The Gender–energy–poverty Nexus Under Review: A Longitudinal Study for Spain

Francisca Toro, Esteban Fernández-Vázquez, and Mònica Serrano

1 Introduction

Energy is a driver of economic development underpinning all forms of economic activity and everyday life, that is connected with climate change due to the combustion of fossil fuels. The current political situation, especially in Eastern Europe, has repercussions on the global energy system. It has pushed up energy prices for many consumers and businesses around the world, hurting entire economies, industries, and households, especially in low-income families where energy is a large share of the budget (Birol 2022). The situation has been further exposing the problems of energy inequality and energy poverty being a recognised challenge across the world that might be even more urgent due to this scenario.

The definition of energy poverty is still under debate (Bouzarovski et al. 2012). Considering that access to affordable energy resources is not guaranteed for everyone, most economists agree that energy poverty can be defined as the inability of households to satisfy basic/domestic energy needs (Thomson et al., 2016), being inextricably connected with social, health, and economic levels (González-Eguino 2015; Awaworyi Churchill et al. 2020). Links between gender, poverty, and energy have been hinted at in many studies mainly focused on livelihood strategy and economic development of low-income countries. However, there are few studies that tackle the gender–energy–poverty nexus head on (Galvin and Sunikka-Blank 2018). These studies mainly show that women are one of the most exposed groups to the so-called energy poverty, since they carry out a major part of activities related to cooking and household work that are directly linked to the need of energy access.

E. Fernández-Vázquez
Department of Applied Economics, University of Oviedo, Oviedo, Spain

F. Toro · M. Serrano (✉)
Department of Economics, University of Barcelona, Barcelona, Spain
e-mail: monica.serrano@ub.edu

R. Bardazzi and M. G. Pazienza (eds.), *Vulnerable Households in the Energy Transition*,
Studies in Energy, Resource and Environmental Economics,
https://doi.org/10.1007/978-3-031-35684-1_6

Moniruzzaman and Day (2020) proved that the consequences of energy poverty may vary between women and men mainly because women are more exposed to deal with energy-related activities. Some examples are collecting domestic energy resources with a higher probability of physical injury while collecting fuel, and indoor cooking that implies to be exposed to indoor air pollution and extremely high indoor temperatures (Kaygusuz 2011; Sovacool 2012; Maji et al. 2021). These situations are usually worsened due to the lack of refrigeration and medical care. Studies as Pueyo and Maestre (2019) and Robinson (2019) pointed to the fact that women may be impacted by energy poverty more than men, the situation even worse when it is a female breadwinner, racialized, and poor household (Hernández and Bird 2010; Sovacool 2012; Kontokosta et al. 2019; Bohr and McCreery 2019; Bednar and Reames 2020; Brown et al. 2020; Wang et al. 2021; Adua et al. 2022).

At the European Union (EU) level, where more than 50 million people are unable to afford proper indoor thermal comfort, the main constraint of applied studies is the lack of public access to gender-disaggregated data on energy poverty, although in 2016 the European Parliament adopted a resolution that explicitly specified to include the gender dimension in the analysis of the energy poverty phenomenon (European Union 2017). Studies have shown that poverty has a female face in the EU where the gender income gap stands at 16%, the gender pension gap at close to 30%, and women with low incomes are by far more often the heads of households either in single-parent families or, due to their higher life expectancy rates, as individuals living alone at pensionable age, and therefore they are far more likely to be suffering fuel poverty than household in general (Eurostat 2021).

Available data such as the one provided by the EU Energy Poverty Observatory lacks the gender perspective and cannot confirm the fact that female population is more likely to experience or fall into energy poverty. This lack of information persists even though projects need to be designed and targeted after careful attention to local energy availability and household decision-making processes to have significant gender benefits by improving the quality of life of women (Köhlin et al. 2011). A significant reduction in energy poverty would reduce important gender inequality issues (Zhu and Chang 2020; Nguyen and Su 2021).

This chapter contributes to literature on gender–energy–poverty nexus with a descriptive quantitative analysis of the gender differences of energy consumption from a longitudinal perspective to empirically support previous studies on the gender-energy-poverty issue. Particularly we focus on Spain from 1998 to 2018 as a case study. This period allows for a longitudinal analysis of the different social and economic developments that the country has undergone over the years, characterized by the introduction of the euro as a unitary currency (Gil et al. 2003) in 2002, and an increasing demand for employment in the construction sector and some basic services (Alonso and Furió 2010) that had different effects on women and men. Spain's annual gross domestic product growth rate between 1998 and 2007 ranged between 2.7% and 5.2% (World Bank 2022); this growth came to a halt with the financial crisis of 2008 (Padros de la Escosura and Sánchez-Alonso 2020). Since 2008, the Spanish economy suffered a fall in its macroeconomic indicators (Ortega and Peñalosa 2012), giving way to a period of recession and crisis from which it only

recovered from 2014 onwards, only to be halted again by the crisis caused by the COVID-19 in 2020 (Hernández de Cos 2021). The study of such two decades will provide information about how energy expenditures are distributed over the years, the impact of the different economic events, and identifying how a potential increase of energy prices might affect women and men differently.

To this aim, we consider female and male breadwinner[1] households given that intrahousehold bargaining power and gender roles may influence the understanding of energy and energy consumption (Clancy et al. 2012; Lewis and Pattanayak 2012). However, the behavior of such types of households might be influenced by other characteristics of the breadwinner different from gender and it also might be influenced by characteristics of other members of the households. To better analyze the gender effects, in this chapter, we also study the energy consumption patterns of female and male one-person households in the analysis (Toro et al. 2019) and we apply an Ordinary Least Square (OLS) regression model to analyze the significance of gender and expenditure level considering the expenditure on energy products and controlling for other household characteristics. We use longitudinal data from the Spanish Household Budget Survey (HBS) to compute expenditures on residential energy products, as well as on energy goods used for private transport, transport fuels, enlarging traditional analyzes that mainly focus on residential energy.

Our results complement a previous study for Spain conducted by Aristondo and Onaindia (2018), who use a different database, the European Union Survey on Income and Living Conditions in 2005, 2008, 2012, and 2016, studied energy poverty under three energy accessibility indicators and its evolution for different household classifications and characteristics of the main breadwinner such as gender, type of house, education, etc. They found that energy poverty, in terms of accessibility and housing conditions, is higher for households whose breadwinners are divorced women. On average, women are 10% more likely to suffer energy poverty than men, and when energy poverty increase tends to penalize Spanish women more than men, increasing the inequality between both groups.

2 Methodology

To study the significance of gender differences, we first analyze the available database in detail. We calculate the consumption shares among the 39 COICOP products that constitute the 12 COICOP categories over the total annual expenditure for each household between 1998 and 2018. We analyze the differences by total expenditure quintile as well as the expenditure on energy-related products over the two decades with a descriptive analysis. For illustrative purposes, we show results for the so-called

[1] Breadwinner is the member of the household aged 16 or over, whose regular (not occasional) contribution to the common budget is used to cover household expenses to a greater extent than the contributions of each of the other members.

12 COICOP categories[2] showing separate results for two groups closely related to energy: C4.5. *Electricity, gas, and other fuels* that include specifically residential energy products; and C7.2.2. *Fuels and lubricants* that include energy products for private transport.

Second, we apply an OLS[3] model to analyze the significance of gender and expenditure level (and its interaction) controlling by other household characteristics. In Eq. 1, the expenditure share of residential and transport energy products (C4.5. *Electricity, gas, and other fuels*; and C7.2.2. *Fuels and lubricants*) of each household (*EES*) is the endogenous variable that is explained by gender (the covariate *GEND* is a binary categorical variable), total annual expenditure (*EXP* represents the household's annual monetary and non-monetary expenditure measured in thousands of euros), the interaction effect between the gender and expenditure (*GEND*EXP*), the breadwinner age (*AGE*), the number of household members (*NMEMB*),[4] the breadwinner's education (*STU* is a categorical variable),[5] the region to control for climate differences (*RE* is a categorial variable),[6] the municipality density to differentiated rural and urban areas (*DENS* is a categorial variable),[7] and finally the year (*YEAR*).

$$\begin{aligned} EES = &\beta_1 GEND + \beta_2 EXP + \beta_3 GEND * EXP + \beta_4 AGE + \beta_5 NMEMB \\ &+ \beta_6 STU + \beta_7 RE + \beta_8 DENS + \beta_9 YEAR + \varepsilon \end{aligned} \quad (1)$$

3 Data Set

The Spanish HBS from the National Statistical Institute (INE by its Spanish acronym) is national surveys that focus primarily on household spending on goods and services. It provides information on the nature and destination of consumption expenditures, as well as various characteristics of household living conditions. In particular, the INE delivers three types of files: a household file, a member file, and an expenditure file. The household file collects data on household characteristics such as household

[2] The 12 COICOP categories are: (C1) Food and non-alcoholic beverages; (C2) Alcoholic beverages and tobacco; (C3) Clothing and footwear; (C4) Housing, water, gas, electricity, and other fuels; (C5) Furnishings, household equipment, and routine maintenance of the house; (C6) Health; (C7) Transport; (C8) Communication; (C9) Recreation and culture; (C10) Education; (C11) Restaurants and hotels; (C12) Miscellaneous goods, and services.

[3] We apply the *lm* command of RStudio software.

[4] In the case of one-person household analysis, this covariate is not taken into consideration.

[5] *STU* has three categories according to the level of complemented studies: (1) first cycle or less; (2) secondary; (3) university.

[6] *RE* refers to the 17 Spanish Autonomous Communities: Andalusia, Aragon, Asturias, Balearic Islands, Canary Islands, Cantabria, Castilla-Leon, Castilla-La Mancha, Catalonia, Valencia, Extremadura, Galicia, Madrid, Murcia, Navarra, Basque Country, and La Rioja.

[7] *DENS* has three categories: (1) densely populated area; (2) medium densely populated area; (3) sparsely populated area.

size, composition, and other general information about the residential area such as autonomous community, size of municipality, population density, etc. The member file shows information on all the individuals who are members of the households. Finally, the expenditure file shows, as already mentioned, the expenditures at the household level. The Spanish HBS over the years varies in its sociodemographic and socioeconomic information. To obtain a homogenized database we retain the common variables between 1998 and 2004 and 2006 and2018.[8]

Bearing in mind that the objective of the survey is to study household consumption expenditures, the basic units of analysis are private households living in the main dwelling. Consumption is organized according to the COICOP European classification, which structures consumption into 12 large product categories with a level of 39 different products.

The complete size of the sample comprises 348,989 households. From this sample, however, our analysis only focuses on two types of households that allow us to analyze consumption energy differences from a gender perspective: female and male breadwinner households, and female and male one-person households. To compare households with different sizes and composition as well as the economies of scale in consumption, households' expenditures are corrected by the OECD scale of equivalence to obtain equivalent consumption units that are comparable. According to the theory of economies of scale, the increase in the number of members of a household is not usually accompanied by a proportional increase in spending to maintain the same pattern of consumption, since there are shared expenses that are not proportional to the number of members (for example, dwelling expenditures). Additionally, the theory of equivalent consumption units in households maintains that the consumption patterns of children are different from those of adults. Following these ideas, the consumption units of that household are calculated following the modified equivalence scales defined by OECD, which it is calculated by adding the household members weighted according to different coefficients: 1 for the main breadwinner (first adult in the household), 0.5 for each additional adult (over 13 years), and 0.3 for each child (13 years and under).

4 Results and Discussion

To study the consumption energy differences from a gender perspective of Spanish households' consumption over twenty years between 1998 and 2018, first, we analyze expenditure shares on 12 COICOP categories including detailed information for residential and transport energy consumption (C4.5 *Electricity, gas, and other fuels*,

[8] Data prior to 1998 is published by quarters with no household tracking. From 1998 to 2004 the series is delivered by quarters. In 2005 a reform was implemented to fulfil the needs of users and the recommendations of the Statistical Office of the European Union and adapted longitudinally, leaving 2005 without available longitudinal data. Since then, the Spanish HBS are delivered annually. Expenditures are in purchaser's prices in pesetas from 1998 to 2000 and in euros from 2001 to 2018; an exchange rate of 1: 0.00598 was applied to convert all the series in euros.

and C7.2.2 *Fuels and lubricants*).[9] Second, we discuss the results of the OLS model that allow us to analyze the significance of gender and expenditure level (and its interaction) controlling by other demographic household characteristics.

In the analysis, we consider all households grouped into female breadwinner households (FBH) and male breadwinner households (MBH). However, a descriptive analysis based exclusively on female and male breadwinner households might have an important drawback because the differences observed between FBH and MBH can be explained by other issues not related to gender differences such as the educational level of the breadwinner, the population density or region where the household live. The differences can be also influenced by the characteristics of other household members. To partially overcome this limitation, the descriptive analysis also includes differences between a female and male living alone, let say—female one-person households (FOPH) and male one-person households (MOPH). Additionally, the regression analysis further refines the study of gender differences by controlling for other household characteristics such as location, climate, and education (Toro et al. 2019).

The complete size of the longitudinal series comprises 348,989 households. From this total, FBH represents 28% and MBH, 72%. One-person households are a subsample of this series representing 21% of households (FOPH, 12% and, MOPH, 9%). Additionally, FOPH represent almost 42% of the total FBH, in contrast to MOPH that just represents 12% of the total MBH. Table 1 shows the average household characteristics by type of household and gender between 1998 and 2018. The differences between female and male breadwinner household in the expenditure level is almost imperceptible (around 260 euros per year), female breadwinner have a slightly higher level of education, are older, live in less dense areas and with less members that their male counterpart. Otherwise, FOPH spend around 1,800 euros less per year than MOPH and have a slightly lower level of education. Finally, FOPH are older than MOPH—probably explained by a higher life expectancy—and live in less dense areas.

Figure 1 presents the mean expenditure share by products and expenditure quintile (computed separately by gender) between 1998 and 2018 of Spanish FBH and MBH.[10] As expected, the proportion of product expenditure related to energy consumption depends directly on the quintile by expenditure irrespective of the breadwinner's gender. In other words, the share spent on residential energy (C4.5) decreases as the total expenditure rises, as it is a basic and daily product, while the proportion spent on transport fuels (C7.2.2) increases with total spending.

Consumption patterns between FBH and MBH do not seem to be very different in general; however, some discrepancies are observed in categories related to energy

[9] Results are obtained for a total of 15 product groups because category (C4) *Housing, water, gas, electricity, and other fuels* is divided into (C4.5) *Electricity, gas, and other fuels* and the rest of products of category C4 (C4r). The same rationally holds for category (C7) *Transport*, that is divided into (C7.2.2) *Fuels and lubricants,* the rest of group C7.2 (C7.2r) *Otherperation of personal transport equipment* and the rest of category C7 (C7r) *Transport*.

[10] This analysis uses total expending as a proxy of income since information about disposable income is not available.

Table 1 Average descriptive statistics of household characteristics, Spain 1998–2018

	Breadwinner household		One person household	
	Mean	St. Deviation	Mean	St. Deviation
Annual expenditure				
Female	15,628.480	39.407	15,981.730	71.769
Male	15,367.510	23.925	17,819.750	104.518
Education level				
Female	1.726	0.004	1.570	0.006
Male	1.658	0.002	1.807	0.008
Age				
Female	56.369	0.072	64.103	0.124
Male	52.745	0.038	52.574	0.147
Density				
Female	1.655	0.003	1.667	0.005
Male	1.792	0.002	1.771	0.007
Household members				
Female	2.092	0.005	–	–
Male	2.953	0.003	–	–

Source Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE 2019)

purchases. Regardless of the expenditure quintile, FBH tend to spend a higher share than MBH in their expenditures on products for household maintenance (C4r: *Housing and water*) as well as in the case of residential energy (C4.5: *Electricity, gas, and other fuels*). Moreover, MBH tend to spend more than FBH on products related to private transport (C7.2r *Other operation of personal transport equipment*) as well as with transport fuels (C7.2.2 *Fuels and lubricants*). For one-person households, these patterns are almost identical (See Fig. A.1 in the Annex).

Expenditure shares on C4.5: *Electricity, gas, and other fuels* hold over the twenty years period (Fig. 2). When it comes to residential energy (C4.5) the lower quintiles spend a higher share than the higher quintiles independent of the year or gender. When comparing the differences between FBH and MBH in the same quintile, FBH always spend a higher share of their expenditure on energy commodities than their male counterpart. After the 2008 crisis, both types of households are affected considerably increasing their share of expenditure on such goods and have not decreased in the following years. For instance, FBH belonging to quintile 1 experienced an increase in 2010 by 21% compared to 2009, while MBH belonging to the same quintile perceived an increase of 12% for the same period. Looking at the richest quintile, the differences between FBH and MBH are smaller compared to the poorest households, especially in the post-crisis years, although FBH belonging to quintile 5 also spend a higher expenditure share on residential energy than their male counterpart.

Fig. 1 Mean expenditure shares by quintile and COICOP product, Spain 1998–2018. *Source* Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE 2019). *Notes* C1. *Food and non-alcoholic beverages*; C2. *Alcoholic beverages and tobacco*; C3. *Clothing and footwear*; C4r. *Housing and water*; C4.5. *Electricity, gas, and other fuels* that include specifically energy products used at home; C5. *Furnishings, household equipment, and routine maintenance of the house*; C6. *Health*; C7r. *Other transportation*; C7.2r. *Other operation of personal transport equipment*; C7.2.2. *Fuels and lubricants*; C8. *Communication*; C9. *Recreation and culture*; C10. *Education*; C11. *Restaurants and hotels*; C12. *Miscellaneous goods, and services*

However, patterns differ for private transport energy C7.2.2 *Fuels and lubricants*. The differences between quintiles tend to change over the years, FBH quintiles tend to have more modest differences than MBH quintiles. While the MBH three middle quintiles tend to compete for the largest share of spending on this type of good, and the higher and the lower quintile are disputed for the lower proportion. FBH, otherwise, shows that quintile 4 tends to have a higher proportion in this type of goods, while quintile 1 and quintile 2 tend to have a lower proportion.

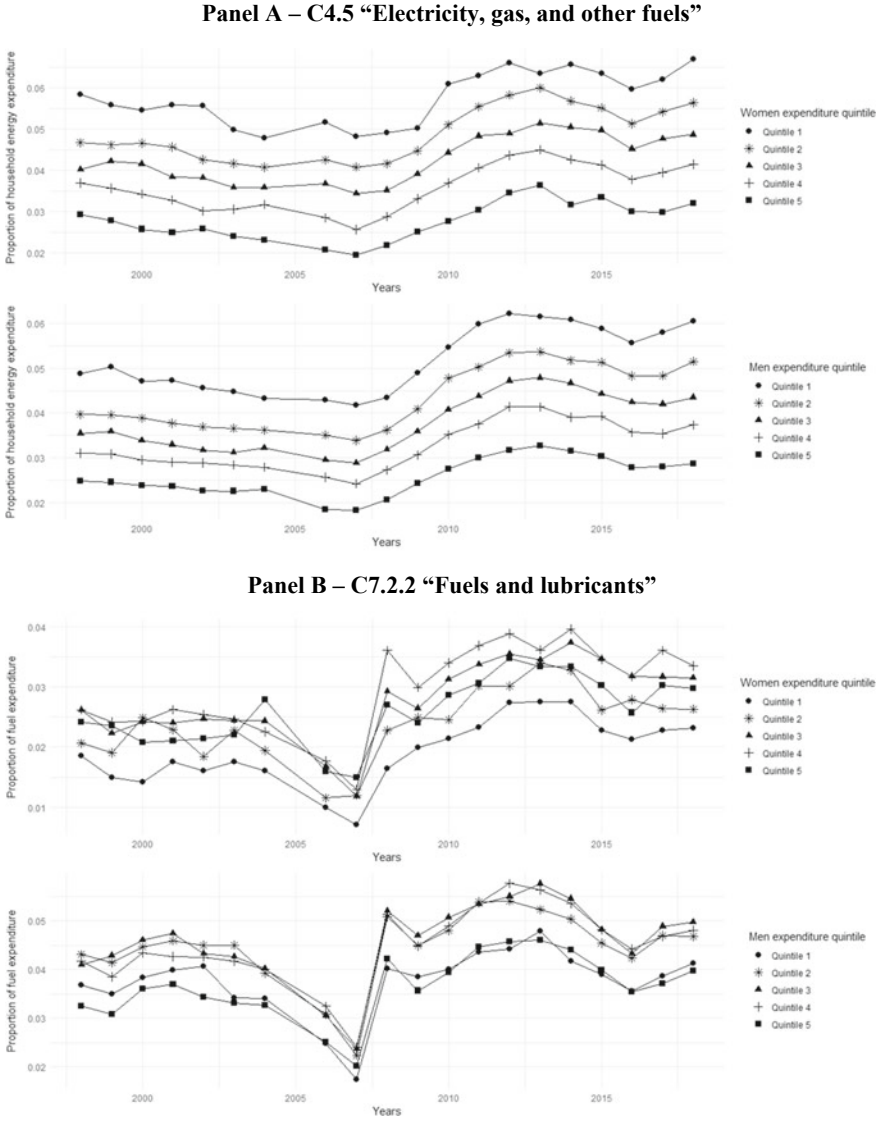

Fig. 2 Expenditure shares by quintile on C4.5 "Electricity, gas, and other fuels" and C7.2.2 "Fuels and lubricants" of female and male breadwinner households, Spain 1998–2018. *Source* Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE 2019)

Results for one-person households are in the same line as breadwinner households in general (see Fig. A.2 in the Annex). Regardless the year and gender, the lowest quintiles spend a higher share of their expenditure on residential energy (C4.5) and a lower share on transport fuels (C7.2.2). We only find differences in the share of expenditures on transport fuels for quintile 2, where MOPH tend to expend a considerably lower proportion than MBH belonging to the same quintile.

To further analyze the effect of the economic crisis of 2008, Table 2 shows the cumulative pre and post-crisis growth rates.

In the case of residential energy (C4.5), the economic crisis of 2008 had different effects on FBH and MBH. All households, regardless of the breadwinner gender and quintile, decreased their share of expenditure on residential energy before the crisis (1998–2008) but increased it afterward (2008–2018). Between 1998 and 2008, households with an FBH experienced a greater fall compared with MBH regardless of the quintile. However, after the 2008 crisis, FBH experienced a greater increase than MBH since the third quintile. During the pre-crisis period, expenditure share on transport fuels (C7.2.2) increased independently of the breadwinner gender, except for quintile 1 of FBH; however, after the crisis, expenditures share of FBH increased in almost all the quintiles, while MBH expenditures shares decreased, enlarging the gender expenditure gap in transport fuels.

This general tendency also held for one-person households (see Table A.1 in the Annex). Like the breadwinner case, the expenditure share on household energy use (C4.5) decreased during pre-crisis years, and increased afterward, regardless of the gender or quintile. On the other hand, the expenditure share on transport fuels

Table 2 Cumulative growth rates of expenditure shares on residential energy and on private transport fuels by expenditures quintile of female and male breadwinner households, Spain (1998–2008 and 2008–2018)

	1998–2008		2008–2018	
	Female	Male	Female	Male
	C4.5 “Electricity, gas, and other fuels”			
Quintile 1	−0.0173	−0.0117	0.0313	0.034
Quintile 2	−0.0113	−0.0091	0.0307	0.0359
Quintile 3	−0.0133	−0.0107	0.033	0.0317
Quintile 4	−0.0242	−0.0128	0.0368	0.0319
Quintile 5	−0.0287	−0.0181	0.0392	0.0331
	C7.2.2 “Fuels and lubricants”			
Quintile 1	−0.0116	0.0089	0.0343	0.0029
Quintile 2	0.0099	0.0168	0.0145	−0.0082
Quintile 3	0.0112	0.0242	0.0076	−0.0045
Quintile 4	0.0326	0.0211	−0.0074	−0.0066
Quintile 5	0.0114	0.0267	0.0098	−0.0059

Source Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE 2019)

(C7.2.2), with some exception, always increased, independent of the gender or years. Like breadwinner case, FOPH spend a higher share of their expenditure on household energy use (C4.5) than MOPH. Before the crisis, the share of FOPH decreased faster than that of MOPH (except for FOPH quintile 1). After the crisis, FOPH belonging to the poorest quintile suffer a smaller increase than the richest FOPH, while MOPH belonging to the poorest quintile suffer a larger increase than the richest MOPH.

For the case of transport fuels (C7.2.2), during the pre-crisis years, the lowest quintile suffers a higher increase in the expenditure share that the richest independent of gender. In contrast to the case of female and male breadwinner households, FOPH belonging to the poorest quintile suffer the highest increase, in both pre- and post-crisis years. In fact, in most cases, FOPH show a larger increase in the proportion spent on such products than MOPH, although as Fig. 2 shows, far from reaching the expenditure levels of their male counterparts.

Finally, to capture the significance of gender and expenditure level (and its interaction) we run an OLS regression model controlling by other demographic household characteristics such as age, number of household members, year, region, density, and level of studies. Table 3 shows the model results for all households, that is for FBH and MBH, on expenditure shares on residential energy and transport fuels independently.

In this analysis, gender (*GEND*) is our variable of interest, and it denotes female by one. Gender is statistically significant and positive for expenditure share on residential energy, and significant and negative for transport fuels. In other words, holding all other household characteristics constant (expenditure level, age, number of members, year of survey, region, density, and education), a household with a female breadwinner allocates a significantly higher proportion of its total expenditure to residential energy and a significantly lower share to transport fuel than a household with the same characteristics but with a male breadwinner. Moreover, looking at the interaction of gender and expenditure (*GEND * EXP*), we see that it is significant meaning that there is an interaction effect and that the impact of extra expenditure on the expenditure share on energy products differs with respect to gender and type of energy product. For residential energy (C4.5), the interaction of gender and expenditure is negative and significant, meaning that each extra thousand euros have a lower effect on FBH than for MBH. However, the interaction is the opposite for transport fuels (C7.2.2), that is to say that each extra thousand euros in FBH have a significantly higher effect than each extra thousand euros in MBH.

In the case of one-person households, the interaction is significant and negative in both residential energy and transport fuels, being higher the effect for residential energy than for transport fuels (see Table A.2 in the Annex).

Table 3 Ordinary Least Square (OLS) model on expenditure shares on residential energy (C4.5) and transport fuels (C7.2.2) for female and male breadwinners' households, Spain 1998–2018

Covariates		Residential energy (C4.5)	Transport fuels (C7.2.2)
		Coefficient	
	(Intercept)	−2.27***	−1.5***
Gender	*GEND (female)*	0.003277***	−0.01227***
Expenditure	*EXP*	−0.0009848***	0.0000382***
Gender * Expenditure	*GEND (fem)*EXP*	−0.00008803***	0.0002138***
Age	*AGE*	0.0002096***	−0.0005043***
Number of Members	*NMEMB*	−0.002422***	0.005771***
Year of survey	*YEAR*	0.001151***	0.0007711***
Region: Aragon	*RE 2*	0.01333***	−0.006918***
Region: Asturias	*RE 3*	0.005685***	−0.00196***
Region: Balearic Islands	*RE 4*	0.002601***	−0.0008928*
Region: Canary Islands	*RE 5*	−0.008352***	0.00358***
Region: Cantabria	*RE 6*	0.0045***	0.001475**
Region: Castilla-Leon	*RE 7*	0.01614***	0.003319***
Region: Castilla-La Mancha	*RE 8*	0.01682***	−0.003836***
Region: Catalonia	*RE 9*	0.007869***	−0.005866***
Region: Valencia	*RE 10*	0.002097***	0.0001535
Region: Extremadura	*RE 11*	0.002085***	−0.0005745
Region: Galicia	*RE 12*	0.005071***	0.0009095*
Region: Madrid	*RE 13*	0.009517***	−0.00218***
Region: Murcia	*RE 14*	0.0007027**	0.001951***
Region: Navarra	*RE 15*	0.01005***	−0.009693***
Region: Basque Country	*RE 16*	0.002944***	−0.01032***
Region: La Rioja	*RE 17*	0.01439***	−0.006968***
Density: Medium	*DENS 2*	0.00438***	0.006814***

(continued)

Table 3 (continued)

Covariates		Residential energy (C4.5)	Transport fuels (C7.2.2)
Density: Sparsely	*DENS 3*	0.009695***	0.01147***
Studies: Secondary	*STU 2*	−0.000347**	0.000343
Studies: University	*STU 3*	−0.0003754**	−0.0009363***

Legend 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Notes Gender (*GEND*) denotes female by one; density (*DENS*) has three categories: (1) densely populated area; (2) medium densely populated area; (3) sparsely populated area, and denotes densely populated area (1) by one; level of studies (*STU*) has three categories according to the level of complemented studies: (1) first cycle or less; (2) secondary; (3) university, and denotes first cycle or less (1) by one; and region (*RE*) includes the 17 Spanish Autonomous Community and denotes Andalusia (1) by one

Source Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE 2019)

5 Conclusions

Previous studies show that women are more at risk of energy poverty, even in developed countries. Additionally, policies aimed at reducing energy poverty with a gender perspective will help to reduce the inequality between women and men on different issues.

Results presented in this chapter contribute to the discussion of energy poverty with a quantitative analysis. By using data from the Spanish HBS for a period of twenty years from 1998 to 2018, this study contributes to the literature by collecting data and providing empirical evidence of the energy consumption by different household structures under a gender approach. Specifically, besides the analysis of female and male breadwinner households, we also provide results for female and male one-person households, and we run an OLS model to further refine the gender differences and avoid differences in energy consumption due to the influence of the household structure.

Previous studies usually focus on the gender energy poverty analysis by looking only at the consumption and effect of the use of residential energy products, mainly recorded by expenditures on COICOP product C4.5 *Electricity, gas, and other fuels.* This chapter, however, goes beyond the analysis of residential energy consumption by analyzing the differences between women and men and how these differences prevail energy gender gap and gender energy poverty also in another group of energy goods used for a different purpose. Particularly, we extend the analysis to the use of transport fuels included in the COICOP group C7.2.2 *Fuels and lubricants.*

Along consumption patterns, the results show that FBH and FOPH spend a significantly higher share on residential energy than their male counterparts observed both over the years and on average independently of the quintile to which they belong. The poorest FBH (quintile 1) allocate more of their total expenditure than the poorest MBH belonging to the same quintile. However, these differences decrease as the expenditure quintile increases. Our results confirm that poorest FBH are those who

suffer from greater inequality where their spending capacity is mostly influenced by the consumption of a basic good related to residential energy. On the contrary, MBH assign a significantly higher share than FBH to products related to private transport energy. In other words, the gender gap in the consumption of transport fuels is even worse by comparing the most disadvantaged households. Looking at differences between FOPH and MOPH the conclusion goes in the same direction but with results of different dimension: women living alone, who are older than their male counterparts, suffer a higher energy gap.

To summarize, both from the descriptive analysis and through the OLS regression, in the case of Spain from 1998 to 2018, we conclude that households with a female breadwinner spend a higher share of their total expenditure on residential energy, while male breadwinner households tend to spend a higher share on transport fuels. We also established that the 2008 crisis affected female and male breadwinner households differently. Finally, the level of expenditure affects FBH and MBH differently. When there is an increase in the expenditure level, MBH decrease their expenditure share on residential energy faster than FBH; while for energy fuels it is the contrary: FBH increase the expenditure share faster than MBH. In the case of one-person household, an increase in the expenditure level makes the MOPH to decrease the expenditure share on residential energy and increase the share on transport fuels faster than FOPH.

Concluding, the inequality between women and men also affects energy issues where women are more exposed as they need more effort to obtain residential energy goods that have almost not good substitutes, while men demand significantly more transport fuels that might have alternative substitutes in public transport. This gender energy inequality is even worse in the case of the most disadvantaged households, where women are still far from being able to spend on energy products, particularly those related to private transport.

Annex: Results for One-Person Household Analysis

Source Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE, 2019).

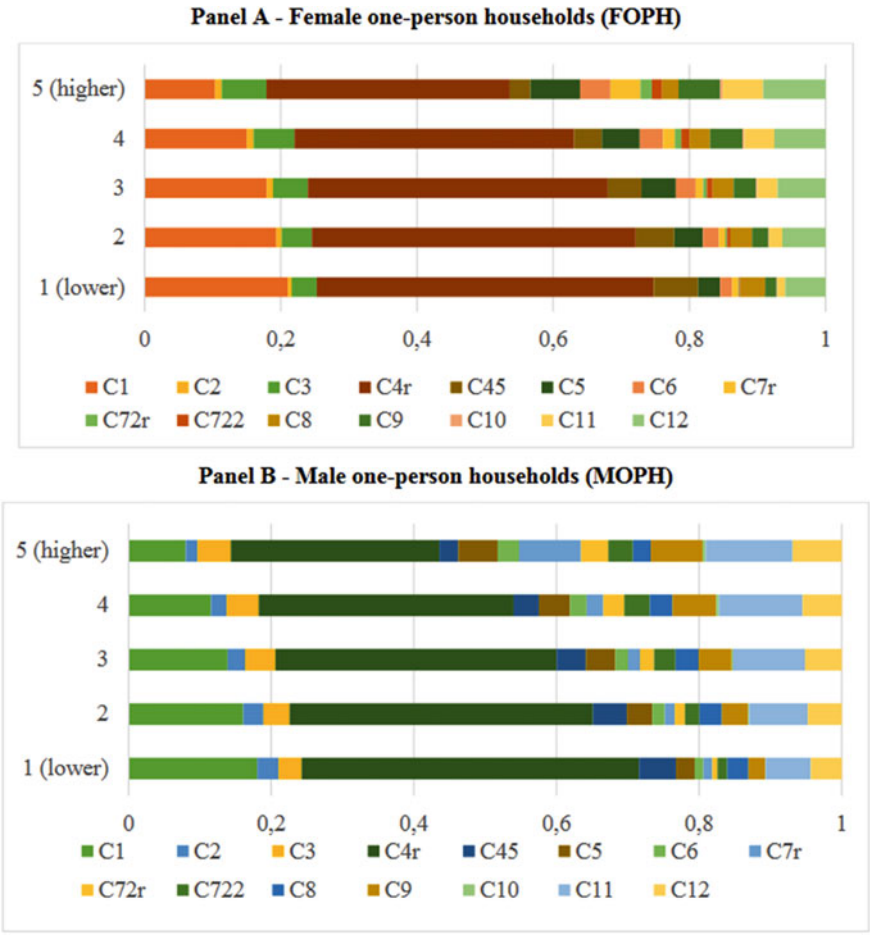

Fig. A.1 Mean expenditure shares by quintile and COICOP product, Spain 1998–2018 (*Source* Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE, 2019) (*Notes* C1. Food and non-alcoholic beverages; C2. Alcoholic beverages and tobacco; C3. Clothing and footwear; C4r. Housing and water; C4.5. Electricity, gas, and other fuels that includes specifically energy products used at home; C5. Furnishings, household equipment, and routine maintenance of the house; C6. Health; C7r. Other transportation; C7.2r. Other operation of personal transport equipment; C7.2.2. Fuels and lubricants; C8. Communication; C9. Recreation and culture; C10. Education; C11. Restaurants and hotels; C12. Miscellaneous goods, and services)

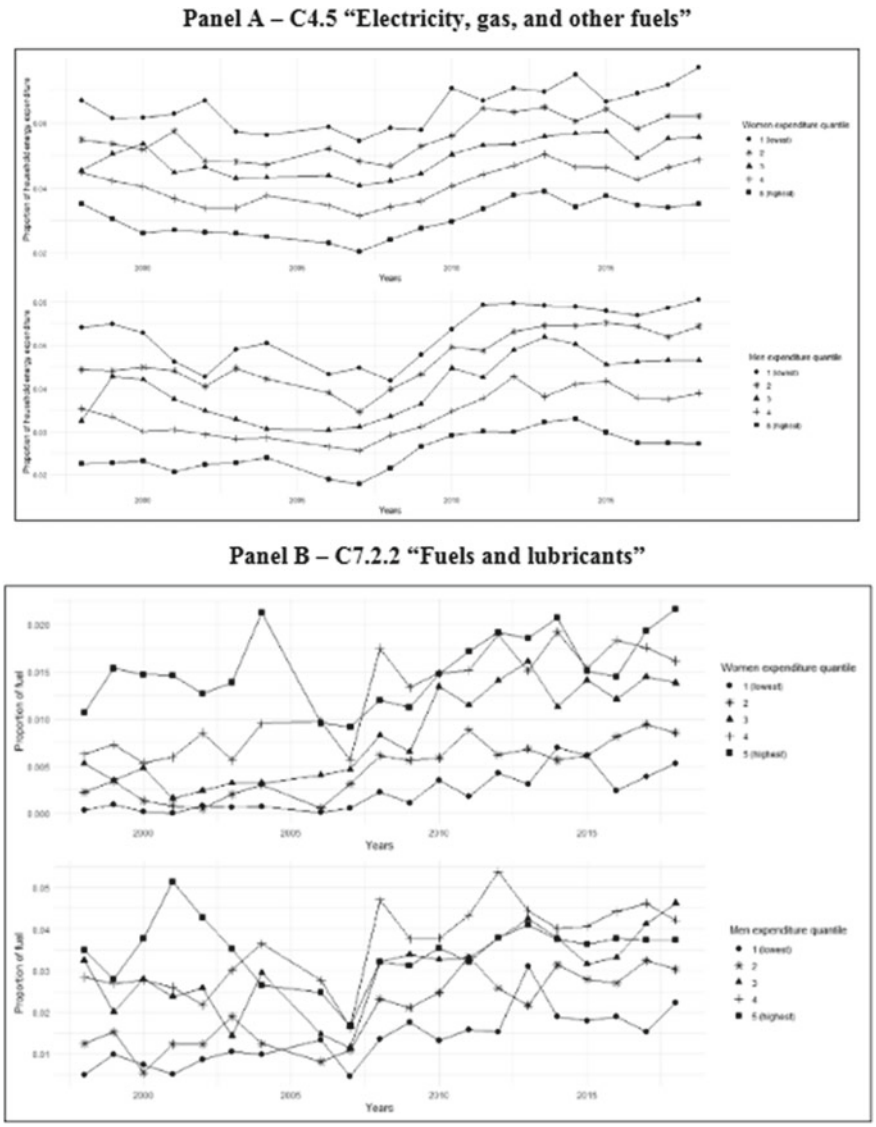

Fig. A.2 Expenditure shares by quintile on C4.5 "Electricity, gas, and other fuels" and C7.2.2 "Fuels and lubricants" of female and male one-person households, Spain 1998–2018 (*Source* Own elaboration from Spanish Household Budget Survey from 1998 to 2018 [INE, 2019])

Table A.1 Cumulative growth rates of expenditure shares on residential energy and on private transport fuels by quintile of female and male one-person households, Spain (1998–2008 and 2008–2018)

	1998–2008		2008–2018	
	Female	Male	Female	Male
	C4.5 "Electricity, gas, and other fuels"			
Quintile 1	−0.0159	−0.0187	0.0356	0.0354
Quintile 2	−0.0108	−0.0098	0.0310	0.0358
Quintile 3	−0.0108	−0.0050	0.0330	0.0354
Quintile 4	−0.0292	−0.0176	0.0406	0.0339
Quintile 5	−0.0383	−0.0101	0.0411	0.0256
	C7.2.2 "Fuels and lubricants"			
Quintile 1	0.2036	0.1048	0.0887	0.0505
Quintile 2	0.1056	0.0646	0.0340	0.0269
Quintile 3	0.0464	−0.0015	0.0523	0.0372
Quintile 4	0.1081	0.0513	−0.0077	−0.0107
Quintile 5	0.0121	−0.0080	0.0604	0.0149

Table A.2 Ordinary Least Square (OLS) model on expenditure shares on residential energy (C4.5) and on transport fuels (C7.2.2) for female and male one-person household, Spain 1998–2018

Covariates		Residential energy (C4.5)	Transport fuels (C7.2.2)
		Coefficients	
	(Intercept)	−2.52***	−0.7469***
Gender	*GEND (female)*	0.01048***	−0.009659***
Expenditure	*EXP*	-0.0006556***	0.0003222***
Gender * Expenditure	*GEND (fem)*EXP*	−0.0003199***	−0.0001407***
Age	*AGE*	0.0002865***	−0.000584***
Year of survey	*YEAR*	0.001267***	0.0003965***
Region: Aragon	*RE 2*	0.01716***	−0.002138**
Region: Asturias	*RE 3*	0.007799***	−0.0003198
Region: Balearic Islands	*RE 4*	0.003433***	0.0009563
Region: Canary Islands	*RE 5*	−0.007016***	0.002367**
Region: Cantabria	*RE 6*	0.006901***	0.0005332
Region: Castilla-Leon	*RE 7*	0.02387***	−0.0003309

(continued)

Table A.2 (continued)

Covariates		Residential energy (C4.5)	Transport fuels (C7.2.2)
Region: Castilla-La Mancha	*RE 8*	0.02084***	−0.001282
Region: Catalonia	*RE 9*	0.01076***	−0.003852***
Region: Valencia	*RE 10*	0.002686***	0.001559*
Region: Extremadura	*RE 11*	0.002514**	0.0008562
Region: Galicia	*RE 12*	0.008234***	0.0007124
Region: Madrid	*RE 13*	0.01238***	−0.002707***
Region: Murcia	*RE 14*	0.001426	0.001552
Region: Navarra	*RE 15*	0.01457***	−0.002012*
Region: Basque Country	*RE 16*	0.005627***	−0.006307***
Region: La Rioja	*RE 17*	0.01976***	−0.001651
Density: Medium	*DENS 2*	0.005506***	0.005815***
Density: Sparsely	*DENS 3*	0.01162***	0.007307***
Studies: Secondary	*STU 2*	−0.001087*	0.004095***
Studies: University	*STU 3*	−0.001655***	0.005251***

Legend: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Notes Gender (*GEND*) denotes female by one; density (*DENS*) has three categories: (1) densely populated area; (2) medium densely populated area; (3) sparsely populated area, and denotes densely populated area (1) by one; level of studies (*STU*) has three categories according to the level of complemented studies: (1) first cycle or less; (2) secondary; (3) university, and denotes first cycle or less (1) by one; and region (*RE*) includes the 17 Spanish Autonomous Community and denotes Andalusia (1) by one

Source Own elaboration from Spanish Household Budget Survey from 1998 to 2018 (INE, 2019)

References

Adua L, De Lange R, Aboyom AI (2022) Differentiated disadvantage: class, race, gender, and residential energy efficiency inequality in the United States. Energ Effi 15(49):1–18. https://doi.org/10.1007/s12053-022-10056-7

Alonso M, Furió E (2010) La economía Española. Cah Civilis Esp Contemp. https://doi.org/10.4000/ccec.3212

Aristondo O, Onaindia E (2018) Inequality of energy poverty between groups in Spain. Energy 153:431–442. https://doi.org/10.1016/j.energy.2018.04.029

Awaworyi Churchill S, Smyth R (2020) Ethnic diversity, energy poverty and the mediating role of trust: evidence from household panel data for Australia. Energy Economics 86:104663. https://doi.org/10.1016/j.eneco.2020.104663

Bednar DJ, Reames TG (2020) Recognition of and response to energy poverty in the United States. Nat Energy 5:432–439. https://doi.org/10.1038/s41560-020-0582-0

Bennett F (2015) Poverty in the UK: the need for gender perspective. Women's budget group. Available at https://wbg.org.uk/wp-content/uploads/2015/02/Gender-and-Poverty-Briefing-June-2015.pdf. Accessed 16 Dec 2022

Bohr J, McCreery AC (2019) Do energy burdens contribute to economic poverty in the United States? A panel analysis. Social Forces 99(1):155–177. https://doi.org/10.1093/sf/soz131
Bouzarovski S, Petrova S, Sarlamanov R (2012) Energy poverty policies in the EU: a critical perspective. Energy Policy 49:76–82. https://doi.org/10.1016/j.enpol.2012.01.033
Brown MA, Soni A, Lapsa MV et al (2020) High energy burden and low-income energy affordability: conclusions from a literature review. Progress in Energy 2(4):042003. https://doi.org/10.1088/2516-1083/abb954
Clancy J, Winther T, Matinga M et al (2012) Gender equity in access to and benefits from modern energy and improved energy technologies. World development report background paper. ETC Nederland BV. Available at: https://www.academia.edu/23408980/Gender_equity_in_access_to_and_benefits_from_modern_energy_and_improved_energy_technologies_world_development_report_background_paper. Accessed 16 Dec 2022
European Union (2017) Gender perspective on access to energy in the EU. Directorate general for internal policies. Policy department c: citizens' rights and constitutional affairs. Women's rights & gender equality. Available a:t http://www.europarl.europa.eu/studies. Accessed 16 Dec 2022
Eurostat (2021) Improving the understanding of poverty and social exclusion in Europe. Statistical Working Papers. Eurostat, Luxembourg. https://doi.org/10.2785/70596
Birol F (2022) What does the current global energy crisis mean for energy investment? International energy agency. Available at: https://www.iea.org/commentaries/what-does-the-current-global-energy-crisis-mean-for-energy-investment. Accessed 16 Dec 2022.
Galvin R, Sunikka-Blank M (2018) Economic inequality and household energy consumption in high-income countries: a challenge for social science-based energy research. Ecol Econ 153:78–88. https://doi.org/10.1016/j.ecolecon.2018.07.003
Gil S, Martínez JA, Llorca R (2003) El euro y la integración comercial española. Economía Industrial 349:139–146
González-Eguino M (2015) Energy poverty: an overview. Renew Sustain Energy Rev 47:377–385. https://doi.org/10.1016/j.rser.2015.03.013
Harkonen J (2017) Single-mother poverty: how much do educational differences in single motherhood matter? In: Nieuwenhuis R, Maldonado L (eds) The triple bind of single parent families. Policy Press, OAPEN, pp 31–50
Hernández D, Bird S (2010) Energy burden and the need for integrated low-income housing and energy policy. Poverty & Public Policy 2(4):668–688. https://doi.org/10.2202/1944-2858.1095
Hernández de Cos P (2021) La economía española ante la crisis del COVID-19. Banco de España. Available at: https://www.bde.es/f/webbde/GAP/Secciones/SalaPrensa/IntervencionesPublicas/Gobernador/Arc/Fic/hdc270421b.pdf. Accessed 16 Dec 2022
Instituto Nacional de Estadística (2019) Nivel y condiciones de vida: Encuesta de presupuestos familiares. *INE* https://ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176806m&me nu=ultiDatos&idp=1254735976608
Jalovaara M, Andersson G (2017) Disparities in children's family experiences by mother's socioeconomic status: the case of Finland. Popul Res Policy Rev 37(5):751–768. https://doi.org/10.1007/s11113-018-9485-1
Kaygusuz K (2011) Energy services and energy poverty for sustainable rural development. Renew Sustain Energy Rev 15(2):936–947. https://doi.org/10.1016/j.rser.2010.11.003
Köhlin G, Sills EO, Pattanayak SK et al (2011) Energy, gender, and development: what are the linkages? Where is the evidence? World Development Report: Gender equality and development. World Bank. https://doi.org/10.1596/1813-9450-5800
Kontokosta CE, Reina VJ, Bonczak B (2019) Energy cost burdens for low-income and minority households: evidence from energy benchmarking and audit data in five U.S. cities. J Am Plan Assoc 86(1): 89–105. https://doi.org/10.1080/01944363.2019.1647446
Lewis JJ, Pattanayak SK (2012) Who adopts improved fuels and cookstoves? A systematic review. Environ Health Perspect 120:637–645. https://doi.org/10.1289/ehp.1104194

Maji P, Mehrabi Z, Kandlikar M (2021) Incomplete transitions to clean household energy reinforce gender inequality by lowering women's respiratory health and household labour productivity. World Dev 139:105309. https://doi.org/10.1016/j.worlddev.2020.105309

Moniruzzaman M, Day R (2020) Gendered energy poverty and energy justice in rural Bangladesh. Energy Policy 144:111554. https://doi.org/10.1016/j.enpol.2020.111554

Nguyen CP, Su TD (2021) Does energy poverty matter for gender inequality? Global evidence. Energy Sustain Dev 64:35–45. https://doi.org/10.1016/j.esd.2021.07.003

Ortega E, Peñalosa J (2012) The Spanish economic crisis: Key factors and growth challenges in the euro area. Banco de España Occasional, Eurosistema, Documento Ocasionales No 1201. Available at: https://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosOcasionales/12/Fich/do1201e.pdf. Accessed 16 Dec 2022

Prados de la Escosura L, Sánchez-Alonso B (2020) Dos siglos de moderno crecimiento económico en España. Papeles de Economía Española. N°164. Available at: https://www.funcas.es/wp-content/uploads/2020/08/PEE164art02.pdf. Accessed 16 Dec 2022

Pueyo A, Mar M (2019) Linking energy access, gender, and poverty: a review of the literature on productive uses of energy. Energy Res Soc Sci 53:170–181. https://doi.org/10.1016/j.erss.2019.02.019

Robinson C (2019) Energy poverty and gender in England: a spatial perspective. Geoforum 104:222–233. https://doi.org/10.1016/j.geoforum.2019.05.001

Sovacool BK (2012) The political economy of energy poverty: a review of key challenges. Energy Sustain Dev 16(3):272–282. https://doi.org/10.1016/j.esd.2012.05.006

Thomson H, Snell CJ, Liddell C (2016) Fuel poverty in the European Union: a concept in need of definition? People, Place & Policy 10(1):5–24. https://doi.org/10.3351/ppp.0010.0001.0002

Toro, F, Serrano M, Guillen M (2019) Who pollutes more? Gender differences in consumption patterns, IREA Working Papers, 2019/06: 1–48. Available at: https://www.ub.edu/irea/working_papers/2019/201906.pdf

Wang Q, Kwan MP, Fan J et al (2021) Racial disparities in energy poverty in the United States. Renew Sustain Energy Rev 137. https://doi.org/110620.10.1016/j.rser.2020.110620

World Bank (2022) GDP growth (annual %)—Spain. Data World Bank https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2020&locations=ES&st art=1998

Zhu N, Chang L (2020) An evolutionary life history explanation of sexism and gender inequality. Personality Individ Differ 157:109806. https://doi.org/10.1016/j.paid.2019.109806