EU SILC Database analysis: identifying techno-economic-socio building archetypes and their available budget to invest on building energy performance improvement. A cross country comparison.

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Presentation

‣ EEG Group / TUW

‣ Building stock model (Invert/EE-Lab) https://invert.at/

‣ My PhD and area of interest of this study:

- **Receive publication: New step-by-step retrofitting model for delivering optimum timing**

The model relies on techno-economic specifications:

1) *Technical specifications*: specification of the renovation measures and their combination (step), identification of building elements' material, specification of material's lifetime according to existing databases, and calculation of material's ageing process;

2) *Economic specifications:* investment costs per step, energy price development per energy carrier, and **homeowner's budget restriction**

- https://www.sciencedirect.com/science/article/pii/S0306261921002348

Introduction: huge pressure to reduce EU's building sector emissions

Buildings consume more than a third of the EU's energy. Here's how to decarbonize them

Energy News / Latest Energy News / Coal

Buildings-related emissions hit record high: Report

pandemic recovery packages provide an opportunity to push deep building renovation and performance standards for newly constructed buildings, and rapidly cut emissions

IANS • December 17, 2020, 08:40 IST

Buildings of the future must be at the heart of the green transition in Europe

Greater circularity in the buildings sector can lead to major cuts in greenhouse gas emissions

Improving efficiency and reuse of materials to construct houses and other buildings can open significant new opportunities to further reducing greenhouse gas emissions, according to a European Environment Agency (EEA) briefing released today.

EU Targets Emission Savings From Buildings

By Tsvetana Paraskova - Oct 12, 2020, 10:30 AM CDT

Introduction: facts!

A European Green Deal

Striving to be the first climate-neutral continent

„Renovation of both public and private buildings is an essential measure in this context, and has been singled out in the European Green Deal as a key initiative to drive energy efficiency in the sector and deliver on objectives"

EU is boosting many investments to accelerate this transition

EU's building stock is 40-50% from single-family

Available budget have been until now a barrier for renovation activities
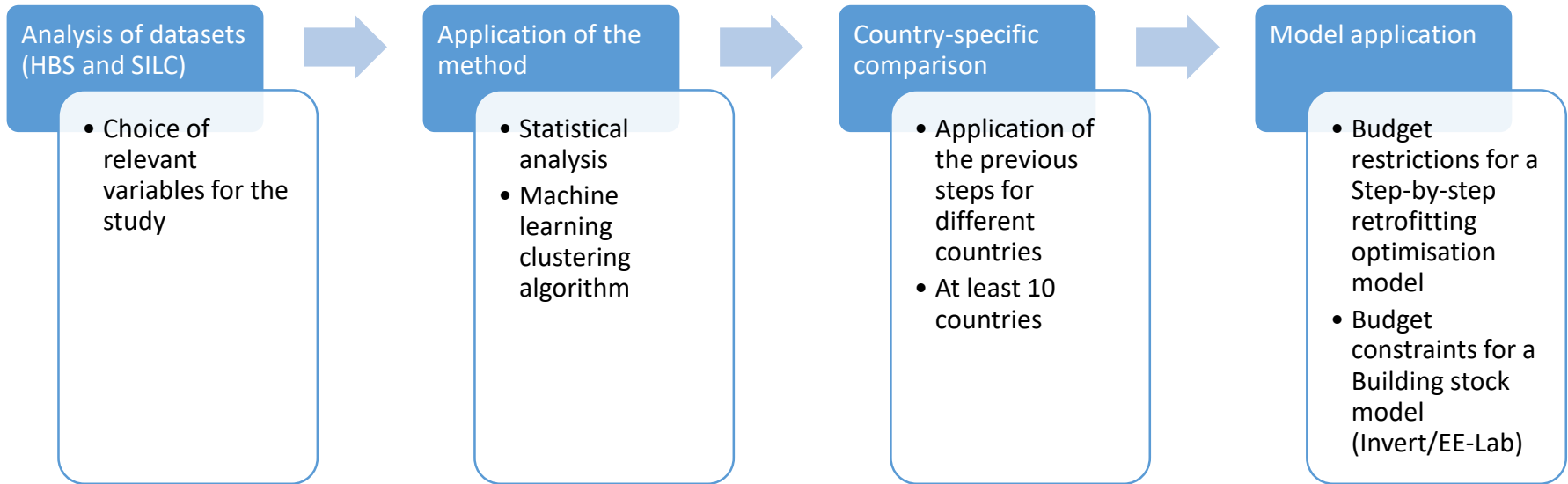
Introduction

▸ **Building (techno) archetypes (or reference buildings) – building typology (building use and construction year)**

Research question

1) How to define techno-economic-socio building archetypes for a representation of European households allowing the consideration of budget constraints in modelling the improvement of building stock energy performance?

2) For each identified archetype, which ranges can be observed of budget available for energy efficiency improvement investments?

3) Which country specific singularities can be observed and have to be considered in this context?

Method: WORK IN PROGRESS

Analysis of datasets (HBS and SILC)
- Choice of relevant variables for the study

Application of the method
- Statistical analysis
- Machine learning clustering algorithm

Country-specific comparison
- Application of the previous steps for different countries
- At least 10 countries

Model application
- Budget restrictions for a Step-by-step retrofitting optimisation model
- Budget constraints for a Building stock model (Invert/EE-Lab)

Method: performed analysis

Due to difficulties to merge SILC and HBS data

SILC

- Dwelling type
- Tenure status
- Disposable income
- Total housing costs

HBS

- 9 categories of household expeditures
- With main focus on: housing, electricity, gas and other fuels (without water)

Analysis 1:
Clustering of 2 variables for 1 country (BG):
- Available budget versus total energy expenditures
- Available budget versus net income

Analysis 2:
Statistical analysis for 10 countries (tenure status, dwelling types and „proxy indicator" of available budget)

Method: SILC descripton of used variables

‣ Dwelling type (HH010)

‣ Tenure status (HH021)

‣ Total housing costs (including water) (HH070)

‣ Total disposable household income (HY020) = Total gross household income - Regular taxes on wealth - Regular inter-household cash transfer paid - Tax on income and social insurance contributions

Variables calculated from the data:

‣ „proxy indicator" for available budget = disposable income – total housing costs (including water)

Method: SILC variables and selected countries

‣ Year: 2018

‣ EU-Countries: AT, ES, RO, SE, PL, BG, PT, FR and NL

‣ Dwelling type

- *1 Detached house (SFH)*
- *2* Semi-detached or terraced house *(SFH)*
- *3 Apartment or flat in a building with less than 10 dwellings (small) (MFH-small)*
- *4 Apartment or flat in a building with 10 or more dwellings (big) (MFH-big)*
- *5 Some other kind of accommodation*

‣ Tenure status

- *1 Outright owner*
- *2 Owner paying mortgage*
- *3 Tenant or subtenant paying rent at prevailing or market rate*
- *4 Accommodation is rented at a reduced rate (lower price than* the market price)
- *5* Accommodation is provided free

Method: HBS variables and selected countries

‣ Year: 2010

‣ Country: Bulgaria (BG)

‣ Total net income (HH099)

‣ Expenditures category (HE01 – HE12)

- Food and non-alcoholic beverages
- Alcoholic beverages, tobacco and narcotics
- Clothing and footwear
- Housing, water, electricity, gas and other fuels -> INTEREST
- Furnishings, household equipment and routine maintenance of the house
- Health
- Transport
- Communication
- Recreation and culture
- Education
- Restaurants and hotels
- Miscellaneous goods and services

Variables calculated with from the data:

‣ Available budget = net income – total household's expenditures

HBS category: Housing, water, electricity and others

Sum of following categories:

▸ Actual rentals for housing

▸ Imputed rentals

▸ Maintenance and repair of the dwelling

▸ Water supply and miscellaneous services relating to the dwelling

▸ Electricity, gas and other fuels -> on FOCUS

- Electricity
- Gas
- Liquid fuels
- Solid fuels
- Heat energy (ND)

Result: SILC number of analysed dwellings per country

|	SFH		MFH		Total
	Detached	**Semi-detached_**	**Small_ Apartment**	**Big_ Apartment**	
AT	2588	460	1189	1839	6076
IT	4720	5128	6115	5175	21138
ES	1781	2812	2708	6035	13336
RO	4481	97	287	2413	7278
SE	2719	515	554	1967	5755
PL	6732	833	1681	5935	15181
BG	3362	857	464	2521	7204
PT	5491	3246	2914	2051	13702
FR	4829	2322	1088	2359	10598
NL	2069	6755	751	2277	11852
				TOTAL	**112120**

Result: SILC statistical analysis

Dwelling type and tenure status per country
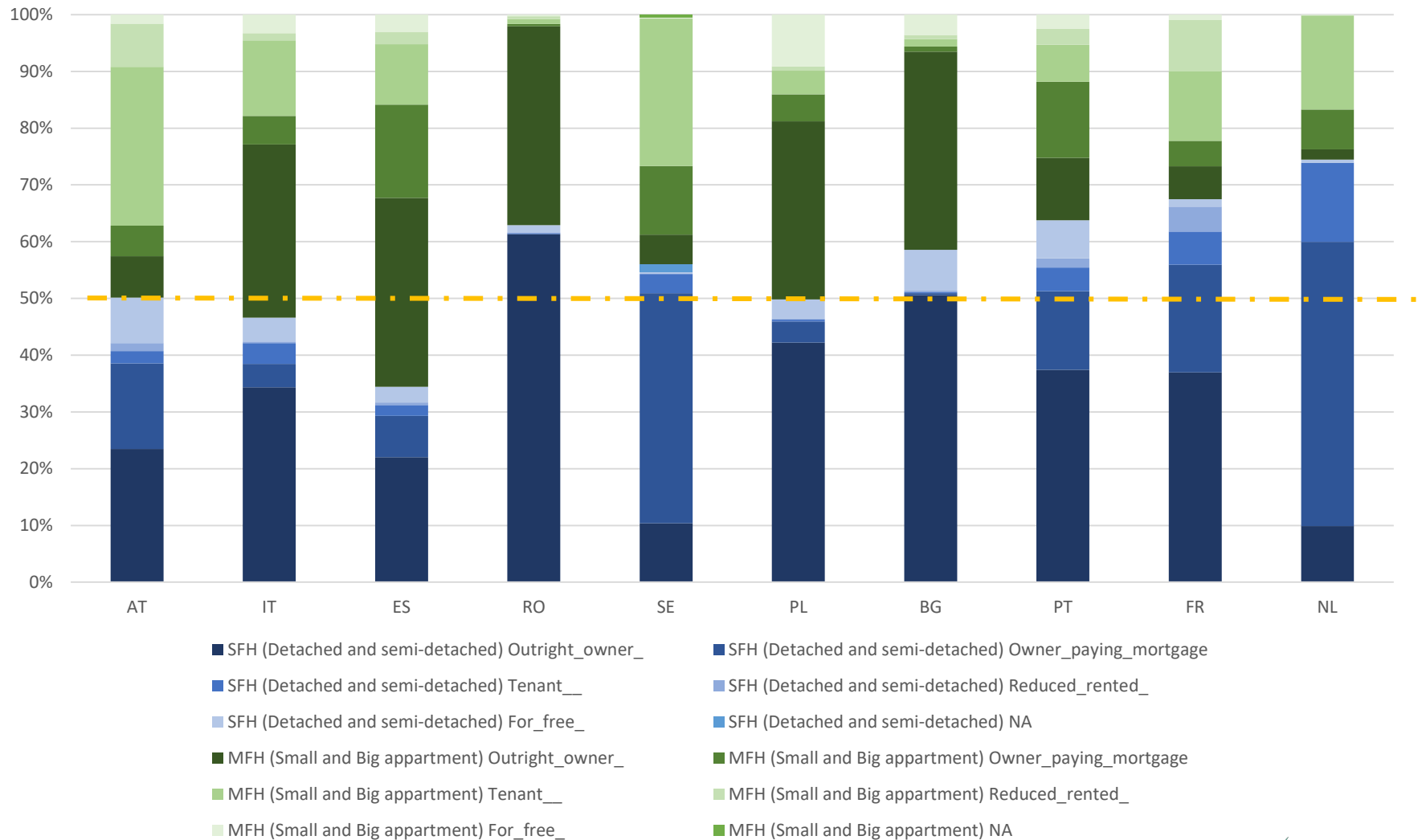
Result: SILC statistical analysis

Annual average „proxy indicator" for available budget (Disposable income minus total housing costs)
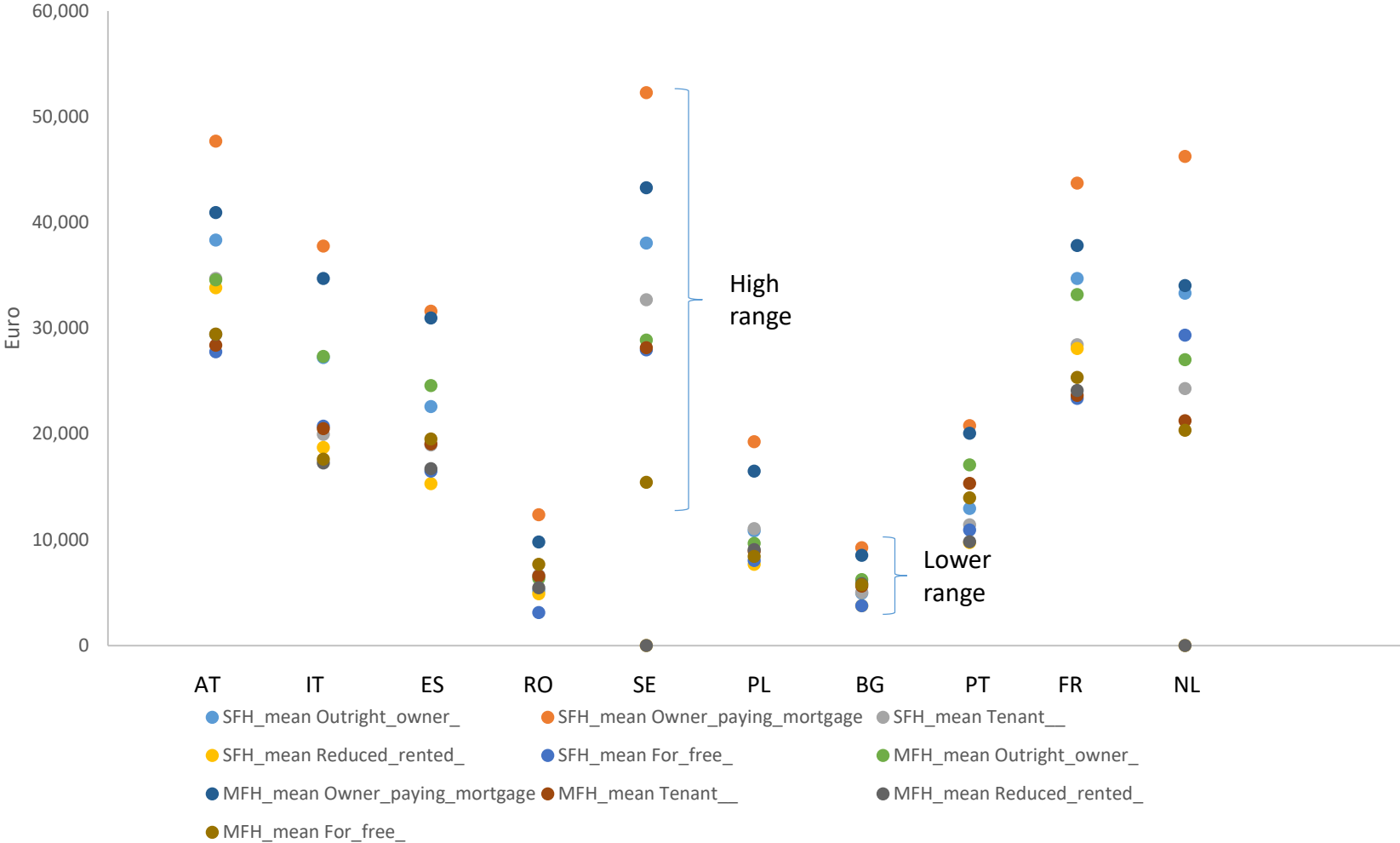
Result: HBS analysis (Bulgaria)

‣ Number of samples: 2084 (raw data = 2980)

‣ Excluding outliers: available budget > 0, net income < 70000

‣ Most dwellings: available budget lower then 2000 Euro and net income lower than 7500 Euro

net income versus available budget
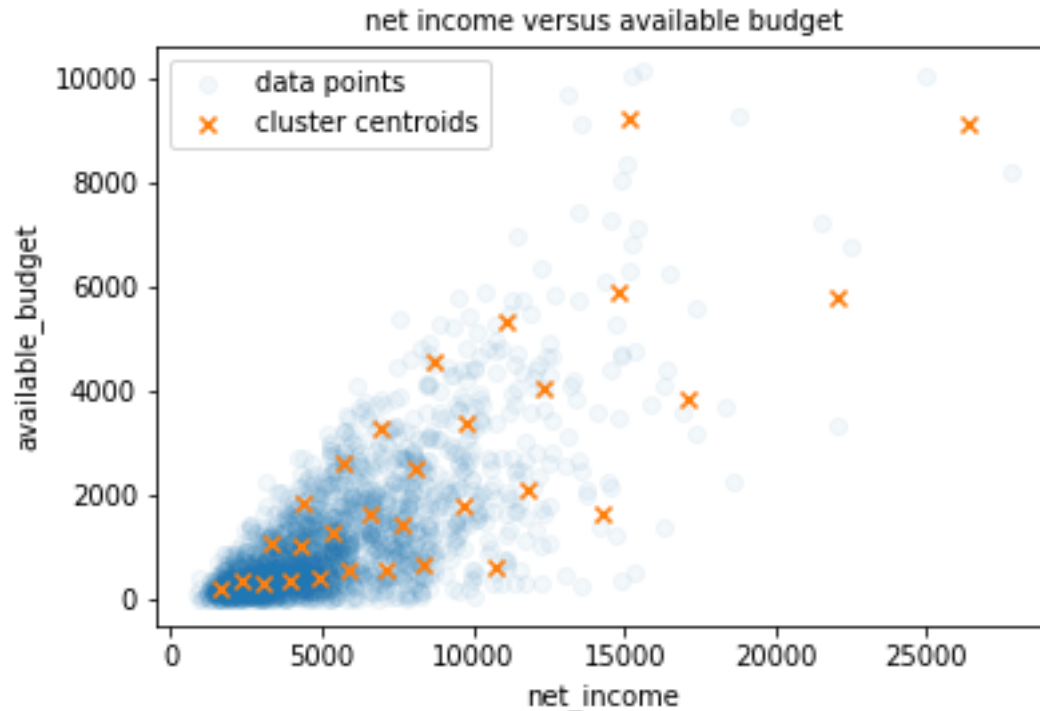
Result: HBS analysis (Bulgaria)

‣ Total energy expenditure increases with net income, it becomes more or less constant

net income versus total energy expenditure
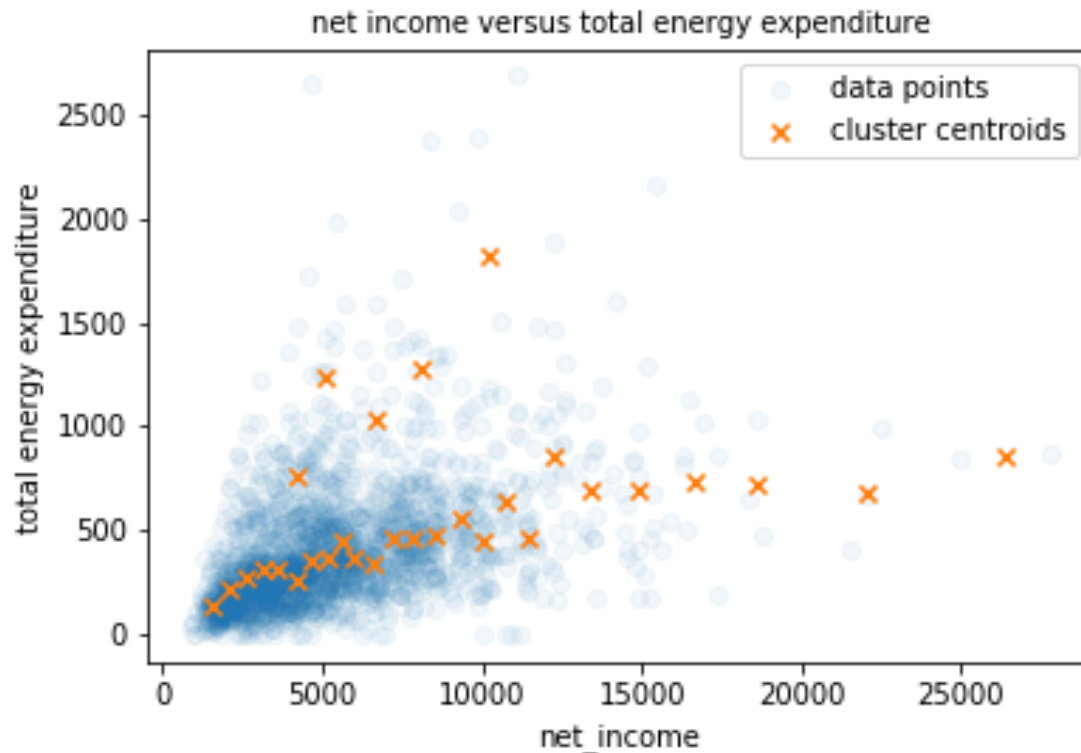
General Conclusions

▸ SILC has relevant information regarding tenure status and dwelling type

▸ HBS provides more specific expenditure data (analysis done for Bulgaria), but the sample for Bulgaria was smaller than in the SILC analysis

▸ HBS has relevant, disaggregated information about housing costs (energy, water, housing, etc.)

▸ HBS shows a clear pattern on the relation between total energy expenditure and the net income

Next steps / Open questions

‣ **Merging SILC and HBS is the optimal approach, however it is not clear how to do merge both (in a building level)**

‣ Further analysis should allow us to deliver policy recommendations regarding financing schemes for retrofitting activities

‣ Additional information from the databases that could add value to this study :

- Year of contract or purchasing or installation (HH031): also *year of building's construction* would be good to have
- *Leaking roof, damp walls, etc (HH040): also renovation / refurbishment activities last renovation*

‣ When will be the HBS 2015 data accessible?

Sources

- https://www.weforum.org/agenda/2021/01/here-s-how-to-decarbonize-the-eu-s-building-stock/

- https://energy.economictimes.indiatimes.com/news/coal/buildings-related-emissions-hit-record-high-report/79771220

- https://oilprice.com/Latest-Energy-News/World-News/EU-Targets-Emission-Savings-From-Buildings.html

- https://www.eea.europa.eu/highlights/greater-circularity-in-the-buildings

- https://episcope.eu/building-typology/webtool/

Thank you for your attention!