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# A Critical Approach on Sustainable Renewable Energy Sources in Rural Area: Evidence from North-West Region of Romania

**Gabriela O. Chiciudean [1], Rezhen Harun [2], Felix H. Arion [1], Daniel I. Chiciudean [1], Camelia F. Oroian [1] and Iulia C. Muresan [1,*]**

[1] Department of Economic Sciences, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Manastur Street, 400372 Cluj-Napoca, Romania; gabriela.chiciudean@usamvcluj.ro (G.O.C.); felixarion@usamvcluj.ro (F.H.A.); chiciudean.daniel@gmail.com (D.I.C.); camelia.oroian@usamvcluj.ro (C.F.O.)

[2] Department of Agribusiness and Rural Development, College of Agricultural Sciences, University of Sulaimani, Kurdistan Regional Government-Iraq, 5100 Sulaimani-Bakrajo, Iraq; rezhen.rashid@univsul.edu.iq

* Correspondence: iulia.muresan@usamvcluj.ro; Tel.: +40-721-643-136

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**Abstract:** In the favorable context of a potential increase in the use of renewable energy sources in Romania, a research was conducted among the rural population in the North-West region of development in order to analyze public perception regarding this alternative energy production. A survey was conducted on a sample of 322 respondents and data was analyzed using different statistical methods (Principal Component Analysis, Cluster analysis, etc.). Results indicated a positive attitude towards renewable energy and support mainly from young and highly educated people. The percentage of users is relatively low and there is little intention in the future to switch to a renewable energy source even if it is perceived as a sustainable way of living. Lack of knowledge regarding renewable energy sources is the most important aspect and authorities should assume a mission in the public education of citizens in order to implement the measures and achieve the goals established in the national strategy plans.

**Keywords:** sustainable energy development; energy management; perceptions on renewable energy sources; public acceptance

## 1. Introduction

During the last several decades, public awareness regarding climate change, pollution's effects, and alternative energy sources increased substantially. Members of the United Nations assumed that by adopting the United Nations Framework Convention on Climate Change (1992) to proceed to measure the reduction of greenhouse emissions and promote sustainable use of energy. The agreements should be reflected in the national policies and strategies of each member state [1]. The reduction of greenhouse emissions was mentioned as a priority in The Kyoto Protocol (1998), which also highlighted the need to research and promote renewable forms of energy [2] and the Copenhagen Accord (2009) [3]. The Doha Amendment (2012) [4] adds new emission reduction targets for the period between 2012 to 2020 for the member states. The urgent need for adopting sustainable energy sources was mentioned in the Paris agreement (2015) and the member states mentioned that the access to such sources should be universal [5]. The above mentioned agreements served as a starting point for different projects and research, but Centobelli et al. [6] emphasized that there are still several gaps such as the classifications of energy efficiency, the impact of energy efficiency, the environmental sustainability on supply chain

performance, and the customer perspective in a sustainable and energy-efficient supply chain that need deeper research in order to achieve the objective of these agreements.

According to a World Bank report published by the institution in 2017, Romania is at the forefront of the RISE (Sustainable Energy Indicators Top) due to obtaining 87/100 points following important countries like Denmark, the United States of America, and the United Kingdom [7]. Among the three pillars analyzed by the institution, 74 points out of 100 were obtained for the renewable energy domain (rank 20), which means there is a huge potential for conversion and expansion. The rapid growth in the use of renewable energy is similarly reflected in the Romanian national indicators where the share of renewable energy sources in the total electric energy sources registered a favorable evolution from 28.8% in 2000 to 40.8% in 2015 [8]. Romania has a great potential in terms of renewable energy resources [9] and the government supports its development by undertaking certain measures such as: increasing the use of renewable sources of energy, extending the green certificates market in order to attract private capital for investments, promoting renewable energy sources for heating and hot water, and accessing structural funds.

The European Court of Auditors mentioned in their special report that the increasing use of renewable energy is an important objective for the European Union member states because of multiple benefits. These benefits include decreasing greenhouse gas emissions, reducing energetic dependency, and increasing the energetic security supply as well as bringing a substantial contribution to sustainable development in rural areas [10]. Moreover, the use of renewable energy is perceived as a key element for achieving sustainability [11]. At the European level, renewable energy production showed a positive evolution (increased by 71%) from 2005 to 2015 compared to energy from other sources, which decreased within the same period [12].

By 2020, it is expected that the use of energy from renewable sources in Romania would increase by 24% including investments in residential buildings [13]. At the same time, it is expected that the energy efficiency to increase by 19%, according to the agreement between Romania and the European Commission approved on 7 August 2014 [13]. The consumers' perception regarding the renewable energy sources and the public acceptability was analyzed by different scholars during the last several years [14–24]. Given the general context and the main public objectives regarding the use of renewable sources of energy, the public perception and acceptance of these relatively new methods of obtaining energy is an essential pillar for sustainable development of the sector in order to achieve the objectives proposed by the national and international strategies. Therefore, research was conducted in order to analyze public perception regarding the use of renewable energy sources among rural residents from the North-West Development Region of Romania and in order to determine the main constrains of using renewable resources. Because previous studies on renewable energy sources conducted in the North-West Region were mainly focused on the potential and the supply of renewable energy sources [25–28], the objective of the current paper is to present the local residents' attitude and perception from a rural area of the North-West Development Region of Romania towards renewable energy sources.

The paper is structured in six main sections. After the introduction, a section related to the literature review of the consumers' perception on renewable sources is presented. The third section presents the research area and describes the research methodology. Furthermore, the results are presented in the fourth section while the fifth section is dedicated to the discussions. The paper ends with the conclusions and implications of the study, which is presented in the sixth section.

## 2. Literature Review

Previous studies related to the subject are mainly focused on consumers' perception regarding the use of renewable energy and levels of awareness of different sources of energy. Public acceptability is the key factor for a successful implementation of renewable sources of energy. The high support is also favored by the new trend regarding a "green lifestyle" and environmental interest. People becoming more "eco-conscious" [14,15]. Generally, there is strong support for renewable energy among populations from different countries such as Austria, Greece, Portugal, Hungary [16], Eastern Ontario

Highlands [17], Nigeria [18], India [19], Canada, the UK, Denmark [16,20], USA [21], and China [22] even if there is not always a clear distinction made between the terms used. While there is a general positive attitude towards renewable energy sources, the study conducted by Devine-Wright [16] indicated that consumers from Slovakia and Romania were more oriented towards fossil fuels and nuclear energy when the study took place, which is a fact explained by the political patterns of the former soviet economy. There was also less understanding of renewable energy and the technologies used that was observed among Swiss consumers [23] who could not distinguish between solar thermal heating and photovoltaics. The authors consider that the low level of knowledge in terms of clean energy is the major barrier for market penetration. Similar conclusions were obtained after conducting a study in USA [24] where the author stated that the major barrier in using this type of energy is the low level of knowledge among consumers who do not understand why such technologies are needed to produce energy.

Regarding the type of renewable energy sources, various studies from different countries show a better awareness and acceptance of solar energy, wind, and water while a low awareness is revealed towards biomass. Solar energy was mentioned as "the most positively regarded form of renewable energy technology" [20], but there is also high support for wind energy among the public in the countries investigated (Canada, Denmark, UK) [16]. There was high interest noticed from the locals in the Ontario municipalities regarding solar technologies while they showed little interest towards wind turbines and hydroelectric dams [17] while in Shandong, China, the mostly used type of renewable energy is biogas and solar power while there is strong support for these two [22]. In a GFK research conducted in UK in 2009 regarding people's awareness about renewable energy, 82% of the respondents are familiar with solar and hydroelectric energy while only 59% with wind energy and 57% with biomass energy [29]. In Nigeria, 87% of the population interviewed consider that solar energy is the solution for improving the electricity system while, for biomass and wind sources, people are not convinced that they represent a viable solution [18]. Findings are very interesting in the context of almost half of the population using hydropower while the solar one is used only by 23% of the population interviewed. In India, the same high interest for solar sources has been observed when compared to other forms of renewable energy such as biogas [19] while, in Turkey [30], a study among the urban population designed to understand the highest preferred source of energy indicated that the opposition against renewable sources is the weakest. Only 4% of the sample interviewed is against using it. Regarding the type of energy sources Italian people mostly prefer, the results indicated the existence of three equal groups in terms of preferences: the first group is strongly attached to wind and solar energy and strongly dislikes biomass and nuclear power, the second group shows moderate preference for wind and solar energy and dislikes biomass and nuclear sources, and a third group strongly prefers solar, wind, and biomass energy and is totally against nuclear energy [31].

Although there is general public acceptance of renewable energy as a viable alternative for traditional sources, there are barriers or constraints in adopting it with capital costs being the most frequently mentioned [19,32–35]. Alongside the cost problem, technical barriers, market barriers, and institutional and regulatory barriers [35,36] were also mentioned. In the case of North African countries, three main risks were identified including regulatory risks, political risks, and force majeure (terrorism) [37]. When it comes to water as a source of electricity, the principal barrier was considered "the excessive number of regulatory approvals" [17]. Barriers like "unattractiveness" and "unaffordability" were mentioned by the population of UK related to the solar systems [38]. In Scotland, there is governmental support for investments in wind farms and hydro schemes. Findings indicated that, apart from the existence of general support from the public, there are people who consider that the projects could affect the quality of the landscape [39].

The public acceptability of renewable energy sources is also influenced by the socio-demographical characteristics of the people interviewed. Therefore, it was observed among the population from Ontario Islands that the income and the level of education influence the way people perceive renewable energy [17]. Lower-income people are interested in keeping energy costs low while less educated

people feel less supportive of alternative energy. In Sweden, a study regarding wind power as an alternative source of energy indicated that the support from the public decreases with age and income [40] while Italian people are divided in two groups including "traditional energy users" who are older and less educated people and "potential users of renewable energy" who are young and educated people [31]. Renewable energy is also strongly supported by young Australian people [41]. Moreover, it was investigated whether people from Queensland Australia are willing to pay extra for energy produced from renewable sources and results indicate that 83% of the sample agree to pay extra [42]. A study from Norway regarding public attitudes towards renewable energy indicates that people above 60 years of age are against this form of energy [43]. The attitude of the rural population from Shandong, China towards renewable energy is positive and the willingness to pay more for obtaining it is increasing with a high level of knowledge and household income but it decreases with age [22]. Similar findings were obtained in Nigeria [18]. In UK, young people with a high socio-economic status have more positive attitudes towards renewable energy [29]. A study from New Mexico (USA) concluded that household size and income is positively related to the willingness to pay extra for renewable energy [44].

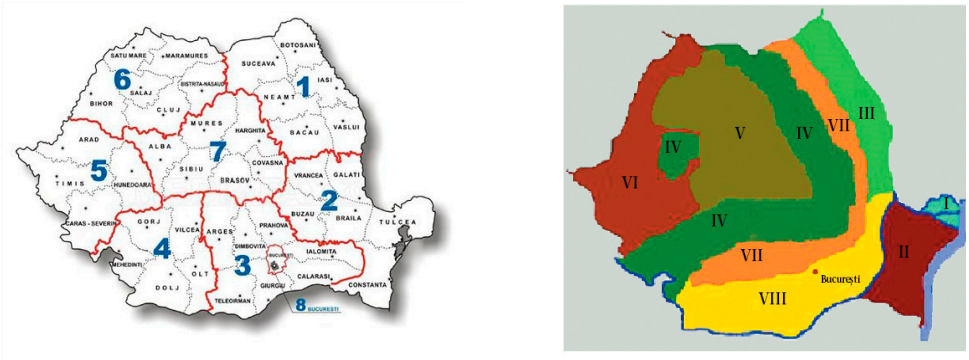
A high level of education is often associated with an increased knowledge regarding the environment and renewable energy, but it does not always lead to pro-environmental behavior [45].

## 3. Materials and Methods

The materials and methods section comprises two subsections. The first subsection "*Data Collection*" presents the research area and the research instrument while the second subsection "*Methods and Data Analysis*" describes the methods used to analyze the data from the survey.

### 3.1. Data Collection

The main objective of the research was to determine the perception of renewable energy among the rural inhabitants from the North-West Region of Romania. This region of development comprises six counties including Bihor, Bistrita-Nasaud, Cluj, Maramures, Satu-Mare, and Salaj and has a surface area of 34,159 km$^2$ (14.32% of the total country surface) (Figure 1a) [46,47]. Romania has a high potential of renewable energy [48]. The North-West region of development is recognized by various types of renewable energy sources such as solar, micro-hydro sources, biomass, geothermal, and wind energy (Figure 1b) [49].




(**a**) (**b**)

**Figure 1.** Territorial distribution of developmental regions of Romania and the renewable energy potential: (**a**) Development regions of Romania [47]. 1-North-East region, 2-South-East region, 3-South-Muntenia region, 4-South-West region, 5-West region, 6-North-West region, 7-Central region, 8-Bucharest-Ilfov region; (**b**) Romanian renewable energy potential [49]. I-solar energy, II-solar, biomass, and wind energy, III-micro-hydro, wind, and biomass energy, IV-biomass, micro-hydro, and wind energy, V-micro-hydro and biomass energy, VI-geothermal and wind energy, VII-biomass and micro-hydro energy, VIII-biomass, geothermal, and solar energy.

A survey was conducted from April to July 2016 using the face-to-face interview as a contact method. The sample was established to 384 respondents with a relative error of a 5% and a 95% confidence level. The total number of inhabitants from rural area was 1,075,725 [50]. The total number of distributed questionnaires was 400 with a response rate of 86.5% (322 respondents). The questionnaire consisted of 19 questions divided into three important sections. Following the socio-demographic profile of the respondents, the perception on renewable energy and the main barriers in using it. For the purpose of this paper, we analyzed the data related to the socio-demographic characteristics of the respondents and their perceptions toward renewable energy sources. The respondents needed between 15 and 20 min to fill in the questionnaire.

### 3.2. Methods and Data Analysis

The collected data were analyzed using a software package SPSS 20.0. Descriptive statistical analysis was used to determine the socio-demographic profile of the consumers and to indicate the means and standard deviations of each of the variables used to describe respondents' perceptions on renewable energy sources. Two principal component analyses (PCA) were conducted separately. The first to group the perception variables about renewable energy sources (12 items measured using 5-points Likert-style scale where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) and the second to group the variables regarding the aspects that may influence the future intention to use renewable energy sources (8 items measured using a 4-point scale where 1 = strongly disagree, 2 = disagree, 3 = agree, and 5 = strongly agree). The Varimax rotation was used to maximize the differences among the components extracted and to maintain correlation among the components. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of Sphericity were used to determine the fitness of the data. All factors with eigenvalues higher than 1 were retained for future analysis [51].

The factors loaded after running the first PCA were, furthermore, used for a cluster analysis. A hierarchical cluster analysis was conducted in order to isolate different groups within the sample and examine their common features. Cluster analysis is recognized for the ability to divide the observations into homogeneous and distinct groups [52]. Ward's algorithm was used to determine the preliminary number of clusters based on the perception factors. Furthermore, the Shapiro-Wilk test was used to test the normality of the statements ($p < 0.05$) and the Mann-Whitney U test was chosen to compare the two groups.

## 4. Results

The results section is divided into three subsections following the main objectives of the research including to identify the socio-demographic profile of the respondents from the rural area, where the research was conducted, and to perform deep analysis of their perceptions and attitudes towards renewable energy sources in order to determine its public acceptance.

### 4.1. Socio-Demographic Profile of the Respondents from the Rural Area

From the point of view of the respondents' gender, Table 1 shows that the percentage of female respondents is higher (52.5%), but there is a quite balanced situation since the difference is not too high. With regards to respondents' age, it can be noticed that the distribution is also balanced even if some segments are well-represented such as the group aged between 20–29 years, which represents 27.2% and the group aged 40–49 years holding 22.8%. Youngsters aged between 15 to 19 years hold the smallest percentage (4.9%) followed by elders aged 60 and over (6.6%). Given the fact that 59% of the respondents graduated from high school and 27.2% have a university degree, it can be stated that the sample is somewhat educated. The variable "income" divides the sample into three groups. It was observed that the majority (61.3%) of the respondents declared a monthly house income of less than 445 euro (Table 1).

**Table 1.** Socio-demographic characteristics of the respondents.

| Variables | % |
|---|---|
| Gender | |
| Female | 52.5 |
| Male | 47.5 |
| Age | |
| <20 years | 4.9 |
| 20–29 years | 27.2 |
| 30–39 years | 16.5 |
| 40–49 years | 22.8 |
| 50–59 years | 19.7 |
| >60 yeas | 6.6 |
| n.a. | 2.3 |
| Education | |
| Illiterate | 1.7 |
| Less than high school | 10.7 |
| High school | 59.0 |
| University degree | 27.2 |
| n.a. | 1.4 |
| Monthly house hold income | |
| <445 euro | 61.3 |
| 445–895 euro | 26.3 |
| >895 euro | 10.4 |
| n.a. | 2.0 |

Note: n.a.—not answer.

### *4.2. Perception on Renewable Energy Sources*

The first PCA was conducted to assess the dimensionality of the 12 items. The Barlett test of Sphericity was significant (Chi-square = 1181.469, $p = 0.000$). The KMO overall measure of sampling was 0.764 (>0.6), which indicated that data were suitable for the PCA [53]. The exploratory factor analysis with Varimax rotation of the 12 variables resulted in a three-factor solution that explains 58.07% of the total variance. All three factors had eigenvalues greater than 1. The Cronbach's alpha reliability coefficient was computed to evaluate the internal consistency of each component. The overall reliability of the 12 variables was 0.74. The first two factors had reliability coefficients ranging higher than 0.6. The third factor (knowledge) had a reliability coefficient of less than 0.6 ($\alpha = 0.48$) and it was not retained for further analysis. Table 2 presents the three underlying dimensions resulting from the first PCA.

The first dimension entitled "Sustainability" explained 27.24% of the total variance with a reliability coefficient of 0.78. The first factor was comprised of seven attributes and had a mean of 3.49 (SD = 0.734) (Table 3). This factor comprised statements that highlight the fact that the use of renewable energy contributes to a sustainable development because of the following reasons. It is more reliable, safer, and capable of phasing out the traditional sources and conventional fuels, which leads to a greener life.

Among the seven statements, the respondents showed the highest degree of agreement with the fact that renewable energy is capable of contributing to a shift in people's lifestyle by adopting a greener way (mean = 4.22, SD (standard deviation) = 0.791). Except for the fact that renewable energy is not perceived as being cheap (mean = 2.94, SD = 1.322), all the rest of the statements were considered more or less neutral (mean varying between 3.22 and 3.60).

The second factor labeled "negative environmental impact" comprised three statements, which explained 21.05% of the total variance with a reliability coefficient of 0.85. This component had a mean of 2.14 (SD = 1.025). The statements indicate that people generally perceived renewable energy as having a reduced impact over the environment, which was supported by the mean values obtained for

all three statements. Therefore, people disagree that renewable energy facilities could harm/disturb people in their surroundings (mean 2.15, SD = 1.145) or it could affect the flora and fauna (mean = 2.12, SD = 1.179) and have a harmful impact on biodiversity and the environment (mean 2.10, SD = 1.169).

**Table 2.** PCA regarding the perception regarding renewable sources of energy.

| Eigenvalue | Variance % | Component | Item | Factor Loading | Communalities |
|---|---|---|---|---|---|
| 3.269 | 27.24 | Sustainability $\alpha = 0.78$ | Electricity generated with renewable energy sources is cheap compared to other sources. | 0.627 | 0.453 |
| | | | Electricity from renewable sources is more reliable in terms of continuous supply. | 0.627 | 0.638 |
| | | | Renewable energy facilities are safer when compared to other types of power stations. | 0.619 | 0.573 |
| | | | For higher cost effectiveness, renewable energy requires improved energy conservation measures. | 0.435 | 0.215 |
| | | | Renewable energy sources are capable of phasing out the traditional energy sources in households in the future. | 0.775 | 0.604 |
| | | | Energy generated from renewable technologies can replace the use of conventional fuels (like oil/coal/gas etc.). | 0.753 | 0.572 |
| | | | A shift to renewable energy can contribute to a greener lifestyle. | 0.685 | 0.556 |
| 2.527 | 21.05 | Negative environmental impact $\alpha = 0.85$ | Renewable energy facilities harm/disturb the people in their surroundings. | 0.882 | 0.792 |
| | | | Renewable energy facilities harm/disturb flora and fauna in their surroundings. | 0.899 | 0.821 |
| | | | Renewable energy application have a harmful impact on biodiversity and the environment. | 0.797 | 0.651 |
| 1.17 | 9.77 | Knowledge $\alpha = 0.48$ | Substantial knowledge on the application of renewable energy is required for its successful application in the household. | 0.781 | 0.643 |
| | | | Do not have enough experience to identify the long term impact of renewable energy sources on the environment. | 0.655 | 0.451 |
| Total variance % | 58.07 | $\alpha = 0.74$ | | | |

The third factor labeled "knowledge" contained two statements. It had a mean of 3.75 (SD = 0.878) and a reliability coefficient of 0.48, which explained 9.77% of the total variance. This factor comprised the statements, which refer to people's perception and knowledge regarding this type of alternative energy. There was a relatively high degree of agreement towards the first statement regarding the fact that knowledge is needed for using renewable energy within households (mean = 3.88, SD = 1.182) while the second reflected the lack of experience for the long-term in using this type of energy in order to evaluate its impact on the environment (mean = 3.60, SD = 0.973). Even if the knowledge component was directly related to the use of renewable energy, it was decided to remove this factor from the future analysis of the data due to the communality value below 0.6 ($\alpha = 0.48$).

**Table 3.** Perception on renewable energy sources.

| Item | Mean | SD |
|---|---|---|
| Sustainability | 3.49 | 0.734 |
| Electricity generated with renewable energy sources is cheap compared to other sources. | 2.94 | 1.322 |
| Electricity from renewable sources is more reliable in terms of a continuous supply. | 3.38 | 1.172 |
| Renewable energy facilities are safer compared to other types of power stations. | 3.41 | 1.143 |
| For higher cost effectiveness, renewable energy requires improved energy conservation measures. | 3.60 | 0.987 |
| Renewable energy sources are capable of phasing out the traditional energy sources in households in the future. | 3.22 | 1.197 |
| Energy generated from renewable technologies can replace the use of conventional fuels (like oil/coal/gas etc.). | 3.54 | 1.048 |
| A shift to renewable energy can contribute to a greener lifestyle. | 4.22 | 0.791 |
| Negative environmental impact | 2.14 | 1.025 |
| Renewable energy facilities harm/disturb the people in their surroundings. | 2.15 | 1.145 |
| Renewable energy facilities harm/disturb flora and fauna in their surroundings. | 2.12 | 1.179 |
| Renewable energy application has a harmful impact on biodiversity and the environment. | 2.10 | 1.169 |
| Knowledge | 3.75 | 0.878 |
| Substantial knowledge on the application of renewable energy is required for its successful application in the household. | 3.88 | 1.182 |
| Do not have enough experience to identify the long-term impact of renewable energy sources on the environment. | 3.60 | 0.973 |

Based on the two dimensions, "Sustainability" and "Negative Environmental Impact," a hierarchical cluster analysis using Ward's algorithm identified two homogenous clusters in the overall sample (Table 4). The k-means algorithm used to distribute them into classes created two groups that counted for more than 90% (93.6%) of the total number. The factor with the highest influence on clustering the respondents was "sustainability" followed with a huge difference by a "negative environmental impact" (Tables 4 and 5).

**Table 4.** Final cluster centers.

| Factors | Cluster 1 (n = 158) | Cluster 2 (n = 164) | F Value | Significance |
|---|---|---|---|---|
| Sustainability | 0.83209 | −0.79991 | 638.738 | 0.000 *** |
| Negative environmental impact | −0.11863 | 0.11429 | 4.412 | 0.036 * |

* $p < 0.05$, *** $p < 0.001$.

**Table 5.** Mean of factors.

| Factors | Cluster 1 (n = 158) | Cluster 2 (n = 164) | U | Significance |
|---|---|---|---|---|
| Sustainability | 4.04 | 2.91 | 104.00 | 0.000 *** |
| Negative environmental impact | 1.99 | 2.20 | 10,021.00 | 0.000 *** |

*** $p < 0.001$.

Using the Mann-Whitney U test, the two clusters were compared in terms of the socio-demographic profile (Table 6). They are relatively numerically balanced and the first cluster is smaller but only by six persons (Cluster 1 = 158 and Cluster 2 = 164).

Lastly, the clusters were labeled, according to the factors considered to be distinctive for the respondents and related to the perception of renewable energy sources. The factor with the highest importance on the clustering of the consumers was "Sustainability" (Table 4).

Cluster 1 (n = 158): "Optimists" was the smallest and represented 49.06% of the consumers. Cluster 1 appeared to have the highest mean score for the "Sustainability" factor (4.04) (Table 5) and the lowest mean score for a "negative environmental impact" (1.99). Therefore, it can be concluded that consumers from this group of respondents perceive the use of renewable energy sources in

a significantly positive way and believe that this alternative energy has a low environmental impact. The first group is dominated by female respondents (57.6%) while, regarding the variable age, it can be noticed that, by comparison with the second Cluster, it grouped young respondents (22.8% of the respondents are aged between 20–29 and 13.90% are aged between 30–39). Additionally, it can be noticed that this cluster exhibits the highest share of highly educated people with a university degree (33.5%) and the highest share of respondents with a relatively high income (49.4%). This group is dominated by renewable energy users (11.4%) compared to the second group, which comprises only 5.5% of people who use such sources (Table 6).

Cluster 2 (n = 164): "Skeptics" was the largest group and represented 50.93% of the consumers. Cluster 2 had the lowest mean score on "sustainability" (mean = 2.91) and the highest on a "negative environmental impact" (mean = 2.20). The second cluster exhibited the highest share of male consumers (53.7%) and the highest percentage of members with a medium level of education (67.1%) and average income (43.3%). It can be stated that generally the skeptics are aged between 40 and 49 years and above. A very small share of respondents use renewable sources of energy (5.5%) (Tables 4 and 6).

**Table 6.** Characteristics of segmented clusters.

| Characteristics | | Cluster I | Cluster II |
|---|---|---|---|
| **Number of Members** | | **158** | **164** |
| Gender | Female | 91 (57.6%) | 76 (46.3%) |
| | Male | 67 (42.4%) | 88 (53.7%) |
| | $\chi^2 = 9.223$, df = 1, $p = 0.026$ * | | |
| Age | Under 20 | 11 (7.00%) | 6 (3.7%) |
| | 20–29 | 36 (22.8%) | 24 (14.6%) |
| | 30–39 | 22 (13.90%) | 10 (6.10%) |
| | 40–49 | 59 (37.30%) | 65 (39.6%) |
| | 50–59 | 23 (14.60%) | 41 (25.0%) |
| | Over 60 | 7 (4.40%) | 18 (11.0%) |
| | $\chi^2 = 25.231$, df = 5, $p = 0.000$ *** | | |
| Education level | Illiterate | 6 (3.8%) | 0 (0%) |
| | Less than high school | 16 (10.20%) | 21 (12.81%) |
| | High school | 83 (52.5%) | 110 (67.1%) |
| | University degree | 53 (33.5%) | 33 (20.1%) |
| | $U = 11{,}272.5$, $p = 0.06$ | | |
| Household monthly income | <225 euro | 14 (8.9%) | 8 (4.9%) |
| | 225–445 euro | 24 (15.2%) | 46 (28.0%) |
| | 445–895 euro | 42 (26.6%) | 71 (43.3%) |
| | >895 euro | 78 (49.4%) | 39 (23.8%) |
| | $\chi^2 = 31.768$, df = 3, $p = 0.000$ *** | | |
| Use of renewable energy sources | YES | 16 (11.4%) | 9 (5.5%) |
| | NO | 142 (88.6%) | 155 (94.5%) |
| | $\chi^2 = 2.524$, df = 1, $p = 0.112$ | | |
| Support for renewable energy | $U = 7035$, $p = 0.000$ *** | 3.65 | 3.30 |
| Friability of renewable energy sources | $U = 12{,}049.5$, $p = 0.254$ | 3.69 | 3.66 |

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

### *4.3. Respondents' Attitudes of Renewable Energy Sources*

The second PCA was conducted to assess the dimensionality of the eight items. The Barlett test of Sphericity was significant (Chi-square = 563.091, $p = 0.000 < 0.05$). The KMO overall measure of sampling was 0.809, which means an exploratory factor analysis was conducted with Varimax rotation of the eight variables. The result obtained indicated a two-factor solution that explains 53.74% of the total variance. Both factors had eigenvalues greater than 1. The Cronbach's alpha reliability coefficient

was computed to evaluate the internal consistency of each component. The overall reliability of the variables was 0.76 and all the factors had reliability coefficients that are higher than 0.6 (Table 7).

**Table 7.** PCA on respondents' attitudes regarding sources of energy.

| Eigenvalue | Variance % | Component | Item | Factor Loading | Communalities | Mean | SD |
|---|---|---|---|---|---|---|---|
| 3.127 | 39.087 | Support for renewable energy sources α = 0.71 | Switch to sustainable energy sources | 0.799 | 0.641 | 3.29 | 0.831 |
| | | | The state supports your energy supply decision | 0.686 | 0.459 | 3.51 | 0.642 |
| | | | Apply energy saving measures in your household | 0.670 | 0.461 | 3.52 | 0.651 |
| | | | Energy supply is from a technically safer source | 0.642 | 0.475 | 3.51 | 0.583 |
| | | | People need to have more information about the various aspects of the energy options available to them | 0.532 | 0.440 | 3.53 | 0.632 |
| 1.172 | 14.649 | Reliability of renewable energy sources α = 0.62 | Electricity does not cost too much | 0.866 | 0.751 | 3.67 | 0.581 |
| | | | Electricity supply to be reliable and continuous | 0.736 | 0.601 | 3.62 | 0.553 |
| | | | Electricity supply should not have a negative impact on the environment | 0.472 | 0.435 | 3.71 | 0.495 |
| Total variance % | 53.736 | α = 0.76 | | | | | |

After conducting the second PCA, two dimensions were obtained and named according to their content. The first dimension explains 39.087% of the total variance with a reliability coefficient of 0.71 and comprises five statements that indicated "Support for renewable energy sources" among the respondents. The large proportion of the total variance can be explained by the general positive attitude that consumers have on renewable energy even if they do not intend to switch to a renewable source. Respondents considered that the most important aspect related to the renewable energy sources is to obtain more information about the options available to them (mean = 3.53, SD = 0.632).

Moreover, the respondents perceive as being equally important to apply energy saving measures in their households (mean = 3.52, SD = 0.651), but the least important statement is related to the possibility to switch to sustainable sources (mean = 3.29, SD = 0.831). This is a fact that indicates a relatively low knowledge about the possibilities to save energy using renewable sources. Respondents considered important to have a technically safe source of energy (mean = 3.51, SD = 0.583) but also expect help and support from the authorities (mean = 3.51, SD = 0.642).

The second dimension labeled "reliability of renewable energy sources" explains 14.649% of the total variance with a reliability coefficient of 0.62 and contains three statements. This dimension recorded mean values greater than the first, which means that respondents perceive electricity more favorable or it can be stated that this source of energy is more familiar to them and also not expensive (mean = 3.67, SD = 0.581). Results reinforce the idea of a political and historical pattern for a former soviet country [16].

The most important aspect from the respondents' point of view is that the equipment that provides electricity does not harm the environment (mean = 3.71, SD = 0.495), but it is also reliable and continuous (mean = 3.62, SD = 0.553) (Table 7).

## 5. Discussions

The results indicated that respondents from the rural areas of the North-Western region of Romania had a generally positive perception on renewable energy sources, which is a fact observed in other countries as well and confirms the importance of bringing these new sources of energy to the attention of the population in order to increase the number of households using sustainable energy [14,16–22]. It is also for the public support in building political and economic strategies [54]. The results reinforce the major directives from the Romanian national and regional strategies that are willing to support the use of renewable sources of energy. Respondents considered that a shift in using such sources would contribute to a sustainable development and give the possibility to adopt a greener way of life, which is safe for the environment [55] and the last decades gave way to the "green consumer", which ensures not to disturb or harm any living organism or the environment [14]. The results also indicated that respondents perceive renewable energy as not being cheap, which is less accessible. This fact might be considered a barrier in their intentions to adopt this form of energy. These financial issues as the main barriers were also reported in other studies [35,55–60].

After clustering the respondents, based on the factors considered important with respect to renewable energy sources, two groups were identified and labeled: optimists and skeptics. Optimists represent the smallest group but are highly supportive in terms of renewable energy and are dominated by female respondents (57.6%) unlike other studies where men are more supportive [61]. The first cluster is more educated than the second. Additionally, 33.5% of the respondents held a university degree when compared to the second cluster, which is more numerous but the respondents with a university degree held a smaller percentage (20.1%). Among the respondents from the first cluster, there are individuals younger than the ones from the second cluster and have higher incomes. The relation between a high level of education and support for renewable energy was also observed by other scholars [17,31,40,41,44,45].

For the individuals from the first cluster, the sustainable issue of renewable energy represented a more important aspect compared to the second cluster where the individuals did not pay such importance to it. Additionally, there is a stronger support for renewable energy sources among respondents from the first cluster when compared to the ones from the second cluster called "skeptics". Even if this group comprised the highest percentage of renewable energy users (11.4% compared to 4.9%), the percentage is still very low if we consider other studies where the users held 38% of the population [59]. The two groups with particular socio-demographic characteristics and attitudes toward renewable energy are similar to other groups identified such as "traditional energy users" and "potential users of renewable energy" [31].

The results obtained underlined the major problem that is associated with the use of renewable energy, which is a lack of knowledge regarding these sources of energy. The same issue was mentioned by other researchers, which concluded that a lack of knowledge is the main barrier in market penetration [23,24,62] while the willingness to pay more for renewable energy is increasing with the level of knowledge [18,22]. The high level of education is often associated with increased knowledge regarding the environment and renewable energy but does not always lead to pro-environmental behavior [45]. On the one hand, the phenomenon might be explained by the novelty of such technologies mainly in a former comunist country like Romania where nuclear energy represented the basis of the economy [63,64] considered as a pattern [16] and, the low level of education among the rural population has led to a lower access of information unlike the urban one. Even if knowledge about the subject is relatively low, respondents were aware of the need to save energy within their households. Still, among the statements, the possibility to switch to renewable sources recorded the lowest level of agreement.

## 6. Conclusions

Currently, the rural economy can no longer rely solely on agriculture activities [39] but must find solutions in order to obtain a proper diversification and contribute to the creation of a non-agriculture

sector as well. This means taking advantage of the huge potential regarding renewable energy utilization. After analyzing the perception about renewable energy sources among the rural population from the North-Western region of Romania, in the context of a favorable trend regarding the support for this form of energy source by national and international institutions, it can be concluded that a favorable attitude toward renewable energy was observed even if there are some issues that must be approached. Previous studies underlined the need for public acceptance in order to proceed to a large scale implementation of programs designed to introduce renewable energy sources within households and industries. A lack of knowledge was observed regarding renewable energy among the older population. The reason may reside in the Romanian historical past but also in the novelty of these sources. A need for information was also observed in the population. Therefore, public authorities that intend to support conversion by different measures must be aware of this need and first adopt some strategies meant to inform and to educate the population. Public acceptance is a key factor for achieving successful renewable energy deployment and exploitation. As such, the population must be taken into consideration in order to accomplish these objectives including increasing the share of renewable energy sources in the total energy consumption, creating a favorable mix of energy sources mainly with an internal origin in order to create a competitive energetically system, increasing the energy-based efficiency, and promoting renewable energy sources [8]. The study has its limitations because it was conducted on the population from only one of the eight regions of development (which is in the top five of the best performing regions from Europe [65]). At the same time, due to the specificity of the region and its potential mainly for biomass renewable sources, micro-hydro energy, and wind power [25], the results are limited to the research area and cannot be extended to the whole country. Therefore, for a broader analysis, all regions must be taken into consideration without resuming to regional strategies and building national strategies. The next studies should focus more on the natural environmental characteristics of each of the research areas and its potential for different renewable sources but also on differences in perceptions among various stakeholders. The perspectives on the use of renewable sources may be different among public authorities and the private sector actors [66]. In addition, the willingness to pay for the population is an important factor that could have an important role for future development strategies.

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