

How Much Does Gender Affect the Behaviour of Using Renewable Energy Resources?

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Abstract: The transition to renewable energy resources is a challenge for Romania, as well as for the whole world. The goal of the European Commission is to accelerate the use of renewable resources to reduce net greenhouse gas emissions by at least 55% by 2030. Romania had in 2022, 40,171 prosumers with the forecast that they will reach 100,000 in 2023. The previous research carried out showed a positive attitude of the household population in Romania towards these energy resources, but also important barriers that considerably slow down the process, Romania being behind the target set by the European Commission. Through this research, we seek to identify how gender differences are reflected in the approach to renewable energy resources to facilitate this transition. The present research covers a gap in the specialized literature by investigating, differentiated by gender, the perception of Romanian residents regarding renewable energy resources. The case study was carried out in 2023 on residents of two cities out of the 266 in Romania, Oradea and Timișoara. The reasons for choosing the two cities are related to their similar economic development, positioning in the same part of the country, and, in particular, their performance in increasing the number of green energy prosumers. A questionnaire survey was carried out with a result of 1098 valid questionnaires with a gender structure that allows a differentiated analysis (42.53 men, 53.18 women, 4.28 unspecified). The internal consistency of the answers was carried out with α Cronbach. The data processing methods used are Importance-Performance Analysis, RStudio202207.1+554, and qualitative processing with Atlas.ti22. A hypothesis we tested is whether women are more sensitive to environmental issues and the type of energy produced and consumed or the cost factor is the one that dictates. The results suggest gender-differentiated solutions for raising public awareness and encouraging action. Limits of the paper are found only in the two Romanian cities, the geographical extension of the sample being a possible future research direction.

Keywords: Renewable Energy, Romania, Importance-Performance Analysis, Barriers

JEL classification: Q2, K32, D1, J1.

1. Introduction

At the level of the European Union, to meet the objectives set for 2030 in the field of energy and climate, members must establish an integrated national plan on energy and climate, for the period 2021-2030. The national plans outline how EU countries should address and develop energy efficiency, renewable energy sources, reducing greenhouse gas emissions, interconnection, research, and innovation. Romania's energy targets are closely related to the general objectives of the EU's energy and climate policy. Romania also aligns itself with EU directives and regulations included in the "Clean energy for all Europeans" package¹. These directives and regulations set out steps to be taken to achieve the transition to a cleaner and more sustainable energy system. Romania developed its National Integrated Plan in the field of Energy and Climate Change according to the requirements of EU regulations. The strategy in the field of Energy and Climate Change developed and included in this National Integrated Plan aligns the national energy and climate priorities with the EU objectives, confirming Romania's firm contribution to achieving community objectives and targets². The green strategy is outlined along five guidelines, the development of energy from renewable resources, the

¹https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_ro

²https://energie.gov.ro/wp-content/uploads/2023/12/NECP_Romania_first-draft-version-21.12.2023_RO.pdf

promotion of energy efficiency, the reduction of emissions, the fair transition, and the development of infrastructure.

Most of the studies in the literature have focused on identifying and measuring the impact of energy consumption, CO₂ emissions, energy conservation, and the use of renewable energies (Wang and Ye, 2017; Ding et al., 2017; Antonakis et. al, 2017; Prokop et al. 2023) but relatively few studies aim to analyse individuals' energy behaviour by analysing gender differences in household energy conservation practices. Although, in general, women are known to be more caring, and protective and have a more environmentally friendly attitude compared to men, the latter have more technical knowledge about the environment and energy and a greater inclination to risk-taking in investment decisions. Thus, in carrying out the study we started from the premise issued by Arachchi and Managi (2021) that women and men have different knowledge and behaviour regarding energy sustainability and its importance. Thus, to capture gender differences in the use of renewable energies, the subjects selected from two representative cities for the western area of Romania were investigated through a questionnaire and responses were statistically processed to facilitate discussion of results. This paper is organized as follows: after a brief introduction, the current state of the art is presented in key trends, the data and methodology is described and results, discussion, and conclusion are outlined in the second part of the work.

2. Theoretical Background

In combating climate change and ensuring energy security, renewable energy has become a particularly important objective. Adopting a gender perspective for renewable energy development is essential to ensure that women's contributions are an integral part of the green transition (Arias et al. 2023). The research of the last decade has proven that a greater number of women on the board of directors and the management of entities determines the growth of performance indicators but at the same time influences the organizational climate by instilling a greater openness to conciliation, collaboration, and empathy. Thus, achieving greater gender equity becomes a topic of interest in the field of renewable energy research as well. As shown by Atahau et al. (2021) renewable energy development in rural areas positively affects women. However, energy scarcity in some rural regions has a negative influence on their household tasks, therefore it is important to promote women's ability to maximize both sustainable development goals and women's well-being (Barrios et al., 2020). Access to energy increases household productivity and in rural areas energy allows women to perform household tasks also at night Atahau et al. (2021). The study conducted by Baruk and Goliszek (2023) showed that young Polish beneficiaries as respondents saw both positive and negative aspects of green energy. In the identified hierarchy of how this type of energy is interpreted, the top positions were occupied by aspects related to its sources and its positive impact on the environment. Most of the women and men surveyed identified green energy as coming from renewable sources. Hermawati's et al. (2023) results showed that micro hydropower as a renewable energy technology not only provides green electricity but also benefits many households. It has a significant impact on Indonesian women's empowerment, gender relations, and their relationship with rural development, including improving their living conditions. The biggest challenges for future implementations of this renewable energy technology in Indonesia are local ownership, networking to connect and motivate practitioners from various institutions and organisations and developing sustainable and successful long-term energy programs.

From the analysis of the socio-demographic characteristics of the investigated Slovenian consumers, Hojnik et al. (2021) noted that female consumers have higher levels of environmental concern and responsibility, while male consumers have a higher level of knowledge about green energy. The authors also showed that younger consumers have a lower level of concern and responsibility, however, they also have the lowest level of risk regarding the use of green energy and are more likely to pay for such energy resources than the rest of the population. The results of the study by Hojnik et al. (2021) revealed that education does not appear to be the deciding factor in that environmental responsibility and behaviour, but knowledge about green energy and willingness to pay for it appears to increase with consumer income. Dogan and Muhammad (2019) but also Lin and Syrgabayeva (2016) showed that environmental concern and responsibility, knowledge, and attitude towards green energy significantly and positively affect the willingness to pay for green energy and thus fuel the trend to choose green energy. Striteska et al. (2024) examined the effects of boards' gender diversity and family ownership on SMEs' green behavior expressed by the monitoring of energy consumption and proactive green strategies implementation. The authors' results highlighted that the presence of environmental managers is beneficial for the implementation of environmental strategies in family firms. They also observed that energy consumption monitoring of family firms is significantly triggered by energy taxes, but also by the gender diversity

of owners. In family firms, especially among owners, gender diversity can have positive effects on green behaviors. In other SMEs in CEE countries, the subject of gender diversity is more of a challenge for the future (Striteska et al., 2024). Environmental managers are important stakeholders, thus Prokop, et al., (2023), and Straub et al. (2023), recommend not only hiring them but also promoting gender diversity and increasing the skills of existing employees.

Aspects of gender diversity discussed in connection with environmental issues as observed by Li et al (2019), are significant not only at the individual level but also at the regional and national level signalling the level of education and culture. For countries like China, as Jayachandran (2015) pointed out, with a specific tradition and long history, solving the problems generated by gender inequality is an even greater challenge in the context of the development and implementation of environmental policies. The empirical results obtained by Li et al. (2019) showed that households in counties with greater gender inequality use less energy-efficient electrical products and are less willing to save energy. Findings are relevant to policymakers as they indicate that promoting gender equality can have a positive impact on ecological development.

In light of the above-reviewed studies, we aimed to find out if the perception of Romanian residents regarding renewable energy resources is biased by gender diversity and how this perception influences individuals' behaviour toward implementing green energy.

3. Data and Methodology

The study was carried out in two important cities in western Romania, Oradea and Timișoara. Both cities and counties to which they belong have an economic development above the Romanian average. In terms of transition to green energy, both counties (Bihor and Timiș) that host these cities are below the national average in terms of the number of prosumers, with approximately 2,000 in Bihor and 4,000 in Timiș, at the level of 2023 (Profit.ro). In June 2023, according to Profit.ro, the number of prosumers in Romania was 63,162 to reach the objective of 100,000. This is why we wanted to find out what are the main barriers to the adoption of renewable energy sources, from the perspective of residents, and if there are notable gender differences in acting on the barriers. The pursued objectives of the study are found in identifying the general attitude, separately of women and men, towards renewable energy sources; the main barriers to the adoption of renewable energy sources, separately for women and men; the influencing factors of the adoption of renewable sources with a good performance, in the opinion of the two categories of potential consumers; the influencing factors of the adoption of renewable energy sources on which the government must act; the influencing factors of the adoption of renewable energy sources that are less priority or even unimportant in the adoption of renewable sources, for the two categories of consumers; and assessing the level of direct and indirect personal experience of residents, women, and men, with the types of renewable energy sources.

The data used in this material are from Ban et al. (2023) which were processed to separately assess the perception of women and men related to the issue of the transition to green energy. In Ban et al. (2023) the data collection was carried out through a survey based on a questionnaire among the residents of the two cities, Oradea and Timișoara, in March-June 2023, according to Regulation no. 679/2016 on personal data protection. The questionnaire had three sections: a section with socio-demographic data (gender, education, age), a section where a 5-point Likert scale was used to record the importance and performance of 22 factors influencing the adoption of renewable energy resources, and a section with questions probing experience with such resources and an open-ended question about identified barriers to adopting these resources. Of the 1098 valid survey questionnaires, we used 1047 (581 female respondents, 466 male respondents). Table 1 presents the description of the total sample. The internal consistency of the questionnaire data is very good, checked with α Cronbach and obtained for importance 0.92 and performance 0.95.

Table 1: Statistics about respondents

Gender	Absolute frequency	Relative frequency (%)
men	466	42.53
woman	581	53.18
I prefer not to say	47	4.28
Education		
secondary, or under	15	1.36

Gender	Absolute frequency	Relative frequency (%)
high school, including professional, complementary, apprentice, and post-high school	241	21.94
university degree	627	57.1
postgraduate, including master's, doctorate	215	19.58
Age		
20-24	424	38.61
25-34	242	22.04
35-44	196	17.85
45-65	206	18.76
above 65	32	2.91
Total respondents		
Oradea	920	83.78
Timișoara	178	16.21

(Source: created after Ban et al, 2023)

The evaluation of the respondents' position towards the influencing factors of the adoption of renewable resources and the present performance of Romania, was done by using the Importance-Performance Analysis (IPA) proposed by Martilla and James in 1977. This presupposes the creation of a matrix with four quadrants and each quadrant has certain strategic recommendations for the factors that are positioned there, according to the respondents' answers. The quadrants are: I. Concentrate here-which means focusing on those factors because they need improvement to increase respondent satisfaction, II. Keep up the good work it is required to maintain the quality level because the rejects are satisfied with the performance of these factors, III. Low priority is the factors that require little interest and IV. Possible overkill factors in this quadrant can even be eliminated because they are of no interest. Importance-Performance analysis is used in many fields, including the field of renewable energy (Agyekum et al., 2023; Agarwal et al., 2023; Chen et al., 2019; Lee, 2019; Lee et al. 2013). The graphical representation of the Importance-Performance Analysis matrices was made with RStudio202207.1+554.

4. Results and Discussion

The answer to the first two fixed objectives of the study is deduced directly from two items of the questionnaire. Thus, identifying the general attitude, separately of women and men, towards renewable energy sources, was achieved through a question with a Likert scale related to the global opinion towards renewable energy resources. Surprisingly, the average of the answers for the two genders is very similar, respectively for men 4.332618026 and women 4.339070568. This average reflects a good attitude, given the size of the 5-point scale. As a distribution of the answers, we can see Figure 1.

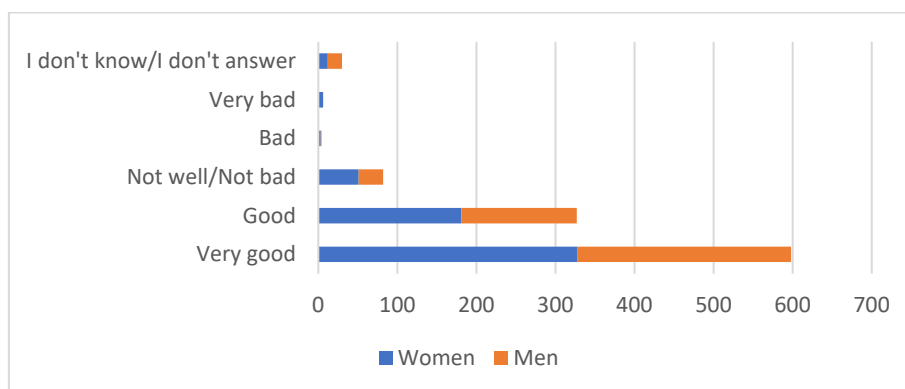


Figure 1: Global attitude towards renewable energy sources

(Source: created by authors)

The question regarding the experience already had with renewable energy sources has limited relevance in the context of gender because we did not include in the research an item related to marital status. In total, a small percentage of respondents (35.43%) used such a resource, most using solar energy (22.85%), a situation also

found at the national level. The distribution of responses by type of renewable energy and gender can be seen in Figure 2. The most used renewable energy resource is solar, as seen in Figure 2, being probably the most accessible in terms of costs and information.

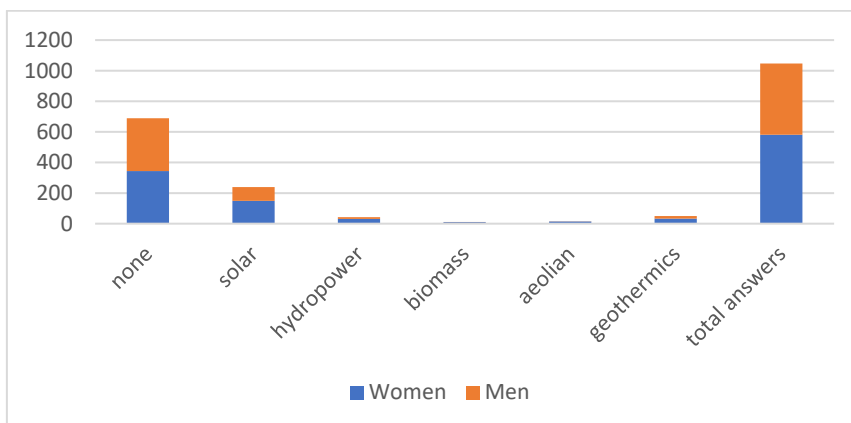


Figure 2: Previous experience with renewable energy sources

(Source: created by authors)

To achieve the objective of the study "Identifying the main barriers to the adoption of renewable energy sources, separately for women and men" we used the open question related to the main barriers and carried out the Importance-Performance Analysis separately by gender. The analysis with Atlas.ti22 of the answers to the open question showed that the main barrier to the adoption of renewable energy resources for both genders is the related budget, understood both as costs and the cost-income ratio (Figure 3, Figure 4, Figure 5). However, upon a closer analysis by gender, we notice that in the case of men, apart from the budget, the other barriers are relatively at the same level as the frequency of mentions and at a great distance from the budget. In the case of women, beyond the budget which is still the most frequently mentioned, the second and third places are the lack of support given by the state and the lack of appropriate information.

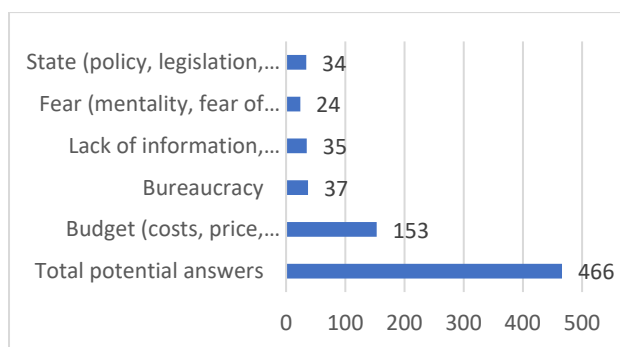


Figure 3: The main barriers to the adoption of renewable energy sources by the men

(Source: created by authors)

An interesting aspect is the fact that in the case of women, 8.26% do not have information about renewable energy resources and do not know what barriers would be in the way of their adoption. In the case of men, this percentage is much lower, below 1%.

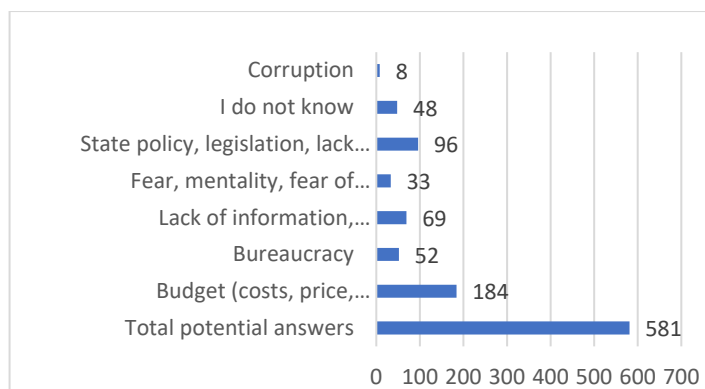


Figure 4: The main barriers to the adoption of renewable energy sources by the women

(Source: created by authors)

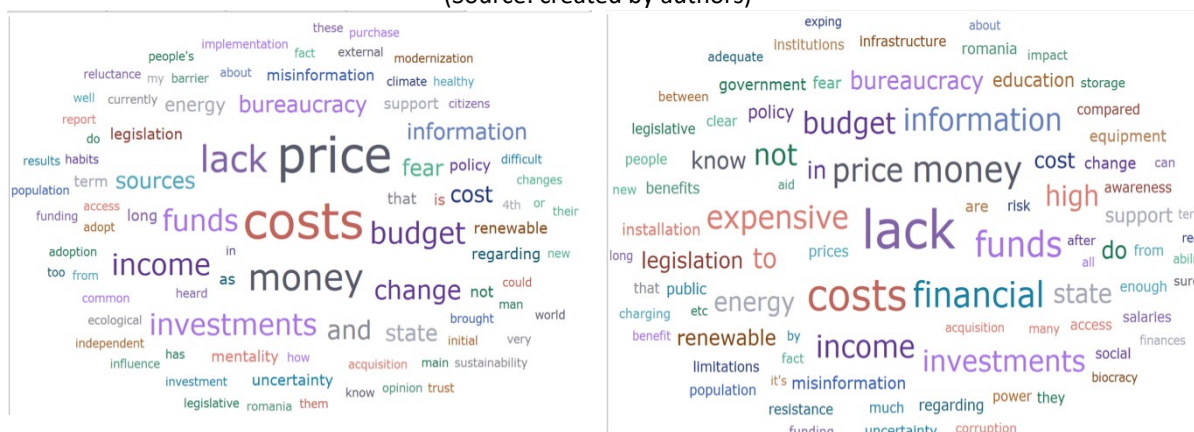


Figure 5: The main barriers to the adoption of renewable energy sources by men (left) and women (right)

(Source: created by authors)

Answers cleaning, homogenization and coding were done to process the data with Atlas.ti22 (Figure 5). To complete the answer regarding the barriers, we also created the Importance-Performance matrix starting from the data collected by Ban et al. (2023) for the influencing factors of the adoption of renewable resources. In the Appendix, can be see the 22 selected factors and the associated codes. In Table 2 we recorded the average of the responses, by women and men, for the 22 factors as the importance assigned by the respondents and as an evaluation of Romania's performance on these factors. We observe that women attribute less importance than men to the proposed factors that could increase the adoption of renewable energy sources but attribute a higher performance to Romania to these factors. The reason could be a lack of information.

Table 2: The values assigned by the respondents (men and women) to the influencing factors of the adoption of renewable energy sources

Factor Code	Performance men	Importance men	Performance women	Importance women
A	3.051	3.978	3.192	3.872
B	2.924	3.266	3.199	3.461
C	2.678	4.012	2.865	3.888
D	2.673	3.927	2.912	3.888
E	2.622	4	2.836	3.838
F	2.744	4.045	2.912	3.857
G	2.701	4.051	2.857	3.924

Factor Code	Performance men	Importance men	Performance women	Importance women
H	2.515	4.218	2.745	4.144
I	2.51	4.669	2.671	4.249
J	2.598	4.751	2.824	4.666
K	2.56	4.16	2.722	3.97
L	2.515	4.302	2.8	4.12
M	2.439	4.139	2.717	3.991
N	2.304	4.783	2.664	4.745
O	2.482	4.229	2.726	4.18
P	2.658	3.793	2.822	3.796
Q	2.826	3.695	2.87	3.352
R	2.684	4.06	2.826	3.901
S	2.888	4.075	2.967	3.931
T	2.669	4.027	2.81	3.896
U	2.628	3.733	2.819	3.767
V	2.427	3.924	2.776	3.777
MEAN	2.640	4.083	2.842	3.964

(Source: created by authors)

In Figure 6 the 22 factors are distributed in the Importance-Performance matrix. on the four quadrants with the related strategic recommendations. As can be seen in both Figure 6 and Table 3, the factors on which action is recommended to favor the transition to renewable energy sources are those in the "Concentrate here" quadrant. Action on these factors could help facilitate access to green energy. There are 8 factors in this category and they coincide for women and men. These factors are: "Reducing the bureaucracy of related procedures", "The government's provision of a subsidy for the installation of renewable energy equipment", "Informing and educating the population about renewable energy. Awareness of environmental issues", "Equipment acquisition costs", "Coordination between institutions to support the production and consumption of renewable energy", "The government's provision of incentives for those who produce energy from renewable sources", "Government provision of tax exemptions", "The government's provision of a reasonable buy-in rate for electricity produced by renewable energy equipment". The information obtained through the Importance-Performance Analysis is corroborated with that from the open question.

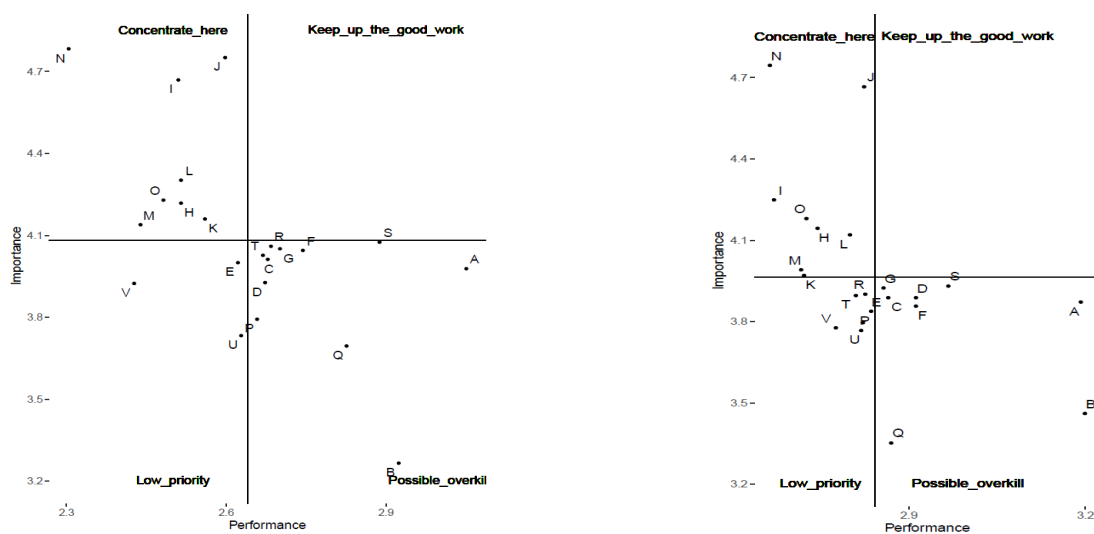


Figure 6: IPA original for men (left) and women (right)

(Source: created by authors)

Table 3: Distribution of factors in quadrants according to respondents

Quadrant	Men	Women
Concentrate here	N, J, I, O, H, L, M K	N, J, I, O, H, L, M, K
Keep up the good work	-	-
Low priority	V, E, U	V, E, U, R, T, P
Possible overkill	Q, A, B, F, S, D, C, G, T, R, P	Q, A, B, F, S, D, C, G

(Source: created by authors)

To answer the objective of identifying the influencing factors of the adoption of renewable sources with good performance, in the opinion of the two categories of potential consumers, the Importance-Performance matrix is very useful, namely the "Keep up the good work" quadrant. Surprisingly, for both women and men, neither factor is found in this quadrant. This result reflects a high degree of dissatisfaction with the Romanian village's performance in supporting the population in this process. For identifying the influencing factors of the adoption of renewable energy sources on which the government must act, in the Importance-Performance matrix, the factors from the "Concentrate here" quadrant will be identified, as can be seen in Figure 6 and Table 3. The 8 factors are identical for women and men and were presented above. The Importance-Performance matrix also allows us to identify the influencing factors of the adoption of renewable energy sources that are less priority or even unnecessary in the adoption of renewable sources, for the two categories of consumers. They are the factors in the "Low priority" and "Possible overkill" quadrants. We observe slight differences for women and men. 14 factors, more than half of those proposed are considered of little interest or can even be eliminated in the sense that they do not contribute to encouraging the transition to renewable energy sources.

5. In Conclusion

The study on the transition to renewable energy resources revealed a rather categorical positive positioning in favor of them, but also multiple barriers to their adoption. The most unexpected result is the one related to the fact that the Romanian state does not perform in any of the factors mentioned. Among the 22 factors discussed, 8 proved relevant for encouraging the transition to renewable energy resources. This result is highlighted both by the Importance-Performance Analysis and by gathering information with an open question. As for the differences between men and women, they are insignificant in the quantitative evaluation, but certain nuances can be revealed through a more in-depth in-layer analysis. Findings are in line with those of Baruk and Golsizek (2023), Hojnik et al. (2021), and Li et al (2019). This study has as the key contribution collecting and analyzing data about the attitude of potential Romanian proposers, women, and men, as far as we know these issues have not been sufficiently investigated yet. The solutions identified are directly related to the resulting barriers and mainly concern aspects regarding costs, state intervention, informing the population, reducing bureaucracy, etc. The limits of the paper are found in choosing only Romanian cities for the empirical study and with a different sample of the two selected cities.

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Appendix

The values assigned by the total respondents to the influencing factors of the adoption of renewable energy sources

	Code
Solving the problem of grid-connected energy production of renewable energy systems and the electricity company	A
Overcoming legislative regulation issues	B
Extending the scale of the renewable energy market/offer	C
Construction of public facilities in the place where renewable energy is installed	D
Increasing the effectiveness of the government administrative process (time and cost)	E
The existence of a professional authority for the correct certification of the design of renewable energy equipment	F
Resolving relevant requirements for renewable energy installation (e.g. environmental assessment)	G
Coordination between institutions to support the production and consumption of renewable energy	H
Informing and educating the population about renewable energy. Awareness of environmental issues	I
The government's provision of a subsidy for the installation of renewable energy equipment	J
The government's provision of a reasonable buy-in rate for electricity produced by renewable energy equipment	K
The government's provision of incentives for those who produce energy from renewable sources	L
Government provision of tax exemptions	M
Reducing the bureaucracy of related procedures, The Government's provision of a subsidy for the installation of renewable energy equipment, Informing and educating the population about renewable energy. Awareness of environmental issues, Equipment acquisition costs, Coordination between institutions to support the production and consumption of renewable energy, The Government's provision of incentives for those who produce energy from renewable sources, Government provision of tax exemptions, The government's provision of a reasonable buy-in rate for electricity produced by renewable energy equipment	N
Equipment acquisition costs	O
The existence of standards for installation and design	P
The existence of reliable energy equipment installation companies	Q
Existence of energy equipment monitoring services after installation	R
The desire for independence of household consumers to produce their energy	S
Independence from the energy sources of other countries (Russia) but even from other states	T
Have other home producers of renewable energy nearby	U
People's ability to change habits	V

(Source: Ban et al., 2023)