

# **WORKING PAPER**

## **TRACKING DEMOGRAPHIC AND FINANCIAL TRENDS IN RENEWABLE ENERGY COOPERATIVE MEMBERSHIP IN BELGIUM USING SURVEY AND BANK TRANSACTION DATA**

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# Tracking Demographic and Financial Trends in Renewable Energy Cooperative Membership in Belgium using Survey and Bank Transaction Data

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## Abstract

This study investigates the demographic and financial profiles of members of 25 renewable energy cooperatives (RECs) in Belgium from 2012 to 2022, representing around 100,000 members. Analyzing anonymous transaction data from 1.3 million bank customers, we find that REC members typically have higher wealth, income, and consumption levels than non-members, with the gap widening over time. New members closely match the financial and age profiles of existing members, following the same upward, diverging trajectory, and indicating a trend towards a homogeneous and aging membership. To diversify REC membership, we conducted surveys with REC members and non-members. The results reveal that potential new members are typically younger and wealthier residents who have a better knowledge of RECs and a more pro-environmental mindset. These findings highlight the opportunity for RECs to innovate and engage a more diverse membership of citizens participating in the renewable energy transition.

The European Union (EU) is committed to an inclusive energy transition, ensuring that no one is left behind and clean energy is available for all (EU Renewable Energy Directive (2008/2001/EU) (RED II)<sup>1</sup>). This commitment requires the EU energy market to enable citizens of all segments of the population to actively participate and to place them at the heart of the energy system. A key concept put forward by the EU to reshape the market is renewable energy cooperatives (RECs)<sup>2-4</sup>. These community-based organizations enable citizens to collectively invest in, produce, and manage renewable energy resources in a democratic way<sup>5</sup>. By doing so, RECs enhance community engagement, ensure inclusivity, and reduce CO<sub>2</sub> emissions<sup>6</sup>. Furthermore, they aim to provide energy at a stable and fair price, increase awareness of the energy transition, and increase the acceptance of renewable energy projects<sup>2,7-10</sup>. As a result, all benefits – economic, environmental, and social – flow directly back to the community.

Over the last decade, RECs have grown significantly, establishing a network of 2,250 RECs in Europe, representing over 1.5 million citizens<sup>11</sup>. Despite these promising developments, RECs face challenges in fostering an inclusive energy transition. Previous literature finds that REC members are predominantly male, tend to be more affluent than the general population, are typically middle aged or older, and are more highly educated<sup>5,6,12-14</sup>. This homogeneity reflects unequal representation of the general population in the REC membership base and thus unequal access to their benefits across different demographic groups<sup>15,16</sup>. However, these studies relied on surveys with limited scope and sample sizes, making it challenging to generalize findings and to fully understand socio-economic diversity among REC members. We fill this research gap by analysing the demographic and financial profiles of REC members at the time of their first investment in a REC (new members), in their subsequent years of membership (existing members), and how they differ from non-members. By examining not only the difference between members and non-members but also the profiles of new members, we can specifically evaluate how entry demographics and membership composition within RECs evolves as these cooperatives continue to gain importance. Unlike prior studies that rely on survey data, we quantitatively assess detailed monthly panel bank transaction data from over 1.3 million customers of a large commercial Belgian bank, BNP Paribas Fortis (BNPPF). This approach allows us to rely on actual behaviour rather than stated survey preferences, providing a more robust and accurate reflection of (new) members and non-members. Moreover, we track REC members and non-members throughout the entire period they are clients of the bank, on a monthly basis over 10 years (2012 to 2022), offering detailed insights into the evolving dynamics between the considered groups.

We apply our analysis to 25 Belgian RECs. This is an interesting case study considering

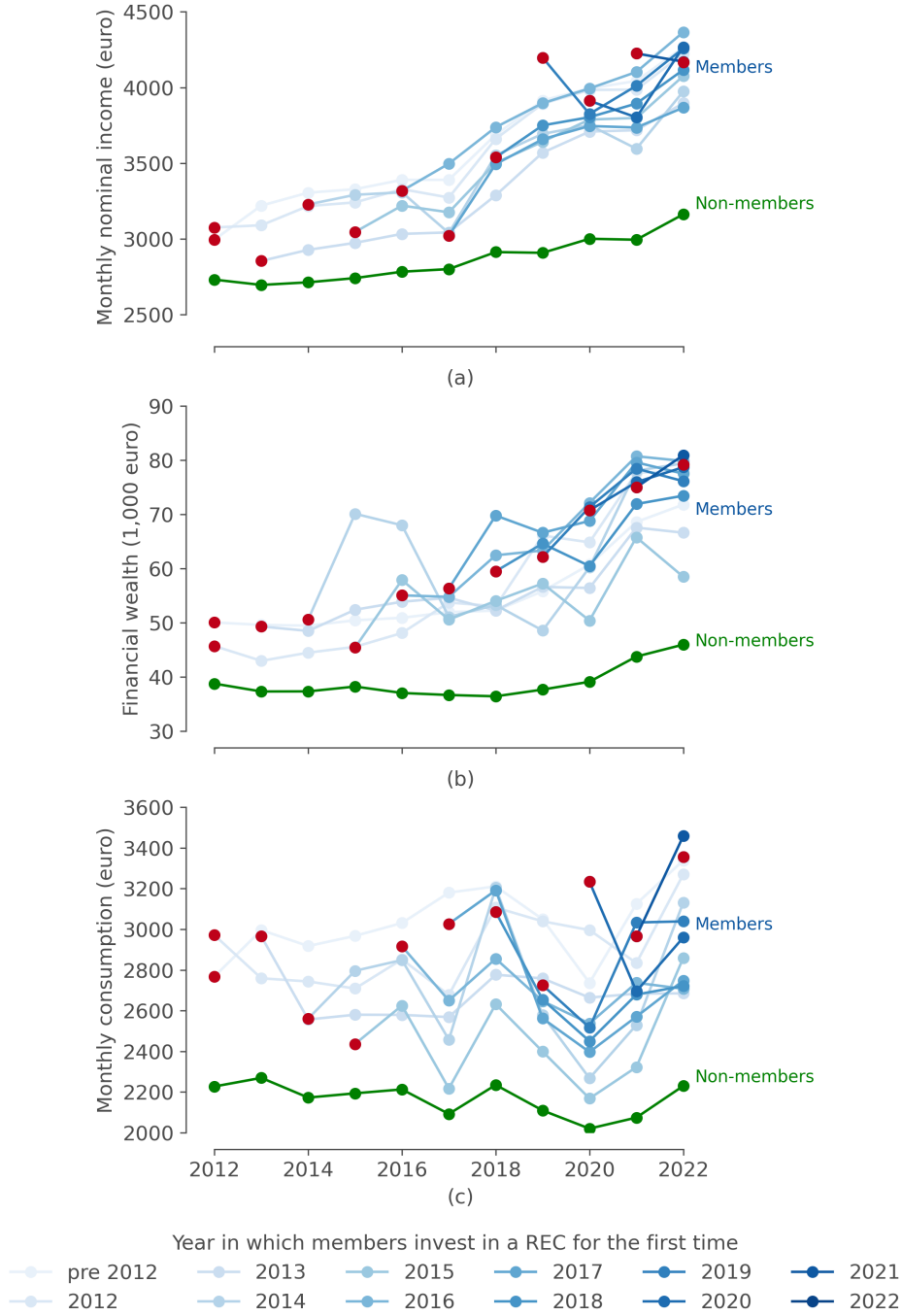
Belgium’s 100,000 REC members in 2022<sup>17</sup>, which is 6.7% of the total number of members in Europe. Belgium also has some of the highest average cooperative membership rates of all RECs in the EU<sup>18</sup>. Moreover, the Belgian cooperative Ecopower is one of the largest cooperatives in Europe (67,010 members in 2022<sup>19</sup>) and has been instrumental in the creation of the ‘REScoop.eu’ federation of RECs at the European level<sup>18,20</sup>.

We find that REC members have higher wealth, income, and consumption levels than non-members, with the gap between both groups increasing over time. New members not only resemble the financial and demographic profiles of existing members, but also continue to match the increasing levels of wealth, income, and consumption of existing members in the years after the start of their membership. This consistent alignment of new members with existing members over the past 10 years indicates a trend towards a homogeneous REC membership, further emphasising the growing gap with non-members over time. Furthermore, the mean age of both new and existing REC members compared to non-members increases significantly. This trend indicates an aging membership base, raising concerns about the inclusivity and sustainability of the studied RECs. It also raises pressing questions about the accessibility and appeal of the studied RECs to a broader spectrum of society, particularly among lower-income groups and younger generations.

We conducted a complementary survey in 2022 with members and young non-members to evaluate the most effective strategies for reaching non-members and how these strategies differ from those used to engage existing members. Among the sample of non-members, we find that those willing to become a member are typically younger, wealthier households living in apartments and with a more pro-environmental mindset. Their most important motivations are the production of renewable energy (RE) and the financial return. In addition, being aware of the concept of RECs increases the willingness to become a member. However, 63.7% of non-members had never heard of or did not understand the concept of RECs. It is therefore crucial to increase public awareness of RECs and their ability to achieve both RE production and financial returns. Our findings thus show that there is a significant untapped potential among REC membership and targeted strategies are necessary to ensure that RECs can contribute to an inclusive energy transition that includes every segment of the population.

## **New members mirror existing members and differ from non-members**

We draw on anonymous and censored bank transaction data of active retail clients of one of the largest Belgian banks. This dataset contains detailed financial transactions and demographic information for each client. All 25 Belgian RECs were identified by the bank and their anonymous identifier was labelled as REC. Bank clients who transfer money to or receive money from one of these RECs were labelled as REC members, the remaining were labelled as non-members (Methods). The identified members are then put into 12 cohorts (pre 2012 - 2022) based on the year in which they became a member (Supplementary table 2). Throughout this paper, red refers to the start year of each member cohort (new members), blue refers to the following years of membership (existing members), and green refers to non-members. We explore differences in financial and demographic characteristics of these three groups between 2012 and 2022.



**Fig. 1. Evolution of new and existing renewable energy cooperative (REC) members and the gap with non-members.** a-c, we distinguish between new REC members (red dots, which indicate the year in which individuals first invest in a REC), cohorts of existing REC members (blue, the cohort is based on their year of first-time investment in a REC) and non-members (green). **a** focuses on monthly nominal income, **b** on financial wealth, and **c** on monthly consumption. A description for each of the variables can be found in Supplementary table 3.

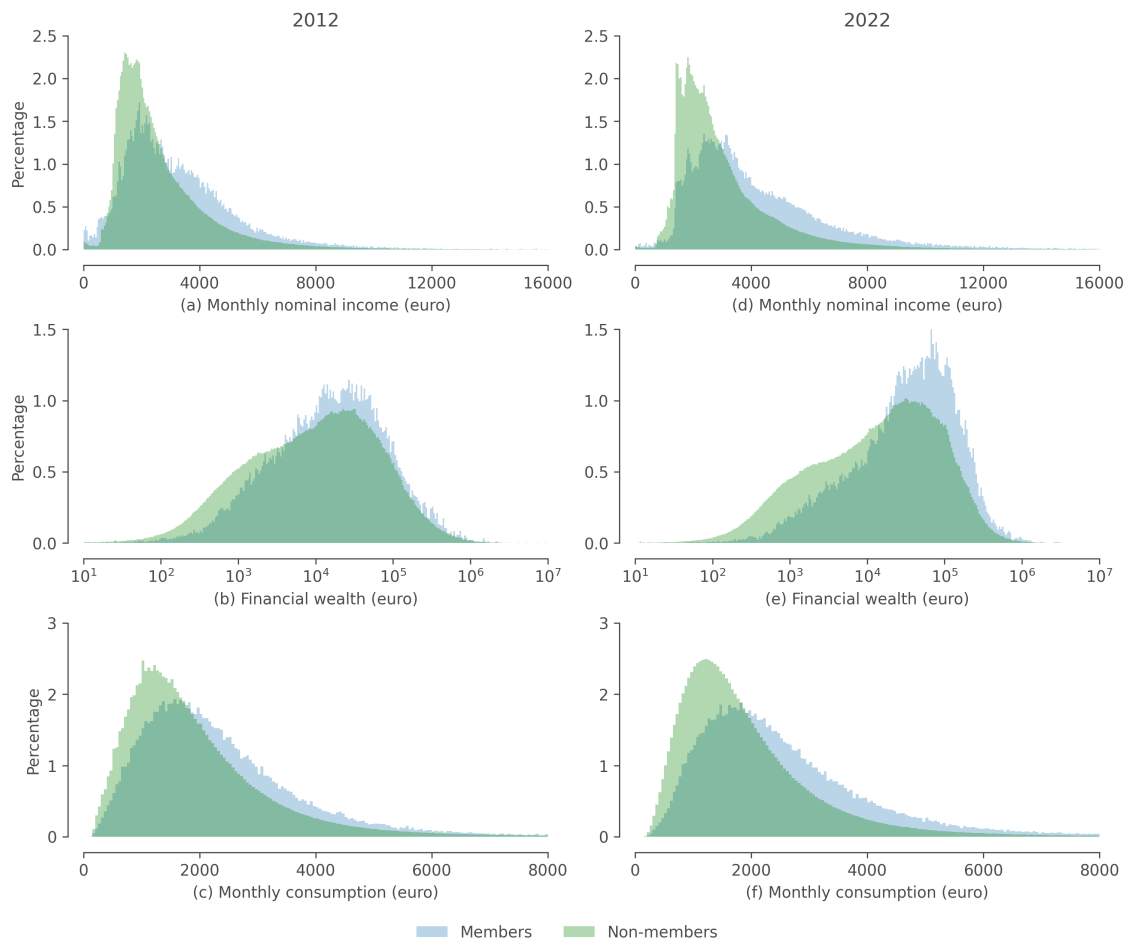
**Income and wealth:** Fig. 1 shows the evolution of nominal income, financial wealth, and monthly consumption between 2012 and 2022 for each cohort of members (blue) and for non-members (green) over the past decade. The figure shows that new members (red) enter the REC membership base with income and financial wealth levels closely aligned with those of existing members (Fig. 1 (a) and (b)). This suggests that our studied RECs consistently attract individuals from the same range of income and financial wealth levels over the last 10 years. The difference between members and non-members is much larger. Even though the RED II<sup>1</sup> presented RECs as an opportunity for low-income households to access more affordable energy tariffs, members consistently report higher average nominal incomes and financial wealth compared to non-members, both at the time of initial investment and in subsequent years. Moreover, this gap is only increasing

over time. This difference underscores a significant financial distinction between members and non-members<sup>9,13</sup>. Fig. 2 (a), (b), (d) and (e) compares the income and wealth distributions in 2012 with that of 2022 for both members and non-members. The figure shows that the income and wealth distributions of members and non-members have a similar shape, but that the distributions of members are shifted to the right compared to non-members. In 2012, this shift was relatively small, however, in 2022, the shift is much more outspoken, with members having significantly higher levels of income and wealth ( $P < 0.001$ ). Table 1 presents the socio-demographic profiles of members and non-members of RECs in 2022. In 2022, new members had a monthly income of €4,166 and financial wealth of €79,162 in 2022. This is similar to the average income (€4,228) and wealth (€73,219) of existing members. Contrary, non-members have significantly lower income (€3,162) and wealth (€45,948) than both new and existing members ( $P < 0.001$ ).

**Table 1: Key financial and demographic characteristics of (1) new renewable energy cooperative (REC) members in 2022, (2) existing REC members with investment year pre 2012 until 2021 in 2022, and (3) non-members in 2022.**

Variable	(1) New members	(2) Existing members	(3) Non-members
Sample size	460	8,715	651,617
Mean age	53.8 (13.6)	57.0 (12.6)	55.1 (16.6)
Share 65+ (%)	24.8 (43.2)	30.2 (45.9)	32.5 (46.8)
Share married (%)	51.0 (50.0)	65.7 (47.5)	44.2 (50.0)
Share with children < 24 y.o. (%)	25.8 (43.7)	27.9 (44.9)	15.0 (35.7)
Mean net monthly income (€)	4,166 (3,161)	4,228 (3,355)	3,162 (5,804)
Mean liquid wealth (€)	58,728 (95,862)	50,814 (85,569)	35,976 (86,347)
Mean financial wealth (€)	79,162 (123,806)	73,219 (121,210)	45,948 (112,243)
Mean securities (€)	15,653 (62883)	16,712 (61,272)	7,748 (55,886)
Mean monthly consumption (€)	3,356 (8,928)	3,231 (20,136)	2,230 (10,664)
Mean debt (€)	49,884 (181,471)	37,409 (86,491)	26,833 (78,568)
Share with mortgage (%)	36.3 (48.1)	35.4 (47.8)	20.1 (40.1)

Standard deviations in parentheses. A description for each of the variables can be found in Supplementary table 3.



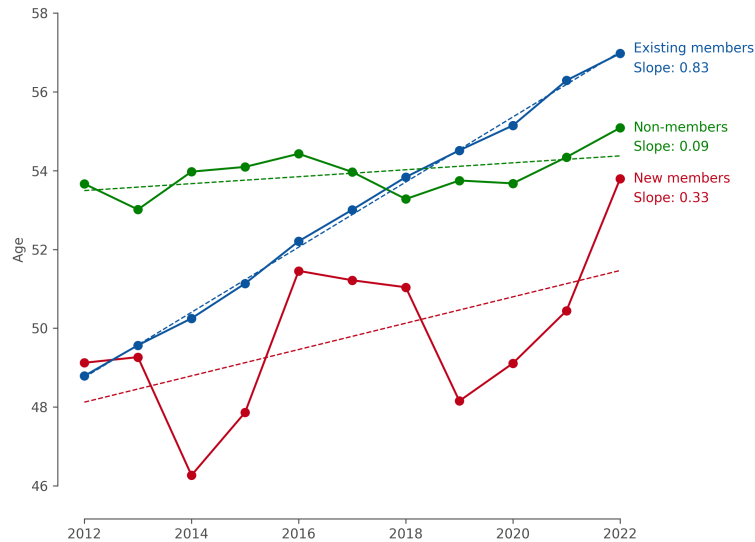
**Fig. 2. Comparison of the distributions of income, financial wealth, and consumption between 2012 and 2022 for renewable energy cooperative (REC) members and non-members.** **a** focuses on nominal income in 2012, **b** on financial wealth (measured on a log scale) in 2012, and **c** on consumption in 2012 ( $N$  members = 8,730,  $N$  non-members = 406,712). **d**, **e**, and **f** focus on the same variables but for the year 2022 ( $N$  members = 9,181,  $N$  non-members = 651,617). A description of all variables can be found in Supplementary table 3.

An important component of financial wealth is the balance on security accounts. Table 1 shows that new members have €15,653 of securities on average, which is lower compared to the existing members (€16,712). However, both member groups have more securities than non-members in 2022 (€7,748). RECs are not only a community to join but also a financial investment of €100 to €260 for an individual share (Methods). A higher value of securities in a portfolio could be indicative of more financial sophistication and could therefore influence an individual’s propensity to invest<sup>21–23</sup>. Additionally, the liquid wealth of new and existing members, which reflects immediately accessible funds from both current and savings accounts, is significantly higher (€58,728 and €50,814, respectively) than that of non-members (€35,976) ( $P < 0.001$ ). Furthermore, non-members maintain a higher proportion of their wealth as liquid assets (78.3%) than new (74.2%) and existing (64.4%) members. This higher liquidity could reflect a cautious approach to investment or a need for ready cash among non-members that might influence their willingness to invest in RECs.

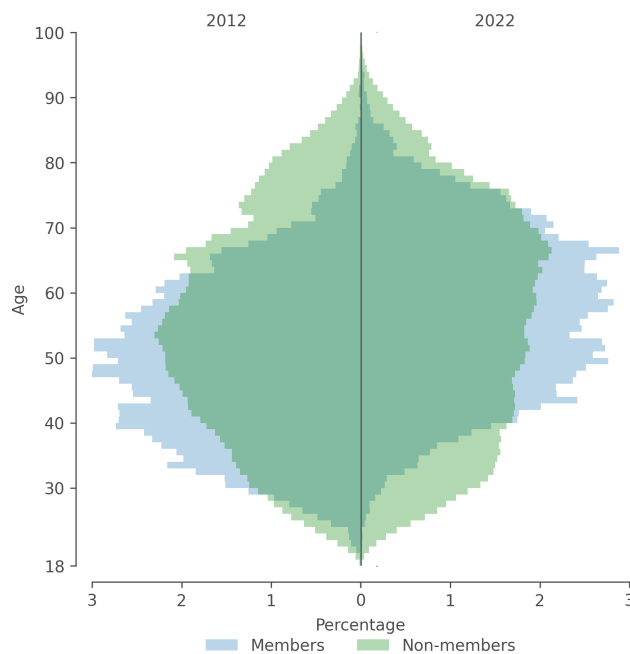
**Consumption:** The homogeneity found between new and existing members for income and wealth, is also present for consumption. However, the variation between the cohorts of members is larger. Most members entering the membership base of RECs have consumption profiles that align with those of existing members (Fig. 1 (c)). The consumption of both groups is also significantly higher than non-members ( $P < 0.001$ ). While in 2012 the difference between the consumption distributions was still relatively small, by 2022, the members’ distribution had shifted to the right (Fig. 2 (c) and (f)). By 2022, new and existing members have an average consumption of €3,356 and €3,231, respectively, compared to €2,230 for non-members. This difference could be related to the higher levels of income and financial wealth of new and existing members and indicates again the affluent profiles of REC members compared to non-members.

**Debt:** In 2022, new members had an average debt of €49,884, which is higher than the existing members' debt of €37,409. In contrast, non-members have an average level of debt of €26,833, significantly lower when compared to the groups of members ( $P < 0.001$ ). An important explanation for the elevated debt can be attributed to the presence of mortgages. In 2022, 36.3% of new members and 35.4% of existing members who carry debt, have a mortgage compared to only 20.1% of non-members. This disparity between members and non-members in 2022 could be again related to lower income and wealth levels of non-members, potentially limiting their ability to secure higher-value mortgages.

### An aging REC membership



**Fig. 3. Mean age of new renewable energy cooperative (REC) members, existing REC members, and non-members.** The dotted lines represent the regression lines for each group.



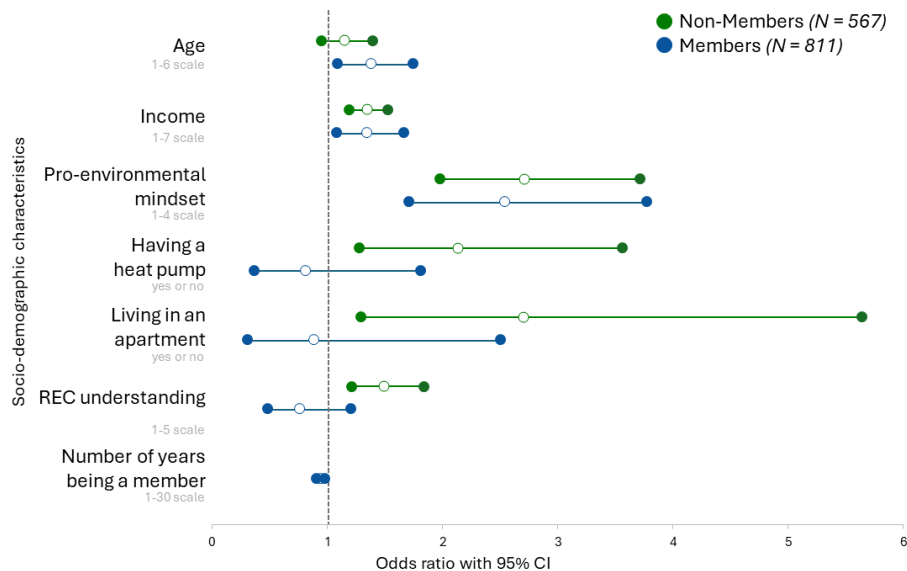
**Fig. 4. Age distribution of REC members and non-members in 2012 and 2022.** The left side of the figure represents the age distribution of members in blue ( $N = 8,730$ ) and non-members in green ( $N = 406,712$ ) in the year 2012. The right side of the figure represents the age distribution of the same groups ( $N$  members = 9,181,  $N$  non-members = 651,617) in the year 2022.

Individuals who joined the REC membership in 2012 were close in age with existing members (49.1 and 48.8, respectively) (Fig. 3). Both new and existing members were, on average, significantly younger than non-members (53.7) ( $P < 0.001$ ). The age distribution among members versus non-members was notably left-centered for members (Fig. 4). Throughout the following decade, existing members aged on average by 0.8 years annually (slope: 0.83). By 2022, this consistent aging brought the average age of existing members to 57.0, 2 years older than non-members (55.1). Although new members were initially similar in age to existing members, by 2022, they were younger (53.8). The share of new members aged 65 or older was 24.8% compared to 30.2% among existing members and 32.5% among non-members, indicating a smaller proportion of retirement-aged individuals joining recently. However, over the 10-year period, new members aged by an average of 0.3 years annually (slope: 0.33). While in 2012, a sizeable share of members was below 55 years old, by 2022, this age group has almost completely disappeared from the membership. The distribution of members in 2022 shifted to the right compared to 2012, with the majority of members aged between 40 and 70 years old (Fig. 4). This shift contrasts with the broader age distribution observed among non-members, which has remained stable over time (slope: 0.09).

In terms of family structure, 51.0% of new members are married, compared to 65.7% for existing members and 44.2% for non-members. However, both new and existing members are more likely to have children under 24 years of age (25.8% and 27.9% respectively) compared to non-members (15.0%).

## Getting a fresh pool of non-members on board

Given the homogeneous nature of REC membership observed in the bank data analysis, we conducted a complementary survey in 2022 targeting both members and non-members. The results discussed below specifically focus on younger non-members, who differ from current members, and aim to identify the most effective strategies for engaging this group to participate in RECs (Methods).

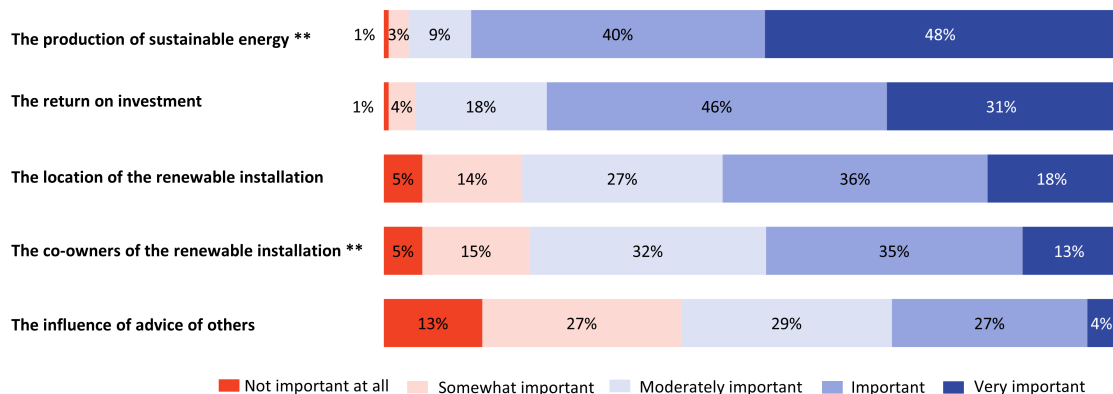


**Fig. 5. Results of a logistic regression: significant socio-demographic characteristics driving the willingness to invest in a renewable energy cooperative.** The willingness to invest (WTI) of survey respondents was measured on a Likert scale ranging from one to five. Neutral responses (3) were excluded, negative (1 and 2) and positive (4 and 5) responses were regrouped into a binary scale for the logit regression analysis. The logit coefficients have been translated to odds ratios to improve the ease of interpreting the results (Methods). Each open dot represents the odds ratio within the 95% confidence interval, shown in filled dots. Non-members' results are shown in green, existing members' in blue. The vertical dashed line is the 'no effect' threshold, corresponding to the value of 1, which indicates that the considered socio-demographic characteristic does not affect the WTI. Two-sided z-test for significance. A description of all variables can be found in Supplementary table 5



We are particularly interested in the socio-demographic characteristics that set non-members who are willing to invest apart from existing members who are willing to invest more money in RECs. The significant coefficients of the logistic regression that are presented in Fig. 5 allow us to identify a pool of potential new members who could diversify the currently too homogeneous composition of REC members. A complete list of the logit regression is shown in Supplementary table 6. Interestingly, higher age does not significantly increase the willingness to invest (WTI) among non-members ( $P = 0.157$ ), while it does for members ( $P = 0.07$ ) which is a first promising diversifying characteristic. Income, on the other hand, does play a significant role ( $P < 0.001$ ): each €1,000 increase in total monthly net household income of a non-member raises the odds of their WTI by 35.1%. In this regard, non-members do not differ much from members. This finding is consistent with previous literature<sup>6,12,21,24,25</sup> and also with our findings from the bank data, where REC members are identified as a group with an above-average income. On the one hand, attracting higher-earning households to invest will not help to diversify the pool of REC members, but on the other hand, it is also clear that families who are unable to afford a REC share or who are unable to bear the risk of its value fluctuations are unlikely to invest.

A pro-environmental mindset is shown to be a key determinant for the WTI of both groups of respondents ( $P < 0.001$ )<sup>12,26,27</sup>. We find that each one-unit increase on the four-unit scale of pro-environmental mindset boosts the odds of non-members' WTI by 171.1%, even more so than among members. Living in an apartment ( $P = 0.008$ ) and using a heat pump ( $P = 0.004$ ) as the primary heating source are significant factors for non-members, increasing the odds with 170.2% and 113.4%, respectively. This suggests that families who have invested in energy-efficient renovations or live in new homes who are not a member yet are more inclined to support sustainable investment projects<sup>13,26</sup>. Furthermore, familiarity with the concept of a REC significantly impacts WTI<sup>21</sup>; a one-unit increase in self-reported understanding on a four-unit scale raises the odds of investing by 49.5%. Furthermore, 63.7% of non-members had never heard of or did not understand the concept of RECs. This underscores the need for better education about RECs, especially among groups with the above-mentioned characteristics, to attract a more diverse membership base.



**Fig. 6. Motivations to invest in a renewable energy cooperative (REC) for non-members (who are willing to invest).** N = 590 (non-members who indicated to be willing to invest: 3, 4 or 5 on a 5-step Likert scale). Significance levels after two-sided t-test are indicated with \*\*\* for  $P < 0.01$ , with \*\* for  $P < 0.05$  and with \* for  $P < 0.1$

Fig. 6 presents the motivations to invest in a REC for non-members who indicated a neutral to positive WTI (3, 4 or 5 on a 5-step Likert scale). Their primary driving force is the sustainable nature of RECs ( $P = 0.010$ ), namely the production of RE<sup>8,12,28,29</sup>. This contrasts with conventional financial instruments, where the expected return on investment (ROI) is usually the primary motivation. Although ROI is the second stated motivation among survey respondents, its statistical significance cannot be confirmed ( $P = 0.265$ ) (Supplementary table 7).

The regression analysis of non-members' motivations (Supplementary table 7) reveals that the sustainable production of energy and the personal connection to co-owners are significant predictors of the WTI in RECs. Other factors such as the ROI, the location of the renewable installation, and the influence of advice from others do not show statistical significance in predicting WTI.

## Discussion and conclusions

Using detailed anonymous bank transaction data between 2012 and 2022, we find that members of 25 Belgian RECs have significantly higher wealth, income, and consumption than non-members, with the difference between both groups increasing over time. Irrespective of when they join, new members have very similar wealth, income, and consumption than existing members. Additionally, the studied RECs have an aging membership base with few young individuals joining and the average age of new members increasing.

As our studied RECs have been front-runners in the European REC landscape, our results are a warning sign that it is not guaranteed that RECs will automatically live up to their objective of actively engaging all layers of society in the energy transition. If unchecked, this lack of inclusivity could hinder both the development of RECs and the renewable energy transition<sup>15,16</sup>.

To counter the identified trend, we identified strategies for RECs to reach a more diverse and representative membership, using a survey of members and non-members. We find that potential new members are typically younger and wealthier residents who have a better knowledge of RECs and a more pro-environmental mindset. To engage this demographic, it is crucial to increase public awareness of RECs, emphasising their ability to achieve renewable energy production and financial returns. Additionally, RECs should actively work on including other underrepresented groups with low willingness or capability to invest. This might include offering free membership shares to underrepresented groups, providing access to locally-produced renewable electricity at a subsidised and stable price, or initiating social community programs that support diverse non-members with RE or energy efficiency investments<sup>30</sup>. Vulnerable groups often have less energy-efficient homes, higher energy bills, and are less financially capable of investing in RECs and RE<sup>31</sup>. When there is a diverse community of engaged and participating members<sup>32</sup>, RECs can also enhance equitable access to distributed energy resources by increasing local acceptance of non-residential RE projects<sup>7,33</sup> and by advocating for needed grid infrastructure upgrades<sup>34</sup>.

However, society-led groups like RECs have limitations on what they can achieve alone<sup>35,36</sup>, indicating that sustained policy support is crucial for their success<sup>4</sup>. After establishing and supporting the concept of RECs, policymakers should now focus more on encouraging RECs to include vulnerable communities and younger, lower-income households. One way to achieve this is by providing financial incentives for RECs that meet diversity and inclusivity targets. Current European legislation has yet to address this need<sup>37,38</sup>.

## Methods

### Bank transaction data

#### Data

The bank dataset originates from BNP Paribas Fortis (BNPPF), a leading commercial bank in Belgium, holding a market share of 19.14 % in terms of total assets in 2022<sup>39</sup>. Covering the period from January 2012 to December 2022, it comprises anonymized and censored financial transactions from over 4.4 million unique retail clients. The transactions include various financial activities, such as cash withdrawals, debit card purchases, and wire or SEPA transfers. Regarding card transactions alone, the dataset includes a monthly average of 65 million transactions, amounting to a total exceeding €2 billion. Each financial transaction recorded in the dataset provides detailed information, including the transaction date, the amount in euro, a label indicating the economic purpose, the direction (debit or credit), and anonymized identifiers corresponding to each client and the counterparty. Based on the labelled transactions, monthly totals and balances were constructed. Additionally, BNPPF also provides a set of anonymized socio-demographic data for each individual client, which includes information on age, gender, civil state, and residential area.

#### REC member identification

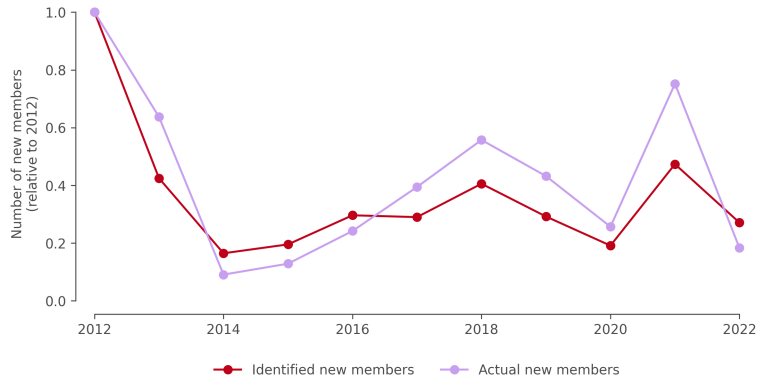
We consider an unbalanced panel of active bank clients, representing the dynamic nature within the bank's clientele (clients can leave the bank, new clients can enter the bank, clients can become (in)active when moving outside the house, opening a joined account at (another) bank, etc.). The definition of an 'active client' is inspired by the minimum income and expenditures required to survive in Belgium<sup>40</sup>. An active client needs to have sufficient non-durable consumption (groceries, restaurants, medicines, utilities, personal care products, fuel and cash) in every month of the year and sufficient income (labour income, unemployment benefits, pensions, replacement income that is not unemployment benefits or pensions; and rental income) in most of the months of the year. The minimum thresholds for non-durable consumption and income are €139.64 and €537.33,

respectively<sup>40</sup>. These thresholds have been adjusted for inflation at the start of our sample period and subsequently updated for inflation on later dates within our sample. More precisely, active clients are identified in stepping windows where each window covers a calendar year. A client is active if, for every month that we observe the client in a given year, they have sufficient non-durable expenditures in every month and sufficient income in most, but not all months. We allow active clients to have up to 2 months without sufficient income. This is to capture the delay between unemployment and unemployment benefits. This approach identifies 1.3 million unique active bank clients, with an average of 500,000 clients per year which forms the foundation for our subsequent analysis.

The identification of REC members involves two steps. Initially, Belgian RECs are identified within the bank data by the proprietary transaction labelling process by the bank. This involves creating a correspondence between counterparties identified by the labelling process with data of the Kruispuntbank van Ondernemingen (KBO)<sup>41</sup>. Within this process, 25 Belgian RECs were successfully identified in the bank data. Next, we identify members belonging to the 25 identified RECs. In our analysis, we do not differentiate between REC members who obtain electricity from a cooperative supplier and those who do not. A bank client qualifies as a REC member upon engaging in financial transactions -either debit or credit- with any of the identified cooperatives. These transactions include either the payments of energy bills, in the case the member is also a REC client and is thus consuming energy from the cooperative, or receiving an annual dividend, if distributed that year. With the application of the 'active client' condition, the resulting dataset reveals 26,636 REC members. Additionally, we further differentiate these members into 13 cohorts, categorized by the year of their initial membership in an REC. Entry into a specific cohort is marked by the date of a clients' first financial commitment to a REC, quantified by transactions amounting to €100, €125, €250 or €260 or multiples (with a maximum of €5,000) to one of the 25 identified RECs. For each member's first financial commitment, we obtain the date, amount and anonymous REC of their initial investment (Supplementary table 2). If in the 2012-2022 period a first financial commitment of the above specified amounts (to buy membership shares) cannot be observed but a bank client has other financial transactions to one of the identified RECs (indicating membership), the date of initial investment is classified as either 'pre 2012', if the bank client is active from 2012 onward, or 'unknown', if the bank client is inactive in 2012 but active in some subsequent years. Two noteworthy considerations merit attention in our analysis. Firstly, bank clients with an investment year labelled as 'unknown' are excluded from our study. Secondly, we exclude the possibility to exit the REC membership in our sample. This omission is justified as very few members ever sell their shares. For a member to sell their cooperative shares, two requirements need to be met: ownership for a minimum of three years and attendance at the general assembly meeting. Following the successful identification of REC members and their associated cohorts, the anonymous monthly transaction and socio-demographic data are incorporated. Important to note is that we do not consider gender in our study. This is due to the nature of our data, which is based on the head of the account holder from bank records, which does not specify which individual within a household made the decision to become a member. In addition, becoming a member of a REC and obtaining the associated benefits, such as the offtake of electricity, is often a decision made by the entire household. Although various household members may participate in the decision to join a REC, societal norms often dictate that formal memberships and head of the bank account are registered under the names of male household heads.

### **Data representativeness**

In order to ascertain the representativeness of our REC member identification, we compared the annual trend of identified new REC members of the largest cooperative in terms of members in our bank data, against the official numbers documented by the largest energy cooperative in Belgium, relative to 2012. Fig. 7 reveals a remarkable alignment between the membership evolution captured in our bank data and the official statistics maintained by the largest REC across the entirety of the study period, affirming the representativeness of our REC member identification in the bank data.



**Fig. 7. Representativeness of the identification of renewable energy cooperative (REC) members in the bank transaction data.** We compare the number of identified new members via the bank transaction data (red) with the actual new members of the largest renewable energy cooperative in Belgium (purple), relative to 2012.

### RECs in Belgium

Most Belgian cooperatives are affiliated with REScoop Vlaanderen or REScoop Wallonië, the Flemish and Walloon federations of citizen cooperatives for RE. All REScoop energy cooperatives meet the European definitions of energy communities (renewable energy cooperatives (RECs) and citizen energy cooperatives (CECs), as outlined in RED II<sup>1</sup>) and operate according to the internationally recognized principles of cooperative enterprises<sup>42</sup>. Belgian REC members are not only shareholders but can also purchase the citizen-produced RE at a stable and fair price through one of the two retail RECs, Ecopower, operating in Flanders, and Cociter, operating in Wallonia. In 2022, 85% of REC members took advantage of this opportunity, purchasing the electricity generated by their own cooperative<sup>17</sup>. This model promotes a close alignment between energy production and consumption, enhancing sustainability and fostering a stronger sense of community ownership and involvement in RE. To keep RECs inclusive and mitigate financial risk, cooperatives cap the maximum investment per individual at €5,000<sup>43</sup>. The financial returns on shares are deliberately limited to a maximum of 6% per year<sup>44</sup>, underscoring that these cooperatives prioritize environmental, social and community benefits over maximizing capital returns.

## Survey data

### Data Collection

Survey data was collected from two distinct samples during the last quarter of 2022. Initially, the survey was disseminated via the electronic newsletters and online media channels of the Belgian RECs Energent and Ecopower. The survey reached a total of 61,330 members (1,506 from Energent and 59,824 from Ecopower), yielding a total of 2,294 responses. The overall response rate was approximately 2%, with a higher response rate from Energent (12.4%) compared to Ecopower (1.9%).

Additionally, the survey of non-members was distributed via the open online platform Prolific, initially resulting in 1,309 responses from registered users across Central Western Europe.

Respondents with incomplete data, those who failed attention checks, those who were uncertain about their cooperative membership status, or who declined to share demographic information such as age or income were excluded from the analysis. Furthermore, responses from Luxembourg were excluded due to the small number of responses (only three), which was insufficient for meaningful statistical analysis. In total, 1,245 observations were excluded, leaving 1,037 valid results from the questionnaire to Energent and Ecopower members and another 1,321 valid results from the Prolific questionnaire. Only 28 (2.7%) of the Prolific respondents were members of a REC at the time of the survey. The geographical distribution of the retained Prolific observations is as follows: 153 respondents were registered in Germany (35.1%), 281 in the Netherlands (27.1%), 239 in France (23.1%) and 153 in Belgium (14.8%). Further details of the final survey sample populations are provided in Supplementary table 4.

### Survey design

The survey was part of a broader data collection effort focused on respondents' views on electricity flexibility programs, alongside socio-demographic and environmental characteristics. The section dedicated to RECs assessed respondents' knowledge of these cooperatives, their willingness

to invest in them, and their potential motivations for doing so. Certain survey questions were adapted from a previous study by Bauwens<sup>45</sup> that collected data from REC members up to 2014. By combining survey results from both REC members and a diverse sample of non-members, we provide a valuable comparison that is particularly useful for membership expansion efforts.

### Diverse sample of non-members

Utilizing the Prolific platform enabled us to reach a diverse pool of non-members, distinct from the surveyed members of Ecopower and Energent, as well as from the non-member population represented in the bank data. Prolific respondents were typically younger, had lower incomes, and more frequently resided in apartments than surveyed REC members. Further details on the two groups are represented in Supplementary table 4. Accessing this diverse sample of non-members allowed us to gain insights into the motivations of potential new members and helped identify strategies for diversifying the cooperative membership base.

### Analytical approach and regression model

The collected data were analyzed using a binary logit regression to determine the significant factors influencing WTI in RECs. This method emphasizes the binary nature of WTI and identifies the socio-demographic and environmental characteristics that significantly predict investment willingness. The binary logit regression model is represented as follows:

$$\begin{aligned} \text{logit(WTI)} = & \beta_0 + \beta_1 \cdot \text{age} + \beta_2 \cdot \text{income} + \beta_3 \cdot \text{pro-environmental mindset} + \beta_4 \cdot \text{education} \\ & + \beta_5 \cdot \text{REC understanding} + \beta_6 \cdot \text{EV} + \beta_7 \cdot \text{HP} + \beta_8 \cdot \text{PV} + \beta_9 \cdot \text{apartment} \\ & + \beta_{10} \cdot \text{semidetached} + \beta_{11} \cdot \text{terraced} + \beta_{12} \cdot \text{villa} + \beta_{13} \cdot \text{rural} + \beta_{14} \cdot \text{suburban} \\ & + \beta_{15} \cdot \text{city} + \beta_{16} \cdot \text{home owner} + \beta_{17} \cdot \text{years member} \end{aligned}$$

The variables as used in this regression are specified in Supplementary table 5.

Respondents were first provided with the following description of a REC and then asked to indicate their familiarity with the concept on a one to four Likert scale. The following definition was provided: "An energy cooperative is a cooperative that focuses on providing energy in a sustainable way. Citizens have the opportunity to become co-owners through the purchase of a share and thus control the cooperative together. The cooperative invests the collected citizen capital in energy projects such as solar installations, wind turbines, heat grids or others." To assess pro-environmental mindset, respondents indicated their agreement with four environmentally-themed statements. These responses were subsequently aggregated into a single parameter for inclusion in the logit regression (Supplementary table 8). The results of the regression analysis, including the coefficients, standard errors, z-values, and p-values, are presented in Supplementary table 6.

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## Supplementary tables

**Table 2: Renewable energy cooperative membership status of bank clients**

Renewable energy cooperative	Count	Frequency
Members	26,636	2.0
unknown	13,549	50.9
pre 2012	8,247	31.0
2012	948	3.6
2013	421	1.6
2014	178	0.7
2015	217	0.8
2016	456	1.7
2017	387	1.5
2018	519	2.0
2019	394	1.5
2020	334	1.3
2021	520	2.0
2022	466	1.8
Non-members	1,332,631	98.0
Total	1,359,267	100.0

**Table 3: Variables and their definitions: bank data**

Variable	Definition
Age	Age of the client.
Age > 65 y.o.	Dummy variable being 1 if the client is 65 or older.
Children < 24 y.o.	Dummy variable being 1 if the clients has children under the age of 24.
Consumption (monthly)	Alcoholic beverages and tobacco, cash, fines, food and beverage serving services, fuels and lubricants for personal transport equipment, garden products and pets, groceries, medicines and health products, other non-durable goods, personal care products, security equipment and materials for the maintenance and repair of the dwelling and utilities. Assistive products, cultural and recreational durables, furniture, furnishings, and loose carpets, information and communication equipment, luxury goods, and purchase of vehicles. Clothing and footwear, households textiles, tableware, and small appliances, other cultural and recreational goods, and parts and accessories for personal transport equipment. Accommodation services, actual rentals for housing, cultural and recreational services, domestic services and household services, education (mandatory, other, tertiary), health services, food and beverage serving services, information and communication services, insurance, other services, package holidays, passenger transport services (air, public, road, and water), personal care services, refuse collection, services for maintenance, repair, and security of the dwelling, services in respect of personal transport equipment, sewage collection, social protection, and transport services of goods. Household appliances, mixed retail (building materials and personal use), credit card payments.
Debt	Balance of long-term loans, short-term loans, overdrafts and average monthly negative balance in checking account.
Financial wealth (monthly)	Balance of current, saving, active term, security, and invest account and pension savings.
Liquid wealth (monthly)	Balance of current and savings account.
Net Income (monthly)	Labour wages, replacement unemployment income, replacement pension income, real estate income and social security, child benefits.
Married	Dummy variable being 1 if the clients is married.
Securities	Balance on security accounts.

**Table 4: Table of balance: survey respondents**

	Members	Non-members	Full sample
Sample size	1,012	1,349	2,361
Share younger than 25 years (%)	0.4	26.5	11.5
Share 25 to 34 years (%)	5.6	45.3	22.6
Share 35 to 44 years (%)	16.6	17.6	17.0
Share 45 to 54 years (%)	22.8	7.1	16.1
Share 55 to 64 years (%)	26.4	2.8	16.3
Share older than 64 years (%)	28.2	0.7	16.4
Share with a monthly net household income below 2,000 euros (%)	8.7	27.1	16.5
Share with a monthly net household income 2,000 to 2,999 euros (%)	19.1	19.2	19.2
Share with a monthly net household income 3,000 to 3,999 euros (%)	21.2	18.8	20.2
Share with a monthly net household income 4,000 to 4,999 euros (%)	21.0	15.5	18.6
Share with a monthly net household income 5,000 to 5,999 euros (%)	17.6	11.2	14.9
Share with a monthly net household income of 6,000 euros or higher (%)	12.3	8.2	10.6
Share with primary as highest educational degree (%)	0.4	0.2	0.3
Share with secondary as highest educational degree (%)	18.8	19.9	19.3
Share with bachelor as highest educational degree (%)	32.8	37.9	35.0
Share with master as highest educational degree (%)	43.3	37.0	40.6
Share with a PhD as highest educational degree (%)	4.3	4.5	4.4
Share home-owners (%)	94.7	34.2	68.8
Share with a heat pump (%)	17.7	14.5	16.3
Share with photovoltaics (%)	67.7	14.4	44.9
Share living in an apartment (%)	11.0	63.2	33.4
Share living in a terraced house (%)	23.3	14.6	19.6
Share living in a semi-detached house (%)	25.4	8.3	18.1
Share living in a villa (%)	40.2	13.9	28.9
Share living in a rural area (%)	37.4	13.1	27.0
Share living in a suburban area (%)	33.4	24.7	29.6
Share living in a city	29.2	62.2	43.3
Mean number of membership years	9.98		9.98
Median self-assessed understanding about RECs	3.345	2.012	2.775

Self-assessed knowledge about RECs is a reported value on a scale from one to four, as respondents were asked to indicate how well they knew the concept of RECs on a one to four Likert scale.

**Table 5: Variables and their definitions: survey data**

Variable	Definition	Scale
Age	Age of the survey respondent.	1 to 6 scale: starting at 18-24 years old, ten years added per unit increase
Education	The survey respondent's highest degree.	1 to 6 scale: unidentified, primary, secondary, bachelors, masters, PhD.
Income	Respondent's net monthly household income.	1 to 7 scale: starting at 0-999 euro, thousand euros added per unit increase
Pro-environmental mindset	The level of the survey respondent's agreement with four environmentally-themed statements.	1 to 4 scale
REC understanding	The survey respondent's self-reported understanding of the concept of a REC.	1 to 4 scale
EV	The survey respondent drives an electric vehicle.	Dummy
HP	The survey respondent has invested in a residential heat pump.	Dummy
PV	The survey respondent has invested in a residential photovoltaic system.	Dummy
Apartment	The survey respondent lives in an apartment.	Dummy
Semidetached	The survey respondent lives in a semidetached building.	Dummy
Terraced	The survey respondent lives in a terraced house.	Dummy
Villa	The survey respondent lives in a villa.	Dummy
Rural	The survey respondent lives in a rural area.	Dummy
Suburban	The survey respondent lives in the suburbs of a city.	Dummy
City	The survey respondent lives in a city.	dummy
Home owner	The survey respondent is the owner of the dwelling in which the respondent lives.	Dummy
Years member	The number of years being a REC member.	Number of years

Table 6: Logit regression: willingness to invest (WTI) of non-members vs members.

Willingness to invest	Members	Non-members	Full sample
Sample size	811	567	1,453
Age	0.323*** (0.121)	0.141 (0.099)	0.375*** (0.058)
Income	0.297*** (0.109)	0.301*** (0.063)	0.265*** (0.050)
Pro-environmental mindset	0.933*** (0.202)	0.997*** (0.161)	1.000*** (0.116)
Education	0.189 (0.161)	0.003 (0.117)	0.026 (0.087)
REC understanding	-0.265 (0.232)	0.402*** (0.107)	0.486*** (0.085)
HP	-0.201 (0.407)	0.758*** (0.262)	0.451** (0.211)
PV	0.417 (0.321)	-0.105 (0.304)	0.331* (0.188)
Home owner	0.022 (0.537)	-0.199 (0.258)	0.072 (0.217)
Apartment	-0.122 (0.532)	0.994*** (0.376)	0.438 (0.280)
Semi-detached	-0.342 (0.370)	0.622 (0.430)	0.041 (0.250)
Terraced	-0.069 (0.446)	0.228 (0.393)	-0.010 (0.254)
Villa	0	0 (omitted)	0
Rural	0.769* (0.452)	0.444 (0.353)	-10.160 (468.497)
Suburban	-0.097 (0.356)	-0.009 (0.243)	-10.632 (468.497)
City		0 (omitted)	-10.555 (468.497)
Years member	-0.055*** (0.019)		
Constant	-8.118*** (-2.092)	-11.874*** (-1.592)	-1.394 (0.468)
Pseudo R2	0.124	0.142	0.279
Log likelihood	-206645	-334579	-610.871

Significance levels after two-sided z-test are indicated with \*\*\* for  $P < 0.01$ , with \*\* for  $P < 0.05$  and with \* for  $P < 0.1$ . Observations of respondents who indicated to have a WTI of 3 on a 1 to 5 Likert scales were not retained. Standard errors reported in parentheses.

**Table 7: OLS regression result: non-members' motivations to invest in a renewable energy cooperative**

Variable	Coefficient
Production of sustainable energy	0.078** (0.030)
The return on investment	0.032 (0.027)
The location of the renewable installation	-0.004 (0.024)
The co-owners of the renewable installation	0.064** (0.025)
The influence of advice of others	0.018 (0.022)
Constant	2.722*** (0.174)

Standard errors of the OLS regression between parentheses. Only non-members who indicated to have a willingness to invest in a REC of minimum 3 on a 1 to 5 Likert scale were included in this regression ( $n = 588$ ). Significance levels after two-sided t-test are indicated with \*\*\* for  $P < 0.01$ , with \*\* for  $P < 0.05$  and with \* for  $P < 0.1$ .

**Table 8: Item correlations and Cronbach's alpha for regrouped variables of pro-environmental mindset for the full sample ( $N = 2,358$ )**

Variable	Item-test correlation	Item-rest correlation
<b>Pro-environmental mindset</b>		
I want to feel that I am personally contributing to the protection of the environment	0.850	0.722
I am concerned about climate change	0.771	0.595
I am the type of person who cares about the environment	0.881	0.776
I see myself as an environmentally conscious consumer	0.838	0.702
Cronbach's alpha	0.855	