



## The role of gender and self-efficacy in domestic energy saving behaviors: A case study in Lombardy, Italy

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### ABSTRACT

A deeper understanding of the domestic saving behaviors is crucial for improving Italian energy policies, as the country is still characterized by the dependence on foreign non-renewable sources and by an underestimation of psycho-social and behavioral factors. This research explores the relationship between gender, self-efficacy and energy saving behaviors at the household level in the Lombardy region, Italy. We investigated the characteristics of the well-documented gender gap in energy saving behaviors, to understand if virtuous habits by women are observed also in that context, how gender effects are related with different types of addressed behaviors and the role of self-efficacy in this process. Results suggest that gender effects are not uniformly spread across energy saving behaviors, but interrelated with the local and national culture, following specific patterns. Moreover, data show that domain-specific self-efficacy is gender-sensitive. The study indicates that promoting a gender perspective is a key factor when designing sustainability policies at individual, family, and community level. Moreover, it points to the need for specific strategies dedicated to the various domestic energy saving targets and behaviors, in general and in the Italian context.

### 1. Introduction

Although the use of renewable energies is steadily increasing, the Italian context is still largely marked by the use of fossil fuels and natural gas, which satisfy about 70% of the national primary demand (2019, Ministry of Economic Development, 2020). In addition, this demand is mainly covered by imports (75% in 2019, *ibidem*), resulting in a strong energy dependence on foreign countries. Residential energy consumption covers a significant portion of this amount, accounting for 20% of national total energy use in Italy. After a constant growth in the 1990–2010 period, it experienced a slight decrease during the economic stagnation (2011–2017), returning to an upward trend in more recent years (ENEA, 2020). According to this scenario, domestic energy saving behaviors play a crucial role in the national strategies (Ministry of Economic Development, 2017) to promote the country's energy independence and to mitigate the energy poverty effects, which affects 8.8% of families (Faiella et al., 2020), but they have been poorly addressed so far.

Adopting a psychological perspective, a recent review (Inghilleri et al., 2020) suggested that the importance assigned to domestic energy

saving behaviors and their relatively weak coverage compared to other technical issues in the Italian scientific panorama characterize the inconsistent national context. Such inconsistency is among the main barriers that limit Italian society in promoting a “cultural shift” on energy sustainability issues. The authors also argued that top-down approaches developed in engineering or economics fields have been historically privileged in Italy, underestimating the predictive value of studying the psychosocial determinants of citizens' energy behaviors. Many scholars stressed indeed the importance of investigating socio-cultural and psychological dimensions of domestic energy consumption and saving (Stern, 1992; Abrahamse and Steg, 2011), with the aim of better targeting public policies to promote a broader transition towards more advanced forms of sustainability. Addressing the main socio-demographic variables for this purpose, numerous national and comparative studies (see 2.1) found a gender gap, in favor of women, in the intensity of energy saving attitudes and the frequency of sustainable behaviors, calling into question the processes of socialization (see Clausen, 1968; Morawski and St. Martin, 2011 for critical reviews) and education. Self-efficacy (Bandura, 1977; Hanss and Bohm, 2010; see 2.1) has not been adequately included among the possible factors influencing this trend,

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although it has been related both to gender differences (Huang, 2012) and to the antecedents of virtuous pro-environmental behaviors (Thøgersen and Grønhoj, 2010).

The present research focuses on the role of gender and self-efficacy in energy saving behaviors, with the aim of developing strategies and policies suitable for the Lombard and Italian cultural context. The existence of a gender gap regarding energy saving behaviors is investigated, together with the patterns of relationship between gender and the different types of addressed behaviors. More in general, gender effects on domain-specific self-efficacy and on the relationship between self-efficacy and energy saving behaviors is also investigated. The paper is organized as follows: in the next section the literature on gender differences in sustainable and energy saving behaviors and on self-efficacy as an antecedent of sustainable behaviors is presented. The Italian psychosocial context regarding sustainability and energy saving is also briefly tackled. In the subsequent sections a study conducted in Lombardy, the region with the highest energy demand in Italy, is presented, and its policy implications are discussed in the final paragraph.

## 1.1. Literature review

### 1.1.1. Gender, sustainable behaviors and culture

Since the 1970s, sustainability has become a main topic in social sciences in general, and even more important in environmental psychology. According to Pol (2007), this issue has impacted the discipline to the extent that in this phase it can be defined as “environmental psychology for sustainability”. Moreover, it has increasingly been acknowledged that sustainability cannot be separated from the study of individual and collective behaviors, as the joint research on these issues can favor the promotion of ecological health and well-being (Winter and Koger, 2014; Rainisio et al., 2015). In this scenario, the research on sustainable behaviors has been gradually connected to other existing lines of research, in particular those that study gender and cross-cultural differences, giving life to a fruitful field of studies addressing gender differences in sustainable behavior in different cultural contexts.

The majority of studies focused on this topic converged on the existence of consistent cross-cultural gender differences in the adoption of sustainable behaviours, although there is no consensus, and the issue is still under discussion. The classic review by Zelezny et al. (2000), considering 13 behavioral studies from various countries published in the decade 1988–1998, concluded that in 9 of them women showed a greater tendency than men towards pro-environmental behaviours, against only one study with opposite results. In the same article an original study conducted on 14 European, South, and North American countries confirmed the gender difference. A more recent review (Gifford and Nilsson, 2014) stated that, compared with the previous results, this gender divide is emerging in a clearer way in the current literature. A research on 22 countries around the world (Hunter et al., 2004) found that this gender difference was confirmed in 14 countries (Asia, Europe, North America, Oceania) when environmentally oriented behaviours in the private sphere are addressed. In contrast, the number of countries where this gap is significant is reduced to 5 if the public sphere is taken into account. A similar pattern was highlighted in the Chinese context (Xiao and Hong, 2010), where women were found to be more active in domestic sustainability behaviors, whereas for public engagement on these issues (e.g., activism) no differences between men and women have been detected. Diverging results emerge from other studies, which found no significant differences based on gender (Scott and Willits, 1994; Eisler et al., 2003). Among these, a study conducted on a sample of Spanish students (Vicente-Molina et al., 2018) argued that the gender gap is dependent on the type of addressed behavior and may not exist for specific environmental tasks and high-level educational targets. Furthermore, it showed that the antecedents of pro-environmental behavior vary between men and women, as attitudes are not significant for the latter.

This gender difference was generally explained through two connected frameworks. On the one hand, more generally, it is hypothesized that socialization and educational processes push women to be more focused on the dimensions of care and cooperation in many cultures (Hofstede, 1980; Blocker and Eckberg, 1997; Eagly, 2009). On the other hand, that consequently they develop specific personality traits (McCrae and Costa, 1987, 1999) such as more agreeableness and conscientiousness (Luchs and Mooradian, 2012), less “masculinity” (Hofstede, 2001) and a general orientation to more ecocentric values (Schultz, 2001, 2002). This latter point has also been stressed by ecofeminist scholars, who postulated a natural tendency of women towards ecocentric values regardless of the socialization processes (Diamond and Orenstein, 1990).

The gender gap findings on sustainable behaviors are generally confirmed by the results of the fewer studies which specifically addressed the energy saving behaviors. According to the social-cognitive approach proposed by Thøgersen and Grønhoj (2010), women are more oriented towards domestic energy saving, but for men (and not for women) a significant motivational factor is the virtuous behavior of other household members. Du and Pan (2021) highlighted a difference in the psychological antecedents of saving behavior between men and women. Attitudes and personal moral norms have been found to be good predictors of the intentions to undertake sustainable behaviors in women, but not in men. Moreover, the relationship between intention and behavior was much stronger for males than females. Similarly, Lee et al. (2013) found higher scores for women on subjective norms related to energy-efficient lighting and a broader tendency in females to be engaged in energy saving practices. The authors also stated that energy saving by females is more intense than for the males as far as household-oriented (private) behaviors are addressed, but this gap disappears with regard to community/society-oriented behaviors (i.e., purchase of energy efficient lighting, public policy support). These findings are consistent with the results of other previous studies (Hunter et al., 2004; Xiao and Hong, 2010) and with the gender socialization theory, as in many cultures the role of women is mainly confined to the private and domestic dimension. At this regard, Shrestha et al. (2020) pointed out that, especially in Asia, women provide for the daily management of electricity as they are much more involved in housekeeping. Although they are the main users, purchase decisions on electrical appliances are largely entrusted to men.

Also, Yang et al. (2016) found a gender gap in favor of females on indirect energy curtailment behaviours (consumed goods and services) in Chinese urban residents, whereas the difference was absent on direct ones (household electricity management).

### 1.2. Self-efficacy and sustainable behaviors

Perceived self-efficacy (Bandura, 1977), one of the most popular concepts in psychological science, was defined as individuals’ “beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” (Bandura, 1994, p.71). According to this, “people with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. Such an efficacious outlook fosters intrinsic interest and deep engrossment in activities. They set themselves challenging goals and maintain strong commitment to them” (ibidem).

Therefore, a high level of perceived self-efficacy was found to be related with positive outcomes in numerous behavioral domains (see Bandura, 1997; Sadri and Robertson, 1993; Stajkovic and Luthans, 1998 for sectorial reviews). It was also integrated (Fishbein and Cappella, 2006) in the theory of planned behavior (TPB; Ajzen, 1991), one of the most influential frameworks to analyze the pro-environmental behavior antecedents. Accordingly, the role of perceived self-efficacy, and other similar concepts like *internal locus of control* (Rotter, 1966) and *perceived consumer effectiveness* (PCE) in triggering

sustainable behaviors was deeply investigated. In their classic meta-analysis, Hines et al. (1987) pointed to the internal locus of control, namely the individual's tendency to attribute life outcomes to their own agency and abilities, as a key factor to promote pro-environmental behaviors. Lately, some scholars (Berger and Corbin, 1992; Nguyen et al., 2019) argued that PCE, namely the belief of being able to impact the environment through individual consumption or purchase choices, has a moderating effect on the relationship between green intentions and sustainable actions. Hanss and Bohm (2010) proposed the *sustainable development self-efficacy* (SDSE) “to refer to people's self-efficacy beliefs regarding sustainable development; that is, to the degree to which people believe that their individual behavior can contribute to sustainable development” (*ibidem*, p. 49). They discovered that this type of domain-specific self-efficacy is a significant predictor of sustainable consumption behavior, whereas general self-efficacy (GSE) is not. Moreover, the authors highlighted that self-efficacy concerning encouraging others (i.e., “my actions to contribute to the preservation of natural resources will encourage others to do the same”) was found to be the stronger behavioral predictor. Addressing energy saving behaviours, Thøgersen and Grønhoj (2010) argued that self-efficacy factors influence significantly consumers' saving efforts. A qualitative study on office buildings (Lo et al., 2012) stated that, comparing different companies, self-efficacy is considered by management and employees as the main determinant of office energy-saving behavior in all of them. The importance of self-efficacy in promoting electricity saving and wider pro-environmental behaviors was also found in a study on the spillover effects of different communication frames (Steinhorst et al., 2015). Coherently, Yang et al. (2020) found that self-efficacy acts as a mediator between information intervention factors and energy-saving behavior intention, together with perceptual control.

To our best knowledge, the relationship between gender, self-efficacy and sustainable/energy saving behaviors have been inadequately investigated so far. The present article, focusing on this issue in the Lombard and Italian context, is aimed at providing an explorative contribution to fill this gap. Considering the literature in general, perceived self-efficacy has been criticized as a typical Western construct (Klassen, 2004), but also recognized to vary in accord with the Hofstede's (1980) cultural dimensions (Oettingen, 1995). Significant differences were found comparing individualistic and collectivistic cultures (Yan and Gaier, 1994; Eaton and Dembo, 1997; Klassen, 2004) and wide variations in scores between countries emerged (Scholtz et al., 2002). These latter authors also pointed out a gender difference for higher degrees of self-efficacy in favor of men, with a national unsystematic effect. A more recent meta-analysis (Huang, 2012) highlighted again a small difference in favor of men in general academic self-efficacy, but also that the gender gap is mainly domain specific (i.e., females showed a higher language and arts self-efficacy than males). As in the case of the relationship between gender and sustainability (see previous paragraph), it could be assumed that the socialization and educational processes play a significant role.

### 1.3. Sustainable and energy saving behaviours in the Italian context

According to recent reviews (Sarrica et al., 2018; ENEA, 2020), the Italian context is represented by an apparently contradictory picture. Indeed, Italian citizens show a high awareness on sustainability and energy issues, along with a weak tendency to change their related everyday behavior (Inghilleri et al., 2020). Coherently, a European extensive survey on sustainable attitudes and behaviors (Poortinga et al., 2018) stated that Italian citizens, compared with other Europeans, show lower values on perceived individual responsibility, and moderate values on self-efficacy and proactivity. A similar outcome was found by Kühntz (2007) addressing the cynicism and resignation of Italians towards the practical application of the main concepts related to sustainable development. Moreover, the spread of sustainable behaviours in Italy, in-

cluding some energy saving actions (usage patterns of electrical appliances and lighting), resulted to be lower than the EU average (European Commission, 2017). Accordingly, Thøgersen (2018) found that attitude towards energy saving was positively and significantly related to some energy-saving behavior (light switching, washing machine use, heating/cooling habits, sustainable appliances purchasing) in 8 other European countries, but not in Italy. Referring to a culture-oriented approach, Inghilleri et al. (2020) argued that Italians tend to have a predominantly external *locus of control* (i.e., rejection of individual disincentive policies) and to be aligned with cultural dimensions (individualism, masculinity) associated with a low intensity of pro-environmental behaviors (Husted, 2005). At the same time, some propaedeutic values for pro-environmental actions are also widespread in the population (long-term orientation, trust in collective action). The same authors highlighted the need to further investigate the different energy subcultures within the country, due to its internal socio-economic, geographical, and climatic heterogeneity.

At present, no specific studies dedicated to gender differences and energy saving behaviors in the Italian context are available. This deficiency is also due to the fact that top-down approaches developed in engineering or economics fields have been privileged so far, taking into little consideration the psycho-social dimensions.

Addressing this topic, our research is articulated around the following research questions.

Firstly, we aim to explore if in the Northern Italian region of Lombardy, in line with the cross-cultural findings addressed in the literature review (see 2.1), a significant gender gap in energy saving behaviors in favor of women is also present. Also, the research deepens the different types of energy saving behaviors in this context in relation to gender.

Secondly, gender differences in domain-specific (sustainability) self-efficacy are investigated, also addressing the relationship between self-efficacy and energy saving behaviors in the Lombardy scenario. Both are aimed to produce context-sensitive policy suggestions.

## 2. Methodology

### 2.1. Case study

The Lombardy region has a crucial socio-economic role in the Italian scenario, as it has about 17% of the country's inhabitants (over 10 million), it produces 22% of the Italian GDP and consumes 21,5% of the national energy (SRM, 2019). It is the industrial and tertiary core of a homogeneous area (Northern Italy) with about 30 million inhabitants. It is densely populated (420 residents per km<sup>2</sup>; ISTAT, 2021), significantly polluted (see below) and was frequently described as a *megalopolis* (Turri, 2000; Bonomi and Abruzzese, 2004), being part of the so-called *blue banana*, the main development backbone of Western Europe. In line with the national trends described in paragraph 2.3, it is characterized by a marked contradiction with regard to environmental sustainability. On one hand, it was recently stated that Lombardy is a leader in Italy in the number of companies that invest in green technologies and in economic investment towards environmental sustainability, as well as in the virtuous collection of domestic waste (Fondazione Symbola, 2020). On the other hand, the Lombard cities are among the most polluted in Europe (European Environment Agency, 2020) and the use of renewable energy sources is lower than the Italian average, while the production of CO<sub>2</sub> is higher, as is soil and waters contamination (Regione Lombardia, 2020). According to this alarming scenario, the Regional Strategy for Sustainable Development set as one of its main objectives for 2030 “a significant and rapid reduction of energy consumption from fossil sources in the residential and tertiary sector, in synergy with air quality policies and towards the transition to more sustainable cities” (Regione Lombardia, 2020, p. 68). As for Italy as a whole, also Lombardy has a great unexplored potential in deepening residential energy saving behaviors, as domestic consumption constitutes the 18% of

total regional consumption and is more subject to forms of individual and collective persuasion. In light of the above, Lombardy can be considered a promising case study for identifying and experimenting innovative policies at a local and national level.

### 2.2. Participants

The sample consists of 155 participants, residing in Lombardy, northern Italy. They are almost equally divided by gender (men 48.4%, women 51.6%) and age (35.5% age group 18–37, 36.1% 38–57, 28.4% over 58, 7.8% over 78). 66.1% of them live in an apartment, while 32.2% in an independent dwelling. Subjects were recruited applying a snowball sampling technique, starting from the voluntary participation of 27 university students (Università degli Studi di Milano). The first participants, residing in all the Lombard provinces, were trained to disseminate the questionnaire to 3 families each. At the end of the research process, 59 families were involved in total. Consistent with this procedure, the sample shows a higher presence of young students (21,2%) and High school graduates (or higher degree, 75%) than the national and regional average. Conversely, the sample is in line with the regional average in terms of gender (51% of Lombards are women) and older ages (28.7% of Lombard citizens are over 60, 7% over 80).

### 2.3. Measures and procedure

A paper questionnaire was administered (winter 2019–2020) to answer the aforementioned research questions, investigating energy saving behaviours in the Italian context in relation to gender and perceived self-efficacy. Other attitude and household measures were also included in the survey but are not included in the analysis of the current paper.

Domestic energy saving behaviours were measured by a 7-item frequency scale (“How often do you happen to ...”) and rated by the participants on a 7-points Likert Scale (*never-always*) (adapted from Michalos et al., 2009). Addressed behaviours are among those most commonly associated with domestic energy consumption and waste (i.e., “To reduce\turn off the heating system on less cold winter days”; see Table 1). More in detail, they encompass three macro-areas: heating/cooling systems and thermal comfort (3 items), lighting and electrical devices (2 items), main domestic cleaning appliances (1 item, comprehending washing machine and dishwasher) Furthermore, an item on the use of stairs instead of the lift has been added, as this type of behavior has both collective (savings for the condominium) and health impact. Domain-specific self-efficacy was assessed via a three items scale (see Table 2) inspired by the Sustainable Development Self-Efficacy Question-

**Table 1**  
Domestic energy saving behaviours frequency scale. \* = reverse item.

Items
How often do you happen to ...
1 Reduce\turn off the heating system on less cold winter days
2 Use the air conditioner during summer*
3 Intentionally use the stairs instead of the elevator
4 Fully load washing machine/dishwasher before starting it
5 Wear a t-shirt indoors during winter*
6 Turn off the house lights when not strictly necessary
7 Turn off electronic devices completely (instead of leaving them on stand-by)

**Table 2**  
Domain-specific (sustainability) efficacy scale.

Items
1 My domestic consumption and my lifestyle affect environmental sustainability
2 By reducing my consumption, I can contribute to the preservation of environmental sustainability
3 My actions to preserve sustainability will encourage others to do the same

naire (SDSE; Hanss and Bohm, 2010) and rated by the participants on a 7-points Likert Scale (*strongly disagree-strongly agree*). The scale showed a monofactorial structure, thus proving its saturation on the predicted single factor, and a moderate reliability (Cronbach's Alpha = 0.729; Ponterotto and Ruckdeschel, 2007). Data on socio-demographic variables and on the importance attributed to energy saving were also collected. This latter was addressed using a single item (“How important is energy saving is to you?”) and rated on a 7-points Likert Scale (*not at all-very much*). Data was processed through the statistical software IBM SPSS Statistics (version 25).

### 3. Results

To explore if a significant gender gap in energy saving behaviors in favor of women is present in our case study (first research question), in line with the discussed international literature, an Analysis of Variance (ANOVA; Fisher, 1925) on the self-reported frequency of the assessed domestic energy saving behaviors between genders was performed. The ANOVA test is widely used in social research to determine whether the differences in score between two groups are random (not statistically significant) or due to the independent variable being addressed, in our case the gender difference.

Results show (Table 3) that a significant difference ( $p < .05$ ) emerges in favor of women on two behaviors (“Wear a t-shirt indoors during winter” and “Fully load washing machine/dishwasher before starting it”). No significant differences emerge in favor of men. More in general, even if statistical significance is not reached on five behaviors, it could be noticed that women score higher (or lower, in case of reverse items) than men on sustainable behaviors concerning lighting and electricity (“Fully loading machines/dishwashers ...”, “Turn off the house lights when not strictly necessary”, “Turn off electronic devices completely (instead of leaving them on stand-by)”). The opposite effect is observed with regard to domestic habits concerning heating and cooling systems, as men show more sustainability-oriented behaviors.

To answer the second research question, focused on investigating the role of perceived self-efficacy in gender differences regarding energy saving, the relationship between gender, perceived self-efficacy and domestic energy saving behaviors was deepened as follows.

Firstly, an Analysis of Variance (ANOVA) on importance attributed to energy saving and on domain-specific self-efficacy between genders was conducted to test whether there is a significant relationship between gender differences and these two variables.

Results show the absence of a significant difference between the two genders concerning the importance attributed to energy saving. On the contrary, this difference is significant ( $p < .05$ ) with regard to the general scores on the domain-specific self-efficacy scale, in favor of women ( $m. 5.57$  vs.  $5.16$ ). Moreover, average scores on single items show that the widest gap between men and women lies in the different belief that they can represent a model and an example for the others' behavior (“My actions to preserve sustainability will encourage others to do the same”, Table 4). A correlation matrix (Table 5) was also calculated to

**Table 3**  
Average scores on the selected domestic energy saving behaviors, by gender (\* $p < .05$ ).

Items	MEN (m.)	WOMEN (m.)
1 Reduce\turn off the heating system on less cold winter days	5.66	5.45
2 Use the air conditioner during summer	4.17	4.59
3 Intentionally use the stairs instead of the elevator	4.5	4.83
4 Fully load washing machine/dishwasher before starting it*	5.08	5.83
5 Wear a t-shirt indoors during winter*	3.08	2.36
6 Turn off the house lights when not strictly necessary	6.15	6.29
7 Turn off electronic devices completely (instead of leaving them on stand-by)	3.98	4.63

**Table 4**  
Average scores on domain-specific self-efficacy items, by gender.

	MEN ( <i>m.</i> )	WOMEN ( <i>m.</i> )
1 My domestic consumption and my lifestyle affect environmental sustainability	5.36	5.68
2 By reducing my consumption, I can contribute to the preservation of environmental sustainability	5.60	5.95
3 My actions to preserve sustainability will encourage others to do the same	4.51	5.09

**Table 5**  
Domain-specific self-efficacy and energy saving behaviors (Correlation matrix, \*\* $p < .01$ ).

	MEN ( <i>r.</i> )	WOMEN ( <i>r.</i> )
1 Reduce\turn off the heating system on less cold winter days	0.19	0.15
2 Use the air conditioner during summer	0.03	0.10
3 Intentionally use the stairs instead of the elevator	0.32	0.39**
4 Fully load washing machine/dishwasher before starting it	0.08	0.30**
5 Wear a t-shirt indoors during winter	-0.07	0.03
6 Turn off the house lights when not strictly necessary	0.30**	0.12
7 Turn off electronic devices completely (instead of leaving them on stand-by)	0.27	0.50**

further address how self-efficacy could influence energy saving behaviors within the genders. The correlation matrix allows the calculation of the statistical significance and the strength of the relationship between the addressed variables. Different patterns were highlighted, since in men's self-efficacy is found to be significantly and positively correlated ( $p < .01$ ) only with turning off lights when not necessary ( $r = 0.30$ ), whereas in women it is related to three behavioral dimensions (voluntary use of stairs,  $r = 0.39$ ; washing/dishwashing with full load,  $r = 0.30$ ; turning off electrical appliances instead of leaving them in stand-by,  $r = 0.50$ ).

#### 4. Discussion

Our case study analysis partially disconfirmed what was highlighted by other studies regarding the cross-culturality of gender effects on energy saving behaviors (see 2.1). Data showed that only a few of the addressed behaviors are significantly more widespread among women. On the other hand, even in the case of Lombardy, energy saving behaviors with a higher frequency among men have not been detected, in line with the results from previous research (Zelezny et al., 2000). These results can be better interpreted referring to the specific energy saving behaviors considered. If previous research highlighted significant differences between domestic and public behavior on sustainability issues (Hunter et al., 2004), in our analysis the gender differences mainly emerged based on the type of addressed behaviors. It could be argued that, at least in the addressed (Italian) culture, the gender gap is present (and in some cases significant) only for some types of behavior, especially those concerning the individual habits in using heating/cooling systems and electrical appliances. These findings are consistent with what other authors found about greater indoor thermal discomfort in women, especially with respect to cooling (Karjalainen, 2012). This higher discomfort could lead women to adopt less frequently a poorly sustainable habit like wearing a t-shirt at home in winter, but also could potentially explain the men's greater attention in controlling the home temperature, although this latter data was not found to be statistically significant. Women's greater attention to the consumption of electrical appliances may instead be referred, in line with Shrestha et al. (2020), to their more intense involvement in routine household management activities (i.e., cooking, washing), and more generally to a greater amount of time spent on domestic premises compared to men in the Italian and Lombard context. In this regard, the most recent review on

the subject (Gimenez-Nadal and Molina, 2020) found that the Italian situation is still characterized by a strong gender gap to the detriment of women as regards the daily hours of paid and unpaid (domestic) work (the highest in Europe behind Turkey). Addressing attitudes, results showed a significant gender gap in favor of women on domain-specific self-efficacy, despite the lack of difference with men with regards to the importance attributed to energy saving. Women showed significantly higher scores on the perceived possibility of representing a model for others and encouraging them in energy saving behaviors. Furthermore, their behavioral patterns are more strongly associated with perceived self-efficacy, particularly regarding electricity consumption, than men. Those findings are consistent with previous studies (see 2.1) which found a greater tendency in women towards sustainable attitudes, mainly due to gender-biased socialization processes promoting a greater orientation towards altruism, care and ecocentrism in females. Moreover, it can be hypothesized that, given the greater amount of daily time devoted to domestic unpaid work compared to men, women are (at least in the Italian scenario) the main reference in the family context as regards the dimension of sustainability applied to the home (Waite et al., 2012) and for this reason they are invested with the role of model and example for other family members on these issues. The relationship between domain-specific self-efficacy and the social roles of the family members should be further explored in future research.

Our results have some limitations that are worth mentioning when reasoning on policies implementation. The limitation constituted by the sample size and its geographical distribution should be overcome, enlarging the sample in order to provide sounder conclusions that can be extended to the entire national territory and allow us to make comparisons between different Italian areas. Moreover, our results should be tested via non-self-reported behavioral measures, i.e. through direct behavioral observations or monitoring energy consumptions, to avoid the unverifiable effects of self-representation biases. Also, future research may expand the repertoire of domestic energy saving behaviors considered, in order to detail, with increasing precision, the emergent gender gap in sustainable behaviors.

#### 5. Conclusions and policy implications

Our analysis, focused on the Lombardy Region case study, in Italy, confirmed a crucial role for gender and self-efficacy in energy saving behaviors, also highlighting the need for a culture-sensitive perspective. As far as gender is concerned, the results of the Lombard sample are only partially in agreement with the existing literature that shows higher sustainable attitudes and more frequent sustainable behaviors in the female population. More specifically, they show that the gender effect is not uniformly distributed but affected by the type of addressed energy saving behaviors, according to the local culture. Moreover, the research shows that gender differences in attitudes are not due to a higher female sensitivity to sustainability in general, but to a higher individual agency which most strongly affects daily practices. A significant discriminating element between the two groups is indeed the higher domain-specific self-efficacy of women. Men are equally convinced of the importance of sustainability issues, whereas they are more skeptical about the actual impact that individual behaviors can exert on the society at large.

The relevance of gender and efficacy in promoting sustainable attitudes and behaviors is a valid source of information for defining policy guidelines and intervention strategies. Yet, such knowledge is not to be interpreted as a prediction of an intrinsic and permanent ability of women to be more prone to sustainability. It is instead a tool to leverage our understanding of the precursors of sustainable behaviors to favor their spread in various contexts. In most cases initiatives for sustainability are conceived as though the general population were composed of homogenous average individuals, paying little attention to differentiated strategies aimed at specific targets with certain characteristics, and

gender is no different in this respect (Meinzen-Dick et al., 2014). We suggest that gender is a relevant variable to be considered, among those neglected in defining such targets. For example, Cheng et al. (2011) summarize some factors that can be considered when using framing and threat in defining the communication strategy, highlighting that social loss framing tends to be more effective on female populations. In a similar fashion, women appear to be more sensitive to guilt effects in advertising that motivates shoppers to bring their own grocery bags (Muralidharan and Sheehan, 2018). Moreover, according to Arachchi and Managi (2021), to favor sustainable decision-making concerning energy consumption it is important to promote the integration of two styles of thought, one more focused on the cause-effect logic and the other on a holistic approach. As men tend to rely more on the former and women on the latter (*ibidem*), designing of persuasive messages should be adapted accordingly; in addition, this emphasizes the importance of encouraging shared decisions among family and community members, facilitating the exchange of perspectives. Promoting a gender perspective is a key factor when designing sustainability policies, however it cannot be satisfactorily fostered by the mere active engagement of women. On the contrary, it implies considering gender roles at different levels, to ensure that such engagement is impactful and not simply a formal act. In this perspective, we must take into account women's and men's motivations, but also their material conditions and the daily routines where their energy decisions are made. At the individual level this can be done considering the necessity of reinforcing not awareness and commitment per se, but other factors that might trigger the already existing environmental consciousness. Regarding the reduction of domestic energy consumption for example, men might be facilitated through a more concrete explanation, by other members of the family, of the sustainable behaviors they perform (Thøgersen and Grønhoj, 2010). Women might be supported in building more competences about devices to increase the positive impact of their sustainable attitudes and behaviors (Salvia et al., 2020; Sunikka-Blank et al., 2018; Tjørring, and Gausset, 2019). At the family level it is important to consider the social roles and the specific activities connected with them as cultural outcomes. Indeed, a key challenge is to improve the compliance rate of families, and not only individuals, in sustainable choices, also considering the cultural origins of the gender gap and the prospect of reducing it. According to our research, it might also be useful to design differentiated policies or interventions for various issues (e.g., electrical appliances, heating system, thermal insulation), keeping into consideration alternative proposals depending on the gender of the persons mainly responsible for them. More gender-oriented intervention strategies would allow to tackle different practical situations, avoiding or minimizing the effect of potentially conflicting elements. The community level is key in promoting grassroot innovations in the transition toward more sustainable energy consumption (Van Der Schoor et al., 2016), and at this level gender perspective brings a new set of challenges. The accessibility of groups, the possibility to gain decision-making power, the material conditions for maintaining active membership over time (e.g., being in charge of the domestic duties, being able to travel to meet other members, having sufficient financial resources) are some of the gender-sensitive aspects we must consider. For example, opportunities to participate in citizens power plant initiatives are not equal, as men are over-represented: participants themselves attribute this to larger economic availability and higher interest in technology (Schreuer, 2016). Also the "do-it-yourself" (DIY) groups dedicated to domestic thermal improvements tend to exclude women, hence overcoming the traditional masculine culture of these groups is a main challenge (Sunikka-Blank et al., 2018). Paradoxically, community initiatives tend to exclude women despite their higher efficacy in sustainability, which is a loss also for the community at large. All those reflections on gender issues at individual, family and community level must be considered in light of the broader culture, as those contexts where gender gap is more robust will call for stronger interventions. In such perspective, all those

initiatives reducing inequalities among women and men can indirectly support sustainability. This calls for a more critical approach to energy saving behaviors, whose promotion "should include consideration of the intersection of lifestyle practices with gendered social identities and the importance of including marginalized voices in solutions implemented to address unsustainable practices" (Bloodhart and Swim, 2020, p.110). An attempt in this vein is addressed by the communication policies recently developed by the Energy Efficiency Department of ENEA. In the framework of the national campaign "Italy in Class A" a specific initiative called "Women in Class A" has been launched. It relies on female testimonials whose virtuous successful experiences in the field of sustainability has become the symbolic reference for illustrating the path toward sustainability. It represents female figures as leaders in the field of sustainability, which is a first step to creating alternative models to the traditional masculine association with leadership in business and science (Swim et al., 2018). A deeper analysis of the impact of similar communication strategies in various cultural contexts is crucial to design more effective initiatives in the future.

### CRedit authorship contribution statement

**Nicola Rainisio:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, preparation. **Marco Boffi:** Conceptualization, Methodology, Investigation, Writing – review & editing. **Linda Pola:** Formal analysis, Investigation, Data curation. **Paolo Inghilleri:** Conceptualization, Supervision. **Iliaria Sergi:** Funding acquisition. **Maura Liberatori:** Funding acquisition.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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