

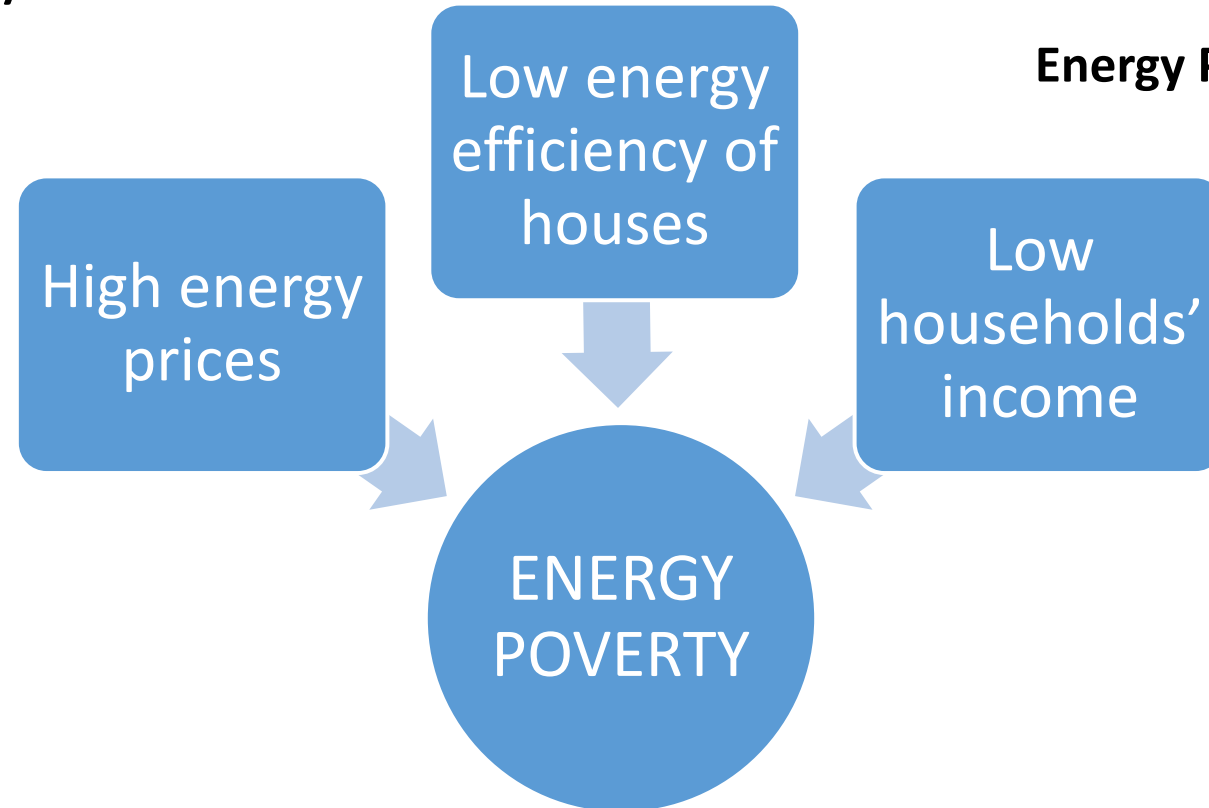
Hidden energy poverty in Central and Eastern Europe

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Energy poverty

“Energy poor households experience **inadequate levels of essential energy services**, due to a combination of high energy expenditure, low household incomes, inefficient buildings and appliances, and specific household energy needs”



Energy Poverty Observatory

Hidden energy poverty

- Abnormally low energy expenditures = under-consumption of energy
- **Reasons:**
 - Self-disconnections
 - Use of cheap dirty fuels (coal, wood, waste)

Housing costs approach

Energy poor under-consume energy



Energy costs = significant portion of utility expenditures included in total housing expenditures



Estimate the required total housing costs

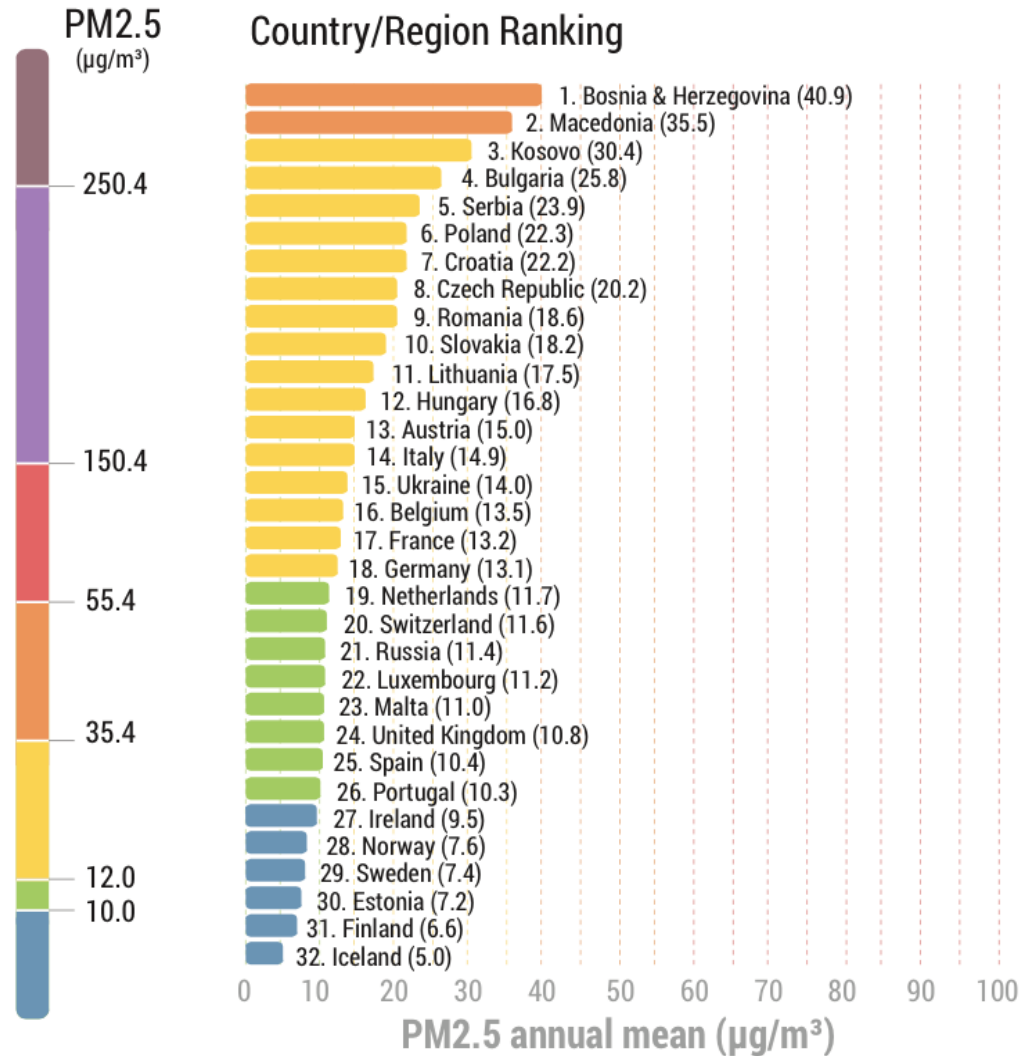


After housing costs equalised total disposable income is below the threshold of 60% median value



Exposed to hidden energy poverty

Central and Eastern Europe pollution rates



2018 World Air Quality Report, AirVisual

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Table.1 Variables

Housing aspect	Income aspect
Dwelling type	Ability to make ends meet
Tenure status	Household type
Number of rooms available to the household	Household size
Leaking roofs, damp walls/floors/foundation, or rot in window frames or floor	Arrears on utility bills
Bath or shower in dwelling	Ability to keep home adequately warm
Indoor flushing toilet for sole use of household	
Problems with the dwelling: too dark, not enough light	
Region	
Degree of urbanization	
Year of contract or purchasing of installation	

Fig 1. Equivalised disposable income distribution and the CEE11 median value (5875.85), EUR per year

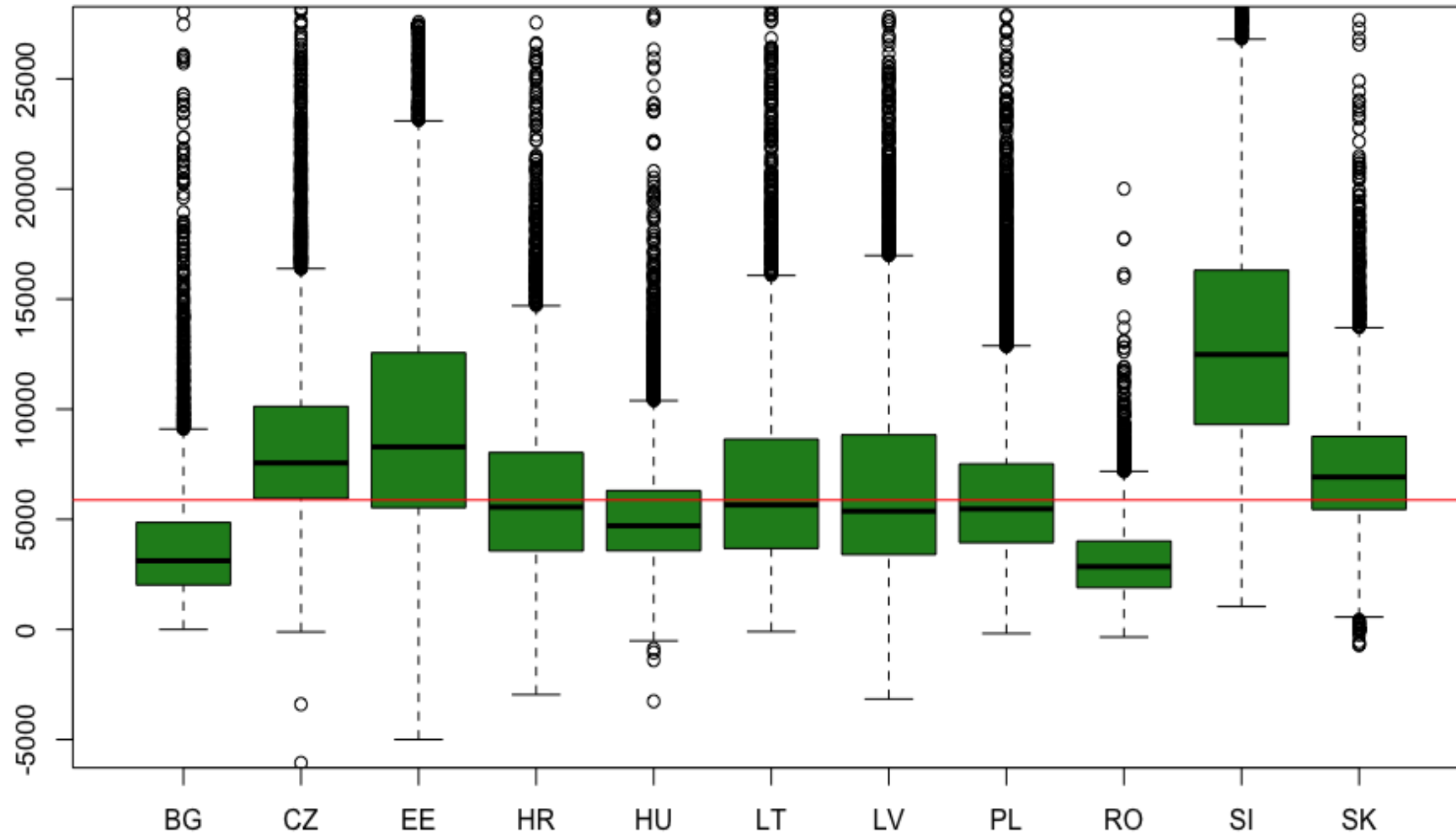


Fig 2. Housing costs distribution and the CEE11 median value (135.66), EUR per month

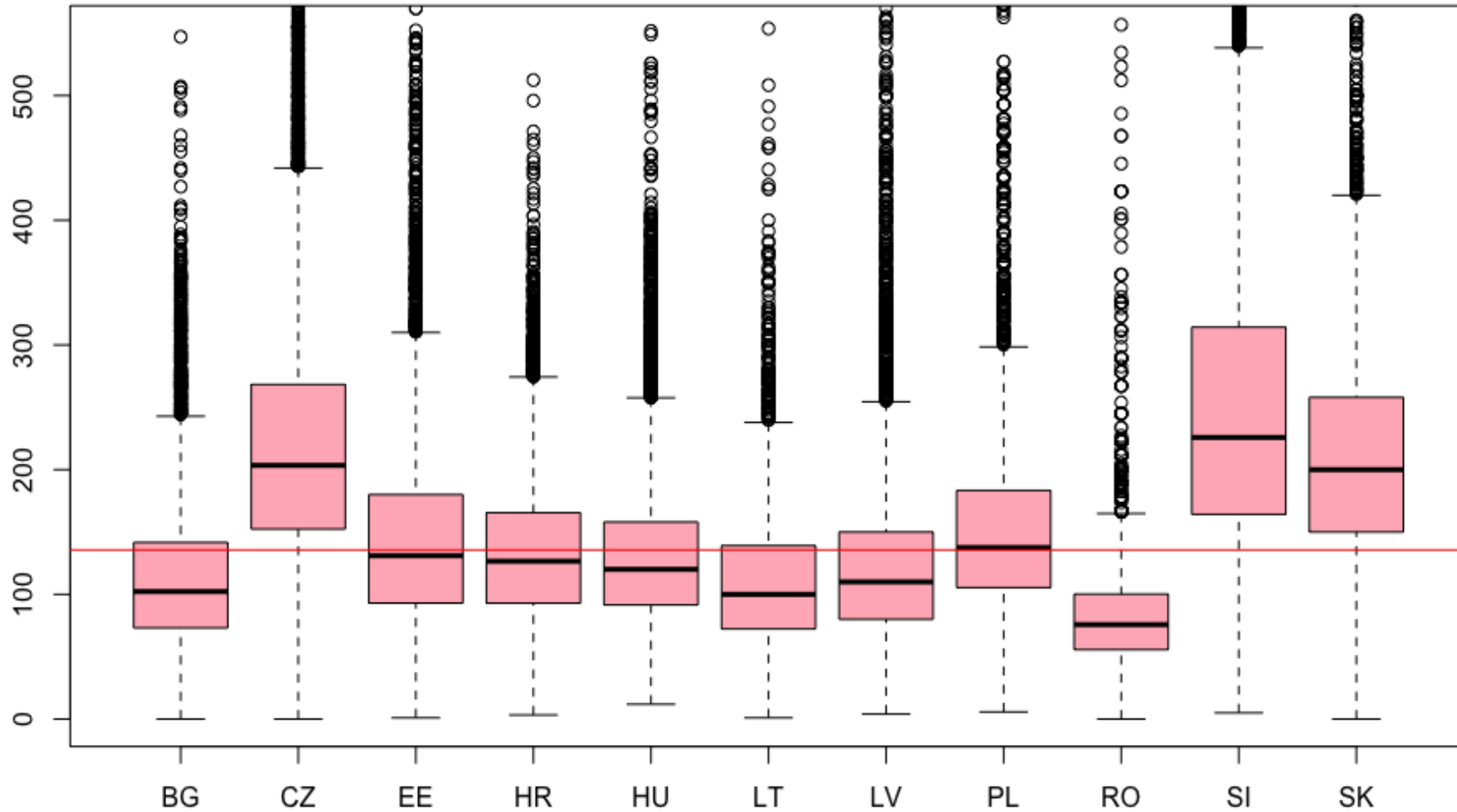
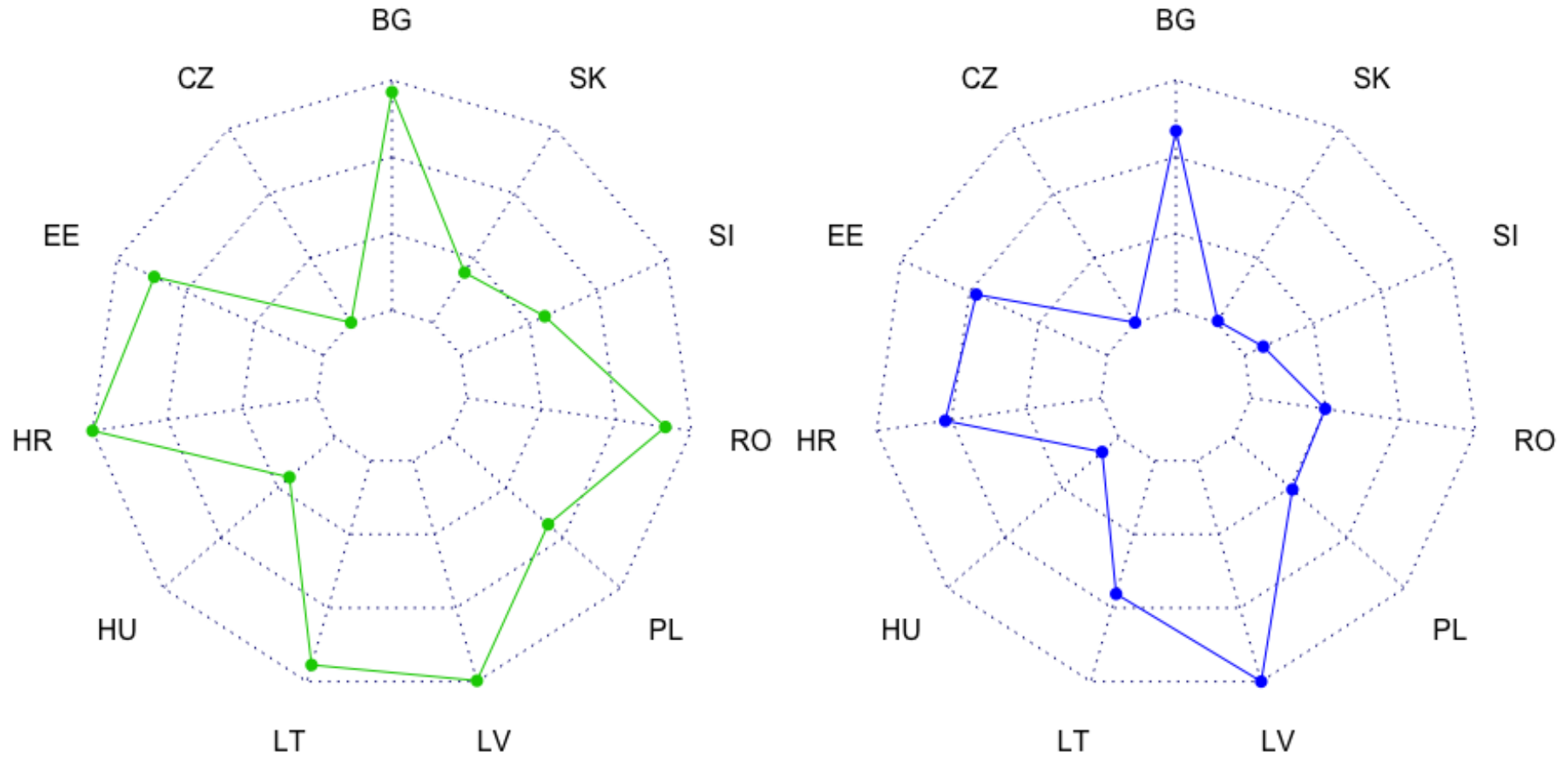
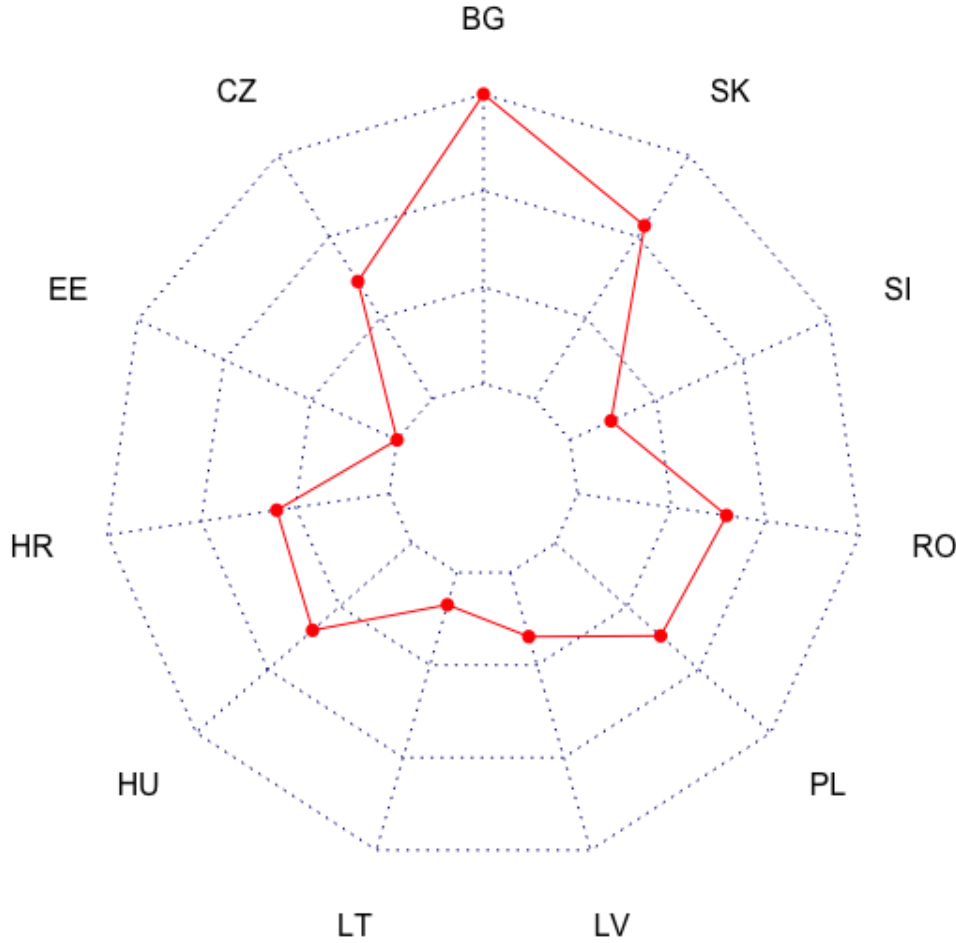


Fig 3. Income poverty in the CEE11



left panel: min = 6.49%, max = 21.96%, right panel: min = 11.59%, max = 33.82%

Fig 4. Housing costs overburden in the CEE11 (min = 10.82%, max = 48.52%)



Methodology

- **Linear regression**

- $Y = X\beta + \varepsilon$

- where Y is an $n \times 1$ vector of response, β is a m -dimensional vector of coefficients, $X = (X_1, \dots, X_m)$ is a $n \times m$ matrix of predictors, $\varepsilon = (\varepsilon_1, \dots, \varepsilon_m)$ is a vector of i.i.d. random error with mean zero and variance σ^2

Methodology

- **Lasso regression** minimizes the following expression based on a tuning parameter: $\lambda \geq 0$
- $\hat{\beta}(\lambda) = \arg \min_{\beta} ||Y - X\beta||_2^2 + \lambda ||\beta||_1$
- where $||\cdot||_1$ is ℓ_1 -norm (penalty in lasso) and $||\cdot||_2$ is a ℓ_2 -norm.
- **Adjusted Rand index**
- counting pairs measure of comparison, which accounts for the normalized difference between the Rand index and its expected value

Fig.5 Adjusted R-squared measures obtained in multiple linear regressions

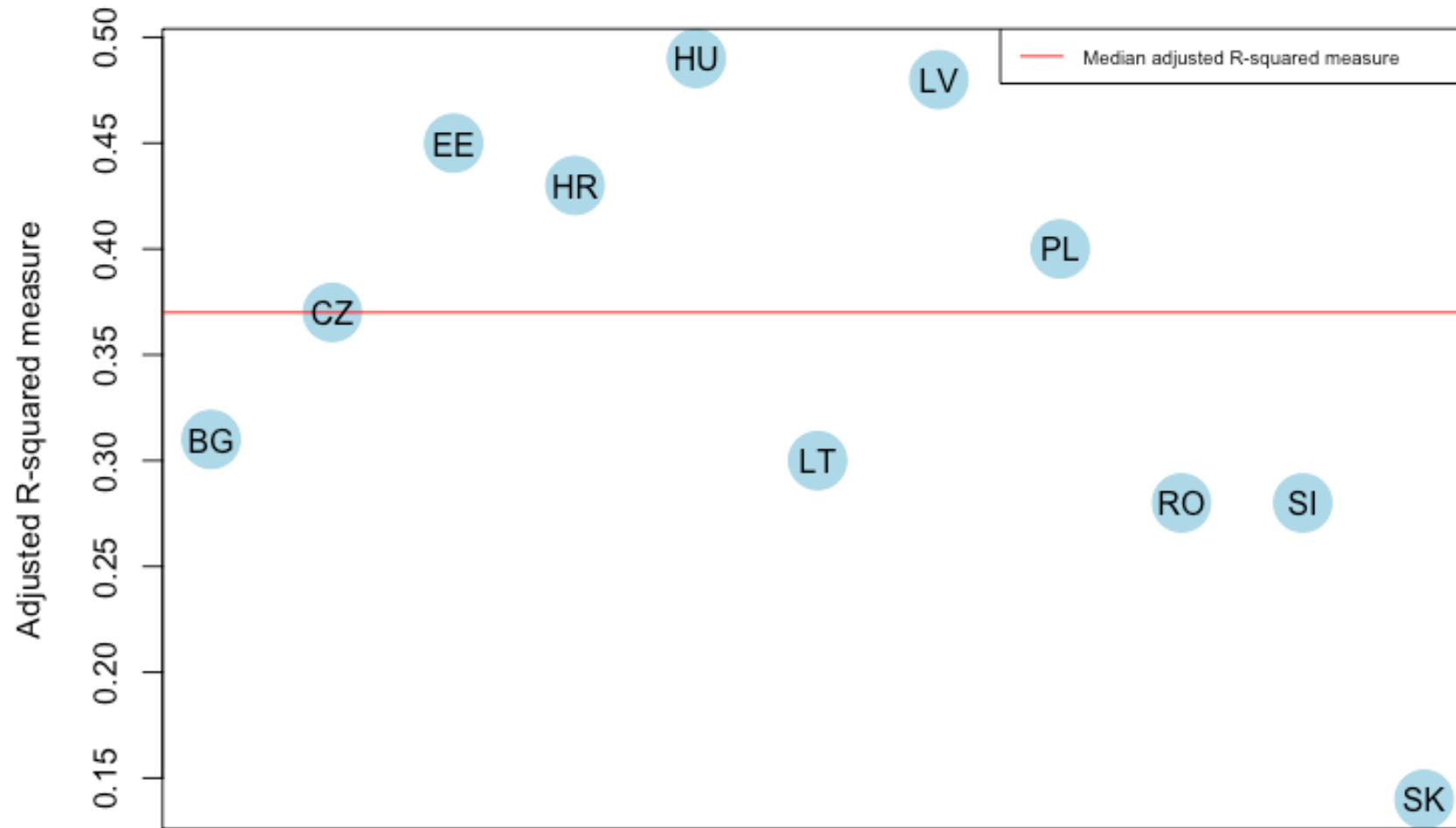


Table 2. The difference between actual and modelled housing costs per income decile, EUR per year

Countries	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
BG	-213.10	-189.87	-180.23	-178.93	-161.60	-114.91	-47.86	101.83	409.12	4114.88
CZ	-303.45	-249.05	-219.92	-194.56	-146.62	-99.67	-37.91	60.08	420.75	12889.31
EE	-244.77	-229.84	-212.04	-146.41	-97.83	-32.11	38.58	77.41	231.59	8270.27
HR	-212.53	-171.94	-179.48	-136.28	-85.10	-24.68	27.08	134.30	326.34	2021.67
HU	-198.52	-149.28	-116.47	-80.76	-22.98	25.60	68.95	94.01	127.59	2968.09
LT	-233.00	-236.40	-171.66	-153.44	-123.16	-44.09	54.77	185.33	350.62	10914.93
LV	-158.55	-202.70	-160.85	-98.12	-109.49	-118.01	-44.03	-21.34	272.53	14184.21
PL	-245.61	-238.73	-179.67	-163.06	-147.41	-24.57	35.00	123.34	248.86	6737.83
RO	-300.70	-163.54	-133.56	-215.21	-41.44	-74.54	-5.97	152.76	332.78	3675.95
SI	-644.44	-640.15	-516.15	-391.97	-227.75	-34.38	222.36	546.00	426.29	12846.99
SK	-830.70	-552.00	-362.77	-245.19	-118.08	13.33	142.31	371.59	879.69	5881.20

Table 3. Agreement of classifications between two models and income poverty

	Model 1 & Model 2	Model 1 & Income poverty	Model 2 & Income poverty
BG	0.83	0.55	0.60
CZ	0.86	0.46	0.48
EE	0.90	0.74	0.76
HR	0.95	0.73	0.75
HU	0.91	0.49	0.48
LT	0.91	0.74	0.74
LV	0.86	0.69	0.73
PL	0.93	0.61	0.62
RO	0.91	0.71	0.71
SI	0.91	0.68	0.69
SK	0.89	0.61	0.60

Fig.6 Exposure to hidden energy poverty in the CEE11 (min = 15.69% , max = 31.35%)

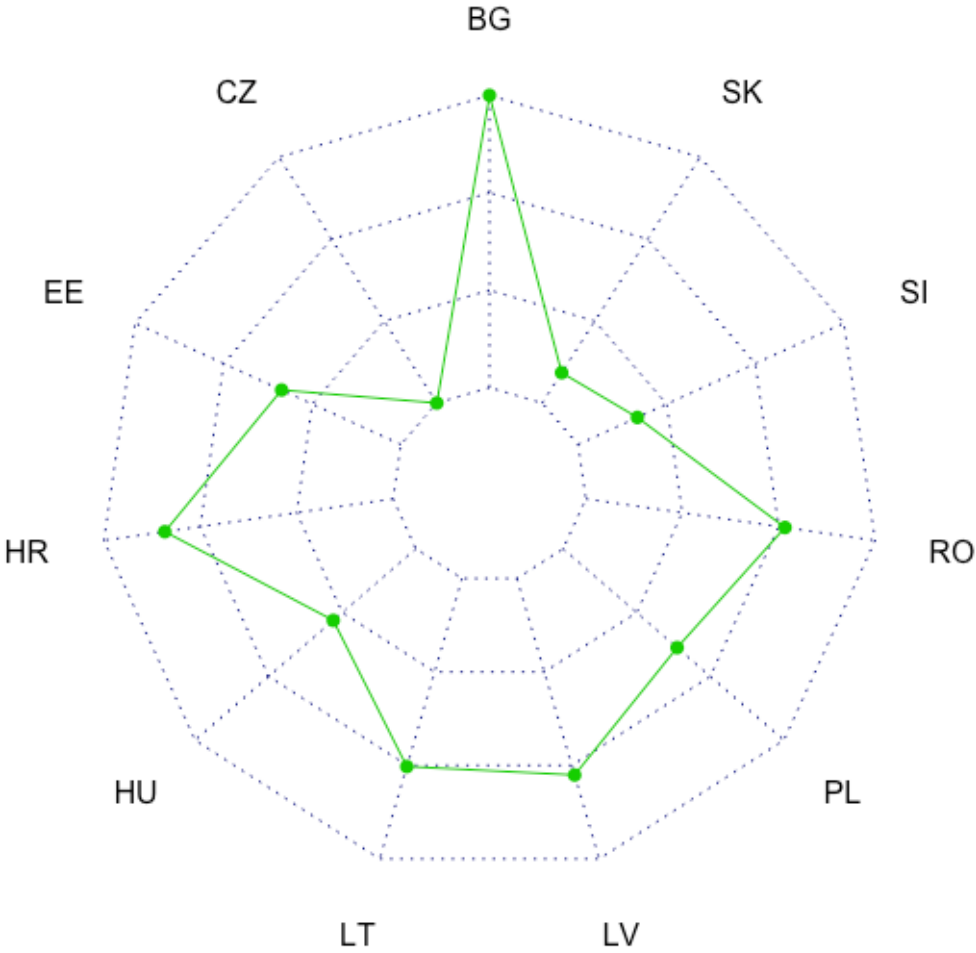


Fig. 7 Distribution of income poverty among exposed to hidden energy poverty households in Central and Eastern European countries

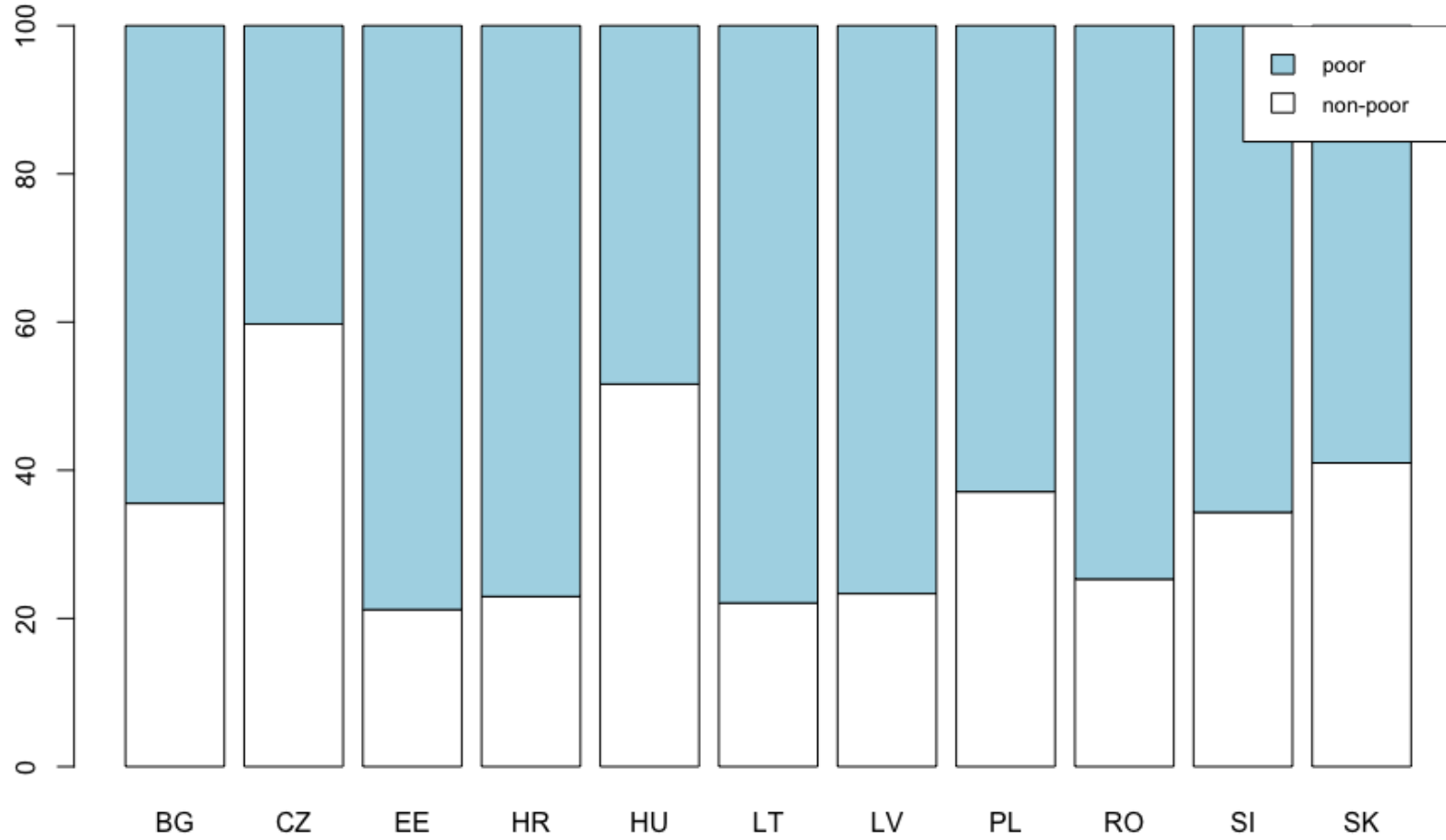


Fig. 8 Distribution of income per income deciles across exposed to hidden energy poverty households in Central and Eastern European countries

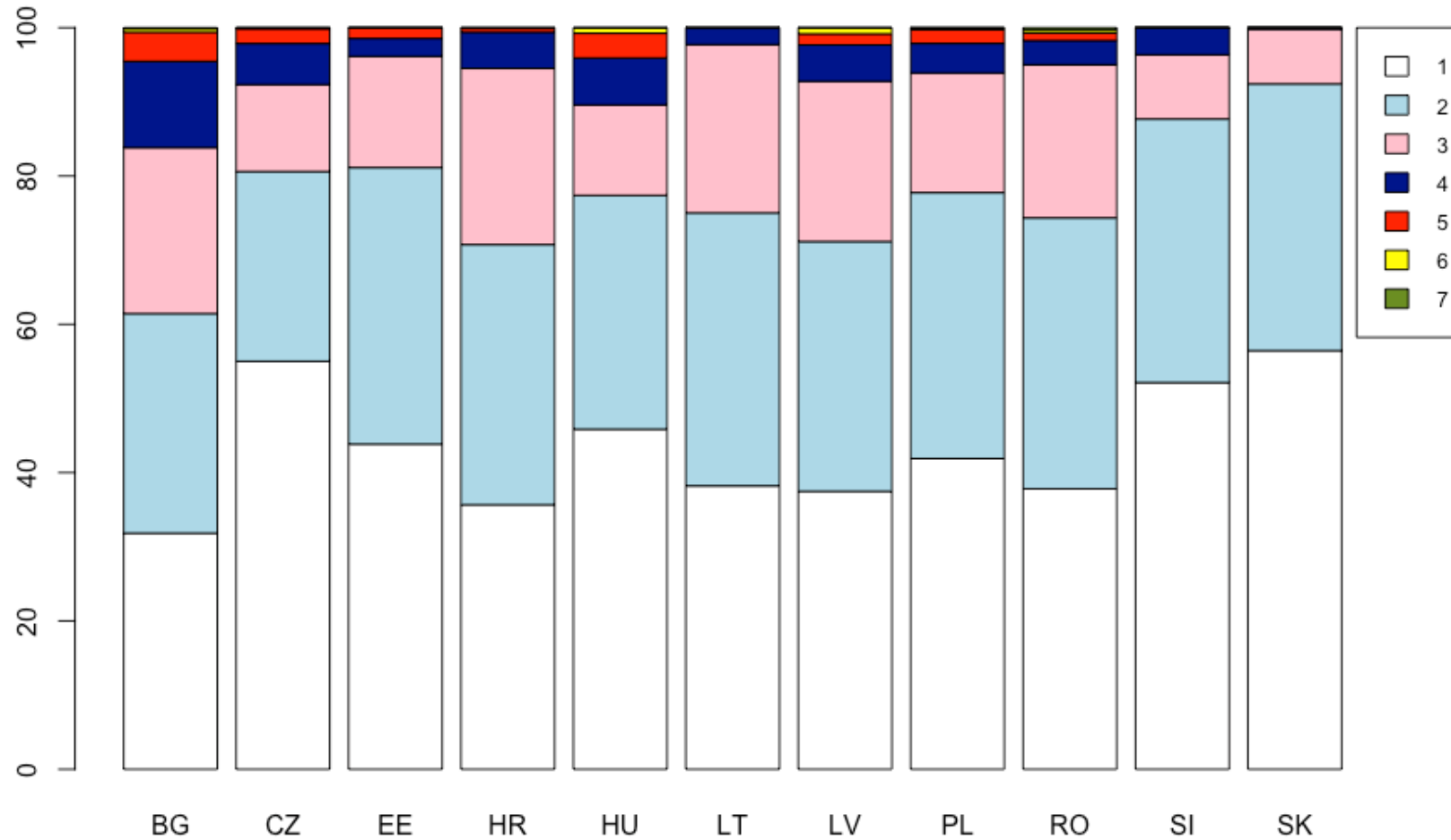
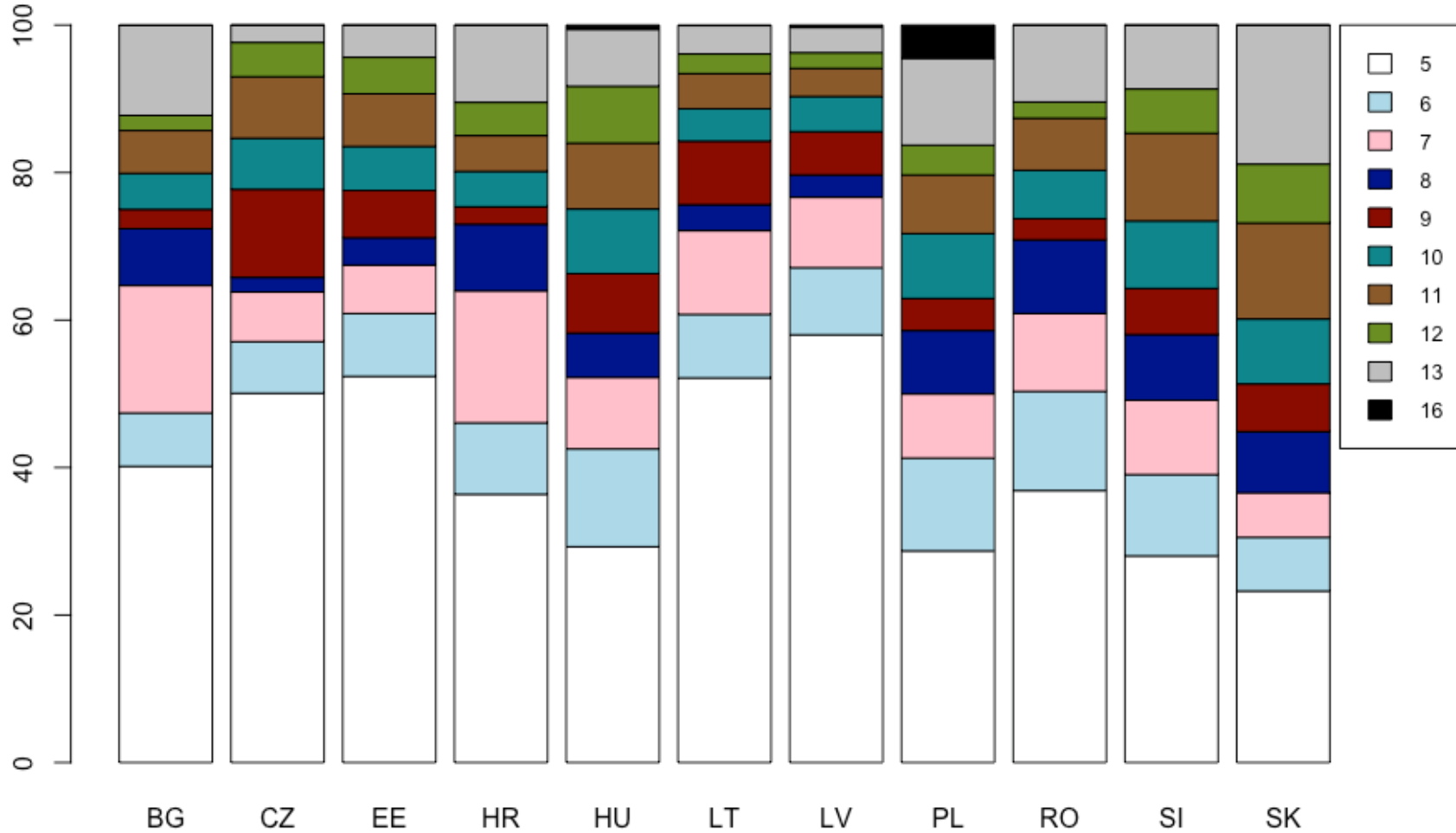


Fig. 9 Distribution of household types across exposed to hidden energy poverty households in Central and Eastern European countries



5. one-person household

6. 2 adults, no dependent children, both adults under 65 years^[L]_[SEP]

7. 2 adults, no dependent children, at least one adult 65 years or more^[L]_[SEP]

8. other households without dependent children^[L]_[SEP]

9. single parent household, one or more dependent children^[L]_[SEP]

10. 2 adults, one dependent child^[L]_[SEP]

11. 2 adults, two dependent children^[L]_[SEP]

12. 2 adults, three or more dependent children^[L]_[SEP]

13. other households with dependent children^[L]_[SEP]

16. other^[L]_[SEP]

Fig. 10 Distribution of dwelling types across exposed to hidden energy poverty households in Central and Eastern European countries

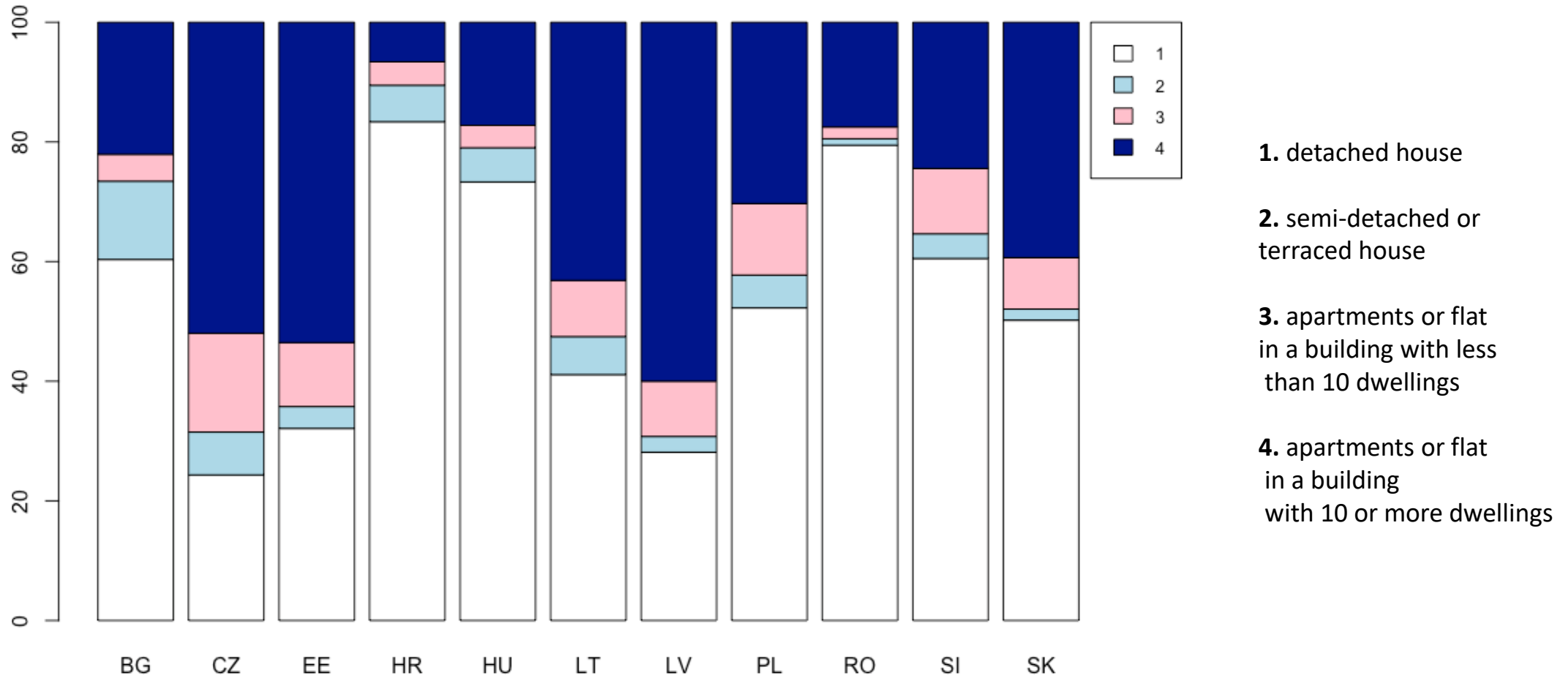


Fig. 11 Degree of urbanization distribution across exposed to hidden energy poverty households in Central and Eastern European countries

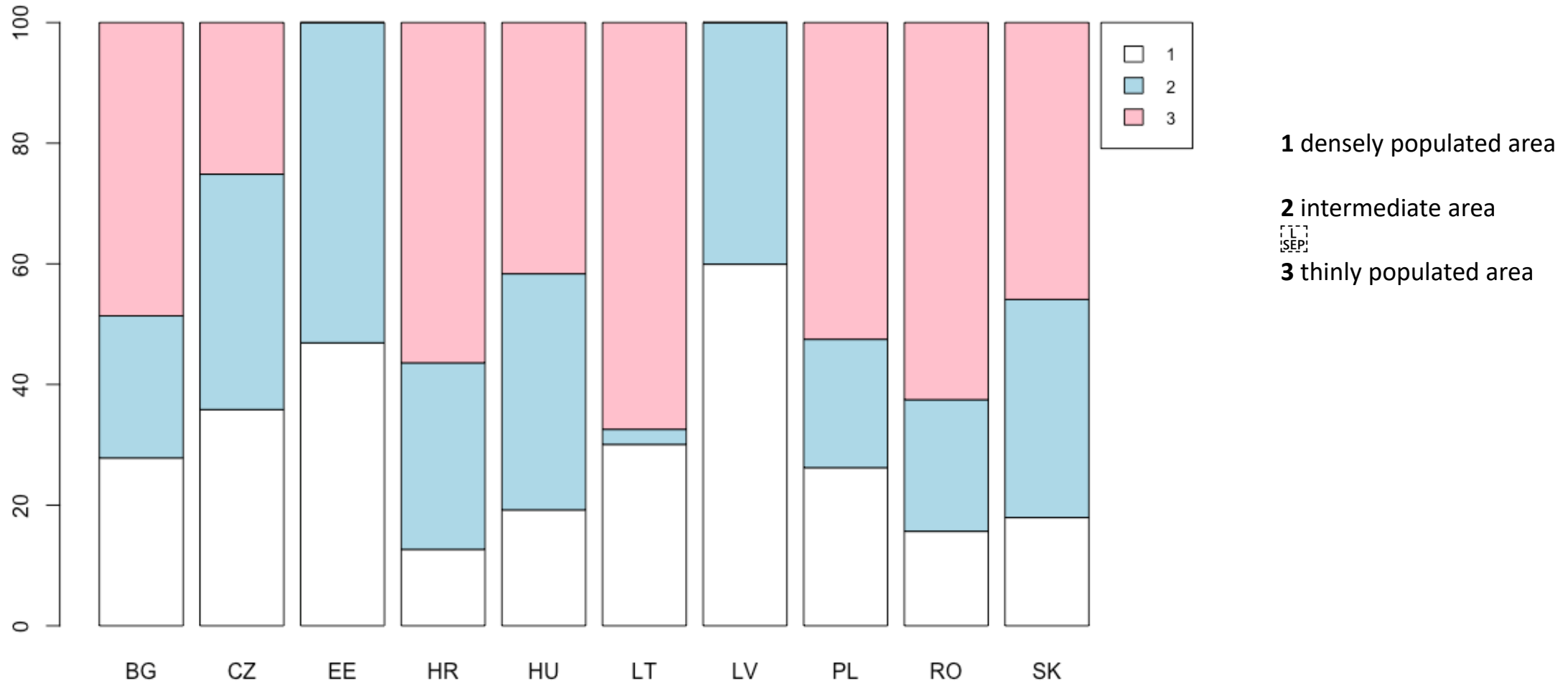


Fig. 12 Distribution of tenure status across exposed to hidden energy poverty households in Central and Eastern European countries

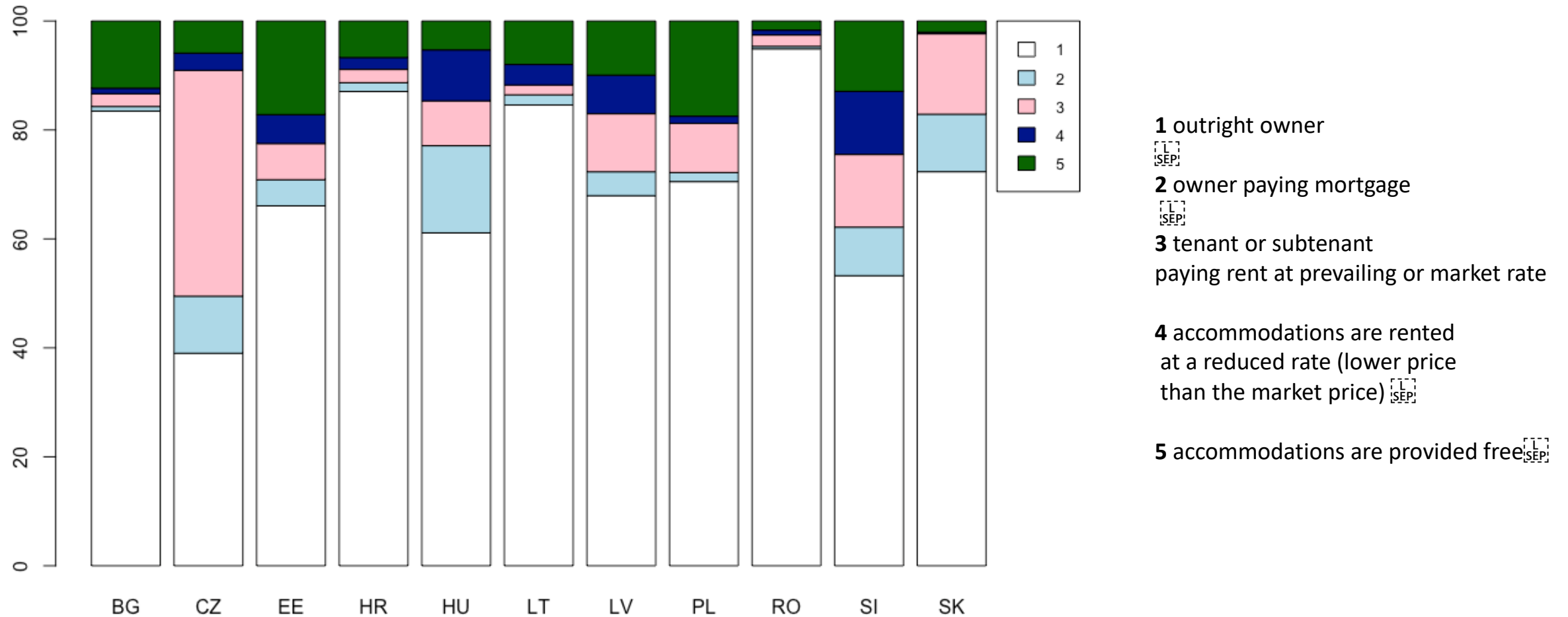


Fig. 13 Distribution of the ability to keep home warm indicator across exposed to hidden energy poverty households in Central and Eastern European countries

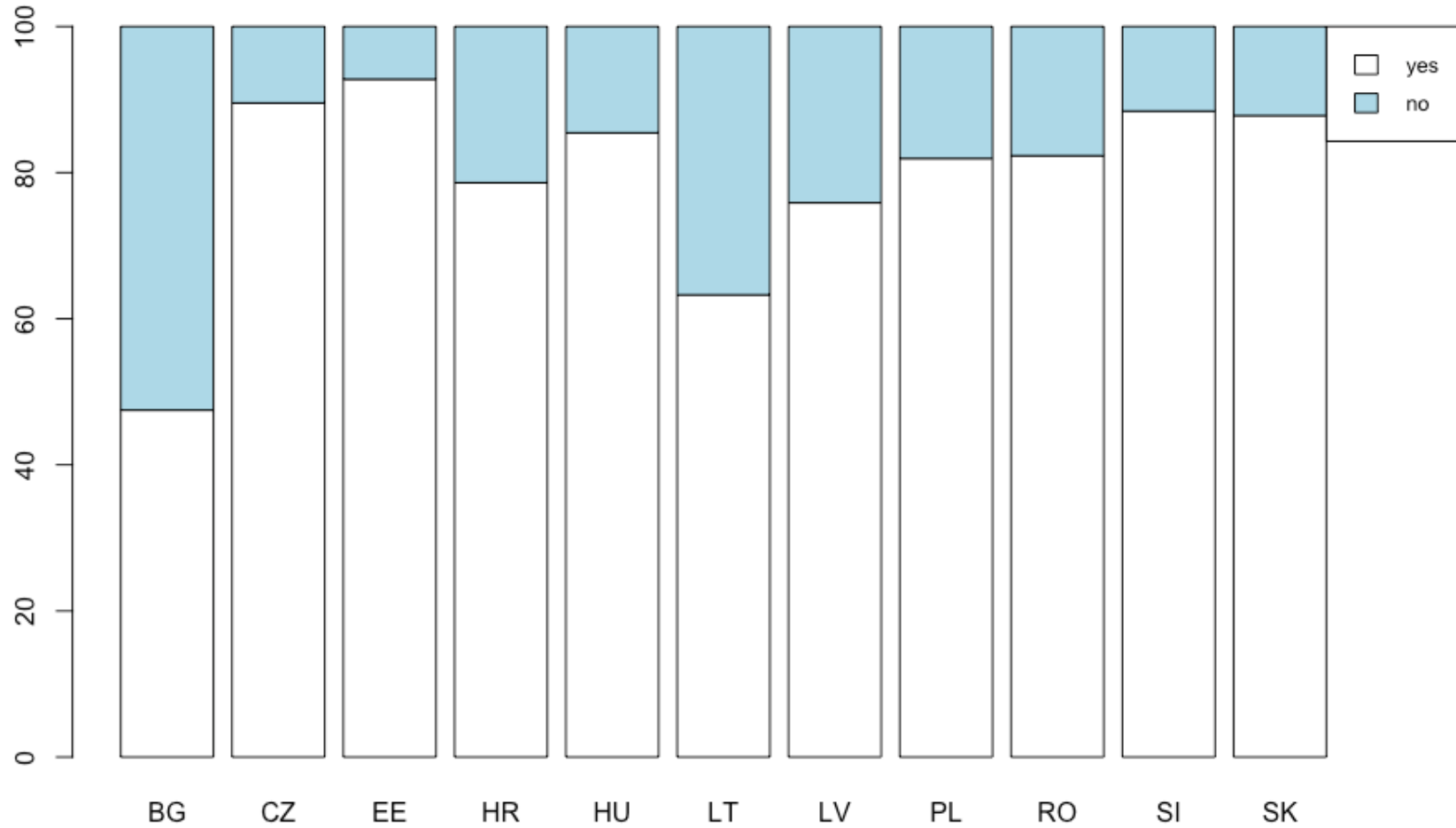
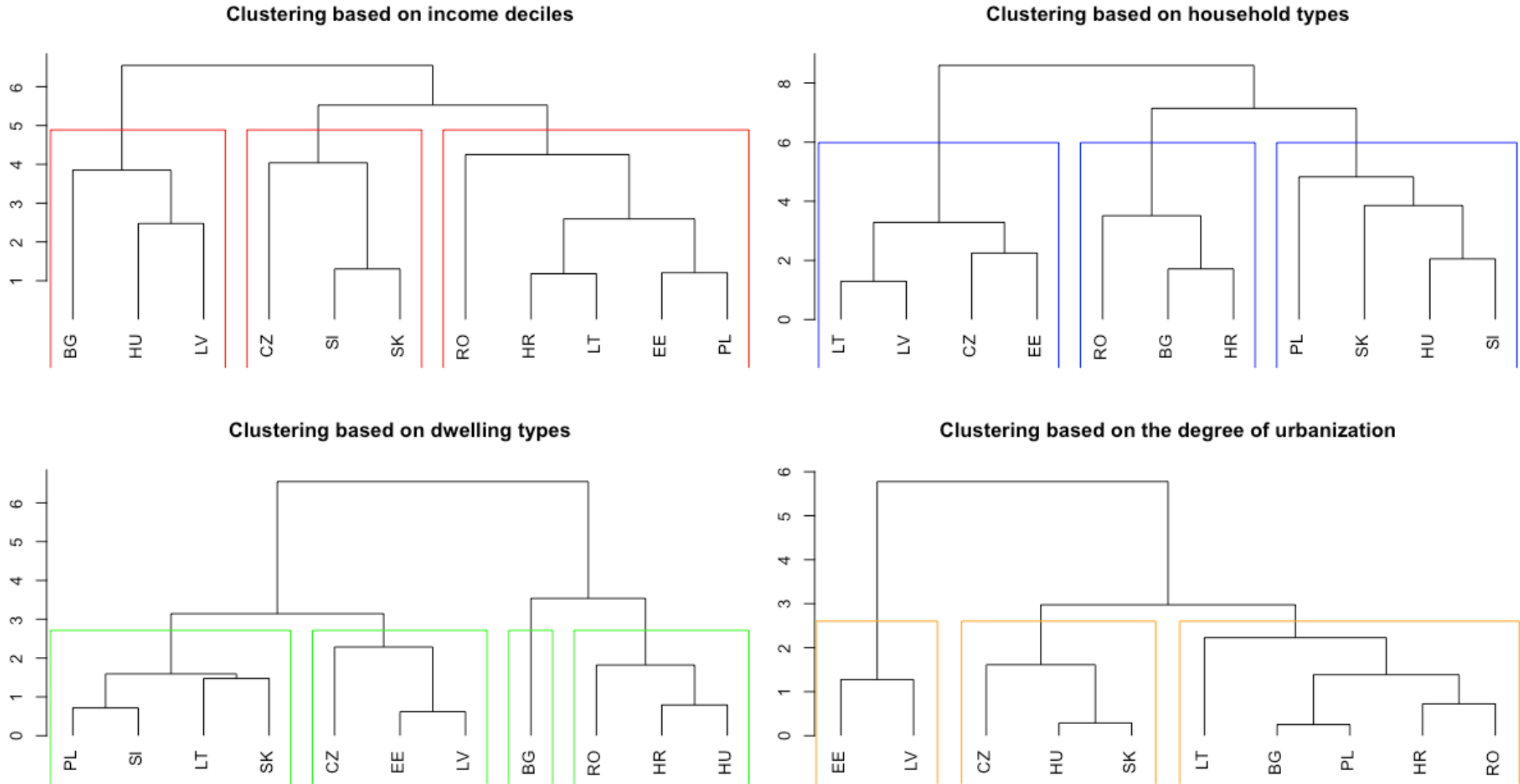


Fig. 14 Hierarchical clustering of Central and Eastern European countries based on the distribution of different variables across exposed to hidden energy poverty households



Conclusions

1. On average, **23.57% of the CEE11 population** are exposed to hidden energy poverty
2. The **profile** of households affected by hidden energy poverty is highly **heterogeneous**
3. As a rule, the exposed to hidden energy poverty occupy **detached and semi-detached houses**
4. The problem of hidden energy poverty is acute among households living in **thinly and medium populated arrears**
5. The majority of the exposed to hidden energy poverty **do not acknowledge the problem**
6. Hidden energy poverty is, to some extent, **independent from income poverty**

Acknowledgments

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Thank you!