

# Willingness to pay for green energy: Evidence from Italian households

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## HIGHLIGHTS

- WTP for RES energy is estimated to assess public support for green policies.
- WTP estimates are positive, indicating strong support for green electricity and gas.
- Age negatively affects WTP for renewable energy sources.
- Environmental concern and habits drive higher WTP for RES.

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## ABSTRACT

This study investigates the willingness to pay (WTP) of Italian households for green electricity and gas using data from an ad-hoc survey conducted by FORMAT RESEARCH. A double-bounded discrete choice model is employed to estimate WTP and assess its relationship to socio-demographic, psychological, and attitudinal factors. The findings indicate a strong correlation between WTP and income, environmental concern, and sustainable behaviors, while age is inversely related to financial support for renewable energy sources. Furthermore, the study identifies significant variations in WTP between green electricity and green gas, pointing out differing levels of consumer awareness and acceptance. The results yield valuable insights for policy-makers, emphasizing the importance of tailored strategies and equitable cost-sharing mechanisms to enhance public support for renewable energy policies, particularly in light of economic and social constraints. By treating WTP as a signal of both economic acceptance and civic endorsement, this study highlights its potential to inform the design of inclusive, equitable, and publicly accountable energy policies, core priorities within the governance frameworks required for a just transition.

## 1. Introduction

The second decade of the 21st century has been marked by destabilizing global events, such as the COVID-19 pandemic, energy price surges, and geopolitical tensions in Eastern Europe. These crises exposed vulnerabilities in the global energy system, especially within Europe, highlighting the risks of energy dependence and the complexities of sustaining long-term decarbonization goals under the Paris Agreement. Recent climate summits (COP28 and COP29) have emphasized the urgent need for heightened ambition and policy coordination to achieve the 2030 climate targets and to realize a just and inclusive energy transition. In this context, the European Union has launched sweeping reforms to align climate goals with energy security. The European Climate Law, passed in 2021, mandates climate neutrality by 2050 and

55 % emissions cut by 2030 relative to 1990 levels. The Fit for 55 package operationalizes these goals through instruments like the Emissions Trading System (ETS) reform, the Carbon Border Adjustment Mechanism (CBAM), and new targets for renewables and efficiency. Complementing this is the REPowerEU initiative (2022), designed in response to the Ukraine war, which focuses on cutting EU reliance on Russian fossil fuels and boosting renewable energy deployment. Together, Fit for 55 and REPowerEU constitute the EU's strategic response to intertwining energy and climate challenges. Yet, the effectiveness of these policies depends not only on technical design but also on public support and democratic legitimacy. Ensuring a just transition involves governance that is not only efficient but also fair and inclusive. Understanding households' preferences and willingness to financially contribute to renewable

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energy is thus vital for equitable policy design and for strengthening public trust in climate governance but, surprisingly, there has not been a comprehensive analysis of households' preferences.

This paper addresses this research gap by investigating the willingness to pay (WTP) of Italian households for electricity and gas from renewable energy sources (RES), thereby providing empirical insights into the intersection of consumer behavior, environmental justice, and governance frameworks. Specifically, it explores how socio-demographic, psychological, and attitudinal factors are associated with consumer support for decarbonization policies. The findings provide empirical grounding for designing policies that are transparent, socially equitable, and responsive to public preferences.

In this perspective, WTP is not merely a reflection of consumer demand but serves as a democratic indicator of societal endorsement, an interpretative lens through which civic engagement in the energy transition can be understood. More specifically, expressed WTP for renewable energy is not only a response to hypothetical prices but also a measure of individuals' willingness to internalize the costs of sustainability and collective goods beyond short-term fiscal incentives (Dobson, 2007). Operationally, a positive WTP represents a consumer's voluntary allocation of private resources to support collective environmental outcomes. By accepting a higher price for clean energy, individuals actively participate in and endorse the green transition: their monetary commitment becomes a market-mediated act of ecological citizenship. By leveraging their purchasing power, citizens thus transform the marketplace into a key arena for democratic participation and the pursuit of environmental goals through political consumerism (Stolle et al., 2005). As noted by Pellizzoni (2004), consumption constitutes a political act, a decision-making arena where values, citizenship, and sustainability intersect. Accordingly, individuals increasingly use market mechanisms to express political values and to support or oppose policies (Micheletti et al., 2009). Just as political consumerism reflects commitments to justice, fairness, and environmental concern, WTP for renewable energy can be interpreted as an expression of civic engagement in the energy transition (Seyfang, 2013).

The just transition requires that cost burdens be fairly distributed. By estimating WTP and examining socio-demographic differences, we offer insights into how public acceptance can be integrated into policy through inclusive processes and equitable cost-sharing mechanisms. This enhances both legitimacy and practical feasibility of transition policies. In particular, the study examines preference variations by income, region, and demographic segments, offering a framework for tailoring support schemes and compensatory measures that ensure distributive justice and avoid overburdening vulnerable groups.

Furthermore, assessing consumer valuation of renewable energy attributes also highlights market-driven opportunities to enhance the financial sustainability of energy policies (Painuly, 2001). Indeed, consumers' WTP for RES serves as a signal of green energy's market acceptance (Wustenhagen et al., 2007), which plays a pivotal role in expanding RES generation capacity and advancing the energy transition (Markard and Truffer, 2006; Stern, 2014).

Although organizations like Eurostat and International Energy Agency provide macro-level indicators of green transition progress, they do not capture behavioral dimensions of public acceptance. To fill this gap, we implemented an ad-hoc survey in Italy, employing a stratified sample based on demographic and regional diversity. The survey collected comprehensive data on individual characteristics (e.g., age, income), attitudes (e.g., beliefs about sustainability), and behaviors (e.g., ethical values, intergenerational concern).

This research offers three main contributions. First, it extends the scope of WTP research by simultaneously examining green electricity and green gas, allowing a direct comparison between the two technologies and offering novel evidence on household support for green gas, a less familiar yet strategically important component of the decarbonization agenda. Second, it advances empirical knowledge by systematically analyzing how socio-demographic, attitudinal, and psychological factors

shape WTP for renewable energy in Italy. Drawing on an ad hoc and nationally representative survey, the study provides robust and up-to-date estimates on Italian households' support for green energy. Third, it generates policy-relevant insights for designing equitable and socially inclusive mechanisms within the Fit for 55 and REPowerEU frameworks. Here, WTP is conceptualized not merely as a price signal but as an economic measure of social acceptance that can be interpreted through the lens of environmental citizenship and political consumerism, linking individual monetary commitments to civic endorsement of the energy transition. Understanding how Italian households value and support renewable energy is central to making energy transition policies more inclusive, accountable, and effective. Indeed, this work highlights the need to develop compensation mechanisms that prevent regressive cost burdens and protect lower-income households. By linking economic behaviors to values like fairness and participation, the study informs the design of socially robust climate governance.

The paper is structured as follows. Section 2 presents the literature review. Section 3 defines WTP within a standard utility model of consumer preferences. Section 4 introduces the probabilistic derivation of WTP using a double-bounded discrete choice model. Section 5 presents the results. Conclusions follow in Section 6. The Appendix presents the distribution of survey responses for the main variables and the different WTP estimates derived from alternative sample partitions.

## 2. Literature

Stated preference methods, particularly CV and Choice Experiments (CE), are widely employed in environmental and energy economics to estimate WTP for non-market goods like renewable energy. CV surveys directly elicit maximum WTP, while CE presents respondents with attribute-defined scenarios, allowing inference of WTP for single components rather than an overall value. These approaches have underpinned a robust body of literature examining public support for renewable energy.

Meta-analyses provide an overarching picture of WTP for renewables. Sundt and Rehdanz (2015) show that WTP varies systematically with technology type, elicitation method, and income, with wind and solar typically receiving the highest support. Ma et al. (2015) likewise report higher WTP for wind and solar compared to biomass. Chaikumbung (2021) applies a meta-regression analysis to 509 observations of WTP for green electricity from 91 renewable energy studies in 27 countries and identifies as key determinants of WTP the political and economic institutions, the types of renewable energy, and various country- and survey-specific characteristics. Citizens in more democratic and liberal countries report higher WTP for renewables. Most recently, Cerdà et al. (2024), pooling 63 choice-experiment studies across 28 countries, estimates an average WTP of around 113–124 euros per household per year, with onshore wind emerging as the most favored technology. These reviews highlight the consistently positive WTP estimates for RES, as well as the influence of socio-demographic and methodological factors.

Empirical studies confirm these patterns across diverse countries. In the United States, Goett et al. (2000); Roe et al. (2001); Zarnikau (2003); Wiser (2007), and Borchers et al. (2007) document strong WTP for green electricity. Similar findings emerge in Asia, where Nomura et al. (2004) and Yoo and Kwak (2009) report positive WTP in the form of a flat monthly surcharge in Japan and South Korea, and Guo et al. (2014) estimate that Beijing residents' monthly WTP is roughly 3 US dollars. In the aftermath of the Fukushima disaster, Murakami et al. (2015) observes rising WTP for renewables in Japan and declining support for nuclear.

In the United Kingdom, Longo et al. (2008) find that support for RES reflects both climate mitigation and energy security concerns, Akcura (2015) shows that mandatory green power schemes generate higher WTP compared to voluntary payment options, and Bergmann et al. (2006) find that WTP varies depending on the energy source considered.

Across Europe, Faulques et al. (2022) investigate preferences in France's Haute-Normandie region through a Discrete CE, providing

evidence of a positive WTP to expand the renewable share in the energy mix. Yang et al. (2015) identify a positive price premium for renewables in Denmark's residential electricity market, and Navrud and Braten (2007) report similar results for Norway. In Italy, Cicia et al. (2007); Bollino (2009), and Vecchiato and Tempesta (2015) consistently show higher WTP for photovoltaics and wind relative to biomass or fossil-based energy. Hanemann et al. (2011) provide evidence of a strong willingness to financially support a green electricity program in Spain. Koundouri et al. (2009) apply a double-bounded CV model in Greece to assess public support for wind farms. In Eastern Europe, Trifonova (2022) reports positive WTP for renewables in Bulgaria, based on CV and logit models.

Among African studies, Oluoch et al. (2021) find that although households express positive WTP, contributions are insufficient to fully finance renewable projects in Kenya.

Across these studies, a number of regularities emerge. First, consumers consistently prefer solar, wind, and hydro over biomass, which typically elicits lower support (Goett et al., 2000; Bergmann et al., 2006; Navrud and Braten, 2007; Cicia et al., 2007; Borchers et al., 2007; Sundt and Rehdanz, 2015; Yang et al., 2016).

Second, age shows a consistently negative association with WTP (Trifonova, 2022; Willis et al., 2011; Hanemann et al., 2011; Faulques et al., 2022). Third, income and education are also systematically related to WTP for renewables. Guo et al. (2014); Chaikumbung (2021), and Carlsson et al. (2012) find that income is positively correlated with WTP, while Trifonova (2022) reports that higher education levels are associated with stronger support for renewables.

Beyond socio-demographic variables, psychological and attitudinal factors also shape WTP. Habits and resistance to change are linked to lower levels of pro-environmental action (Diekmann and Preisendorfer, 2003; Carrus et al., 2008), while perceiving climate change as a distant risk reduces urgency (Lorenzoni et al., 2007; Kollmuss and Agyeman, 2002). Conversely, acknowledging the anthropogenic nature of climate change is associated with a greater willingness to act (Zhang et al., 2014). Environmental concern is consistently related to behaviors such as volunteering (Binder and Blankenberg, 2016), green purchasing (Tatic and Cinjarevic, 2010), and resource conservation (Nauges and Wheeler, 2017; Urban and Scasny, 2012), and it also shows a strong correlation with WTP (Dienes, 2015; Zorić and Hrovatin, 2012). The concept of locus of control is also central: individuals with a strong internal locus, who believe their actions matter, tend to report higher support for pro-environmental behavior and greater WTP (Johnson et al., 2004; Knussen et al., 2004; Hines et al., 1987). Lorenzoni et al. (2007) identify the displacement of personal responsibility as a barrier, while Chen (2016) highlights the role of moral obligation. Steg et al. (2014) likewise report that beliefs about the efficacy of individual actions are positively linked to WTP. More broadly, pro-environmental attitudes and values emerge as central dimensions of both everyday sustainable practices and stated WTP for renewables (Hines et al., 1987; Choi and Fielding, 2013; Kotchen and Reiling, 2000).

Taken together, these insights affirm that WTP is not a purely economic measure of preferences but is embedded in social norms, political values, and behavioral attitudes (Aldy et al., 2012). This suggests that WTP can be interpreted as more than a market signal: it may also reflect broader public support and civic commitment to sustainable transitions. From this perspective, WTP for renewable energy can be conceived as an act of ecological citizenship, whereby households demonstrate a willingness to align their private consumption with broader ecological responsibilities (Seyfang, 2013). This conceptual expansion of WTP, from an economic indicator to an expression of political support, is grounded in the domain of political consumerism and environmental citizenship, which recognizes that the marketplace has become a key arena in which consumption choices function as political acts and citizens leverage their purchasing power to endorse or oppose policies (Pellizzoni, 2004; Micheletti et al., 2009; Stolle et al., 2005; Dobson, 2007).

Building on this body of evidence, our study advances the literature with several novel contributions. First, we analyze a nationally representative Italian survey of more than 8 thousand respondents, providing robust and policy-relevant estimates of WTP for RES. Second, we apply a double-bounded contingent valuation design to tighten bounds on WTP, and crucially, we examine both green electricity and green gas, the latter largely neglected in prior work. Third, we situate WTP estimates within debates on equity and legitimacy in the energy transition, emphasizing their variations across income groups and the implications for the design of fair policy instruments.

### 3. Materials and methods

#### 3.1. The willingness to pay

Let  $q$  be the item to be valued; we assume agents have a utility function defined over the quantities of various market commodities,  $\mathbf{x}$ , and  $q$ ,  $u(\mathbf{x}, q)$ . Corresponding to this direct utility function, we can write an indirect utility function,  $v(\mathbf{p}, q, y)$ , where  $\mathbf{p}$  is the vector of prices and  $y$  is the agent's income.  $u(\mathbf{x}, q)$  is increasing and quasi-concave in  $\mathbf{x}$ , thus,  $v(\mathbf{p}, q, y)$  is homogeneous of degree zero in  $\mathbf{p}$  and  $y$ , increasing in  $y$ , non-increasing in  $\mathbf{p}$ , and quasi-convex in  $\mathbf{p}$ .

If  $q$  is regarded as a "good",  $u$  and  $v$  will both increase with  $q$ ; otherwise they will both decrease with  $q$ . If the agent is indifferent to  $q$ ,  $u$  and  $v$  will both be independent of  $q$ .

The WTP involves the comparison between two different situations, characterized by two different quantities of  $q$ :  $q_0 < q_1$ . The value comes from a change in utility due to a change in  $q$ , from  $u_0 \equiv v(\mathbf{p}, q_0, y)$  to  $u_1 \equiv v(\mathbf{p}, q_1, y)$ . If the change in  $q$  is regarded as an improvement,  $u_1 > u_0$ ; if it is regarded as a deterioration,  $u_1 < u_0$ . This change in utility is expressed in monetary terms by using two Hicksian measures, the compensating variation  $C$  which satisfies:

$$v(\mathbf{p}, q_1, y - C) = v(\mathbf{p}, q_0, y) \quad (1)$$

and the equivalent variation  $E$  which satisfies:

$$v(\mathbf{p}, q_1, y) = v(\mathbf{p}, q_0, y + E) \quad (2)$$

If  $u_1 > u_0$ , then  $C > 0$  and  $E > 0$ .  $C$  represents the agent's maximum WTP to secure the change, while  $E$  measures the minimum willingness to accept (WTA) to forego it. If  $u_1 < u_0$ , then  $C < 0$  and  $E < 0$ ;  $C$  measures the agent's WTA to endure the change, while  $E$  measures the WTP to avoid it. From here to below we assume that  $q$  is regarded as a "good".

Let  $y = m(\mathbf{p}, q, u)$  be the expenditure function corresponding to the direct utility function  $u(\mathbf{x}, q)$  and the indirect utility function  $v(\mathbf{p}, q, y)$ ; this should be increasing in  $u$ , non-decreasing, concave and homogeneous of degree 1 in  $\mathbf{p}$ , and decreasing in  $q$ .

In terms of the expenditure function, the WTP is defined as:

$$C = m(\mathbf{p}, q_0, u_0) - m(\mathbf{p}, q_1, u_0) \quad (3)$$

$$= y - m(\mathbf{p}, q_1, u_0) \quad (4)$$

and the WTA is defined as:

$$E = m(\mathbf{p}, q_0, u_1) - m(\mathbf{p}, q_1, u_1) \quad (5)$$

$$= m(\mathbf{p}, q_0, u_1) - y \quad (6)$$

#### 3.2. Double-bounded discrete choice

CV implies asking a sample of the population about their WTP for the provision of a given good or service  $q$ . Survey responses are assumed to reflect utility maximizing behavior and are treated as realizations of a random variable with a specific probability distribution. Therefore, the deterministic utility model has to be recast as a stochastic one, typically in two steps:

- First, we define the latent regression model, which expresses compensating variation as a linear function of a vector of explanatory variables for agents' preferences,  $z$ , and a stochastic component  $u \sim N(0, \sigma)$ :

$$WTP = z'\beta + u \quad (7)$$

As a result,  $WTP$  is characterized by the cumulative distribution function  $G_C(\cdot)$ . The probability that an agent's  $WTP$  is less than a given amount  $x$  is denoted by  $G_C(x) = Pr(C < x)$ , with the corresponding probability density function denoted by  $g_C(x)$ .

- Second, we establish the link between the  $WTP$  distribution and the survey response probability distribution.

The survey follows a multilevel questioning strategy with an iterative bidding design. At the first level, respondents are asked a general question about their  $WTP$ , with four possible answers: "Very willing", "Fairly willing", "Not very willing" and "Not at all willing".<sup>1</sup>

Only those who do not select "Not at all willing" proceed to the second level, where questions follow a double-bounded dichotomous choice format with an iterative bidding process. At this second stage, respondents are first asked: "Would you vote to support the change from  $q_0$  to  $q_1$  if it would cost you  $t_1$ ?"<sup>2</sup> The initial bid  $t_1$  is randomly drawn from six ordered categories representing ranges of percentage increases in the household energy bill: (0–2 %), [2–5 %), [5–10 %), [10–15 %), [15–20 %), and >20 %.

If the respondent answers *yes*, the follow-up bid  $t_2$  is set to the next higher adjacent range ( $t_2 > t_1$ ). The ascending bidding process continues, moving up one category at a time, until the respondent answers *no* or the maximum category is reached. Conversely, if the respondent answers *no* at  $t_1$ , the next bid is set to the next lower adjacent range ( $t_2 < t_1$ ), and the descending bidding process continues until the respondent answers *yes* or the minimum category is reached.<sup>3</sup> This structure implies that the iterative bids are endogenous, as  $t_2$  and all following bids depend on the response to  $t_1$ , which is treated as exogenous.

For the whole sample, the possible paths of response are as follows:

- Level 1 Question: Answer No  $\rightarrow WTP \leq 0$
- Level 1 Question: Answer Yes  $\rightarrow WTP > 0 \rightarrow$  Level 2 Bidding sequence: Answer *yes*  $\rightarrow$  Increasing bidding process
- Level 1 Question: Answer Yes  $\rightarrow WTP > 0 \rightarrow$  Level 2 Bidding sequence: Answer *no*  $\rightarrow$  Decreasing bidding process

Compared to the standard single-bounded format, the multi-step double-bounded design provides richer information, as it can elicit more than one response per respondent through the iterative bidding process.

The iterative bidding process generates a sequence of responses  $a_1, a_2, \dots, a_J$ , where  $J$  is the number of bids posed until the process stops (because respondent answers *no* or the maximum bid is reached in the ascending bidding process, or respondent answers *yes* or the minimum category is reached in the descending process), with  $a_j = 1$  for *yes* and  $a_j = 0$  for *no*. Note that the number of steps  $J$  varies across respondents, and  $t_J$  always denotes the final bid reached. Each individual can fall into one of the following categories:

1. The respondent accepts all bids up to the final one ( $a_1 = 1, a_2 = 1, \dots, a_J = 1$ ), implying  $WTP > t_J$ .
2. The respondent accepts the initial bid ( $a_1 = 1$ ) but at some point, in the ascending sequence, rejects a higher bid, yielding an interval  $t_{J-1} < WTP < t_J$ .

3. The respondent rejects the initial bid ( $a_1 = 0$ ) but later accepts a lower bid in the descending sequence, implying  $t_J < WTP < t_{J-1}$ .
4. The respondent rejects all bids down to the final one ( $a_1 = 0, a_2 = 0, \dots, a_J = 0$ ), implying  $0 \leq WTP < t_J$ .

In cases (2) and (3), we obtain well-defined intervals for  $WTP$ . In cases (1) and (4), the resulting intervals are analogous to those derived from a single-bounded dichotomous question, but here the iterative bidding process yields narrower bounds for  $WTP$  by exploiting information throughout the sequence.<sup>4</sup> This generalization nests the standard double-bounded case as a special case where the interval is determined after two responses.

Then, the probability of each of the four response patterns can be expressed in terms of the final two bids of the sequence,  $t_{J-1}$  and  $t_J$ :

1. The respondent accepts all bids up to the final one ( $a_J = 1$ ):

$$Pr(a_J = 1|z_i) = Pr(WTP > t_J) = \Psi\left(\frac{z_i'\beta - t_J}{\sigma}\right) \quad (8)$$

2. The respondent switches from acceptance to rejection at the final bid ( $a_{J-1} = 1, a_J = 0$ ) in the ascending bidding process:

$$Pr(a_{J-1} = 1, a_J = 0|z_i) = Pr(t_{J-1} < WTP < t_J) \\ = \Psi\left(\frac{t_J - z_i'\beta}{\sigma}\right) - \Psi\left(\frac{t_{J-1} - z_i'\beta}{\sigma}\right) \quad (9)$$

3. The respondent switches from rejection to acceptance at the final bid ( $a_{J-1} = 0, a_J = 1$ ) in the descending bidding process:

$$Pr(a_{J-1} = 0, a_J = 1|z_i) = Pr(t_J < WTP < t_{J-1}) \\ = \Psi\left(\frac{t_{J-1} - z_i'\beta}{\sigma}\right) - \Psi\left(\frac{t_J - z_i'\beta}{\sigma}\right) \quad (10)$$

4. The respondent rejects all bids down to the final one ( $a_J = 0$ ):

$$Pr(a_J = 0|z_i) = Pr(WTP < t_J) = \Psi\left(\frac{t_J - z_i'\beta}{\sigma}\right) \quad (11)$$

Estimates for  $\frac{\hat{\beta}}{\hat{\sigma}}$  and  $\frac{1}{\hat{\sigma}}$  are obtained by applying the maximum likelihood method:

$$\left[\frac{\hat{\beta}}{\hat{\sigma}}, \frac{1}{\hat{\sigma}}\right] = \arg \max_{\frac{\beta}{\sigma}, \frac{1}{\sigma}} \sum_{i=1}^N d_i^{1,1} \Psi\left(\frac{z_i'\beta - t_J}{\sigma}\right) \\ + d_i^{1,0} \left[ \Psi\left(\frac{z_i'\beta - t_J}{\sigma}\right) - \Psi\left(\frac{t_{J-1} - z_i'\beta}{\sigma}\right) \right] \\ + d_i^{0,1} \left[ \Psi\left(\frac{t_{J-1} - z_i'\beta}{\sigma}\right) - \Psi\left(\frac{t_J - z_i'\beta}{\sigma}\right) \right] \\ + d_i^{0,0} \Psi\left(\frac{t_J - z_i'\beta}{\sigma}\right) \quad (12)$$

where the indicator variables  $d_i$ , with  $i = 1, \dots, N$ , are defined with respect to the final two steps of the bidding sequence,  $(t_{J-1}, t_J)$ :  $d_i^{1,1} = \{a_{J-1} = 1, a_J = 1\}$ ,  $d_i^{1,0} = \{a_{J-1} = 1, a_J = 0\}$ ,  $d_i^{0,1} = \{a_{J-1} = 0, a_J = 1\}$ ,  $d_i^{0,0} = \{a_{J-1} = 0, a_J = 0\}$ . Each  $d_i$  takes value one or zero depending on the relevant case for each individual.

Unlike the standard probit model, which assumes unit variance, here this restriction is unnecessary. The multi-step double-bounded design provides additional information through the ordered bid thresholds  $(t_{J-1}, t_J)$ , allowing us to estimate both the mean and the scale parameter. Accordingly, the resulting estimates are:  $\hat{\alpha} = \frac{\hat{\beta}}{\hat{\sigma}}$ , the vector of coefficient estimates associated with each explanatory variable, and  $\hat{\delta} = -\frac{1}{\hat{\sigma}}$ , the coefficient estimate associated with bids.

<sup>1</sup> The aim of this so-called "payment principle question" is to validate refusals and reduce protest behavior.

<sup>2</sup> This double-bounded format, introduced by Bishop and Heberlein (1978), dominates the CV literature and is endorsed by the NOAA panel guidelines.

<sup>3</sup> If respondents answer *no* at bid  $t_1 = (0-2 \%)$ , their  $WTP$  is inferred to be non-positive. Conversely, if they answer *yes* at the highest bid level  $t_1 > 20 \%$ , their  $WTP$  is inferred to lie within the interval  $[+20 \%, \infty)$ .

<sup>4</sup> In case 4, if the last response is *no* at  $t_J \in (0, 2 \%)$ , then  $WTP = 0$ .

Given the normality assumption and using Eq. (7), the estimate for the WTP is given by:

$$E(WTP|z, \beta) = z \frac{\hat{\alpha}}{\hat{\delta}} \quad (13)$$

The estimate of the *WTP* depends on the specific value of *z*, that is, it may be evaluated based on the characteristics of an individual, a specific subgroup, or the sample average.

#### 4. Empirical estimation of WTP

The empirical analysis is based on data derived from an ad-hoc survey designed for the research project “Models of Sustainable Uses of Energy for Just Transition Environmental Policies: A Theoretical and Empirical Investigation”. The project, funded by the Italian Ministry for University and Research (MUR) under the framework of the National Plan for Recovery and Resilience (PNRR), aims to assess environmental awareness and sustainable consumption behaviors among Italian consumers.

The survey explores public preferences related to ecological transition policies and market dynamics shaped by the Next Generation EU and the PNRR. It was designed and implemented in collaboration with Format Research, which was responsible for both developing and administering the questionnaire. The survey draws on a statistically representative sample of the adult Italian population, stratified by key demographic variables, including gender, age, geographical macro-area, and municipality size. Data were collected from 8252 respondents between May and June 2024, capturing a broad range of individual characteristics such as income, employment status and occupation. Additionally, the dataset includes information on environmentally related psychological and attitudinal characteristics of respondents, offering a robust framework for analyzing consumer engagement with sustainability and environmental responsibility. The Appendix provides a detailed overview of the sample composition in terms of socio-demographic, psychological and attitudinal characteristics of the respondents.

This study focuses on two key survey items: respondents' stated WTP for green electricity and green gas.<sup>5</sup>

Tables 1 and 2 report the distribution of the responses to the first-level question. Notice the distribution of the answers to the first open-ended question. Table 1 shows that 87.37 percent of the sample provides answers different from “Not willing at all”, thus having a non-negative WTP for green electricity.

Table 2 highlights the presence of missing data (1621 observations), indicating that the public is not yet aware of the existence of green gas. This lack of awareness has led some respondents to leave the first level open-ended question unanswered. Nevertheless, more than 64 % of the sample shows a non-negative premium price for gas from RES.

Then, Tables 3 and 4 present the distribution of the answers to the initial bid  $t_1$  proposed to those respondents providing in the first level an answer different from “Not at all willing”. In Table 3, missing values for the second level question concern those respondents who answer “Not at all willing” in the first level question, while in Table 4, missing values concern individuals who do not answer the first level question or answer “Not willing at all”.

When using CV data, an essential aspect to verify is whether individuals are sensitive to the bid amount. Specifically, it is expected that as the bid increases, the proportion of respondents providing a positive response decreases. As shown in Table 3, this expected pattern is confirmed: the share of *yes* responses declines as the bid level rises. A similar trend is observed for green gas responses in Table 4, except at bid level 5, where the proportion of *yes* responses slightly exceeds that of level 6.

<sup>5</sup> The term green gas refers to low-carbon gaseous fuels such as hydrogen and biomethane, which are produced from renewable sources and are intended to serve as sustainable alternatives to conventional natural gas. The question presented in the survey was the following: “Would you be willing to pay more for gas if the supply were from RES (e.g. hydrogen, biomethane)?”

**Table 1**

Distribution of the answers to the first open-ended question for green electricity.

	Code	Freq.	Percent	Cum.
Very Willing	1	2007	24.32	24.32
Fairly Willing	2	3398	41.18	65.50
Not very Willing	3	1804	21.86	87.37
Not at all Willing	4	1043	12.64	100
Total		8252	100	

**Table 2**

Distribution of answers to the first open question for green gas.

	Code	Freq.	Percent	Cum.
Missing	-1	1621	19.64	19.64
Very Willing	1	1171	14.19	33.83
Fairly Willing	2	2491	30.19	64.02
Not very Willing	3	1678	20.33	84.36
Not at all Willing	4	1291	15.64	100
Total		8252	100	

**Table 3**

Distribution of the answers to the first bid  $t_1$  for green electricity.

Bid	Code	Stat.	Missing	yes	no
Missing	-1	freq.	1043	0	0
		perc.	100	0	0
[0, 2)	1	freq.	0	868	355
		perc.	0	25.70	9.27
[2, 5)	2	freq.	0	809	421
		perc.	0	23.95	10.99
[5, 10)	3	freq.	0	592	611
		perc.	0	17.53	15.95
[10, 15)	4	freq.	0	439	768
		perc.	0	13	20.05
[15, 20)	5	freq.	0	336	855
		perc.	0	9.95	22.32
[20, ∞)	6	freq.	0	334	821
		perc.	0	9.89	21.43
Total		freq.	1043	3378	3831
		perc.	100	100	100

**Table 4**

Distribution of the answers to the first bid  $t_1$  for green gas.

Bid	Code	Stat.	Missing	yes	no
Missing	-1	freq.	2912	0	0
		perc.	100	0	0
[0, 2)	1	freq.	0	620	244
		perc.	0	26.51	8.13
[2, 5)	2	freq.	0	613	325
		perc.	0	26.21	10.83
[5, 10)	3	freq.	0	389	506
		perc.	0	16.63	16.86
[10, 15)	4	freq.	0	309	606
		perc.	0	13.21	20.19
[15, 20)	5	freq.	0	200	678
		perc.	0	8.55	22.59
[20, ∞)	6	freq.	0	208	642
		perc.	0	8.89	21.39
Total		freq.	2912	2339	3001
		perc.	100	100	100

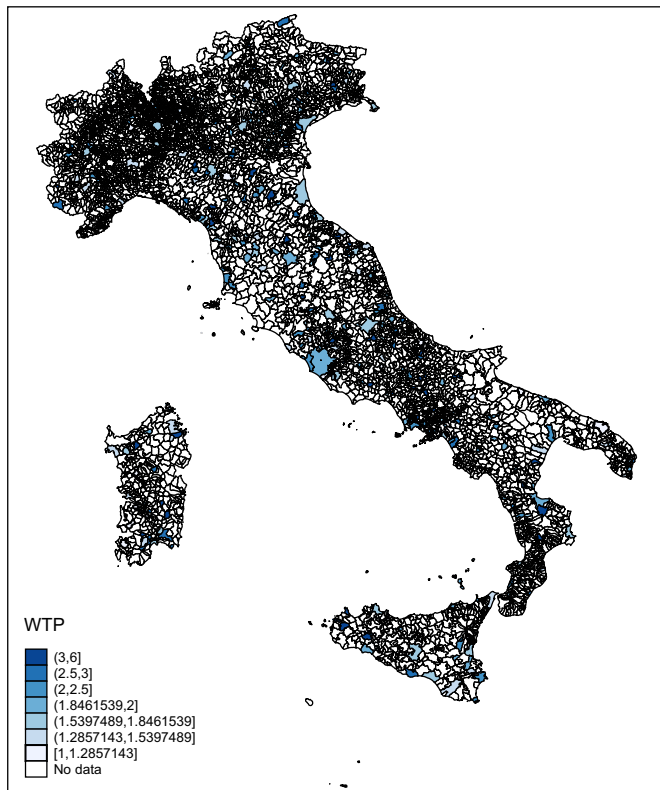
The distributions of final answers,  $t_j$ , ordered from 1 to 6 are then presented in Tables 5 and 6, while their spatial distributions are reported in Figs. 1 and 2. Note that WTP estimates are based exclusively

**Table 5**  
Distribution of the final answers  $t_j$  for green electricity.

Accepted Bid	Code	Freq.	Percent	Cum.
Missing		1072	12.99	12.99
(0, 2)	1	1085	13.15	26.14
[2, 5)	2	1547	18.75	44.89
[5, 10)	3	1223	14.82	59.71
[10, 15)	4	728	8.82	68.53
[15, 20)	5	500	6.06	74.59
[20, $\infty$ )	6	724	8.77	83.36
Not at all	7	1373	16.64	100
Total		8252	100	

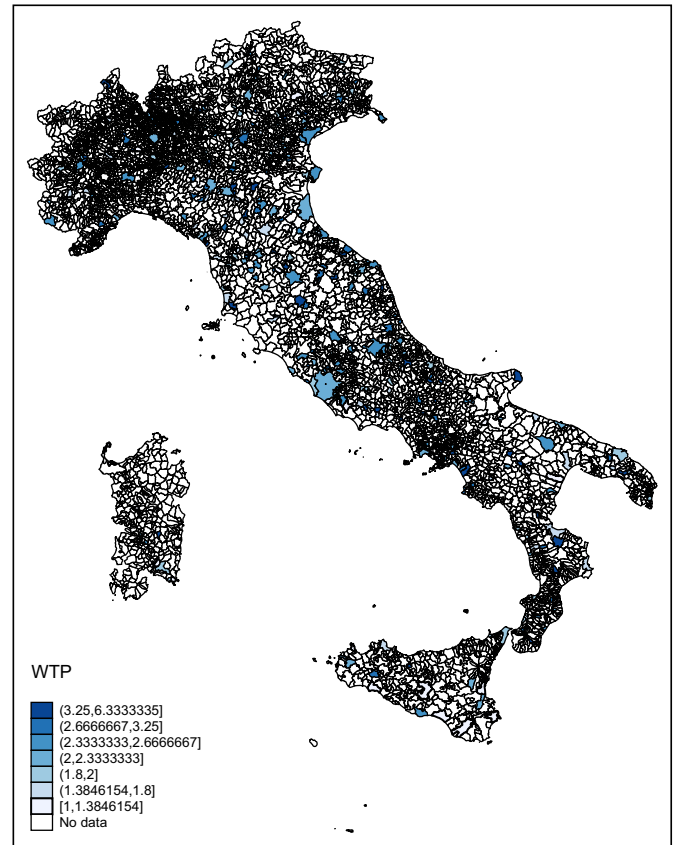
**Table 6**  
Distribution of the final answers  $t_j$  for green gas.

Accepted Bid	Code	Freq.	Percent	Cum.
Missing	-1	2935	35.57	35.57
(0, 2)	1	886	10.72	46.29
[2, 5)	2	1315	15.93	62.23
[5, 10)	3	816	9.89	72.12
[10, 15)	4	527	6.39	78.5
[15, 20)	5	307	3.72	82.22
[20, $\infty$ )	6	535	6.5	88.72
Not at all	7	932	11.28	100
Total		8252	100	



**Fig. 1.** Spatial distribution of the final answers for green electricity. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

on observations with valid responses, that is, cases where the final answer is neither missing nor coded as “Not at all willing”. The resulting estimation samples consist of 5807 observations for green electricity and 4386 for green gas.



**Fig. 2.** Spatial distribution of the final answers for green gas. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

#### 4.1. Estimation of the WTP

The estimation results for green electricity (Table 7) and green gas (Table 8) yield insightful findings on the socio-demographic and attitudinal factors associated with individuals’ willingness to financially support renewable energy sources. The models progressively incorporate these variables, offering a comprehensive view of the facets of consumer preferences.

In the first model, which serves as the benchmark, WTP is estimated without the inclusion of control variables and is represented solely by the constant term. Models (2) to (5) progressively introduce controls for socio-demographic characteristics, environmental awareness, and sustainability-related attitudes.

In the second specification, the inclusion of *Age*, the regional dummy *South*, and a dummy for the highest income percentiles, *High Income*,<sup>6</sup> provides preliminary insight into how WTP is statistically related to socio-demographic characteristics.

The third model adds predictors capturing environmental awareness: *Interest*, *Concern*, and *Habit shift*. Specifically, *Interest* and *Concern* measure the degree of engagement with environmental issues, while *Habit shift* reflects the respondent’s willingness to change daily routines to reduce environmental impact. All three variables are measured on a 1–4 scale, with higher values indicating greater environmental awareness.

The fourth model expands the analysis by including attitudinal measures of perceived individual responsibility for sustainability (*Impact*) and the perceived importance of educating younger generations (*Future Gen.*). These variables follow the same 1–4 scale, with higher values

<sup>6</sup> This dummy assumes value equal to one for monthly income levels greater than 5000 euros.

**Table 7**  
WTP Estimates for green electricity.

	M(1) b/se	M(2) b/se	M(3) b/se	M(4) b/se	M(5) b/se
<i>Age</i>		-0.075*** 0.005	-0.071*** 0.005	-0.064*** 0.005	-0.066*** 0.005
<i>High Income</i>		1.203*** 0.328	0.835*** 0.321	0.858*** 0.319	0.838*** 0.319
<i>South</i>		0.656*** 0.216	0.387* 0.211	0.346* 0.210	0.353* 0.209
<i>Habit Shift</i>			1.770*** 0.197	1.670*** 0.201	1.528*** 0.202
<i>Interest</i>			1.064*** 0.205	1.034*** 0.207	0.836*** 0.210
<i>Concern</i>			0.536*** 0.189	0.609*** 0.191	0.579*** 0.190
<i>Impact</i>				1.201*** 0.180	1.087*** 0.181
<i>Future Gen.</i>				-1.464*** 0.185	-1.478*** 0.185
<i>Practices</i>					1.270*** 0.225
<i>Constant</i>	8.654*** 0.099	12.119*** 0.296	1.067 0.668	2.198*** 0.737	-0.011 0.833
$\hat{\sigma}$	7.375*** 0.077	7.229*** 0.075	6.997*** 0.074	6.948*** 0.073	6.929*** 0.073
<i>WTP%</i>	8.654	8.193	7.561	8.627	8.639
<i>Observations</i>	5807	5807	5807	5807	5807

Note: b/se indicates that, for each explanatory variable, the first row reports the coefficient estimates (b), while the second row presents their standard errors (se). \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

denoting stronger acknowledgement of personal and intergenerational responsibility for sustainability.

In the final model, we introduce *Practice*, a composite variable summarizing the frequency of sustainable behaviors. It is calculated as the mean frequency of reported environmentally responsible actions, with higher values indicating more frequent engagement.

#### 4.2. WTP for green electricity

Table 7 reports the maximum likelihood estimates of additional WTP for renewable electricity, along with the socio-demographic and attitudinal factors related to it.

In the benchmark model, the estimated WTP is significantly greater than zero, with a value of 8.654. This indicates a positive baseline level of support for green electricity, even in the absence of explanatory variables. On average, respondents are willing to sustain an 8.654 % increase in their electricity bill for renewable supply.

In the second model, *Age* consistently enters with a negative and highly significant coefficient across specifications, ranging from -0.075 to -0.064. This finding aligns with the literature, which suggests that older individuals may exhibit lower environmental concern and a reduced propensity to pay a premium for green electricity compared to younger consumers (Trifonova, 2022; Willis et al., 2011; Hanemann et al., 2011; Faulques et al., 2022). By contrast, younger respondents tend to show stronger orientations toward sustainability, possibly linked to greater exposure to environmental education and more adaptive consumption habits.

*High Income* is positively and significantly related to WTP, reflecting that households with greater financial resources are more likely to report higher willingness to support renewable energy. This result is in line with prior studies (Carlsson et al., 2012; Guo et al., 2014; Chaikumbung, 2021). The regional dummy *South* is also positively associated with WTP, suggesting some regional variation, albeit the magnitude of the coefficient declines in later models.

The third model introduces environmental awareness indicators, all of which have significant and positive coefficients. In particular,

*Habit shift*, which captures respondents' willingness to change daily routines to minimize environmental impact, reports consistently significant and sizable values (ranging from 1.528 to 1.770). This pattern reflects the behavioral dimension of environmental commitment and is in line with Lorenzoni et al. (2007), who document that climate change concerns are strongly linked to mitigation behaviors, especially in pro-environmentally motivated households.

Both the *Interest* and *Concern* variables show positive coefficients, reinforcing the idea that environmental engagement translates into concrete financial support for renewable energy. Respondents with greater interest in environmental issues are more likely to recognize an additional premium for green electricity, ranging between 0.836 and 1.064. Regarding the *Concern* variable, the coefficients are smaller, ranging from 0.536 to 0.609. These results are consistent with previous evidence showing that climate-related concern is correlated with a higher likelihood of supporting mitigation measures financially (Dienes, 2015; Zhang et al., 2014; Binder and Blankenberg, 2016; Tatic and Cinjarevic, 2010; Urban and Scasny, 2012; Zorić and Hrovatin, 2012).

In the fourth model, perceptions of personal responsibility for sustainability (*Impact*) and the importance attributed to environmental education (*Future Gen.*) are introduced as additional controls. *Impact* is positively and significantly associated with WTP, with estimated coefficients ranging from 1.087 to 1.201. This indicates that individuals who feel personally responsible for sustainability are more willing to financially support renewable electricity. This result supports the hypothesis that a stronger internal locus of control is linked to greater engagement in pro-environmental behaviors, as highlighted in previous research (Hines et al., 1987; Johnson et al., 2004; Knussen et al., 2004; Ek and Söderholm, 2008; Steg et al., 2014).

*Future Gen.* displays a significant negative coefficient, between -1.478 and -1.464. Respondents who emphasize the role of future generations in bearing environmental responsibility appear less inclined to report present-day financial support. This dynamic is also discussed in Blankenberg and Alhusen (2019), who argue that individuals emphasizing intergenerational responsibility may delegate action rather than personally contribute financially.

The contrast between the positive coefficients for *Impact* and the negative ones for *Future Gen.* highlights a relevant psychological mechanism: while personal accountability tends to motivate action, a deferral of responsibility may lead to disengagement. Together, these results underscore the importance of framing sustainability in terms of present, individual agency rather than distant, collective obligation.

The final model includes *Practices*, the composite measure of the frequency of sustainable behaviors. This variable displays a positive and significant coefficient, equal to 1.270, indicating that respondents who report more frequent engagement in pro-environmental behaviors also tend to state higher WTP for renewable electricity. This aligns with previous evidence showing that everyday sustainable practices are closely linked to environmentally supportive economic decisions (Hines et al., 1987; Choi and Fielding, 2013; Kotchen and Reiling, 2000).

Across all models, the signs and statistical significance of the key variables remain stable, supporting the robustness of the results. The results as a whole show that socio-demographic and attitudinal factors are systematically related to stated WTP for renewable electricity.

In models 2 to 5, the estimated WTP ranges from 7.561 % to 8.639 %, indicating a broadly favorable attitude toward financially supporting renewable electricity.<sup>7</sup> When translated into absolute monetary terms, based on an average bimonthly electricity bill of 161 euros, this corresponds to an average WTP of approximately 13.04 euros. This value is in line with the broader empirical literature in environmental economics, which generally reports monthly WTP estimates in the range

<sup>7</sup> The WTP estimates depend on the specific values taken by the vector  $z$ . In this table, the estimates are computed using the sample means of the explanatory variables.

**Table 8**  
WTP Estimates for green gas.

	M(1) b/se	M(2) b/se	M(3) b/se	M(4) b/se	M(5) b/se
<i>Age</i>		-0.096*** 0.006	-0.092*** 0.006	-0.083*** 0.006	-0.085*** 0.006
<i>High Income</i>		1.323*** 0.358	1.001*** 0.349	0.979*** 0.345	0.944*** 0.343
<i>South</i>		0.921*** 0.253	0.651*** 0.246	0.560** 0.244	0.561** 0.242
<i>Habit Shift</i>			1.778*** 0.225	1.639*** 0.228	1.466*** 0.229
<i>Interest</i>			0.833*** 0.230	0.861*** 0.231	0.601*** 0.233
<i>Concern</i>			0.784*** 0.210	0.922*** 0.211	0.872*** 0.210
<i>Impact</i>				1.484*** 0.204	1.326*** 0.205
<i>Future Gen.</i>				-2.037*** 0.214	-2.067*** 0.213
<i>Practices</i>					1.672*** 0.253
<i>Constant</i>	8.184*** 0.113	12.617*** 0.328	1.406* 0.763	3.260*** 0.847	0.374 0.949
$\hat{\sigma}$	7.320*** 0.088	7.073*** 0.085	6.844*** 0.083	6.755*** 0.082	6.721*** 0.081
<i>WTP%</i>	8.184	8.184	8.160	8.158	7.785
<i>Observations</i>	4386	4386	4386	4386	4386

Note: b/se indicates that, for each explanatory variable, the first row reports the coefficient estimates (b), while the second row presents their standard errors (se). \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

of 10 to 20 euros, depending on contextual conditions and respondents' demographics (see, among others, Borchers et al. (2007)).

While our results confirm a generally positive willingness to pay for green electricity, they also reveal significant distributional differences: WTP is systematically higher among younger and higher-income households, while older and lower-income groups display more limited willingness. This heterogeneity provides complementary evidence with equity-sensitive policy implications. If policymakers set green surcharges based on the average WTP, the burden of green policy could become regressive. Policies should instead be progressive in design, so that those with greater willingness and ability to pay bear a proportionally larger share of the transition costs, while vulnerable households are shielded. Furthermore, imposing differentiated contributions better aligns with principles of distributive justice and does not threaten the policy's legitimacy. Therefore, progressive electricity tariffs, income-tested rebates, targeted grants and on-bill financing for low-income households are all crucial fiscal instruments to improve the participatory mechanisms and make effective the just transition.

#### 4.3. WTP for green gas

The results for green gas, reported in Table 8, reveal both similarities and notable differences relative to green electricity. While several variables display comparable patterns across the two energy types, meaningful divergences suggest distinct motivational dynamics behind consumer support for green gas as opposed to green electricity.

Examining the first model, the magnitude of WTP, captured by the constant term, is comparable to that observed for green electricity, with an estimated value of 8.184.

In the second specification, *Age* exhibits a consistently negative and highly significant coefficient, confirming the pattern already observed for green electricity and aligning with previous evidence (Trifonova, 2022; Willis et al., 2011; Hanemann et al., 2011; Faulques et al., 2022). The magnitude of the coefficient is slightly larger in the green gas models (ranging from -0.096 to -0.083), indicating a steeper decline in WTP

among older individuals when the good in question is green gas. This may suggest that older consumers are less receptive to green gas, possibly because they perceive its benefits as less certain or less familiar than those of green electricity.

The *High Income* dummy is again positive and significant, indicating that higher-income households report stronger WTP for green gas. This result raises questions of fairness. Individual contributions to green gas should reflect different income capacities to make green policies aligned with the principles of a just transition. If policy support for green gas were to rely solely on average WTP, it would risk reinforcing structural inequalities, as households with greater economic resources are better positioned to express endorsement. By contrast, aligning contributions with income capacity can help ensure that support for the just transition is not undermined by inequitable burden-sharing. Green policies should therefore rely on progressive fiscal instruments, enabling households with lower willingness and ability to pay to bear a proportionally smaller share of the transition costs.

The regional dummy *South* also retains significance, with larger coefficients in the green gas models. This points to regional differences in acceptance or perceived relevance of green gas within Italy.

In the third model, the variable *Habit Shift* remains strongly and significantly associated with WTP, although the estimated coefficients are slightly smaller than those for green electricity. This difference may reflect a perception that behavioral changes toward sustainability are more directly connected with electricity consumption than with gas usage, possibly due to differing levels of consumer awareness or the availability of green alternatives.

Both *Interest* in and *Concern* for environmental issues also show positive coefficients. The estimates for *Interest* are slightly lower than those for green electricity, ranging from 0.601 to 0.861. By contrast, the coefficients for *Concern* are somewhat higher than in the green electricity models. This pattern suggests that while general interest may align more closely with support for green electricity, stronger levels of concern are linked to higher stated WTP for green gas, perhaps because of its perceived environmental complexity or lower visibility.

Looking at the fourth model, *Impact* displays a consistently positive and significant coefficient, similar to the electricity models. The magnitude for green gas is marginally larger (ranging from 1.326 to 1.484). This may reflect a compensatory dynamic, whereby environmentally conscious individuals, recognizing the novelty or ambiguity of green gas solutions, feel a heightened sense of personal responsibility to support them.

By contrast, *Future Gen.* displays a more pronounced negative coefficient in the green gas models. Respondents who emphasize the role of future generations appear less willing to assume immediate financial responsibility for green gas. As noted by Blankenberg and Alhusen (2019), intergenerational responsibility does not necessarily translate into present-day financial commitment. The relatively high coefficients for this variable may stem from lower familiarity with or perceived urgency of green gas technologies, leading respondents to treat them as a long-term issue that should be addressed by future generations rather than through current individual action.

In the last specification, the *Practices* variable, which captures the frequency of sustainable daily behaviors, remains positively and significantly associated with WTP. Notably, the estimated coefficient is higher in the green gas model (1.672 versus 1.270), suggesting that habitual engagement in sustainability practices corresponds to stronger support for less-established technologies.

The WTP values, expressed as a percentage increase in respondents' gas bill, are stable, ranging between 7.785% and 8.184%. This indicates that respondents' WTP for green gas is broadly comparable to that for green electricity.

While the patterns associated with the two WTPs exhibit substantial overlap, notable differences emerge in the magnitude and consistency of some coefficients. Older respondents appear more resistant to supporting green gas compared to green electricity, whereas individuals with

strong sustainability-oriented habits are more inclined to support green gas, possibly reflecting the greater level of proactive engagement required by less familiar or more novel technologies. The stronger negative coefficient for intergenerational responsibility in the green gas models further suggests the tendency to shift the burden of supporting emerging energy solutions onto future generations.

These differences point to the importance of tailored communication strategies and policy design. Addressing skepticism or limited familiarity with green gas, particularly among older individuals and those less actively engaged in sustainable practices, may require targeted outreach. At the same time, reinforcing perceptions of personal efficacy and highlighting the present-day relevance of green gas may help counteract the tendency to defer responsibility to others or to the future.

## 5. Conclusions

This study enriches the literature on the social acceptability of the ecological transition by examining Italian households' WTP for renewable energy. Specifically, it makes three main contributions. First, alongside green electricity, it estimates WTP for green gas, providing new evidence for a technology that remains less familiar yet strategically important within the decarbonization agenda. Second, it delivers updated and robust estimates of the relationship between socio-demographic, attitudinal, and psychological factors and Italian households' WTP for renewable energy, drawing on an ad hoc and nationally representative survey. Third, by conceptualizing WTP through the interpretative lens of environmental citizenship and civic endorsement, the study generates policy-relevant insights for designing equitable and socially inclusive mechanisms within the Fit for 55 and REPowerEU frameworks.

Against the backdrop of geopolitical disruptions and the urgent need to accelerate decarbonization across Europe, understanding the socio-demographic, psychological, and behavioral facets of public financial support for environmental policies is crucial for designing effective and inclusive strategies.

The empirical results reveal a broad willingness among Italian consumers to financially support renewable energy, with WTP levels varying significantly by age, income, region, and, most notably, by attitudinal and behavioral factors related to sustainability. Age is negatively correlated with WTP, with younger individuals more inclined to financially contribute to green energy. In contrast, higher income and southern regions are associated with increased WTP.

Attitudinal variables emerge as particularly influential. Environmental interest and concern, together with a strong sense of personal responsibility and a willingness to adopt sustainable habits, are consistently associated with higher WTP. Conversely, placing the burden of sustainability on future generations, by emphasizing intergenerational responsibility, is associated with reduced financial commitment in the present, reflecting a tendency to defer action. Furthermore, higher levels of engagement in pro-environmental practices are positively associated with a greater WTP for green energy.

This distinction underscores the importance of decision-making dynamics in shaping stated preferences and supports the use of iterative bidding formats to elicit more thoughtful and robust measures of willingness to pay.

From a policy perspective, these findings yield several implications. Advancing the energy transition requires both robust economic instruments and deliberate efforts to promote a culture of sustainability. Such efforts should prioritize fostering environmental citizenship by communicating the individual and collective benefits of green energy, while implementing equitable redistributive mechanisms to shield vulnerable households from the potentially regressive effects of environmental policies. Indeed, if green policies were designed solely around average WTP, they could prove regressive, disproportionately burdening households with limited means. By contrast, acknowledging that higher-income households possess both greater willingness and greater capacity to pay

implies that they should bear a proportionally larger share of decarbonization costs. Progressive cost-recovery instruments, such as targeted subsidies, rebates, and progressive tariffs, can ensure that the transition does not exacerbate inequality or energy poverty, thereby aligning climate policy with the principles of distributive justice.

In the broader context of the governance challenges posed by the green transition, this study contributes to ongoing efforts to design inclusive and transparent energy policy frameworks. By empirically estimating WTP, we derive a measure of public support for the green transition and the corresponding acceptance of sharing its costs. WTP thus emerges as a practical tool for policy-makers to incorporate public preferences into decision-making, ensuring that the social and distributive dimensions of the energy transition are not overlooked. In this way, the study supports the development of policy mechanisms that are not only economically viable but also socially legitimate and publicly accountable.

In conclusion, aligning public preferences with climate objectives requires a multidimensional approach that integrates economic, psychological, and social perspectives. Only by enhancing both the material and cognitive conditions for participation can broad and sustained public engagement in the energy transition be achieved.

## CRedit authorship contribution statement

**Carlo Andrea Bollino:** Writing – original draft, Conceptualization, Validation, Supervision. **Maria Chiara D'Errico:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Barbara Martini:** Writing – review & editing, Conceptualization.

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## 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.

## Appendix A.

### A.1. Socio-demographic characteristics

The tables A.1–A.5 provide a detailed breakdown of the socio-demographic characteristics of the survey respondents, offering a comprehensive view of the sample composition in terms of gender, age, education level, employment status, and income. Respondents come from a total of 603 municipalities, categorized into four groups based on population size, with each group being uniformly represented (Table A.1). The sample appears to be nearly balanced in terms of gender distribution, with 50.84 % male and 49.16 % female respondents. Such a distribution ensures that gender-related biases in survey responses

**Table A.1**  
Distribution of the Size of municipalities.

Size	Code	Freq.	Percent	Cum.
Up to 10 thousand inhab.	1	2000	24.24	24.24
10 – 50 thousand inhab.	2	2086	25.28	49.52
50 – 250 thousand inhab.	3	2084	25.25	74.77
Over 250 thousand inhab.	4	2082	25.23	100
Total		8252	100	

**Table A.2**  
Distribution of Gender.

Gender	Code	Freq.	Percent	Cum.
Male	1	4195	50.84	50.84
Female	2	4057	49.16	100
Total		8252	100	

**Table A.3**  
Distribution of Age.

Age	Code	Freq.	Percent	Cum.
18–24	1	681	8.25	8.25
25–34	2	1035	12.54	20.79
35–44	3	1189	14.41	35.2
45–54	4	1549	18.77	53.97
55–64	5	1495	18.12	72.09
65–74	6	1151	13.95	86.04
Over 75	7	1152	13.96	100
Total		8252	100	

**Table A.4**  
Distribution of Education.

Education	Code	Freq.	Percent	Cum.
None	1	103	1.25	1.25
Middle School	2	2625	31.81	33.06
High School	3	3791	45.94	79
Degree	4	1524	18.47	97.47
Master Degree / PhD.	5	209	2.53	100
Total		8252	100	

**Table A.5**  
Distribution of Employment Status.

Employment Status	Code	Freq.	Percent	Cum.
Employed	1	4675	56.65	56.65
Unemployed	2	798	9.67	66.32
Retired	3	2045	24.78	91.11
Other occupations*	4	734	8.89	100
Total		8252	100	

are minimized, making the dataset representative of both demographic groups (Table A.2).

The age distribution reveals that respondents are well spread across different age categories (Table A.3). The largest age group is between 45–54 years (18.77 %), followed closely by those aged 55–64 (18.12 %). Younger age groups (18–24 and 25–34) represent a smaller portion of the sample (8.25 % and 12.54 %, respectively). The relatively high proportion of older respondents (particularly those aged 65 and above, comprising 27.91 % of the sample) reflects the process of population ageing in Italy.

The educational distribution highlights a predominance of respondents with secondary education (Table A.4). A significant portion (45.95 %) has attained a high school diploma, while 31.81 % hold a middle school education. University graduates, including those with a master's degree or Ph.D., constitute approximately 21 % of the sample. Notably, only a small fraction of respondents (1.25 %) have no formal education, indicating that the surveyed population is generally well-educated, which could affect their perceptions and responses to the survey questions.

The employment status distribution shows that the majority of respondents (56.65 %) are employed, reflecting an economically active sample. Retired individuals account for 24.78 %, a relatively high percentage, aligning with the previously noted older age distribution. The unemployed represent 9.67 % of the sample, while 8.89 % fall under the category of 'Other occupations,' which includes students, unpaid trainees, housewives, and those engaged in civil service (Table A.5). This diverse employment status distribution suggests that the sample

**Table A.6**  
Distribution of Income.

Income	Interval	Freq.	Percent	Cum.
Up to 500 euros	1	244	2.96	2.96
500–1.000 euros	2	497	6.02	8.98
1.000–1.500 euros	3	1072	12.99	21.97
1.500–2.000 euros	4	1419	17.2	39.17
2.000–3.000 euros	5	1670	20.24	59.4
3.000–4.000 euros	6	1120	13.57	72.98
4.000–5.000 euros	7	595	7.21	80.19
5.000–7.500 euros	8	335	4.06	84.25
7.500–10.000 euros	9	163	1.98	86.22
Over 10.000 euros	10	221	2.68	88.9
Missing	11	916	11.1	100
Total		8252	100	

**Table A.7**  
Distribution of Habit Shift.

Habit shift	Code	Freq.	Percent	Cum.
Missing	–1	314	3.81	3.81
Not at all willing	1	98	1.19	4.99
Not very willing	2	948	11.49	16.48
Fairly willing	3	4763	57.72	74.2
Very willing	4	2129	25.8	100
Total		8252	100	

**Table A.8**  
Distribution of Interest in environmental issues.

Interest	Code	Freq.	Percent	Cum.
Not at all interested	1	277	3.36	3.36
Not very interested	2	1040	12.6	15.96
Fairly Interested	3	4498	54.51	70.47
Very interested	4	2437	29.53	100
Total		8252	100	

incorporates a variety of economic perspectives, from active workers to those outside the labor market.

The income distribution shows that the largest portion of respondents falls within the middle-income brackets, with 20.24 % earning between 2000 and 3000 euros per month, and 17.2 % in the 1500–2000 euro range. Lower-income categories (below 1000 euros) constitute 8.98 % of the sample, whereas higher-income groups earning over 5000 euros collectively account for a smaller proportion (8.72 %). A significant portion of respondents (11.1 %) did not disclose their income, which could impact the overall representativeness of this variable. The predominance of middle-income respondents suggests a sample that is largely reflective of the broader economic structure of the population, while the relatively low percentage of high earners may indicate an under-representation of wealthier individuals (Table A.6).

#### A.2. The willingness to pay attitude

Variables expressing the psychological and attitudinal factors affecting WTP for renewable energy are described in A.7-A.9.

Table A.7 presents the distribution of responses to the survey question assessing individuals' willingness to modify their lifestyle to reduce environmental impact. The findings indicate a strong inclination toward pro-environmental behavioral change among respondents. A significant majority of the sample expresses willingness to adjust their habits, with 25.8 % of respondents identifying as very willing and an additional 57.72 % as fairly willing. Collectively, these two categories account for over 83 % of the sample, suggesting a widespread openness to shift toward more sustainable habits. Conversely, reluctance to modify habits is observed among a smaller proportion of respondents. Specifically, 11.49 % report being not very willing, while only 1.19 % indicate being

**Table A.9**  
Distribution of *Concern* regarding environmental issues.

<i>Concern</i>	Code	Freq.	Percent	Cum.
Not at all concerned	1	314	3.81	3.81
Not very concerned	2	1207	14.63	18.43
Fairly concerned	3	3915	47.44	65.87
Very concerned	4	2816	34.13	100
Total		8252	100	

**Table A.10**  
Distribution of opinions about the perceived *Impact* of daily habits and practices on environmental sustainability.

<i>Impact</i>	Code	Freq.	Percent	Cum.
Not at all interested	1	234	2.84	2.84
Not very interested	2	1015	12.3	15.14
Fairly interested	3	4030	48.84	63.97
Very interested	4	2973	36.03	100
Total		8252	100	

not at all willing to alter their habits. The cumulative distribution highlights that nearly 95 % of respondents exhibit at least some degree of willingness to change, underscoring a strong pro-environmental orientation. The missing responses (3.81 %) constitute a minor fraction of the dataset and are unlikely to significantly alter the overall interpretation of the findings.

Regarding the interest in environmental issues, the majority of respondents express a strong interest in environmental issues. Specifically, 29.53 % report being very interested, while 54.51 % are fairly interested, resulting in a combined 84.03 % of respondents demonstrating engagement with environmental topics. Only a small fraction (3.36 %) report having no interest at all.

A similar pattern emerges in terms of concern for environmental issues, with 34.13 % of respondents stating they are very concerned and 47.44 % fairly concerned, totalling 81.57 % with significant levels of environmental awareness. In contrast, 3.81 % of respondents report no concern at all. These results suggest that environmental issues are highly relevant to the surveyed population, reflecting a broad awareness and engagement that could have implications for policy preferences and behavioral choices.

Regarding the perceived social impact of individual behaviors, the survey results in Table A.10 highlight a strong perception among respondents of their role in environmental sustainability. When asked about the influence of daily habits and practices, a majority of respondents (36.03 %) consider them very important, while an additional 48.84 % regard them as fairly important. This means that over 84 % of the sample acknowledges the role of personal behaviors in contributing to environmental sustainability. In contrast, only a small fraction of respondents (2.84 %) believe that daily habits have no impact at all. These findings suggest a widespread recognition of individual responsibility in addressing environmental challenges.

Similarly, respondents exhibit a strong consensus on the importance of educating future generations about environmental sustainability (Table A.11). A significant majority (59.57 %) consider education to be very important, with an additional 32.08 % perceiving it as fairly important. Only a minimal percentage (2.17 %) dismiss its relevance entirely. The overwhelming support for environmental education highlights the perceived necessity of long-term strategies in fostering sustainable behaviors and policies. These results suggest that respondents not only recognize the immediate impact of individual actions but also see education as a crucial mechanism for ensuring future environmental awareness and responsibility.

**Table A.11**  
Distribution of opinions regarding the role of educating *Future Generations* in environmental sustainability.

<i>Future Gen.</i>	Code	Freq.	Percent	Cum.
Not at all	1	179	2.17	2.17
Not very	2	510	6.18	8.35
Fairly	3	2647	32.08	40.43
Very	4	4916	59.57	100
Total		8252	100	

**Table A.12**  
Distribution of sustainable *Practices*.

<i>Waste recycling</i>	Code	Freq.	Percent	Cum.
Never	1	120	1.45	1.45
Rarely	2	515	6.24	7.7
Yes, occasionally	3	1148	13.91	21.61
Yes, frequently	4	6469	78.39	100
Total		8252	100	
<i>Waste composting</i>	Code	Freq.	Percent	Cum.
Never	1	1747	21.17	21.17
Rarely	2	1826	22.13	43.3
Yes, occasionally	3	2245	27.21	70.5
Yes, frequently	4	2434	29.5	100
Total		8252	100	
<i>Self Production</i>	Code	Freq.	Percent	Cum.
Never	1	3831	46.43	46.43
Rarely	2	2466	29.88	76.31
Yes, occasionally	3	1544	18.71	95.02
Yes, frequently	4	411	4.98	100
Total		8252	100	
<i>Attention to consumption</i>	Code	Freq.	Percent	Cum.
Never	1	128	1.55	1.55
Rarely	2	309	3.74	5.3
Yes, occasionally	3	1498	18.15	23.45
Yes, frequently	4	6317	76.55	100
Total		8252	100	
<i>Purchase of only necessary goods</i>	Code	Freq.	Percent	Cum.
Never	1	136	1.65	1.65
Rarely	2	487	5.9	7.55
Yes, occasionally	3	2534	30.71	23.45
Yes, frequently	4	5095	61.74	100
Total		8252	100	
<i>Purchase of mainly sustainable goods</i>	Code	Freq.	Percent	Cum.
Never	1	485	5.88	5.88
Rarely	2	1650	20	25.87
Yes, occasionally	3	3847	46.62	72.49
Yes, frequently	4	2270	27.51	100
Total		8252	100	
<i>Use of sustainable means of transport</i>	Code	Freq.	Percent	Cum.
Never	1	1204	14.59	14.59
Rarely	2	1856	22.49	37.08
Yes, occasionally	3	2606	31.58	68.66
Yes, frequently	4	2586	31.34	100
Total		8252	100	

Lastly, regarding the prevalence of sustainable practices within the sample, Table A.12 highlights significant engagement among respondents, with certain behaviors being notably more widespread.

Waste recycling emerges as the most prevalent habit, with 78.39 % of individuals reporting frequent participation and an additional 13.91 % engaging occasionally. Similarly, conscious resource consumption, such as reducing unnecessary use of electricity, water, and gas, is highly adopted, as 76.55 % of respondents regularly monitor their usage. Conscious purchasing, buying goods only when necessary, is a relatively common practice, with 61.74 % of respondents frequently engaging in

**Table A.13**  
Distribution of Bid and Final values among the two groups. Green electricity.

Final value	stat	Group (a)			Group (b)		
		no	yes	Total	no	yes	Total
(0, 2)	freq.	0	174	174	340	571	911
	perc.	0	20.84	11.42	17.42	24.49	21.27
[2, 5)	freq.	292	237	529	417	601	1018
	perc.	42.44	28.38	34.73	21.36	25.77	23.76
[5, 10)	freq.	185	201	386	467	370	837
	perc.	26.89	24.07	25.34	23.92	15.87	19.54
[10, 15)	freq.	113	119	232	392	104	496
	perc.	16.42	14.25	15.23	20.08	4.46	11.58
[15, 20)	freq.	98	0	98	336	66	402
	perc.	14.24	0	6.43	17.21	2.83	9.38
[20, inf)	freq.	0	104	104	0	620	620
	perc.	0	12.46	6.83	0	26.59	14.47
Total	freq.	688	835	1523	1952	2332	4284
	perc.	100	100	100	100	100	100
Initial Bid	Stat.	no	yes	Total	no	yes	Total
[0, 2)	freq.	0	292	292	0	571	571
	perc.	0	36.87	19.17	0	22.2	13.33
[2, 5)	freq.	0	185	185	189	618	807
	perc.	0	23.36	12.15	11.04	24.03	18.84
[5, 10)	freq.	174	113	287	218	478	696
	perc.	23.8	14.27	18.84	12.73	18.58	16.25
[10, 15)	freq.	237	98	335	325	339	664
	perc.	32.42	12.37	22	18.98	13.18	15.5
[15, 20)	freq.	201	104	305	457	232	689
	perc.	27.5	13.13	20.03	26.69	9.02	16.08
[20, inf)	freq.	119	0	119	523	334	857
	perc.	16.28	0	7.81	30.55	12.99	20
Total	freq.	731	792	1523	1712	2572	4,284
	perc.	100	100	100	100	100	100

it and 30.71 % doing so occasionally. On the other hand, some sustainable behaviors are less widely adopted. While 27.51 % of respondents frequently purchase mainly sustainable or green products, a considerable portion (20 %) does so rarely, and 5.88 % never engage in this practice. Composting is another behavior with lower adoption, as only 29.5 % engage in it frequently, and a significant 21.17 % never do so. Similarly, self-production of goods is among the least practiced habits, with only 4.98 % frequently engaging and 46.43 % never adopting it. Transportation choices show a more even distribution, with 31.34 % frequently using sustainable modes and 31.58 % occasionally doing so, but 14.59 % never utilizing such means. These results highlight a strong engagement with lower-barrier sustainable practices such as recycling and conscious consumption, while behaviors requiring more effort, investment, or lifestyle changes, such as composting, self-production, and consistent use of sustainable transport, are adopted to a lesser extent.

### A.3. Accounting for the heterogeneity of respondents

To further analyze response patterns, this appendix disaggregates WTP estimates by the type of response sequence observed in the bidding process. Tables A.13 and A.14 report the distribution of final bids for green electricity and gas, disaggregated by respondent type. The first group, labelled "a", comprises respondents whose final interval is determined after exactly two responses (accepting the first bid and rejecting the next higher one, or rejecting the first bid and accepting the next lower one). The second group, labelled "b", comprises respondents who proceed through more than two steps before the final interval is determined. In Table A.13, a non-trivial share of respondents reaches the same final interval either after two responses (group a) or after multiple

**Table A.14**  
Distribution of Bid and Final values among the two groups. Green gas.

Final Value	Stat.	Group (a)			Group (b)		
		no	yes	Total	no	yes	Total
(0, 2)	freq.	0	152	152	216	517	733
	perc.	0	22.72	13.51	16.22	26.8	22.48
[2, 5)	freq.	201	214	415	334	566	900
	perc.	44.08	31.99	36.89	25.08	29.34	27.6
[5, 10)	freq.	133	142	275	285	256	541
	perc.	29.17	21.23	24.44	21.4	13.27	16.59
[10, 15)	freq.	70	84	154	290	83	373
	perc.	15.35	12.56	13.69	21.77	4.3	11.44
[15, 20)	freq.	52	0	52	207	48	255
	perc.	11.4	0	4.62	15.54	2.49	7.82
[20, inf)	freq.	0	77	77	0	459	459
	perc.	0	11.51	6.84	0	23.79	14.08
Total	freq.	456	669	1125	1332	1929	3261
	perc.	100	100	100	100	100	100
First Bid	Stat.	no	yes	Total	no	yes	Total
[0, 2)	freq.	0	201	201	0	413	413
	perc.	0	37.71	17.87	0	23.06	12.66
[2, 5)	freq.	0	133	133	168	474	642
	perc.	0	24.95	11.82	11.43	26.47	19.69
[5, 10)	freq.	152	70	222	182	317	499
	perc.	25.68	13.13	19.73	12.38	17.7	15.3
[10, 15)	freq.	214	52	266	253	256	509
	perc.	36.15	9.76	23.64	17.21	14.29	15.61
[15, 20)	freq.	142	77	219	403	123	526
	perc.	23.99	14.45	19.47	27.41	6.87	16.13
[20, inf)	freq.	84	0	84	464	208	672
	perc.	14.19	0	7.47	31.56	11.61	20.61
Total	freq.	592	533	1125	1470	1791	3,261
	perc.	100	100	100	100	100	100

steps (group b). A broadly similar pattern is observed for green gas in Table A.14.

Overall, two-response outcomes are relatively more frequent at lower bid levels (2–5 %, 5–10 %, or 10–15 %), whereas multi-step outcomes occur more often at higher bid levels (15–20 % or >20 %).<sup>8</sup>

To examine whether stated WTP estimates differ across these response sequences, we re-estimate the models separately for the two groups. The empirical results for green electricity and green gas, disaggregated by respondent type, are reported in Tables A.15 and A.16.

In the green electricity models (Table A.15), the negative association between Age and WTP appears in both groups but is more pronounced in group (b). Attitudinal variables (*Habit Shift*, *Interest*, and *Concern*) display larger coefficients and greater statistical significance in group (b) than in group (a). *Impact* (the perceived personal responsibility) is positively associated with WTP in both groups and is again larger in group (b). By contrast, *Future Gen.* remains negative across specifications, with similar magnitudes in both groups. *Practices* is positively associated with WTP in both groups. The estimated WTP is consistently lower in group (a) than in group (b). These contrasts indicate that modelling the two response sequences separately provides additional information relative to pooled estimates.

For green gas (Table A.16), differences in the coefficient size are even more pronounced. Indeed, while the direction of most coefficients mirrors the electricity case, the magnitude gaps are larger: the Age coefficient is more negative in group (b); *Habit Shift*, *Concern*, *Impact*, and *Practices* are all larger in group (b) than in group (a). *Future Gen.* remains

<sup>8</sup> These differences may reflect design-related issues such as anchoring effects (Herriges and Shogren, 1996; Hadker et al., 1997).

**Table A.15**  
WTP Estimates for green electricity.

	M(1.a) b/se	M(1.b) b/se	M(2.a) b/se	M(2.b) b/se	M(3.a) b/se	M(3.b) b/se	M(4.a) b/se	M(4.b) b/se
<i>Age</i>			-0.041*** 0.008	-0.083*** 0.006	-0.032*** 0.008	-0.077*** 0.007	-0.034*** 0.008	-0.079*** 0.007
<i>Habit Shift</i>			1.494*** 0.325	1.914*** 0.241	1.406*** 0.330	1.784*** 0.246	1.322*** 0.330	1.624*** 0.248
<i>Interest</i>			0.850** 0.335	1.097*** 0.251	0.949*** 0.340	1.011*** 0.254	0.741** 0.345	0.822*** 0.257
<i>Concern</i>			0.260 0.301	0.707*** 0.233	0.379 0.305	0.752*** 0.236	0.363 0.304	0.717*** 0.235
<i>Impact</i>					0.890*** 0.299	1.366*** 0.220	0.750** 0.301	1.262*** 0.220
<i>Future Gen.</i>					-1.547*** 0.304	-1.415*** 0.227	-1.573*** 0.303	-1.426*** 0.226
<i>Practices</i>							1.157*** 0.363	1.288*** 0.278
<i>Constant</i>	7.741*** 0.156	9.005*** 0.123	1.367 1.085	1.052 0.821	3.120** 1.216	1.887** 0.900	1.240 1.348	-0.400 1.024
$\hat{\sigma}$	5.946*** 0.117	7.859*** 0.097	5.723*** 0.113	7.423*** 0.092	5.671*** 0.113	7.372*** 0.091	5.650*** 0.112	7.353*** 0.091
<i>WTP %</i>	7.741	9.005	5.518	7.915	6.492	8.965	5.305	9.365
<i>Observations</i>	1523	4284	1523	4284	1523	4284	1523	4284

Note: b/se indicates that, for each explanatory variable, the first row reports the coefficient estimates (b), while the second row presents their standard errors (se). \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

**Table A.16**  
WTP Estimates for green gas.

	M(1.a) b/se	M(1.b) b/se	M(2.a) b/se	M(2.b) b/se	M(3.a) b/se	M(3.b) b/se	M(4.a) b/se	M(4.b) b/se
<i>Age</i>			-0.067*** 0.009	-0.102*** 0.007	-0.063*** 0.009	-0.091*** 0.007	-0.063*** 0.009	-0.093*** 0.007
<i>Habit Shift</i>			0.856** 0.370	2.206*** 0.275	0.793** 0.377	2.035*** 0.279	0.719* 0.376	1.815*** 0.279
<i>Interest</i>			0.861** 0.377	0.861*** 0.281	0.925** 0.380	0.867*** 0.282	0.749* 0.385	0.573** 0.285
<i>Concern</i>			0.577* 0.340	0.878*** 0.257	0.700** 0.343	1.013*** 0.259	0.656* 0.342	0.963*** 0.257
<i>Impact</i>					0.925*** 0.327	1.666*** 0.252	0.801** 0.329	1.496*** 0.252
<i>Future Gen.</i>					-1.554*** 0.366	-2.154*** 0.259	-1.571*** 0.365	-2.188*** 0.258
<i>Practices</i>							1.083*** 0.419	1.912*** 0.308
<i>Constant</i>	7.255*** 0.178	8.528*** 0.140	3.033** 1.237	0.716 0.938	4.970*** 1.407	2.428** 1.032	3.057* 1.586	-0.849 1.154
$\hat{\sigma}$	5.853*** 0.134	7.798*** 0.110	5.599*** 0.129	7.240*** 0.103	5.546*** 0.128	7.141*** 0.101	5.528*** 0.127	7.099*** 0.101
<i>Observations</i>	1125	3261	1125	3261	1125	3261	1125	3261
<i>WTP%</i>	7.255	8.527	7.228	7.788	7.227	8.502	7.230	9.350

Note: b/se indicates that, for each explanatory variable, the first row reports the coefficient estimates (b), while the second row presents their standard errors (se). \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

negative and highly significant in both groups, with larger absolute values than in the electricity models. Average WTP estimates are again lower for group (a) than for group (b). Given that green gas is a less familiar option, these sharper between-group differences may reflect respondents' lower familiarity as well as the mechanics of the iterative task.

Comparisons with the pooled models (Tables 7 and 8) indicate that ignoring response-sequence heterogeneity may attenuate the estimated coefficients of attitudinal variables, particularly *Concern*, *Impact*, and *Practices*. These findings point to the need for future research that incorporates behavioral indicators, such as response times or revealed-preference data, to more directly assess the behavioral underpinnings of different respondent patterns.

## Data availability

The data that has been used is confidential.

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