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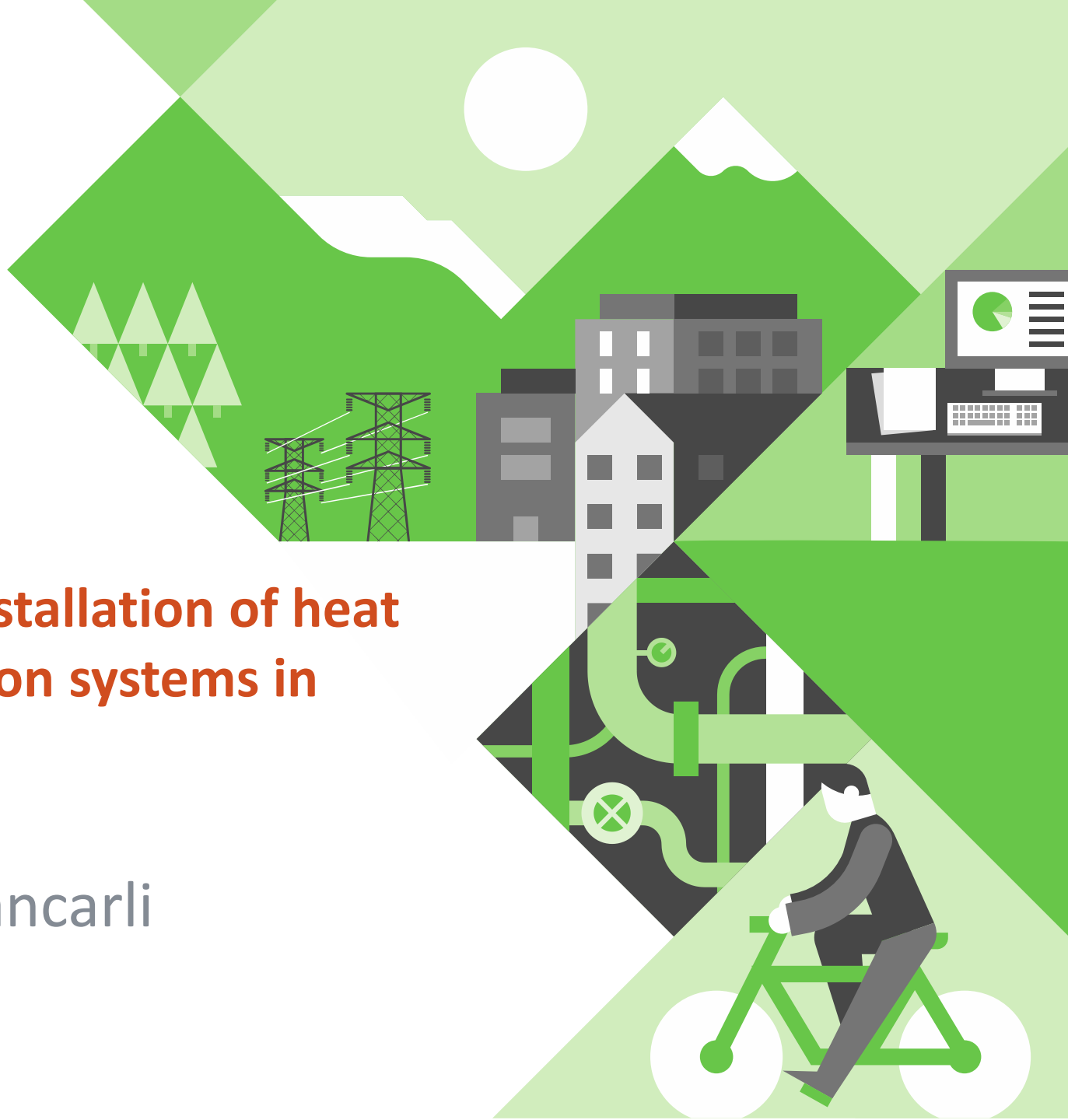

Analysis of the effects of the installation of heat accounting and thermoregulation systems in multi-residential buildings

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Eurac Research

Europe

Author (Year)	Min Saving [%]	Max Saving [%]	Average Saving [%]	Site
Goepfert (1962)	25	40	n.a.	CH
Kuppler (1991)	n.a.	n.a.	20	DE
Kimari (1994)	10	15	n.a.	FI
Poetter (1999)	n.a.	n.a.	23	RU
Berndtsson (2003)	10	20	n.a.	S
Adunka (2005)	10	30	20	AUT
Ademe (2006)	10	20	n.a.	FR
Darby (2006)	3	20	n.a.	NL, UK
Gullev/Poulsen (2006)	17	30	23.5	DK
Siggelsten/Hansson (2010)	10	40	n.a.	S
Rashper (2010)	25	30	n.a.	DE
Gölz (2009)	n.a.	n.a.	13	FI, N
Routledge/Williams (2012)	17	30	20	UK
Euopean Commission (2013)	n.a.	30	n.a.	EU
Gorzycki (2014)	8	33	15	PL
Espi (2014)	n.a.	n.a.	23	ES
Felsmann et al. (2015)	9	30	20.2	DE
Syndicat (2015)	19.8	n.a.	n.a.	FR
Biron (2015)	19.8	n.a.	20	FR
Cholewa/Siuta (2015)	25	30	n.a.	PL

Italy

Author (Year)	Min Saving [%]	Max Saving [%]	Average Saving [%]	Site
L. Canale (2018)	n.a.	n.a.	11	IT
Eurach Research (2019)	?	?	?	IT

RESEARCH REASON:

Lack of real data to verify the effects of installation of heat accounting and thermoregulation system in multi-residential building .

Collecting and Analyzing data

Main operations:

- Collecting building data.
- Calculation of degree day for each building based on its location and billing period.

$$GG = \begin{cases} 0, & T > 15°C \\ \sum_{i=1}^{d} (20 - T), & T \leq 15°C \end{cases}$$

- Normalization of energy consumptions by degree days.
- Calculation of mean normalized consumption for the pre and post installation of HAT systems.
- Calculation of energy saving comparing the normalized data.
- Evaluation of scenarios based on different technical interventions.

NOTE: Not all gathered data referred to heating consumption of building. In same case the data are the sum of heating and domestic hot water consumption. In these cases, we assumed **no variation in DHW use by tenants before and after the installation of HAT.**

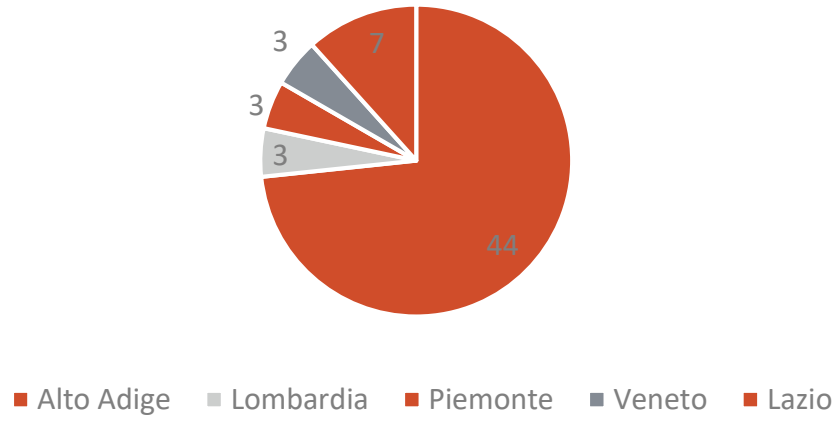
Collecting data

Three ways to collect data:

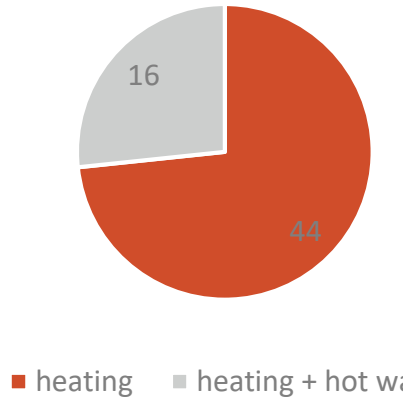
- by a survey (13);
- meeting with administrators (19);
- through collaboration with IPES and the Province of Bozen (28).

60 multi-residential buildings

Location



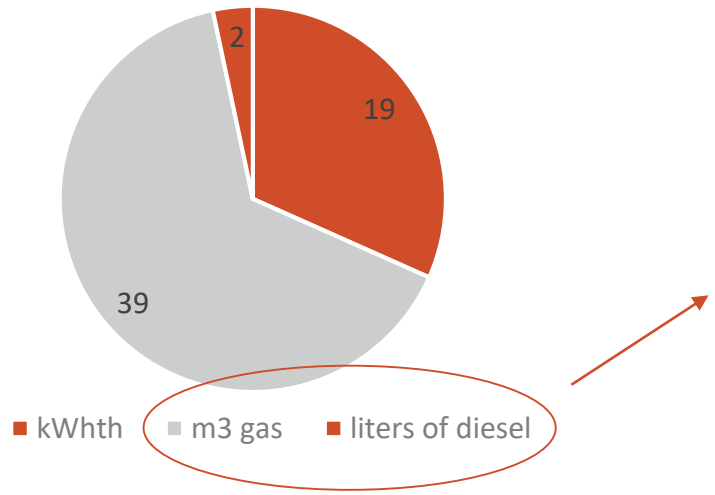
Kind of data



Analyzing data

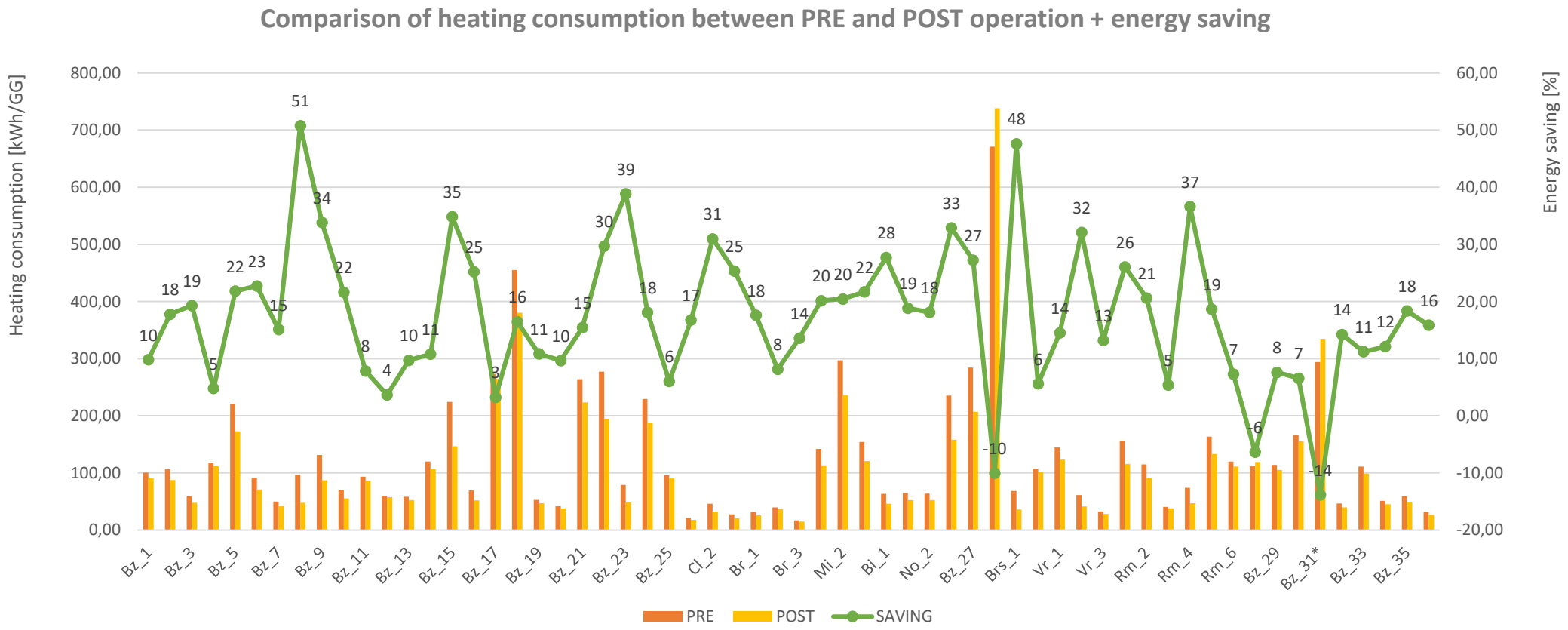
Boundary conditions:

- Data normalization using the number of apartments instead of building square meters (no availability of this data for all buildings).
- Minimum number of data: PRE ~ 2-3 values, POST ~ 1-2 values
- Kind of unit: kWh



Conversion into kWh_{th} using the calorific value of the fuel and the efficiency of the generator

Presentation of results



MEAN ENERGY SAVING

- Building **without** negative values: **18.79%**
- Building **with** negative values: **17.34%**

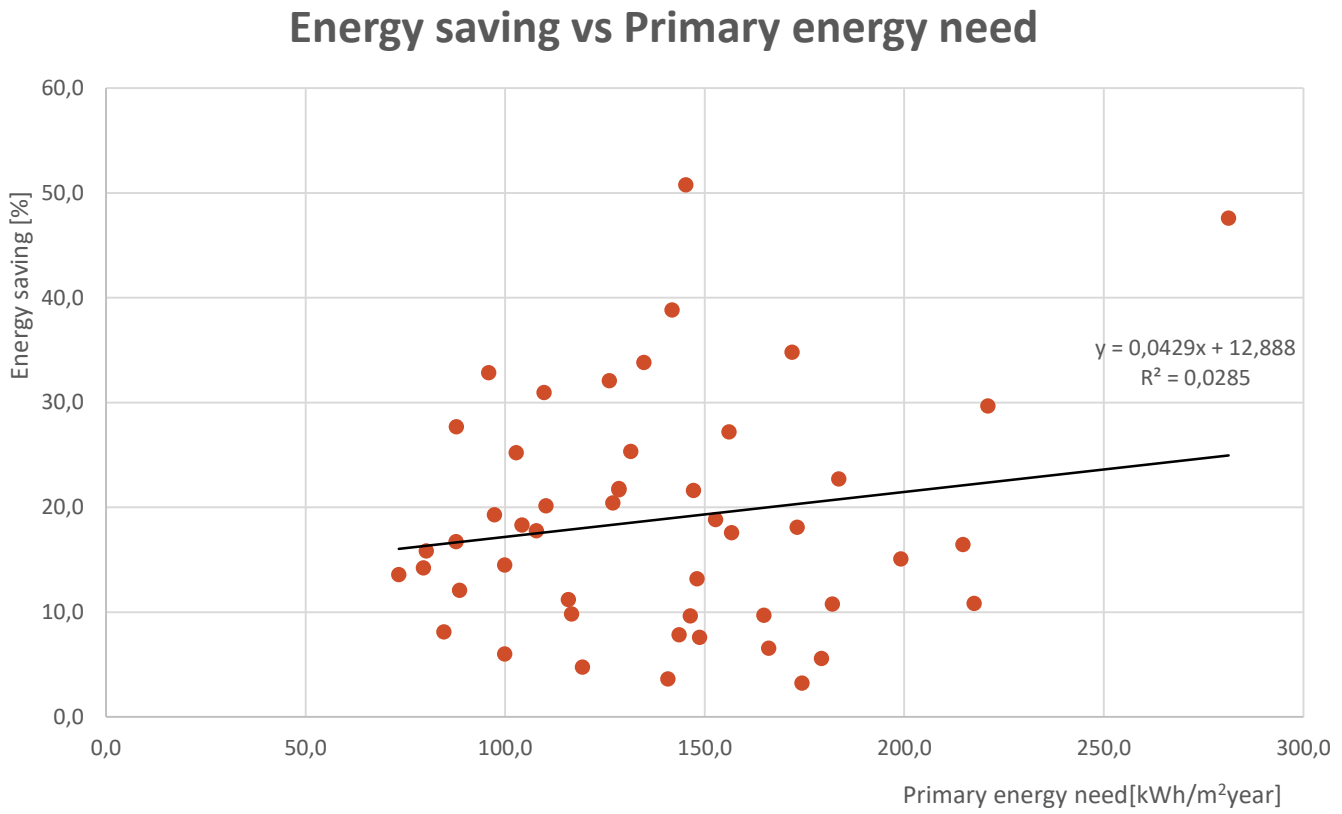
Presentation of results

TYPE OF TECHNICAL INTERVENTION CARRIED OUT:

TECHNICAL INTERVENTION	SAVING [%]
HCA + TV	17.13
HCA + TV + GENERATOR	25.00
HCA + TV + GENERATOR + WINDOWS	28.10
HCA + TV + GENERATOR + WINDOWS + ROOF	25.22
HM + TV + FACADE + WINDOWS	10.85

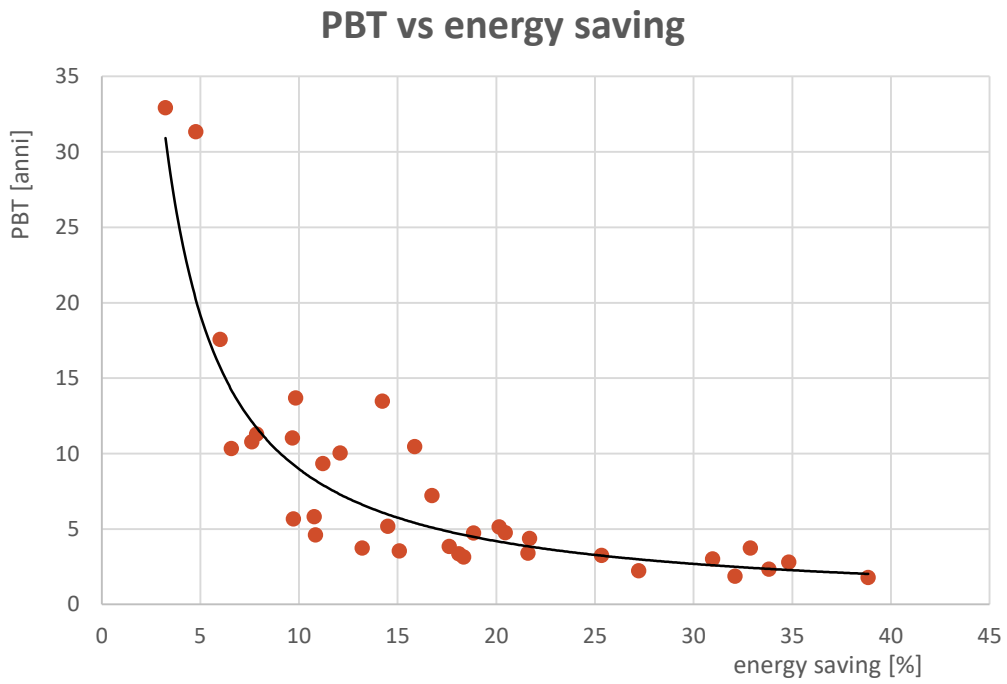
HCA: Heat Cost Allocator
TV: Thermovalves
HM: Heat meter

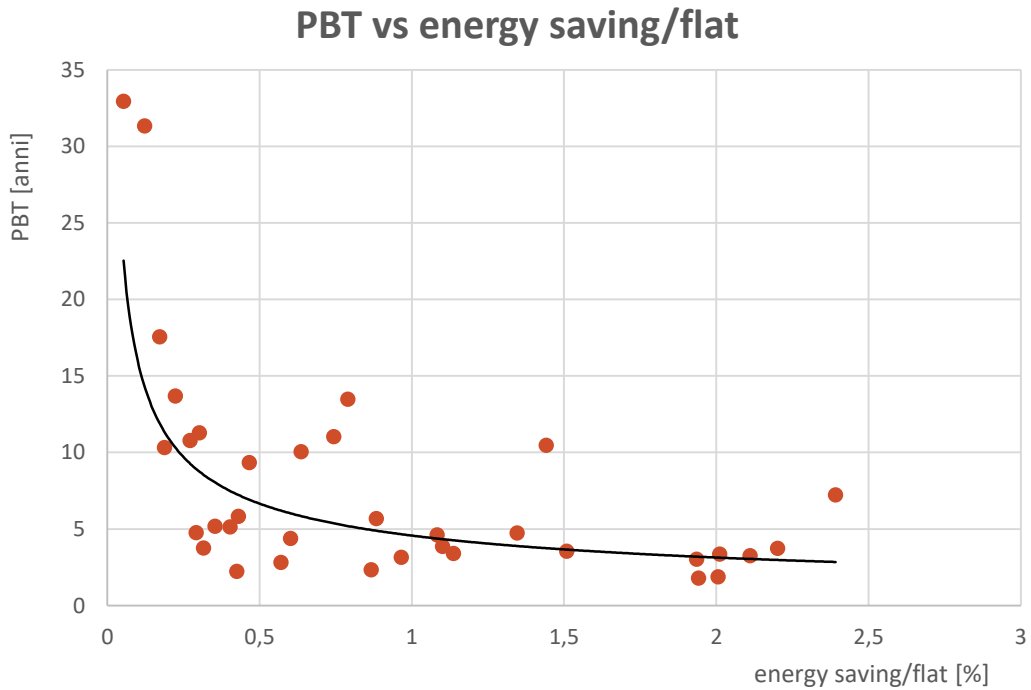
Presentation of results



The higher the primary energy need, the higher the potential energy saving

Presentation of results





- **The higher the energy saving, the lower the PBT to install, operate and mantain HCA + TV**
- **Bigger building can generate higher saving**

Presentation of results

Load factor of the generator

BUILDINGS	HAT SYSTEMS	LOAD FACTOR	TOTAL LOAD FACTOR
Bz_21	No	0.39	0.39
Bz_20	No	0.27	
Bz_22	No	0.71	
Bz_25	No	0.24	
Bi_1	No	0.23	
Bz_21	Sì	0.32	0.31
Bz_20	Sì	0.25	
Bz_22	Sì	0.50	
Bz_25	Sì	0.23	
Bi_1	Sì	0.17	

$$f_c = \frac{E_{th,produced}}{E_{th,max}}$$

Mean reduction of f_c: 20%

Installing generators with a nominal power 20% lower than the old ones can:

1. **Increase the energy efficiency**
2. **Reduce the investment cost for new generators**

Presentation of results

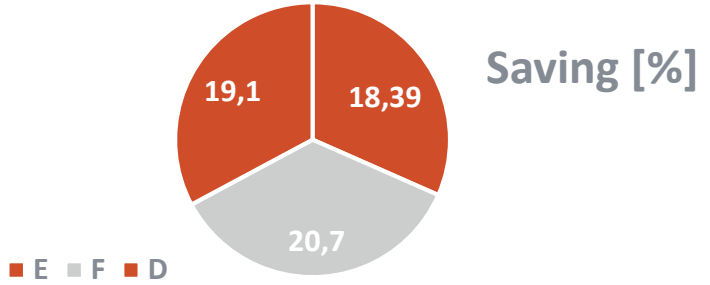
REGION	EXPECTED SAVINGS [Mtep] WITH BENEFIT 18%	CUBIC METERS OF SAVED GAS [Sm^3]	SAVED EURO [€]	SAVED EMISSIONS [tCO_2]
Piemonte	0.14	1.63E+08	4.24E+07	3.19E+05
Valle d'Aosta	0.01	9.11E+06	2.37E+06	1.78E+04
Liguria	0.03	3.73E+07	9.70E+06	7.29E+04
Lombardia	0.25	2.94E+08	7.63E+07	5.74E+05
Tren. Alto Adige	0.05	5.42E+07	1.41E+07	1.06E+05
Veneto	0.05	5.41E+07	1.41E+07	1.06E+05
Friuli V. G.	0.01	1.24E+07	3.22E+06	2.42E+04
Emilia R.	0.07	7.72E+07	2.01E+07	1.51E+05
Toscana	0.03	4.01E+07	1.04E+07	7.84E+04
Umbria	0.01	8.16E+06	2.12E+06	1.60E+04
Marche	0.01	1.05E+07	2.72E+06	2.05E+04
Lazio	0.08	8.94E+07	2.32E+07	1.75E+05
Abruzzo	0.00	5.15E+06	1.34E+06	1.01E+04
Molise	0.00	1.79E+06	4.66E+05	3.51E+03
Campania	0.01	1.60E+07	4.16E+06	3.13E+04
Puglia	0.01	9.50E+06	2.47E+06	1.86E+04
Basilicata	0.00	1.95E+06	5.07E+05	3.81E+03
Calabria	0.00	2.08E+06	5.40E+05	4.06E+03
Sicilia	0.01	5.96E+06	1.55E+06	1.17E+04
Sardegna	0.00	5.49E+06	1.43E+06	1.07E+04
TOTAL	0.78	8.97E+08	2.33E+08	1.75E+06

Potential of HAT systems in Italy:

- energy saving: 0.78 Mtep
- saved gas: 897 mln m^3 gas
- saved euro: 233 mln €
- saved emmission: 1.75 mln tCO_2

Conclusions

- The mean energy saving achievable installing HAT systems with thermo-valves is about 17%. At national level, it corresponds to: 0.78 Mtep, 897 mln m^3 of gas, 233 mln €, 1.75 mln tCO_2;
- Evaluating the energy saving with the climate zones:



- Building with high primary energy need can achieve higher savings with lower PBT compared to energy efficient buildings installing HAT system + TV;
- From the literature is recognised that part of the benefit (8-9%) is due to the psychological impact of the user in relation to the awareness of his consumptions [Deutsche Energie-Agentur, 2017];
- Considering the available data: HAT systems can reduce the load factor of the generator for 20% ;

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THANK YOU!

Daniele Antonucci

Possible next steps

- From report to scientific article
- Improving the consistency of data looking for new buildings (also located in other city) – possible project
- Create a database for monitored data of heating consumption on multiple-residential buildings with a dedicated dashboard.