

The research project is implemented in the framework of H.F.R.I call “Basic research Financing (Horizontal support of all Sciences)” under the National Recovery and Resilience Plan “Greece 2.0” funded by the European Union –Next Generation EU (H.F.R.I. Project Number: 016638).

Energy/**F**uel and human **P**Overty: public policy and **R**Ecommendations in **S**outhern **E**urope (EFPORE-SE)

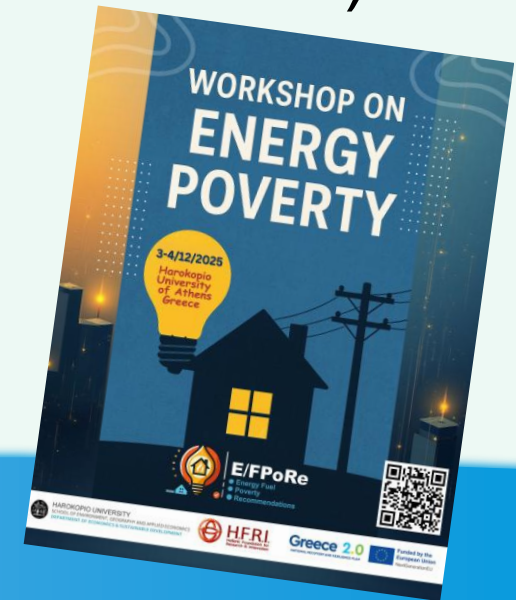
Workshop

Date: December 3-4, 2025

Location: Harokopio University of Athens

H.F.R.I. Project Number: 016638

Funded by the EU - Next Generation EU



*Energy/**F**uel and human **P**Overty: public policy and **R**Ecommendations in **S**outhern **E**urope
December 3-4, 2025*

Session I.B

EFPORE project's presentations

- **Ioannis Kostakis (Coordinator)**, Department of Economics and Sustainable Development, Harokopio University of Athens, Greece
- **Vivian Angeletopoulou**, Department of Economics and Sustainable Development, Harokopio University of Athens, Greece
- **Dimitra Papadaki**, University of Athens, Greece, & Johns Hopkins University, USA
- **Giacomo Di Foggia**, Department of Business and Law, Bicocca University, Milan, Italy
- **Pedro Palma**, NOVA University Lisbon, Portugal

EFPORE-SE primary goals

- Develop strategies to assess energy poverty levels,
- Identify vulnerable households in Southern Europe,
- Enhance public policies and approaches to address energy poverty issues.

Budget 133.800 euro
March 2024-
December 2025

The research team explores energy poverty in four Southern European countries:



EFPORE-SE specific objectives

1

Provide an overview of households' energy consumption in Greece, Italy, Spain and Portugal.

2

Identify specific indicators defining vulnerable population.
Highlight key differences among countries.

EFPORE-SE specific objectives

3

- Interactive website to publish all project outcomes
- Anonymous household questionnaire
- Data collected: socioeconomic, demographic, regional, and dwelling characteristics
- Platform assesses each household's energy poverty status
- Provides tailored recommendations

4

Provide a comprehensive overview of how energy needs impact energy poverty.
Understand how societies respond to major economic and social disruptions while attempting to meet energy needs.

The research team

	Group 1	Group 2	Group 3	Group 4	Group 5
Organization	Harokopio University of Athens (host) and National Technical University of Athens	Biccoca University, Milan and Technical University of Crete	Nova University of Lisbon	Rovira i Virgili University, Reus	Panteion University, Athens
Group leader	Prof. Sardanou	Prof. Di Foggia	Prof. Gouveia	Prof. Arauzo-Carod	Prof. Bithas
Subject	Investigation in Greece	Investigation in Italy	Investigation in Portugal	Investigation in Spain	CBA (cost benefit analysis)

Basic considerations

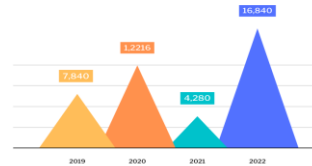
Area under investigation

- Southern European countries: Greece, Italy, Portugal, Spain



Time period covered

- Annual observations between 2016-2023
- NUTS 1 NUTS 2



Data retrieval

- EUROSTAT macro-data
- National statistical authority of each partner country (EU-SILC)

An introduction to energy poverty

Worldwide numbers and global focus

International organizations concentrating

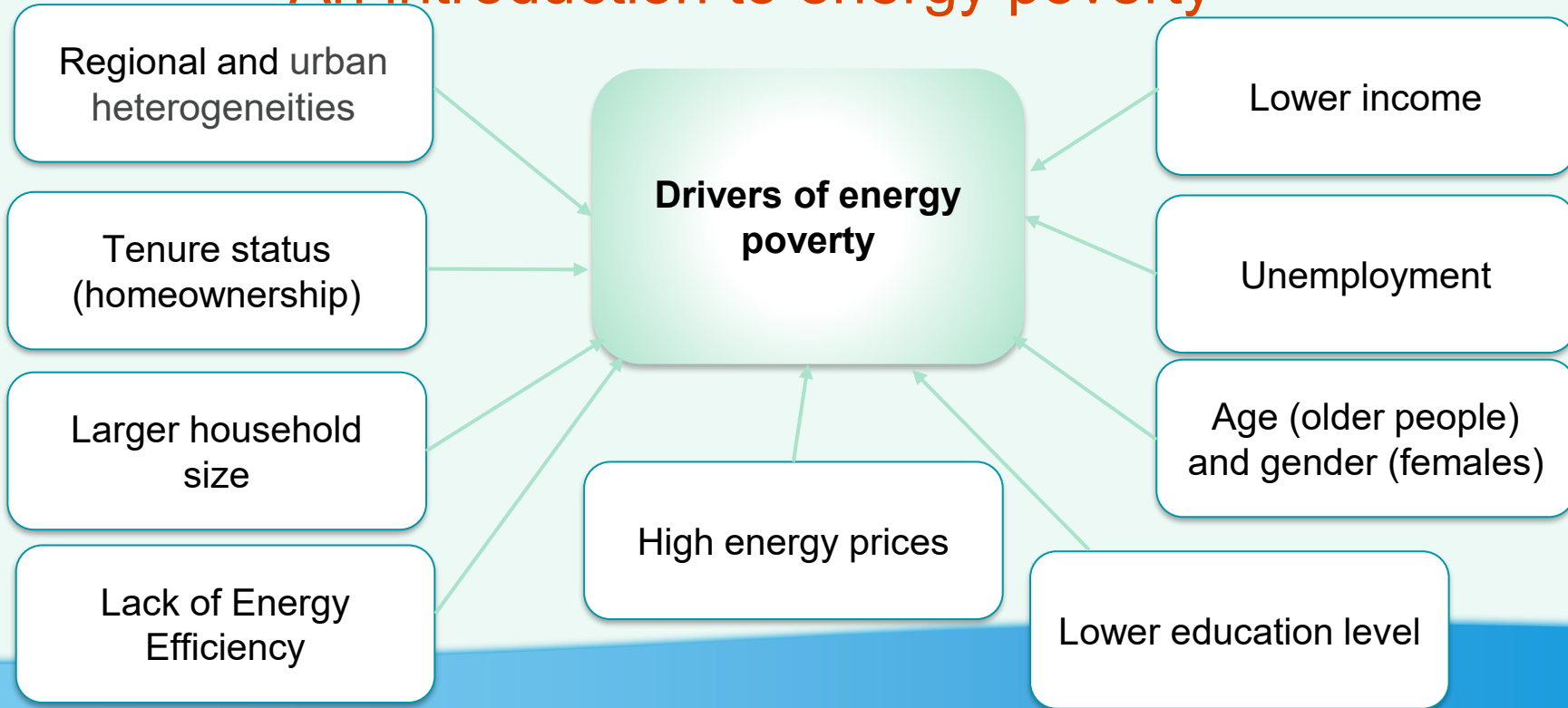
- the World Health Organization,
- the World Bank,
- the United Nations with the program "Sustainable Energy for All" in 2001,
- the 7th Sustainable Development Goal in 2015

Approximately 760M people worldwide are left without access to electricity

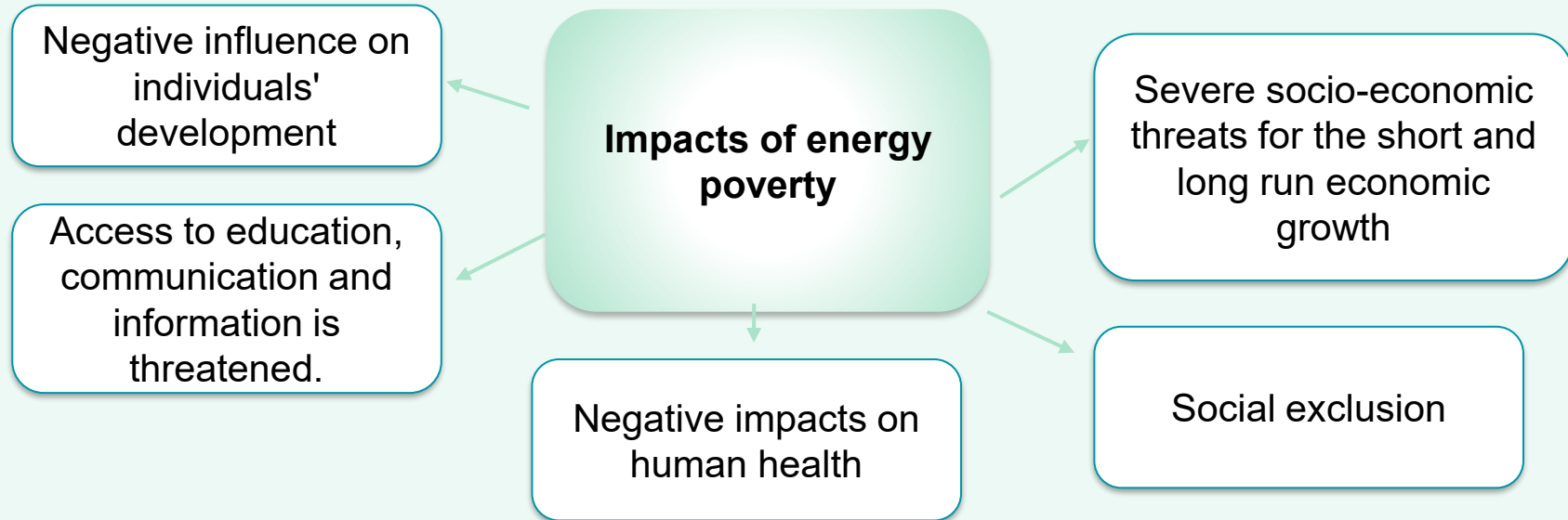
2.3B people depend on traditional fuels for cooking

Indoor air pollution, primarily from cooking smoke, is associated with approximately 3.7M premature deaths annually

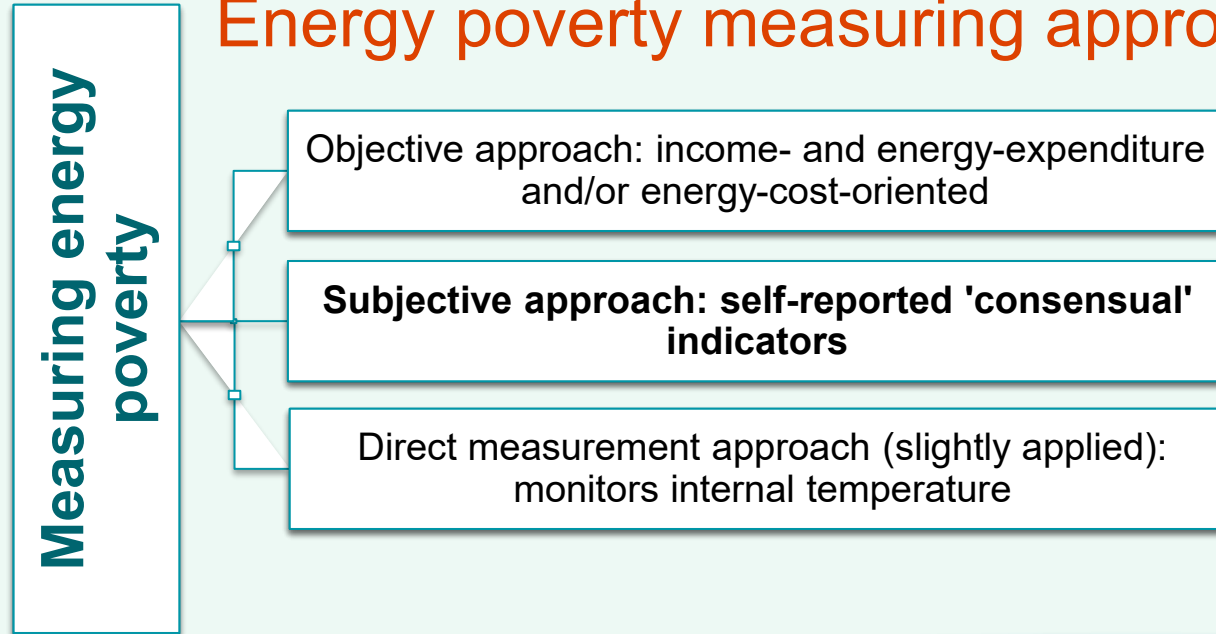
An introduction to energy poverty



An introduction to energy poverty



Energy poverty measuring approaches



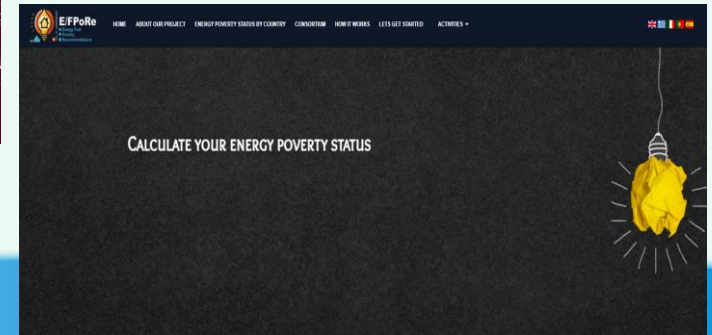
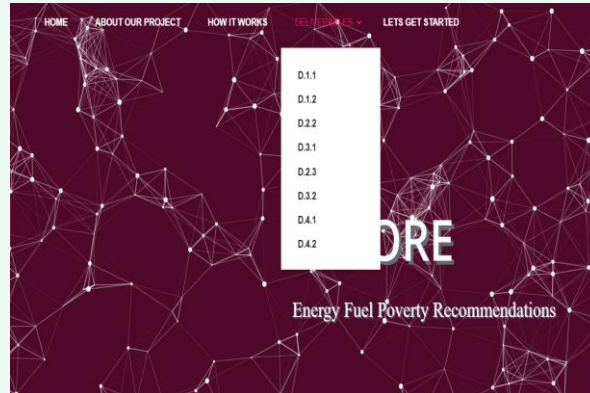
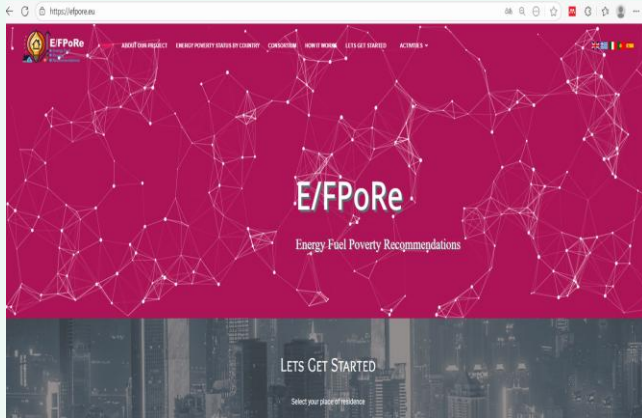
Energy poverty indicators: the challenges

Indicators should be expanded and more inclusive.

Significant gaps between energy poverty indicators.

Disaggregated research could provide more reliable findings

Hidden energy poverty and persistent energy poverty need further treatment.



Risk of
poverty

Summer
energy
poverty

Material
deprivation

Results of descriptive and econometric analysis

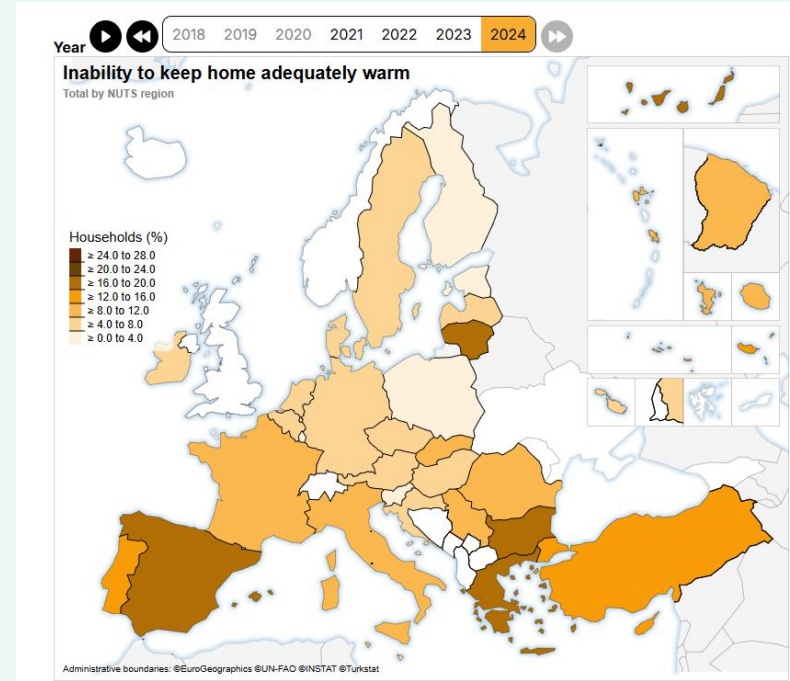
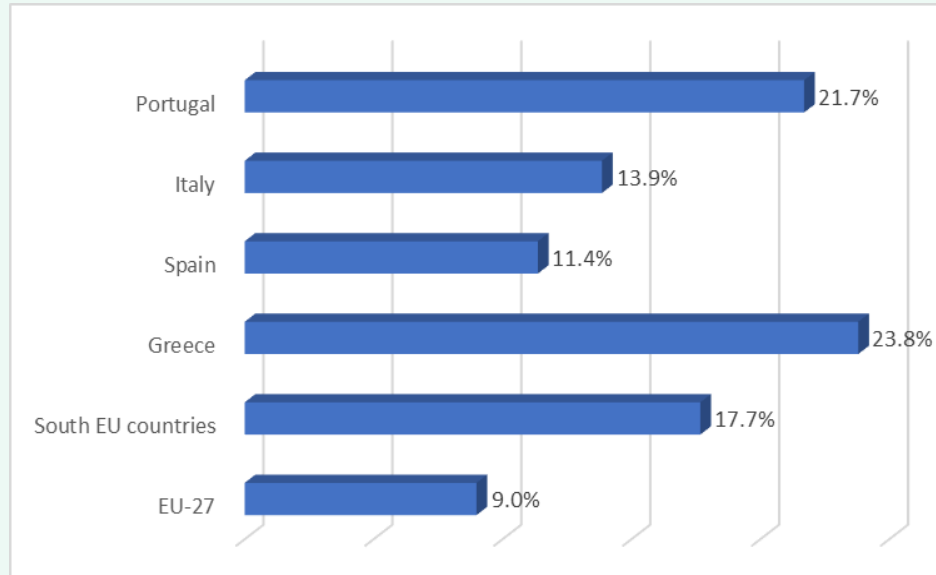
(Logit, Ordered logit, LPM, GLM, Fraction, Pseudo-panels, etc)

Inability

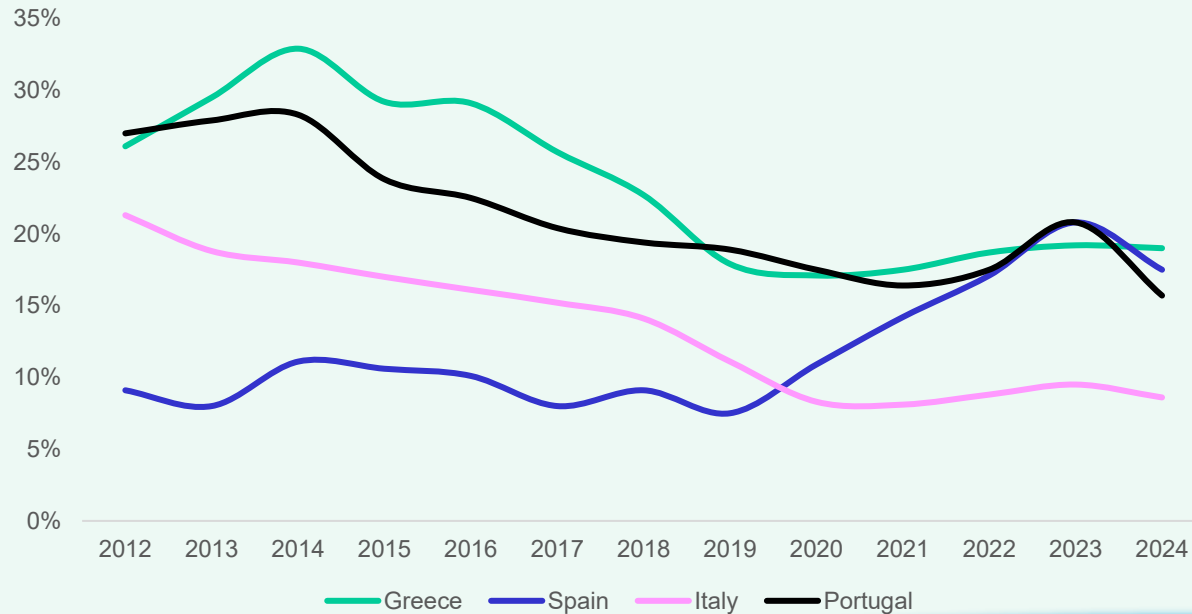
Arrears

Leaks

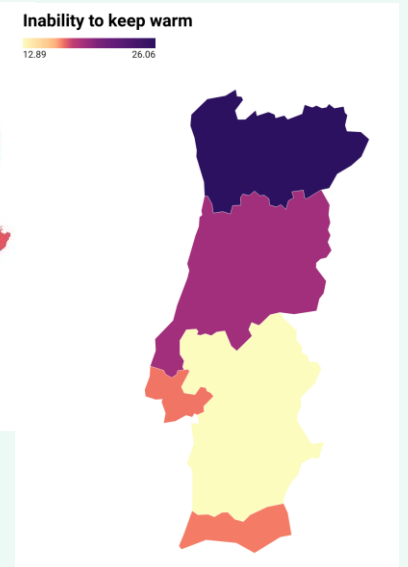
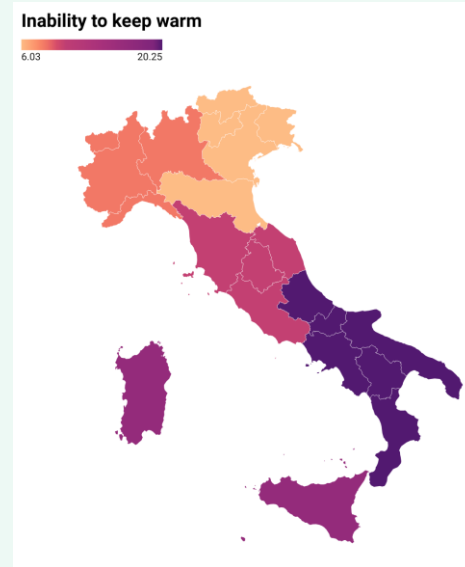
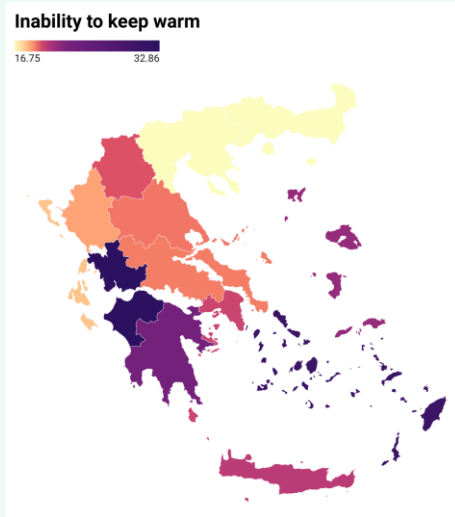
Inability to keep home adequately warm



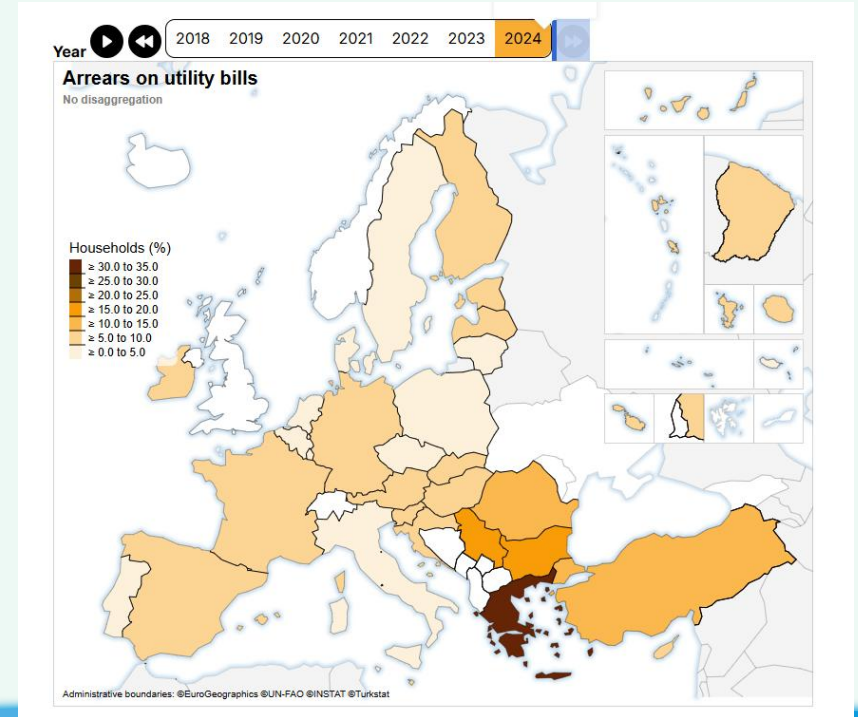
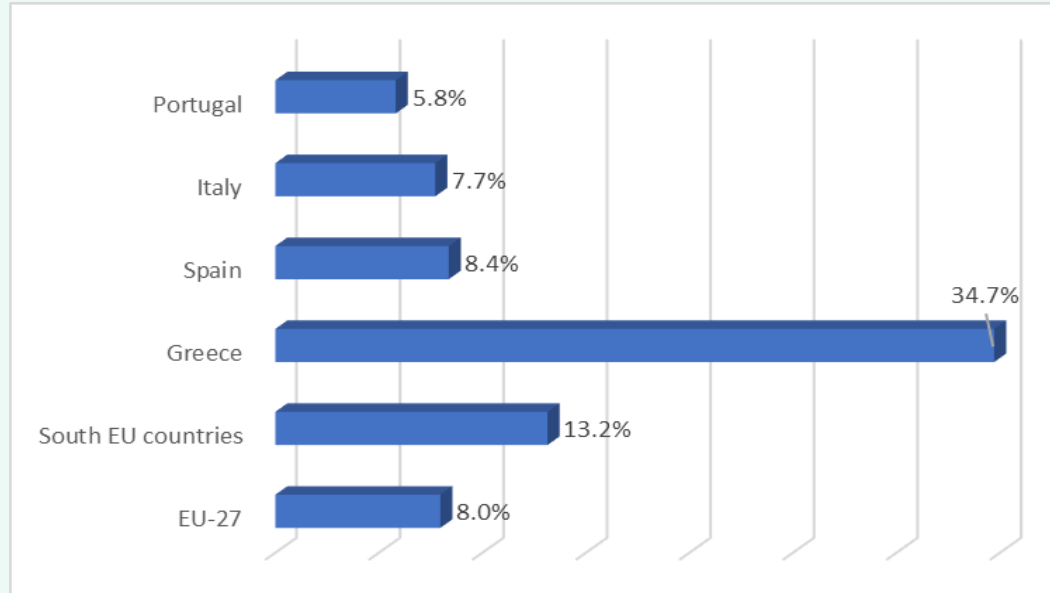
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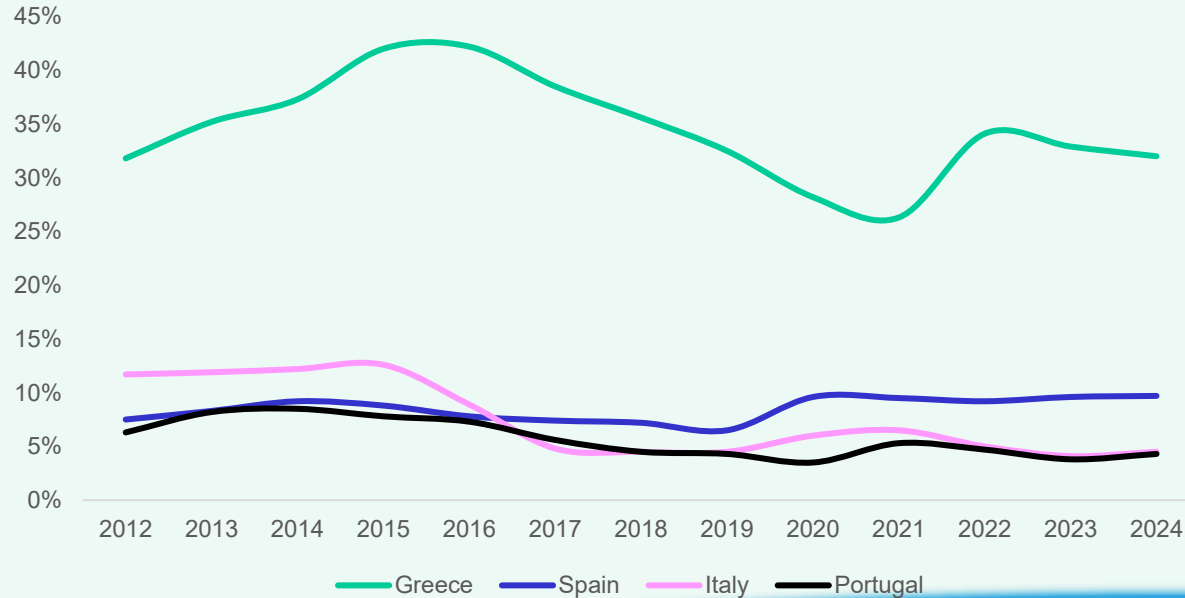
Inability to keep home adequately warm



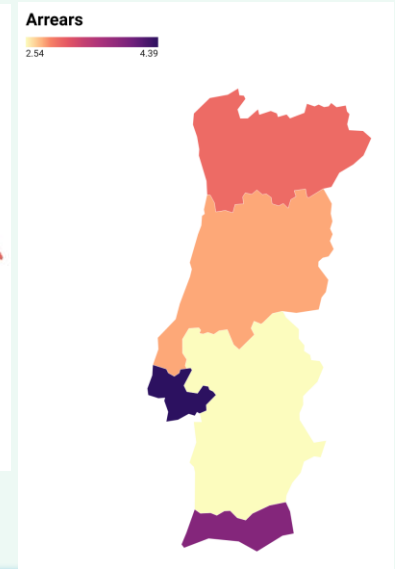
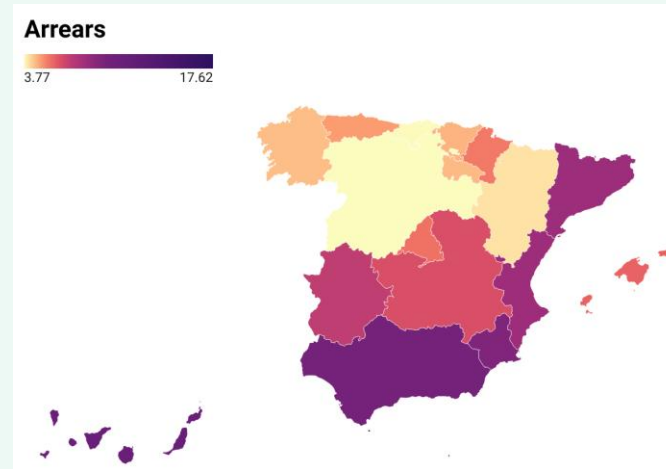
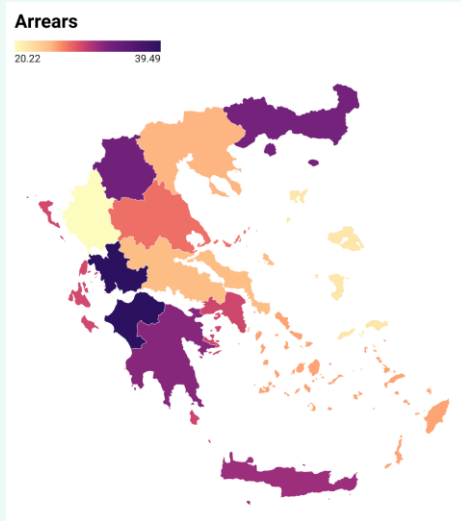
Arrears on utility bills



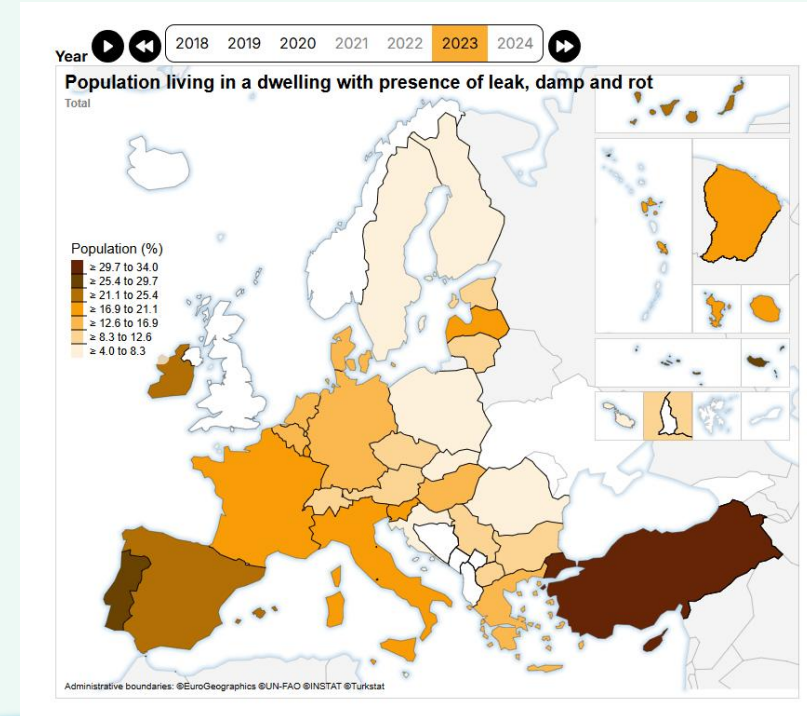
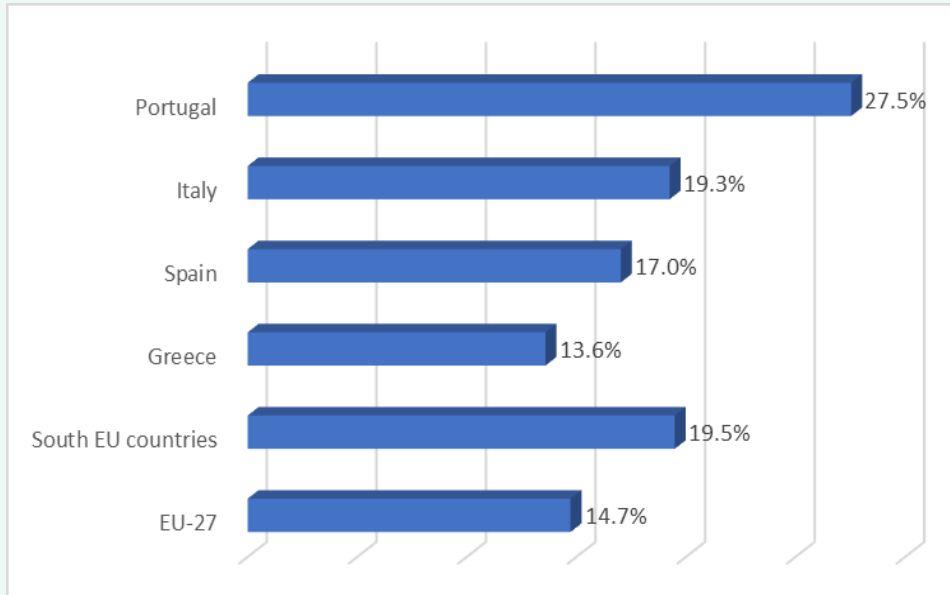
Arrears on utility bills



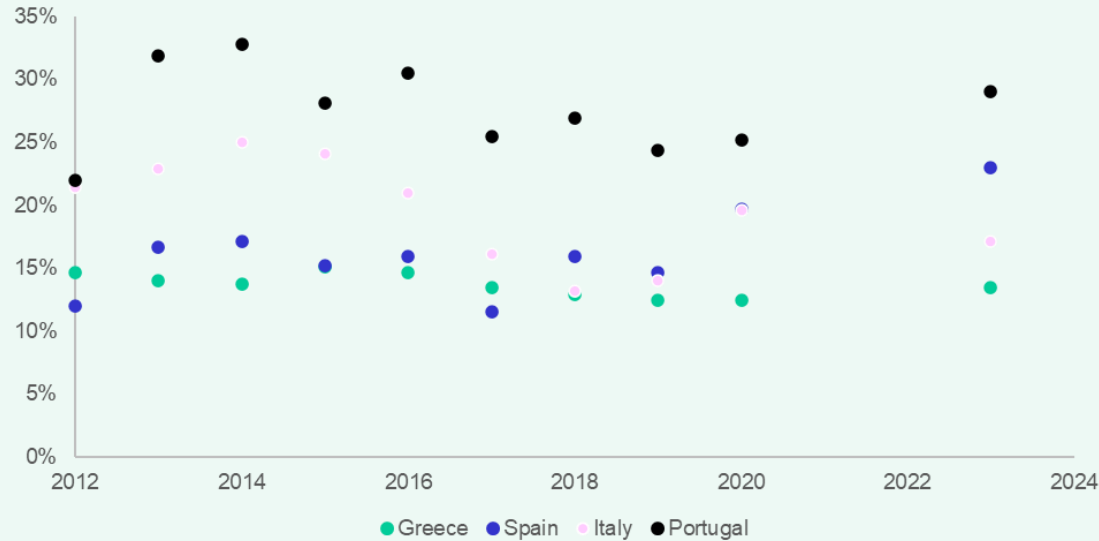
Arrears on utility bills



Dwellings with leak, damp, or rot



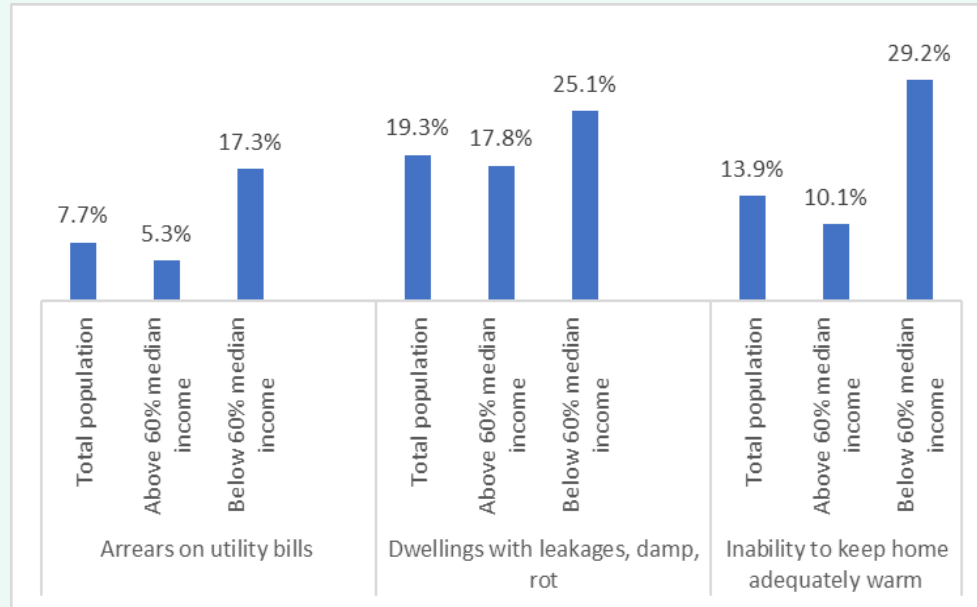
Dwellings with leak, damp, or rot



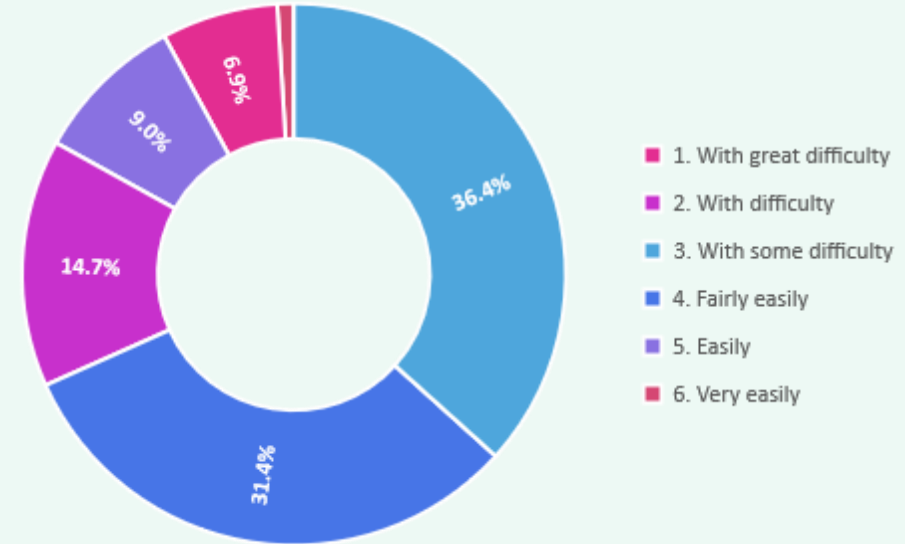
The Italian case study

Giacomo Di Foggia, Bicocca University, Milan, Italy

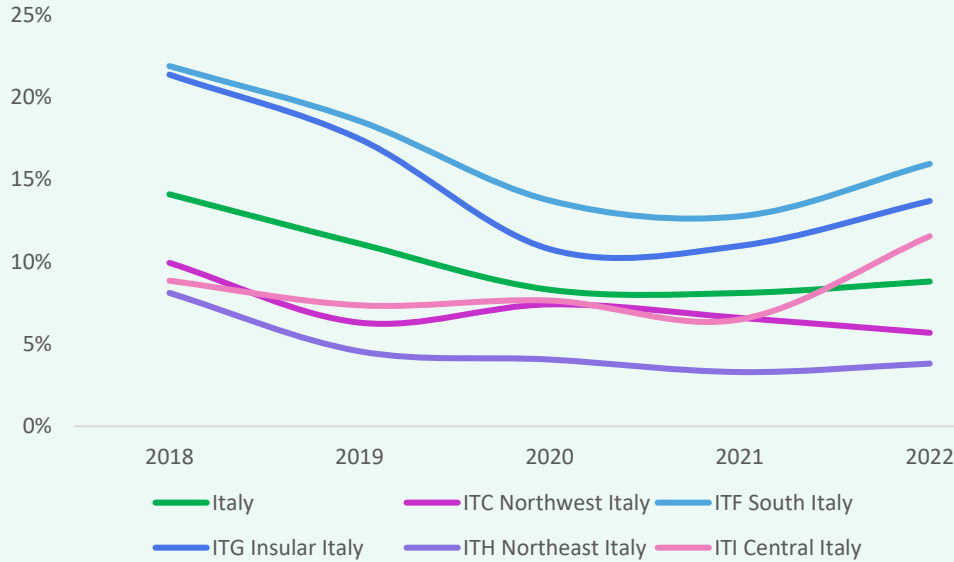
Average values of energy poverty EU-SILC indicators



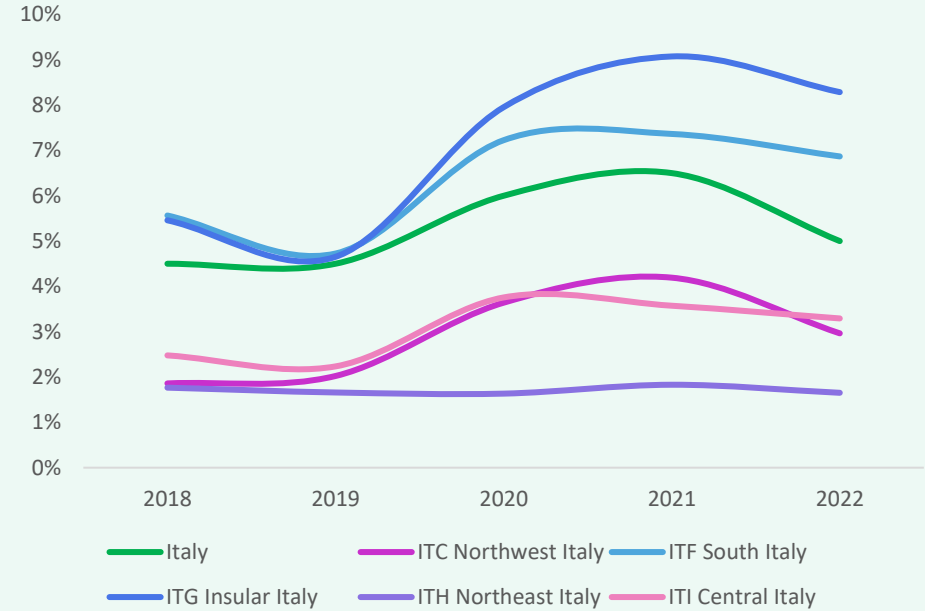
Ability to make ends meet, average values



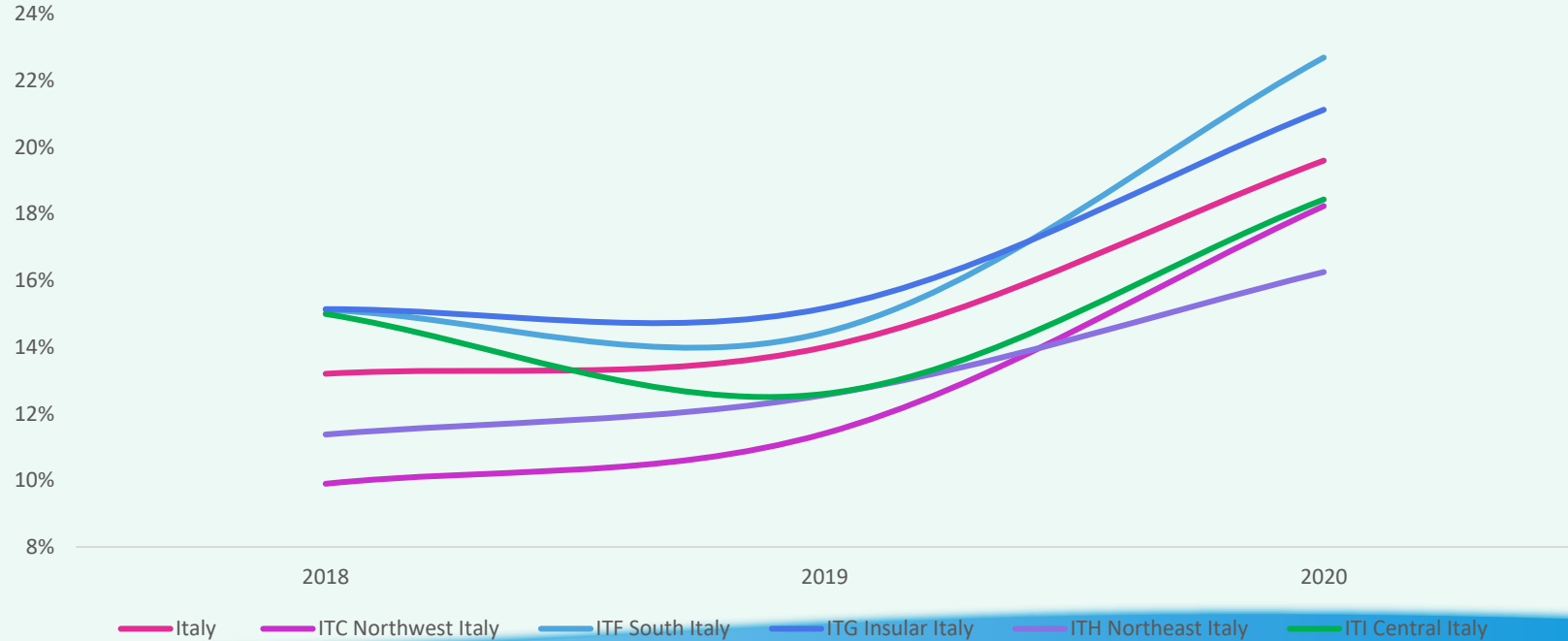
Inability to keep home adequately warm – NUTS1



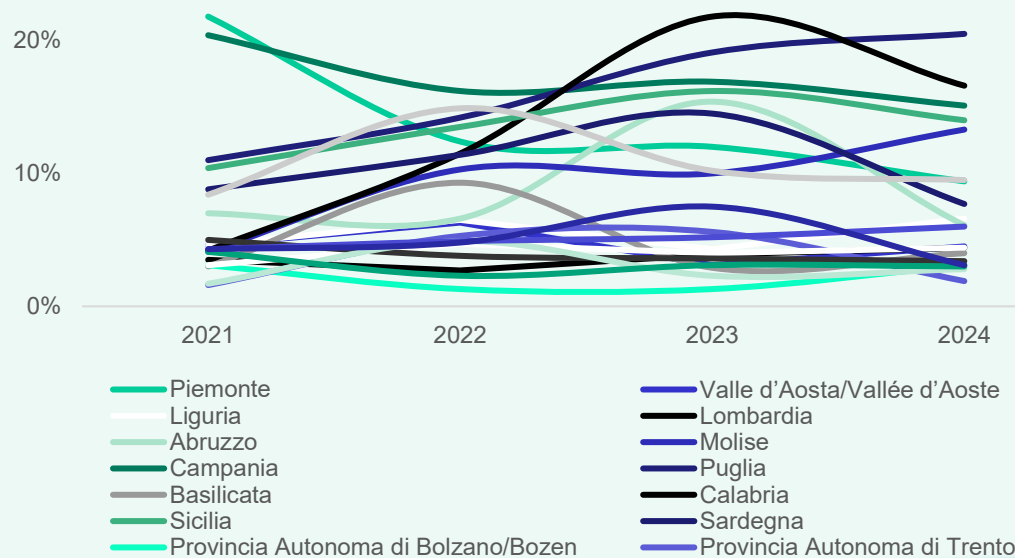
Arrears on utility bills – NUTS1



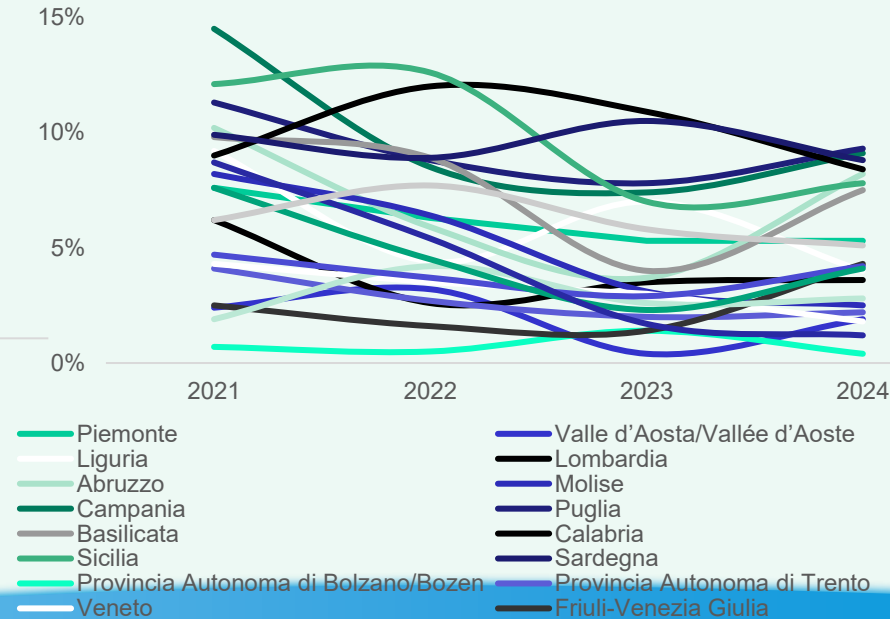
Dwelling with leak, damp, or rot – NUTS1



Inability to keep home adequately warm – NUTS2



Arrears on utility bills – NUTS2



People at risk of poverty or social exclusion – NUTS1

	2018								2019							
	000	001	010	011	100	101	110	111	000	001	010	011	100	101	110	111
ITC Northwest Italy	84.1%	0.9%	2.2%	0.2%	10.0%	1.2%	0.8%	0.5%	84.3%	0.7%	1.8%	0.1%	10.3%	1.4%	0.9%	0.5%
ITF South Italy	63.3%	0.8%	7.4%	0.3%	18.5%	2.6%	5.6%	1.5%	66.3%	0.8%	5.8%	0.2%	19.1%	2.3%	4.4%	1.2%
ITG Insular Italy	63.0%	1.0%	4.2%	0.3%	20.4%	2.5%	5.5%	3.1%	64.3%	1.1%	4.7%	0.3%	18.9%	3.1%	5.3%	2.4%
ITH Northeast Italy	86.3%	0.9%	1.9%	0.1%	8.7%	1.1%	0.8%	0.2%	86.8%	0.7%	1.8%	0.0%	8.7%	1.0%	0.7%	0.2%
ITI Central Italy	80.4%	1.2%	3.5%	0.1%	11.2%	1.5%	1.5%	0.5%	80.1%	0.9%	3.5%	0.1%	11.7%	1.6%	1.6%	0.5%

	2020								2021							
	000	001	010	011	100	101	110	111	000	001	010	011	100	101	110	111
ITC Northwest Italy	84.1%	1.2%	1.7%	0.1%	9.7%	1.4%	1.3%	0.5%	84.8%	0.9%	1.6%	0.2%	8.8%	1.7%	1.4%	0.7%
ITF South Italy	64.6%	0.9%	5.0%	0.5%	19.9%	3.3%	3.8%	2.0%	65.8%	1.2%	4.9%	0.8%	17.0%	3.3%	3.9%	3.2%
ITG Insular Italy	65.6%	1.4%	2.8%	0.1%	21.4%	4.3%	2.2%	2.2%	68.2%	1.4%	1.7%	0.8%	18.3%	5.0%	1.8%	2.7%
ITH Northeast Italy	86.8%	0.7%	1.1%	0.1%	8.8%	1.6%	0.8%	0.1%	87.1%	0.9%	0.8%	0.0%	8.6%	1.7%	0.8%	0.2%
ITI Central Italy	79.2%	1.3%	3.5%	0.1%	12.2%	2.2%	1.1%	0.4%	81.3%	1.0%	2.2%	0.1%	11.4%	2.5%	0.9%	0.6%

	2022							
	000	001	010	011	100	101	110	111
ITC Northwest Italy	85.5%	1.4%	1.3%	0.2%	9.0%	1.5%	0.7%	0.4%
ITF South Italy	63.8%	2.3%	4.6%	1.0%	17.2%	4.6%	3.8%	2.7%
ITG Insular Italy	64.1%	2.6%	2.2%	0.5%	21.1%	5.8%	1.9%	1.7%
ITH Northeast Italy	87.5%	1.0%	0.8%	0.1%	8.7%	1.3%	0.4%	0.2%
ITI Central Italy	80.3%	1.8%	1.2%	0.1%	12.3%	3.3%	0.7%	0.3%

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The Italian case study - Econometric analysis

Model 1 - Inability to keep home warm	2018	2020	2022
Ln(income)	-0.016***	-0.008***	-0.011***
Education	-0.014**	-0.018***	-0.001
Age	-0.002***	0.0001	0.0007
Age2	2.36e-05***	-5.05E-07	-1.35e-05*
Unemployed	0.035***	0.024***	0.009
Persons-per-rooms	-0.004	-0.007*	-0.012**
Health	-0.004*	n/a	0.023***
Gender	-0.004	-0.002	0.008**
Ability to make ends meet	0.070***	0.042***	0.054***
Observations	20,614	12,915	14,063

Model 2 – Arrears on utility bills	2018	2020	2022
Ln(income)	-0.002***	-0.002***	-0.0007
Education	0.0004	-0.005*	0.004*
Age	0.001***	0.001***	0.002***
Age2	-1.19e-05***	-1.20e-05***	-2.21e-05***
Unemployed	0.006***	0.012***	0.004*
Persons-per-rooms	0.00453***	0.008***	0.009***
Health	0.003***	n/a	0.006***
Gender	-0.0003	0.0008	0.002
Ability to make ends meet	0.012***	0.016***	0.016***
Observations	20,614	12,915	14,063

Model 3 - Dwelling with a leaking roof, damp walls/floors/foundation, or rot	2018	2020	2023
Ln(income)	-0.004	-0.008*	n/a
Education	0.019***	0.00372	n/a
Age	0.002**	0.002	n/a
Age2	-2.15e-05**	-1.20E-06	n/a
Unemployed	0.012	0.026	n/a
Persons-per-rooms	0.012**	0.019**	n/a
Health	0.041***	n/a	n/a
Gender	-0.003	-0.007	n/a
Ability to make ends meet	0.048***	0.044***	n/a
Observations	20,614	12,915	

Model 4 - AROPE	2018					2020					2022				
	Coefficient	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Coefficient	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Coefficient	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Ln(income)	-2.109***	0.213***	-0.170***	-0.037***	-0.007***	-2.245***	0.227***	-0.177***	-0.041***	-0.008***	-2.294***	0.232***	-0.171***	-0.048***	-0.012***
Education	-0.190**	.019**	-0.015**	-0.003**	-.0006**	-0.325***	0.032***	-0.025***	-0.006***	-0.001***	-0.391***	0.039***	-0.029***	-0.008***	-0.002***
Age	0.049***	-0.005***	0.004***	0.0008***	0.0002***	0.047***	-0.004***	0.003***	0.0008***	0.0001***	0.084***	-0.008***	0.006***	0.002***	0.0004***
Age2	-0.0005***	0.00005***	-0.00004	-9.09e-06***	-1.76e-06***	-0.0005***	0.00004***	-0.00003***	-0.00001***	-0.000001***	-0.0001***	0.0001***	-0.0001***	-0.00002***	-0.000004***
Unemployed	1.631***	-0.165***	0.131***	0.028***	0.005***	1.128***	-0.114***	0.089***	0.021***	0.004***	1.905***	-0.193***	0.142***	0.040***	0.010***
Persons-per-rooms	0.886***	-0.090***	0.071***	0.015***	0.003***	1.069***	-0.108***	0.084***	0.019***	0.004***	1.005***	-0.102***	0.075***	0.021***	0.005***
Health	0.142***	-0.014***	0.011***	0.002***	0.0004***	n/a	n/a	n/a	n/a	n/a	0.122***	-0.012***	0.009***	0.002***	0.0006***
Gender	0.105**	0.008**	0.002**	0.001**	0.0004**	0.126**	-0.012**	0.009**	0.002**	0.0004**	0.269***	-0.027***	0.020***	0.005***	0.001***
Ability to make ends meet	0.638***	-0.064***	0.051***	0.011***	0.002***	0.575***	-0.058***	0.045***	0.010***	0.002***	0.681***	-0.069***	0.051***	0.014***	0.003***
Observations	20,614					12,915					14,063				

Model 1 - Inability to keep home adequately warm, for NUTS1 regions of Italy (2018, 2020, 2022)

	2018	2020	2022
ITF South Italy	0.0529*** (0.006)	0.005 (0.005)	0.031*** (0.005)
ITG Insular Italy	0.044*** (0.008)	-0.004 (0.006)	0.024*** (0.006)
ITH Northeast Italy	-0.001 (0.005)	-0.019*** (0.005)	-0.009** (0.005)
ITI Central Italy	-0.0005 (0.004)	-0.004 (0.005)	0.037*** (0.005)
<i>Observations</i>	20,614	12,915	14,063

Model 2 - Arrears on utility bills, for NUTS1 regions of Italy (2018, 2020, 2022)

	2018	2020	2022
ITF South Italy	0.007*** (0.002)	0.002 (0.002)	0.002 (0.002)
ITG Insular Italy	0.005*** (0.002)	0.004 (0.003)	0.013*** (0.004)
ITH Northeast Italy	0.0003 (0.001)	-0.007*** (0.002)	-0.007*** (0.002)
ITI Central Italy	0.003** (0.001)	-0.0008 (0.002)	-0.002 (0.002)
<i>Observations</i>	20,614	12,915	14,063

Model 3 - Dwelling with leak, damp, or rot, for NUTS1 regions of Italy (2018, 2020)

	2018	2020	2023
ITF South Italy	0.020*** (0.006)	0.018 (0.011)	n/a
ITG Insular Italy	0.018** (0.008)	0.009 (0.014)	n/a
ITH Northeast Italy	0.016*** (0.006)	-0.009 (0.010)	n/a
ITI Central Italy	0.049*** (0.006)	-0.002 (0.010)	n/a
Observations	20,614	12,915	

Model 4 – Being at risk of poverty or social exclusion for Italian NUTS1 regions (2018, 2020, 2022).

	2018					2020					2022				
	Coefficient	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Coefficient	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Coefficient	Outcome 1	Outcome 2	Outcome 3	Outcome 4
ITF South Italy	1.006*** (0.062)	-0.109*** (0.007)	0.087*** (0.005)	0.018*** (0.007)	0.003*** (0.000)	0.759*** (0.082)	-0.080*** (0.008)	0.063*** (0.006)	0.014*** (0.001)	0.002*** (0.000)	0.978*** (0.077)	-0.105*** (0.008)	0.079*** (0.006)	0.021*** (0.002)	0.005*** (0.001)
ITG Insular Italy	0.936*** (0.079)	-0.100*** (0.009)	0.081*** (0.007)	0.016*** (0.016)	0.003*** (0.000)	0.767*** (0.099)	-0.081*** (0.011)	0.063*** (0.008)	0.014*** (0.002)	0.002*** (0.000)	0.693*** (0.091)	-0.071*** (0.009)	0.054*** (0.007)	0.013*** (0.002)	0.003*** (0.001)
ITH Northeast Italy	0.081 (0.069)	-0.007 (0.006)	0.001 (0.005)	0.001 (0.001)	0.0002 (0.000)	0.037 (0.090)	-0.003 (0.008)	0.002 (0.006)	0.0005 (0.001)	0.0001 (0.000)	0.069 (0.089)	-0.006 (0.008)	0.004 (0.006)	0.001 (0.001)	0.0002 (0.000)
ITI Central Italy	0.340*** (0.063)	-0.032*** (0.006)	0.026*** (0.005)	0.005*** (0.001)	0.001*** (0.000)	0.266*** (0.081)	-0.025*** (0.007)	0.020*** (0.006)	0.004*** (0.001)	0.0008*** (0.000)	0.198** (0.081)	-0.018*** (0.007)	0.014*** (0.005)	0.003*** (0.001)	0.0008*** (0.000)
Observations	20,614					12,915					14,063				

Econometric analysis – pseudo panels

Inability to keep home adequately warm									
Models	LPM			Fraction Logit			Group binomial GLM		
Income	-0.141***	-0.135***	-0.089**	-1.079***	-1.445***	-0.768**	-1.187***	-1.189***	-0.573*
Household size	0.085***	0.041***	0.044**	0.473***	0.226	0.073	0.549***	0.25	0.067
Urbanization	-0.087*	0.214**	0.091	-1.031**	1.123	-0.571	-1.103**	1.480**	-0.025
Detached house	-0.016*	-0.007	0.112*	-0.174**	-0.201**	-0.414	-0.321***	-0.228***	-0.368
Employment	-0.025***	-0.030***	-0.013	-0.246***	-0.311***	-0.002	-0.233***	-0.347***	-0.016
Tertiary ratio	-0.252***	-0.244***	-0.05	-2.214***	-1.015	-0.828	-2.220***	-1.971**	-1.331*
HDD/CDD	-0.182***	0.126***	0.123**	-1.839***	2.202***	0.179	-1.535***	1.963***	1.395*
Constant	1.226***	0.609**	0.329	7.436***	2.05	2.829	7.665***	0.942	-0.411
Cohort effects (NUTS 1)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Time effects	No	No	Yes	No	No	Yes	No	No	Yes
Observations	480	420	420	480	480	480	480	480	480

Arrears on utility bills									
Models	LPM			Fraction Logit			Group binomial GLM		
Income	-0.045***	-0.041**	-0.026	-0.881***	-1.112*	-1.080*	-0.859***	-0.759*	-0.698
Household size	0.074***	0.011*	0.01	1.325***	0.276	0.169	1.543***	0.382**	0.256
Urbanization	-0.065**	-0.023	-0.023	-0.758	0.211	0.184	-1.398**	-0.364	-0.322
Detached house	-0.001	0.012***	0.024	0.438***	0.445***	0.054	0.027	0.305***	0.173
Employment	-0.009**	0.014***	-0.011**	-0.191	0.628***	-0.08	-0.237*	0.587***	-0.151
Tertiary ratio	-0.043*	-0.077	-0.049	-0.482	0.118	0.306	-0.905*	-1.262	-1.109
HDD/CDD	-0.061***	0.130***	-0.03	-1.542***	3.590***	1.135	-1.241**	3.609***	1.245*
Constant	0.382***	0.111	0.245*	3.433***	-3.129	1.253	3.469***	-4.579**	-0.716
Cohort effects (NUTS 1)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Time effects	No	No	Yes	No	No	Yes	No	No	Yes
Observations	480	420	420	480	480	480	480	480	480

Leaking roof, damp walls/floors/foundation, or rot in window frames or floor

Models	LPM			Fraction Logit			Group binomial GLM		
Income	-0.023*	0.024	0.002	-0.066	0.472	0.279	-0.161	0.356	0.029
Household size	0.035***	0.005	-0.016	0.215**	0.025	-0.172	0.356***	0.087	-0.085
Urbanization	0.005	0.024	0.023	-0.138	0.362	0.193	-0.012	-0.07	0.103
Detached house	0.065***	0.033***	-0.027	0.465***	0.272***	-0.443	0.436***	0.337***	-0.214
Employment	0.044***	0.056***	-0.009	0.340***	0.470***	-0.065	0.351***	0.470***	-0.142*
Tertiary ratio	-0.046	-0.037	0.031	-0.362	0.26	0.346	-0.445	-0.278	0.102
HDD/CDD	-0.099***	0.473***	0.11	-0.630***	3.637***	1.573**	-0.624***	3.449***	1.384*
Constant	0.370***	-0.674**	0.011	-0.719	-10.634***	-5.433**	-0.341	-9.531***	-3.978*
Cohort effects (NUTS 1)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Time effects	No	No	Yes	No	No	Yes	No	No	Yes
Observations	360	300	300	360	360	360	360	360	360

The research project is implemented in the framework of H.F.R.I call “Basic research Financing (Horizontal support of all Sciences)” under the National Recovery and Resilience Plan “Greece 2.0” funded by the European Union –Next Generation EU (H.F.R.I. Project Number: 016638).

Determinants of energy poverty in Italy – overall insights

Income

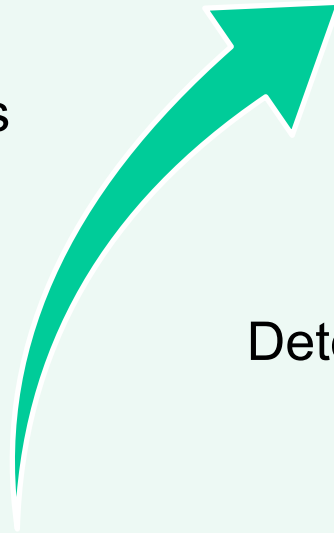


Urbanization

The research project is implemented in the framework of H.F.R.I call “Basic research Financing (Horizontal support of all Sciences)” under the National Recovery and Resilience Plan “Greece 2.0” funded by the European Union –Next Generation EU (H.F.R.I. Project Number: 016638).

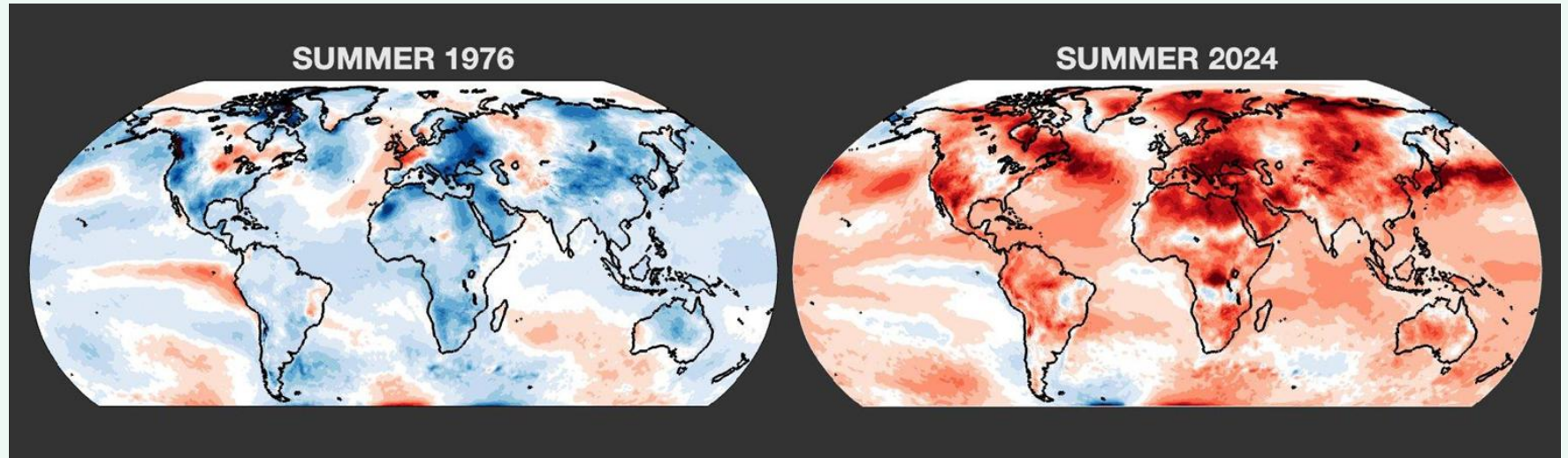
Determinants of energy poverty in Italy – overall insights

Large households



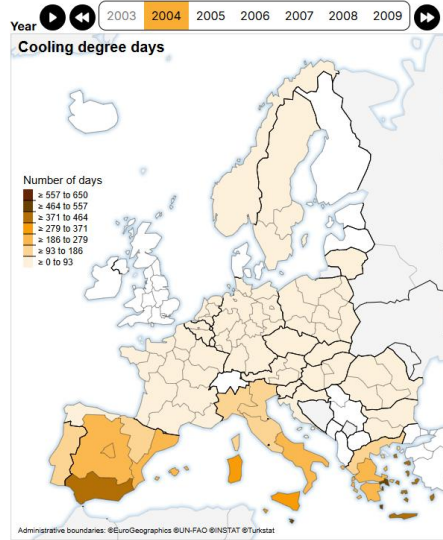
Deteriorating ability to make ends
meet

Now, why also summer energy poverty?

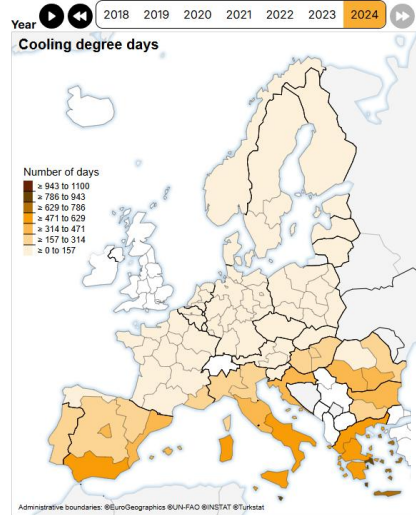


CDD 2004 vs 2024

Cooling degree days

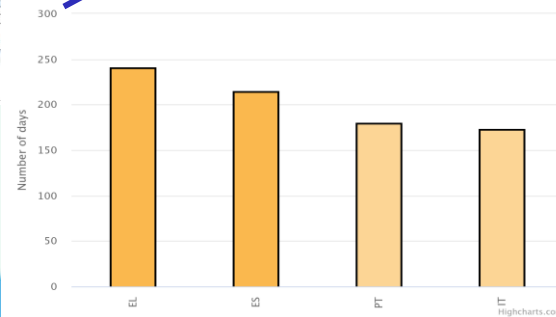


Cooling degree days

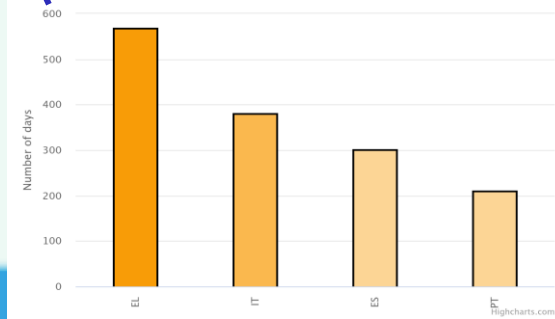


Double

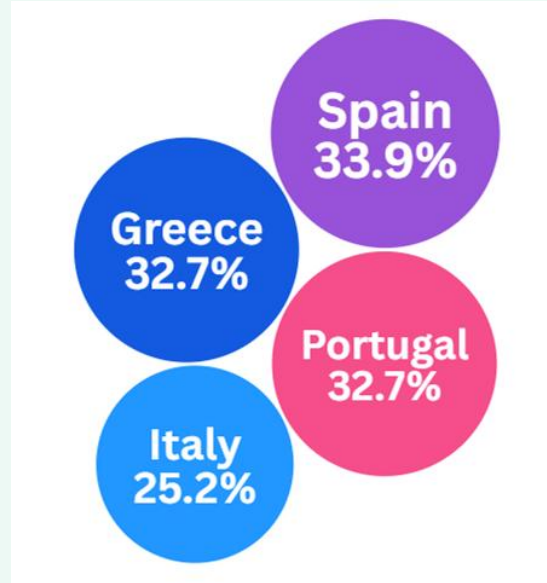
Cooling degree days 2004



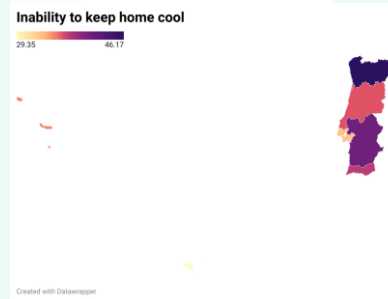
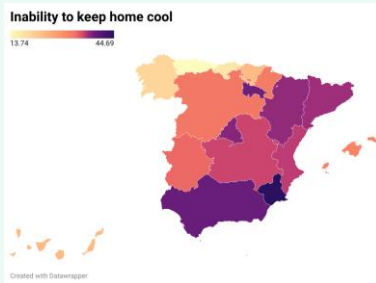
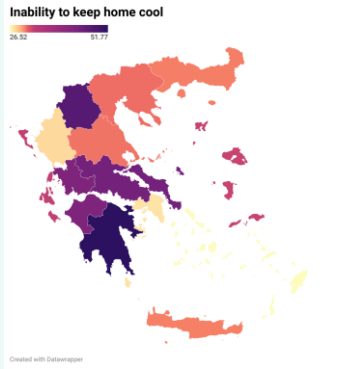
Cooling degree days 2024



Inability of existing cooling and insulation to keep homes cool



Inability of existing cooling and insulation to keep homes cool



Variables	Inability to keep home adequately cool
1946 – 1960	0.140 (0.197)
1961-1980	-0.234 (0.184)
1981 – 2000	-0.694*** (0.185)
2001 – 2020	-1.186*** (0.195)
After 2021	-1.519*** (0.435)
Household size	0.045 (0.030)
Semi-rural area	0.275*** (0.070)
Rural area	0.406*** (0.074)
Age	-0.002 (0.002)
Tertiary education	-0.301*** (0.072)
Income	-0.000*** (0.000)
Region effects	Yes

Policies

- ✓ Strengthen income support and social welfare measures (especially within large families)
- ✓ Promote employment and economic inclusion (especially in rural areas)
- ✓ Include special consideration in social frameworks for populations experiencing health issues and female-headed families
- ✓ Address high heating and cooling demand with energy efficiency programs and affordable renewable solutions
- ✓ Enhance educational opportunities and awareness

Limitations

- ❖ Measurement of energy poverty
- ❖ Unavailable data for NUTS 2 & 3 analysis for some cases
- ❖ Self-reported data (EU-SILC)