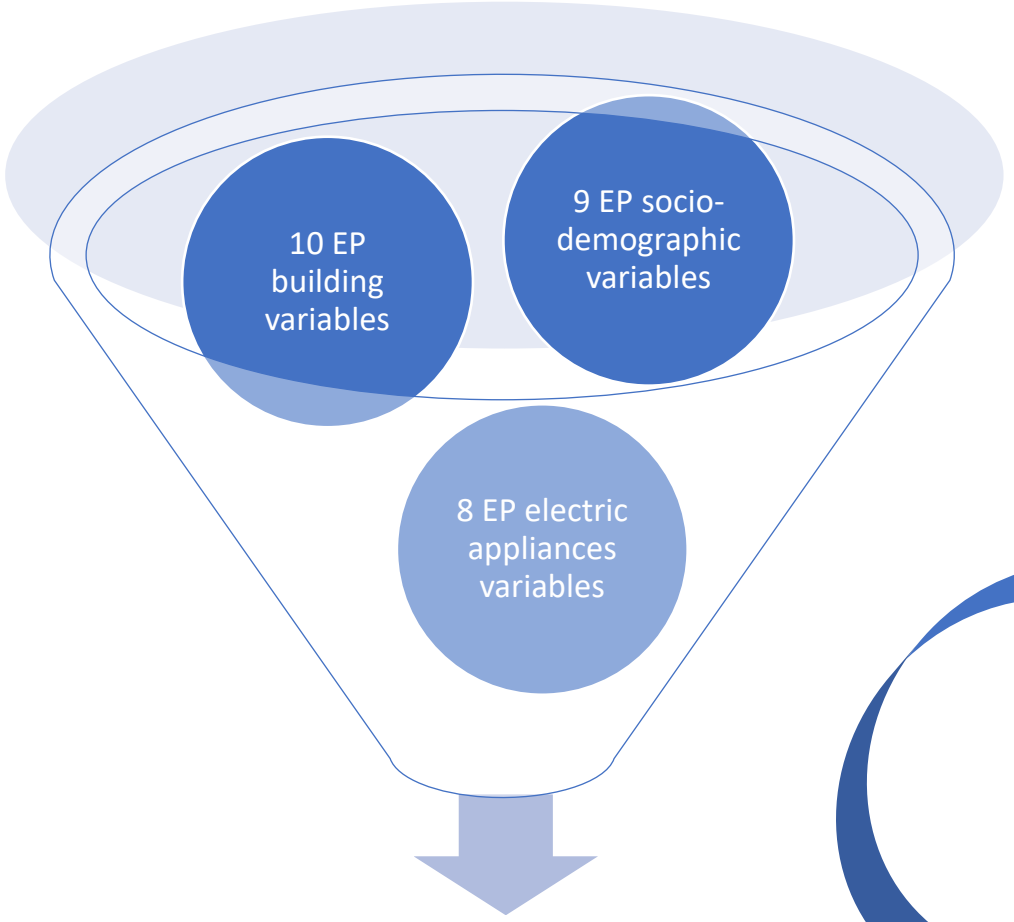
Households more at risk:

- Households with 18,1% uninsulated solid walls;
- Older dwellings (in 18 % particular those pre-1850);
- Tenure: private rented sector; 21,3%
- Household composition: multi-person (adult); single parent with child(ren). 23,6%

17,5%

ASSIST RSE 20

ASSIST2GETHER – Action plan



ASSIST Activities

Soft/engagement activities	Actions	Synergies
2% energy savings	7% energy savings	2% energy savings
@2,000 consumers for each country	**@750 consumers** for each country	

INSUFFICIENT or SCARCE economic resources - the only constraint is related to the economic resources of the family, related however to their possibility to pay energy bills: either don't have enough money to satisfy their basic needs (including energy) or they have enough to satisfy their basic needs (including energy) but nothing to address unforeseen expenses.

ASSIST2GETHER – Carried out actions

2%

Soft/engagement activities

- Advice at home supplies shop
- Energy café (consumers association, energy provider)
- Distribution of material to targeted consumers
- Consultancy on financial support
- General education activities (social workers)

7%

Actions

- Home visits and dedicated consultancy by social/health workers
- Help desks counselling for vulnerable consumers at consumers association premises

2%

Synergies

- Help desks for Vulnerable Consumers through Charity organizations
- Distribution of material and provision of information to targeted consumers

ASSIST2GETHER – Monitoring

2 levels of monitoring:

- involved people (both HEAs and vulnerable consumers)
- **Energy savings/comfort increase/cost reduction/consumers empowerment (ESI and VEF) – for a sample equal to 10% of involved consumers, calculated ex-ante and ex-post through questionnaires and home visits, for the other 90% estimated.**

Key Performance Indicators

- ASSIST Energy Savings Indicator (ESI): it assesses the actual energy saved by the engaged vulnerable consumers, their increased comfort inside their homes and, more in general, the quality of their lives;
- Vulnerability Empowerment Factor (VEF): it assesses consumers' confidence in dealing with energy related issues inside their dwellings;
- Energy savings: it represents the amount of energy saved thanks to the ASSIST actions, both in kWh and in percentage (%).

ASSIST2GETHER – ESI

The Energy Savings Indicator is defined as:

$$ESI = \frac{ES(\%) + (ES(\%) * Comfort\ indicator + ES(\%) * Money\ Savings\ indicator)}{3 * 100}$$

**(ES stands for actual energy savings)*

The maximum value that can be reached is a doubling of the actual savings, so a cap of 5% additional value given by (ES*Comfort + ES*Money Savings) is instated.

Comfort indicator goes from -2 to +2 according to the declared decrease/increase of comfort

Money Savings indicator goes from -1 to +1 according to the ex-ante and ex-post conditions

ASSIST2GETHER – Results

Country	No of HEAs delivering ASSIST activities	No of consumers reached with ASSIST soft / engagement activities	No of consumers engaged with ASSIST actions	ESI	VEF
Belgium	44	102,300	714	3.9%	0.9
Finland	68	~300,000	1,130	1.7%	0.3
Italy	23	8,428	618	5.5%	0.4
Poland	53	2,330	1,875	4.4%	N.A.
Spain	93	5,484	755	4.5%	3.9
United Kingdom	23	4,792	150	5.1%	1.5

ASSIST2GETHER – Results

Country	Energy savings [kWh]	Energy savings [%]
Belgium	99,060	7%
Finland	N.A.	3.9%
Italy	7,799	5%
Poland	N.A.	N.A.
Spain	61.231	4.5%
United Kingdom	42.200	7%

Conclusions

- Definition and metering are done in different ways in different countries: a pan-European definition, supported by a methodology (and availability of data) to evaluate the real impact of energy poverty is needed;

- To effectively address EP it is necessary to have a strong relationship with the local authorities, third sector activities and associations that can support the implementation of pilot actions;

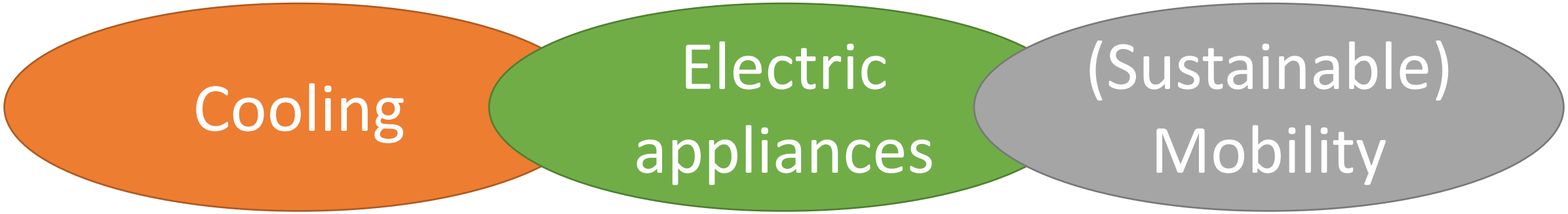
- The monitoring period shall be longer than 6 months (at least 1 year) and, for heating and cooling, it shall take into account seasonal variations as well as use adapting coefficients to take into account the historic data on HDD and CDD to “normalize” the results;

- Direct monitoring, when possible, shall be preferred to questionnaires and similar.

Energy Poverty and health

1991 - «Cold Homes» ➔ HEATING

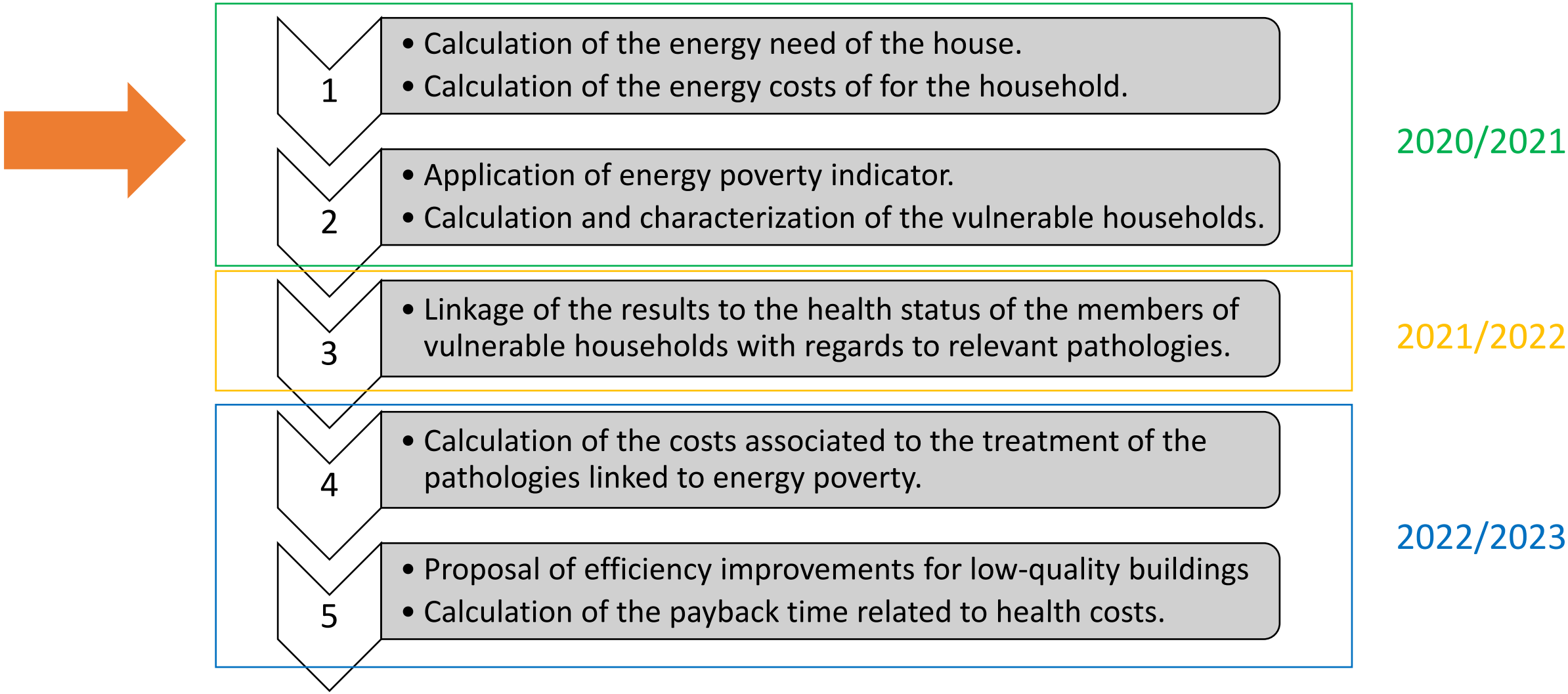
But also



Inability to purchase a minimum set of energy goods and services, with consequences on consumers'physical and mental health

Goals and methods

Goal of the study: estimate the health impact of energy poverty in Italy and its financial implications



Methodology to characterize EP consumers

1. Definition of the available data and the most appropriate energy poverty indicator
2. Calculation of «minimum energy needs» for different types of buildings (Italian case: applied to 140 «typical» buildings)
3. Conversion of the energy needs into expenses and comparison with statistical income and/or expenses databases (according to the selected EP indicator)
4. Application of the energy poverty indicator and analysis of energy poor households characteristics

Energy poverty indicator: our proposal

Italian National Energy Strategy (2017):

$$EP_i = I[(E_i^{tot} - E_i^{minheat}) < \sigma$$

RSE 2021:

$$EP_i = I[(E_i^{tot} - E_i^{minenergy}) < \sigma$$

- EP_i is the energy poverty condition of i-family;
- E_i^{tot} is the total monthly expenditure of the i-family;
- $E_i^{minheat}$ is the minimum heating need expenditure of the i-family over the year, divided by twelve;
- σ is the expenditure threshold that identifies a family as poor according to ISTAT, varying with the number of family members.

$E_i^{minheat}$ is replaced by $E_i^{minenergy}$, that takes into account both heating and cooling needs of the family, including cooling systems installation and maintenance (for families that didn't have one, ~64%) plus electricity consumption from appliances and lighting

Minimum energy needs - recap

CARAPACE (RSE©):
- Building type (4)
- Climatic zone (5)
- Building age (7)

140 building types

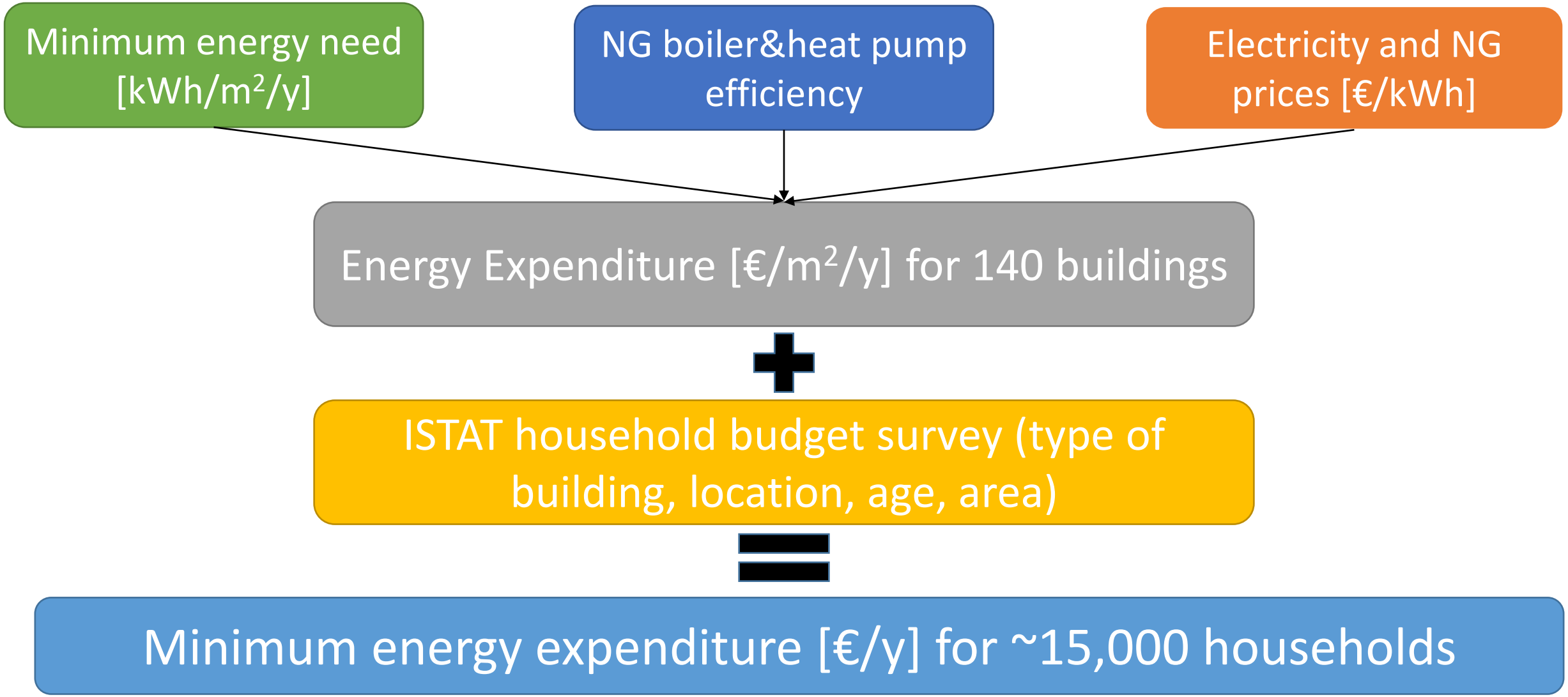
+

Weather data: 2015

Comfort settings:
- T heating: 18°C or 20°C
- T cooling 28°C or 26°C

Reference laws and standards:
- Italian legislation DPR 74/2013
- UNI/TS 11300

Minimum energy expenditure [€/y] – recap



Definition of Energy Poor consumers – recap

Household budget for ~15,000 households

−

Minimum energy expenditure [€/y] for ~15,000 households

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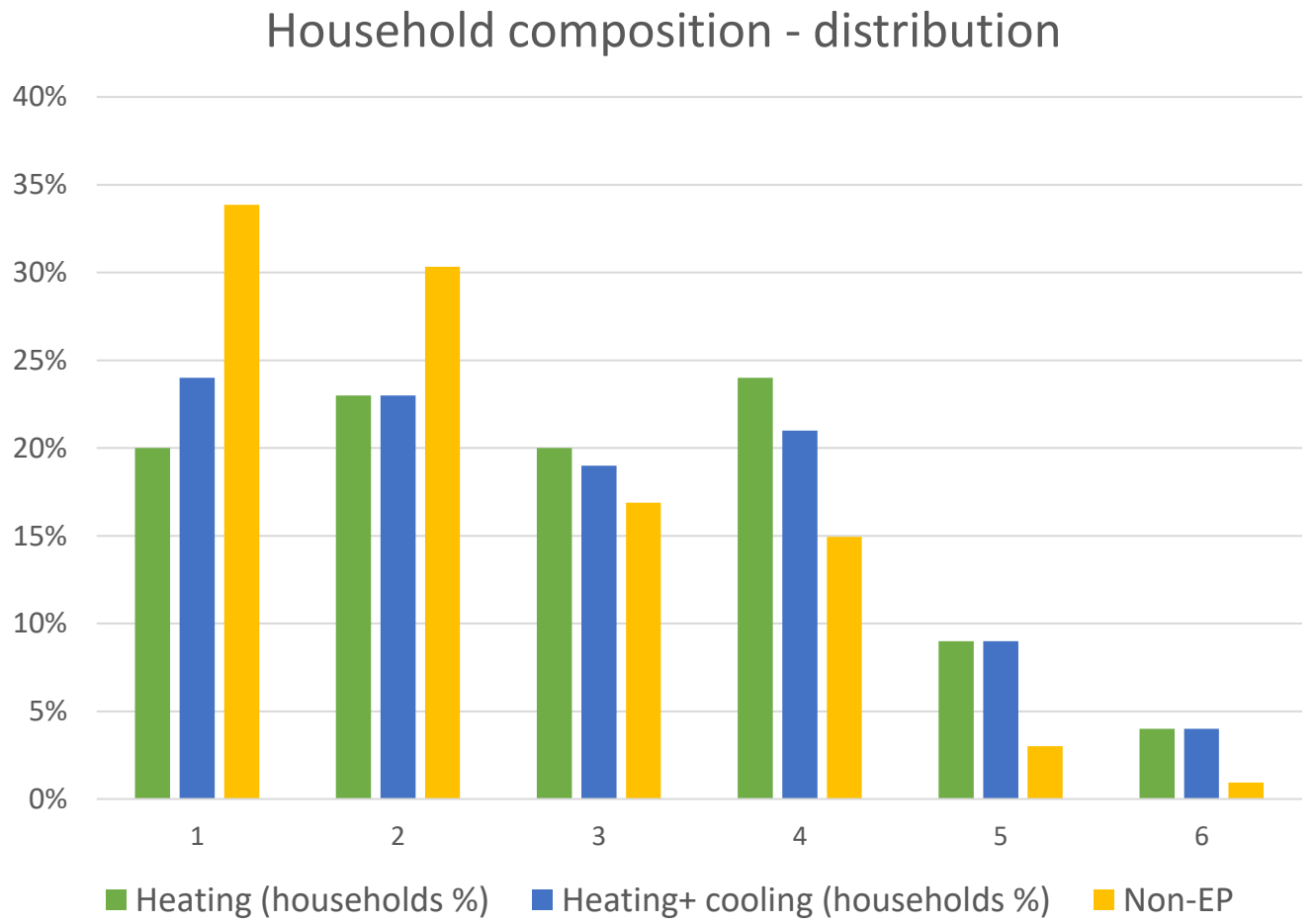
HVAC Installation&maintenance costs [€/y] for ~15,000 households

=

Definition of Energy Poverty condition for ~15,000 households

Analysis of EP consumers characteristics – pt.1

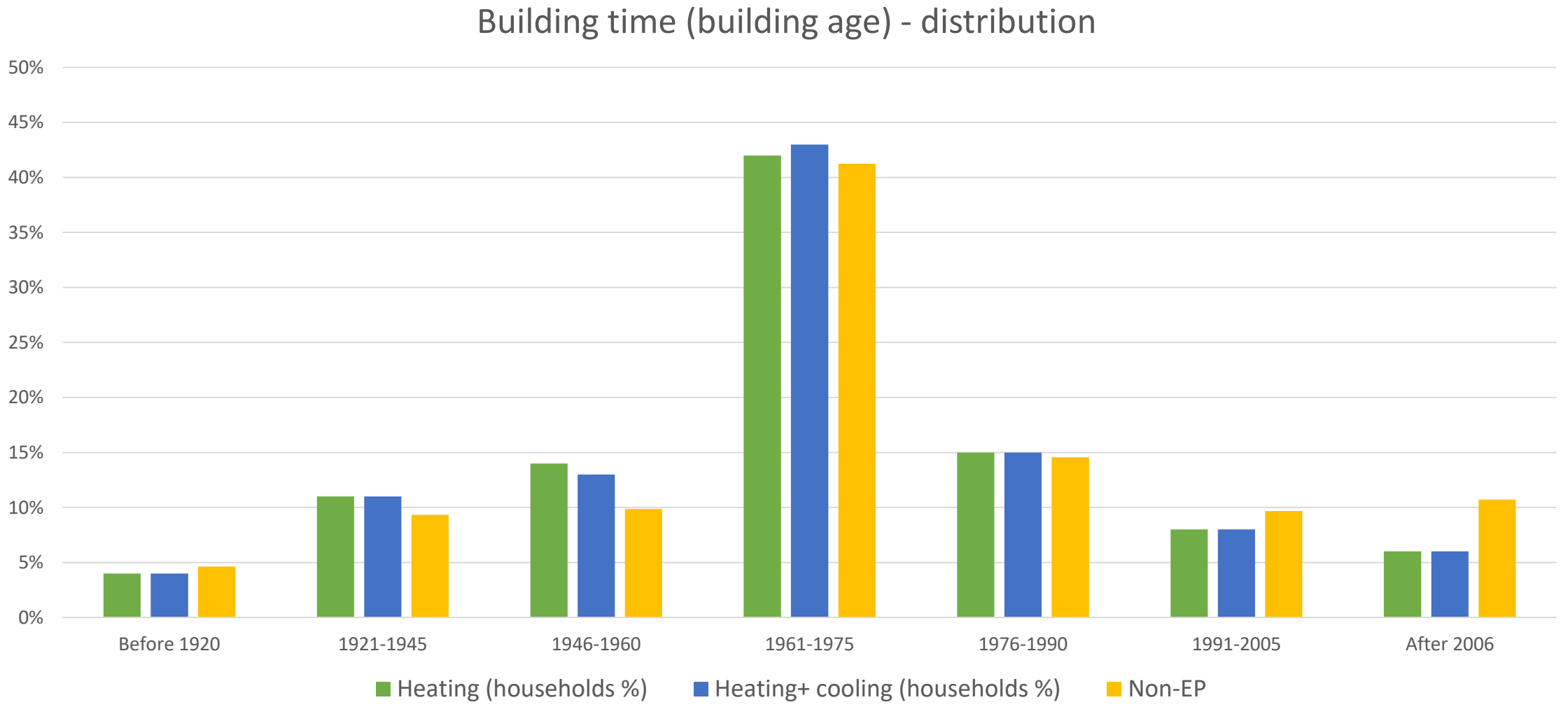
Case	Households (x1000)	Consumers (x1000)
Heating	3,303	9,678
% on Italian families	13%	16%
Heating + cooling	3,808	10,660
% on Italian families	15%	18%
Total difference	505	982
% difference	15%	10%



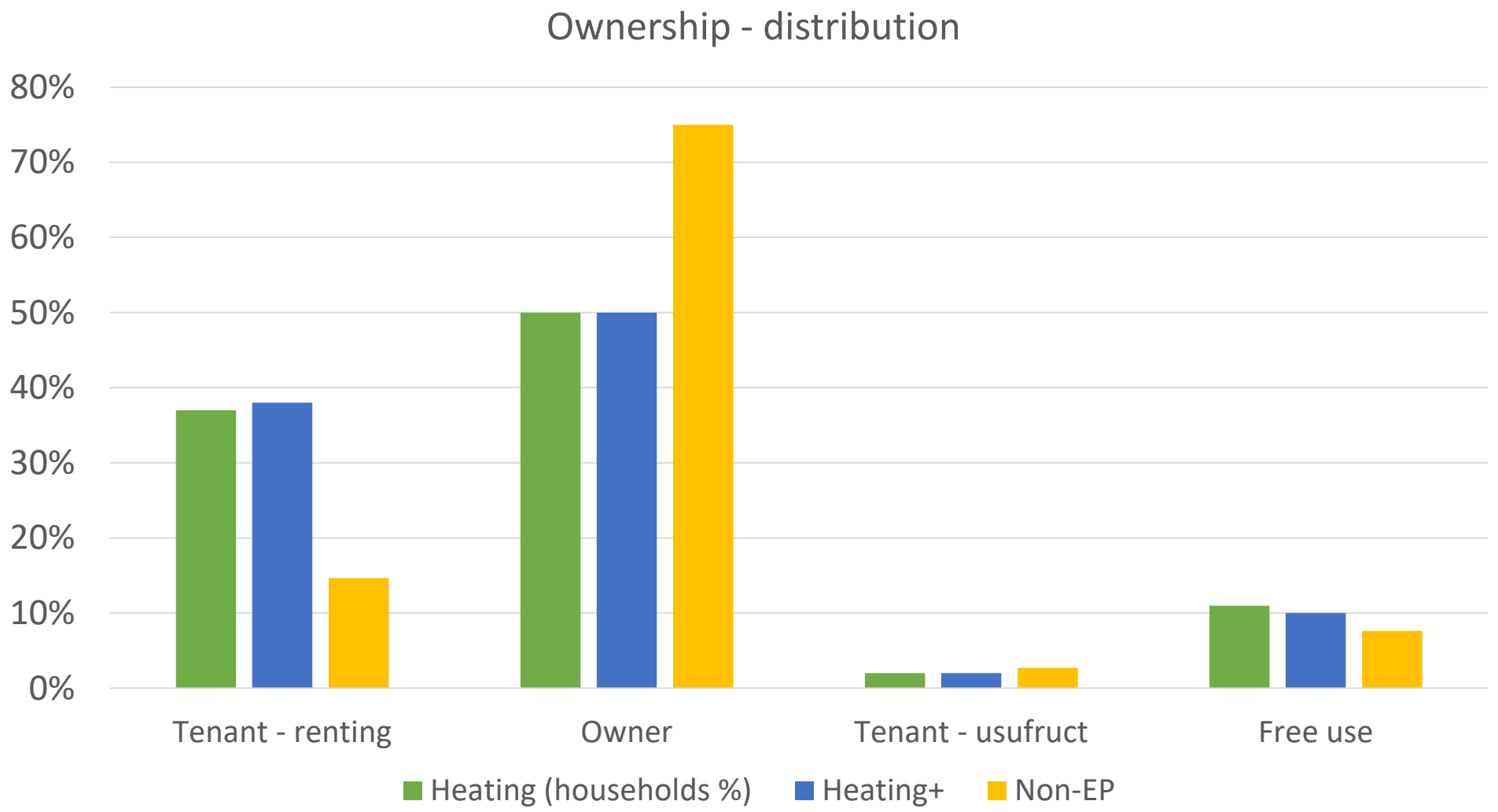
Analysis of EP consumers characteristics – pt.2

% on total household expenditure	Energy poor households	Non-energy poor households	Average
Total energy expenditure ($E_i^{minenergy}$)	**14.8%**	**6.4%**	**6.9%**
Energy use expenditure	**8.5%**	**3.8%**	**4.1%**
Minimum heating + cooling expenditure	4.4%	2.2%	2.3%
Heating expenditure	3.5%	1.8%	1.9%
Cooling expenditure	0.9%	0.4%	0.4%
Purchase & Installation – cooling system	**4.7%**	**2.0%**	**2.1%**
Maintenance – cooling system	**1.6%**	**0.6%**	**0.7%**

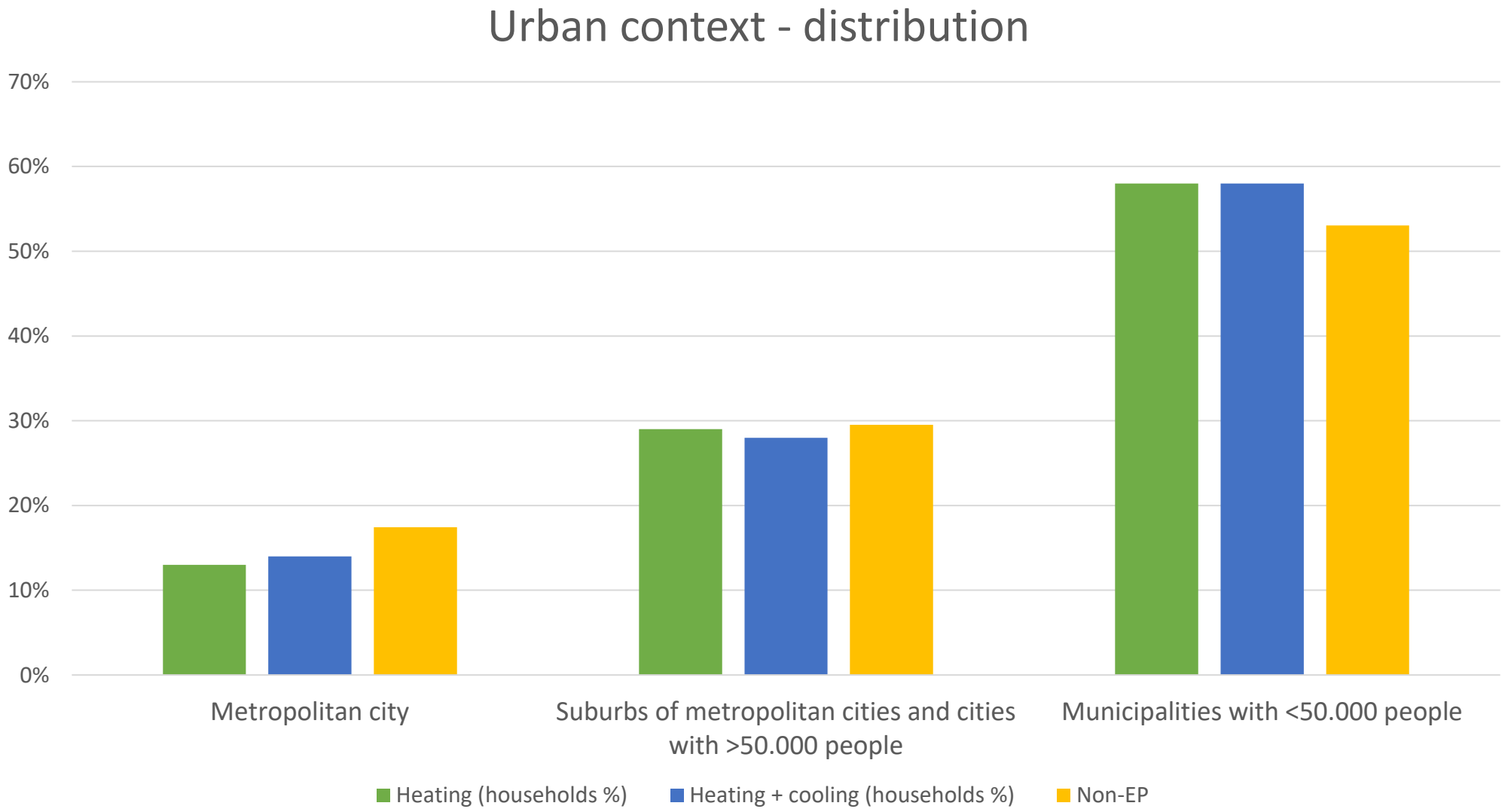
Analysis of EP consumers characteristics – pt.3



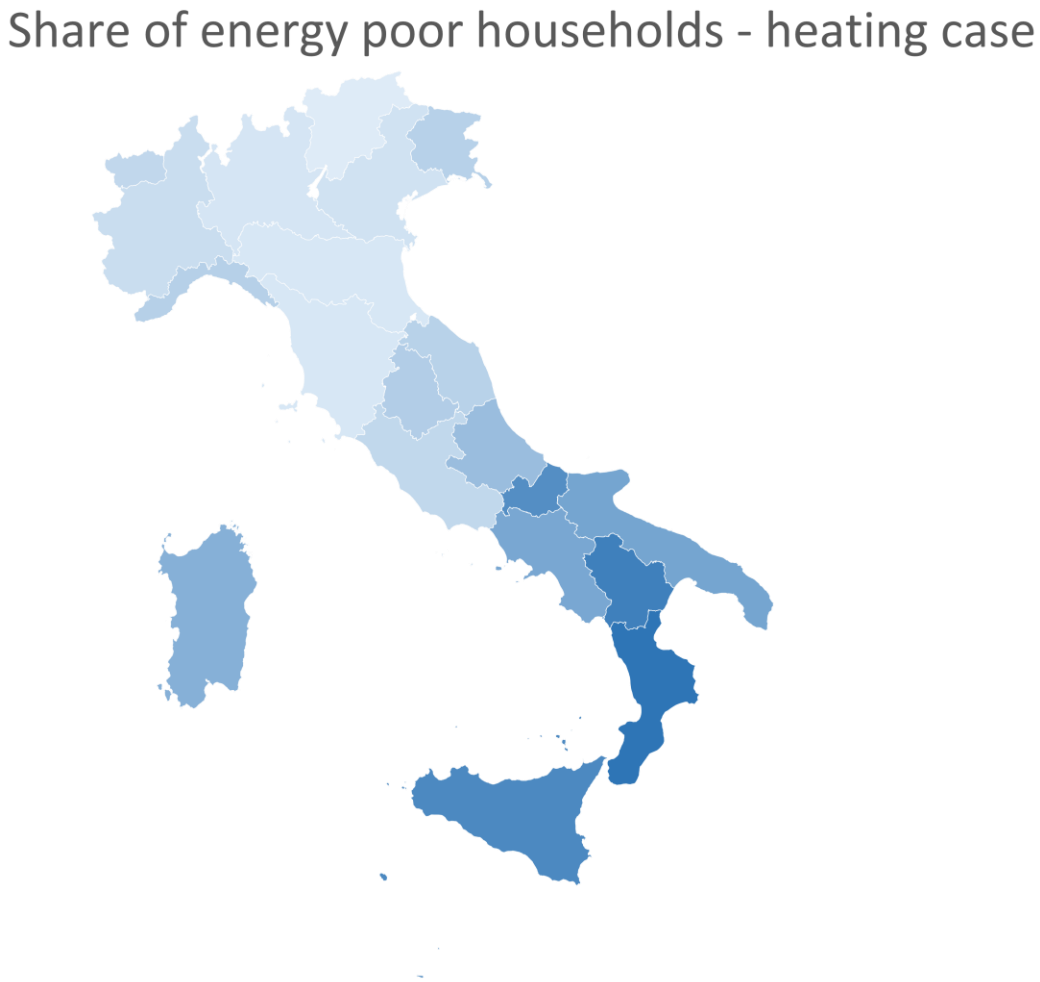
Analysis of EP consumers characteristics – pt.4



Analysis of EP consumers characteristics – pt.5

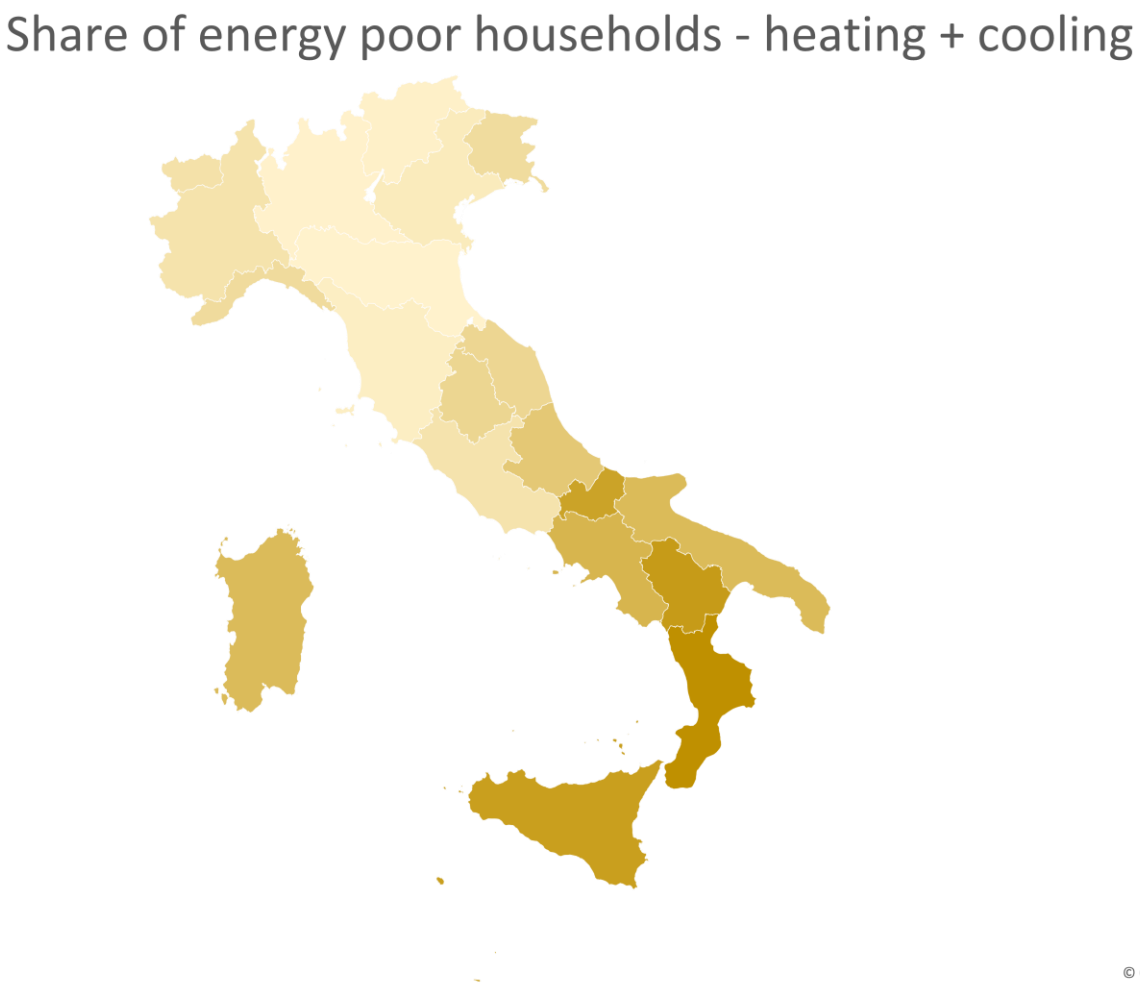


Analysis of EP consumers characteristics – pt.6



3.3 Million households
13% Italian households

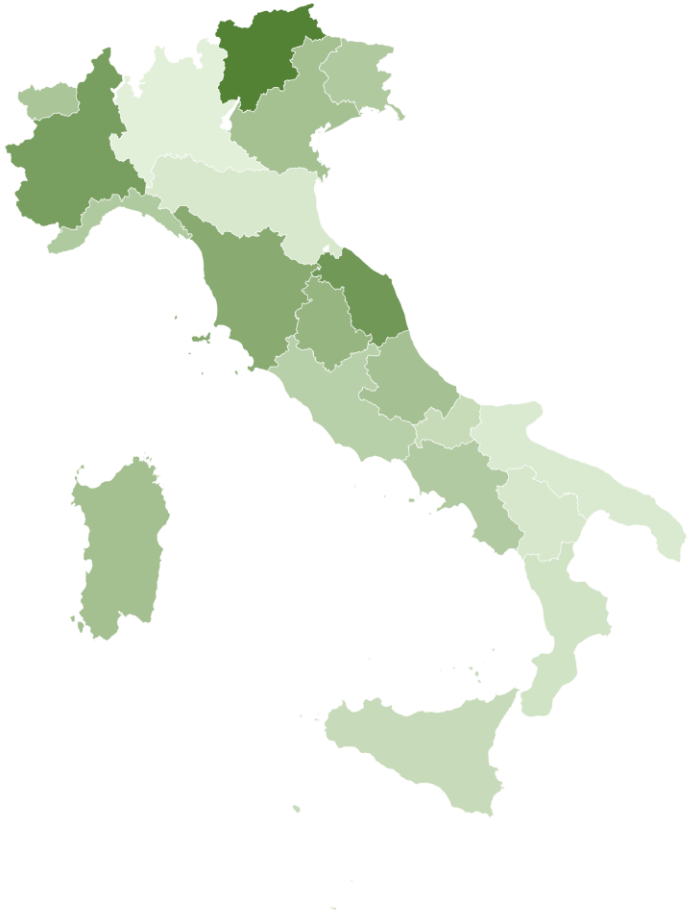
Analysis of EP consumers characteristics – pt.7



3.8 Million households
15% Italian households

Analysis of EP consumers characteristics – pt.8

Comparison between heating and heating + cooling cases



+505,000 households

Conclusions

- Overall impact of cooling: +500,000 households become energy poor;
- Cooling ➔ burden due to installation and maintenance cost, limited impact of energy costs (0.9% vs. 4.7% for installation and 1.6% for maintenance);
- Higher impact in Northern Italy ➔ less AC systems are installed, climate is however changing;
- Need for more specific financial measures (bonus), designed to take into account HDD (already done), CDD, household composition (done for electricity) but also features like urban context;
- Issue related to subsidies for home renovation: amount and accessibility for EP consumers

General conclusions

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Thanks for attending

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