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EXPECTATIONS FOR RENEWABLE ENERGY, AND ITS IMPACTS ON QUALITY OF LIFE IN EUROPEAN UNION COUNTRIES

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Abstract:
The primary goals of the study are to present a qualitative examination of household awareness of renewable energy sources and to ascertain their requirements, as well as their expectations for an improvement in quality of life as a consequence of using renewable energy to reduce greenhouse gas emissions and air pollution while improving public health. There are no empirical studies examining the level of household awareness of renewable energy in EU countries, so this gap is also considered a further area of empirical research. Seven European nations were selected for the study: the Czech Republic, Slovenia, France, Portugal, Spain, Austria, and Germany. The survey was conducted from April 2021 to June 2022 with over 17030 respondents. Additionally, it was given a statistical analysis by using the C-Pearson coefficient. Results of our study showed that households' awareness is low and they also expect that they will not pay more for tourist services that use renewable energy sources. Moreover, results showed that when renewable energy sources are used, in households' opinions, levels of CO2 will decrease and that this will have a favorable effect on the environment, but they still think that this will have a detrimental influence on their health.

Key words: *Index Terms – household awareness, quality of life, C-Pearson coefficient, renewable energy*

INTRODUCTION

Energy conservation and the use of renewable energy are key issues in today's globe [1, 2], affecting both industrialized and developing nations [3, 4]. In the modern world, both developed and developing nations are very concerned about energy conservation and the use of renewable energy [5, 6, 7]. In order to change home energy usage and make environmentally friendly decisions, knowledge is a key factor [8, 9]. Energy conservation and the use of renewable energy are key issues in today's globe, affecting both industrialized and developing nations [3, 4]. Numerous economic, social, and environmental concerns are defining the contemporary world, and for these issues to be resolved, governments, corporate executives, and individuals must take an active role. The supposedly sustainable development notion has become popular in the global society. According to its argument, social security, long-term economic development, and the mitigation of adverse environmental effects are all interrelated [10]. The sector of home energy consumption is evolving as new technologies and policies for switching to renewable energy are developed [11, 12, 13].

The energy industry is undergoing a renewal that might change how we generate and use energy because of global warming and technology advancements. In order to influence family energy usage and environmentally friendly decisions, knowledge is crucial [14, 15, 16]. The social well-being in terms of health status is enhanced by both accessibility and cost of energy use. Although subjective considerations may have a significant impact, awareness alone may not always result in reduced energy use [17].

The use of renewable energy (RE) has a number of advantages, one of which is a decrease in the need for expensive and detrimental to economic development imported fossil fuels because RE is becoming more affordable globally and offers a genuine substitute for conventional energy sources [18, 19].

The quality of life [20] of inhabitants is seen to be improved by RE initiatives in a number of ways. First, RE sources are probably going to lower emissions of greenhouse gases (GHG) and air pollution [21, 22], which will enhance people's health. Second, the penetration of RE boosts domestic economic activity by directly creating new employment for the local people [23, 24]. There are many studies connected to renewable energy, but these only concern the acceptance of RE by households [22, 25, 26, 27, 28, 29, 30, 31] for their assessment by households or in sustainable development aspect [25, 32, 33]. This research covers a knowledge gap on household awareness, expectations related to RE, and improvements in quality of life brought on by utilizing renewable energy to lower greenhouse gas emissions and air pollution. That is novelty in the manuscript. Along with their findings and the observations that followed, the authors offered research questions, which were subsequently reflected in a list of objectives:

1. What is household awareness in relation to renewable energy in EU countries?
2. What are household expectations of RE in EU countries?
3. What is the importance of RE in improving the quality of household life?

The remainder of the text is organized as follows: The literature review is presented in the second section. Research design is covered in the third section. Qualitative methodology and results are presented in the fourth section. Statistical confirmation is presented in five sections. The conclusion is discussed in section six.

LITERATURE REVIEW

The term "renewable energy" (RE) describes clean energy that is drawn from renewable natural resources and promotes better public health. Renewable energies are harnessed from natural resources, including wind, water, and solar sources, that cause limited environmental pollution [34, 35]. By replacing fossil fuels, RE lessens countries' dependence on exporting nations by reducing their demand for energy imports [36]. RE is made using locally available, environmentally acceptable natural materials that are constantly renewed. This makes RE available, accessible and acceptable globally. Although there are many techniques to absorb and create renewable energies from solar and wind energy, they are not a new technology [37, 38, 39]. As a result, the usage of clean energy has risen globally and on a big scale. This is due to the employment of cutting-edge technology to capture renewable energies [19, 40].

Humans have depended on various RE sources for a long time [41]. The most popular kind of renewable energy that is derived from sunshine, for instance, is solar energy. Solar energy is emitted by the sun and reaches the earth's surface where it may be captured by solar technology to create electricity. Electricity is produced by solar energy, which is concentrated using solar panels. The additional renewable energy source produced by wind power is wind energy. Wind turbines, which utilise the wind's energy to move the blades and produce electricity, are a key component of wind energy technologies [19, 42]. Due to the cheap costs associated with producing electricity with wind energy, its usage is steadily growing around the globe. The natural heat from the earth's surface is used to generate geothermal energy, another kind of renewable energy. To produce power, geothermal energy is often transformed. In many regions of the world, geothermal energy isn't used much. Biomass energy is another kind of renewable energy that is used to produce power by using solid fuel made from plant resources. The use of water reservoirs to operate turbines that produce electricity is known as hydropower, and it is one of the most widely utilized renewable energy sources [26, 43, 44, 45].

Some renewable energy sources are a little pricey, such as photovoltaics, whose cost of energy production is greater than that of other renewable energy sources and non-renewable sources (hydropower and coal). Dust and pollutants cause PV panels to lose efficiency. Regular PV panel cleaning, however, comes at a significant expense [33, 46]. Due to RE ability to lower greenhouse gas emissions, renewable energy sources are also essential for halting global warming [19, 47].

There are several obstacles to the global use of RE, which makes it harder to develop sustainable energy. For instance, the ongoing subsidies for fossil fuels are a barrier to the move toward the usage of renewable energy. The fossil fuel industry still faces competition from renewable energy sources because it is able to persuade governments in developed nations to provide massive subsidies to the sector, slowing down the growth in the usage of clean energy. A lack of suitable creative technology to exploit natural energies is another reason why many developing nations find it difficult to switch to renewable energy sources [20, 48]. Even though developing nations have abundant natural resources, the shift to the use of clean energy in these countries is still constrained by a shortage of renewable energy technology.

The European Union (EU) has made significant investments in renewable energy (RE), since its member nations are more vulnerable to hazards in global energy markets than other nations or regions. The authors claim that in recent years, the EU nations have greatly boosted their

use of renewable energy sources for energy production. Germany, the Netherlands, Hungary, Belgium, and the United Kingdom all reported significant increases in the amount of electricity coming from renewable sources. The lowest increases, in turn, were discovered in Slovenia, Latvia, and Sweden.

The variations rely on the energy policy of various nations as well as social awareness of the environment and pressure from citizens on the government to take action on climate change. Economic considerations are also crucial [49]. The significant disparity between oil and natural gas production and consumption forces the EU to import 54% of its total energy [50]. The IEA predicts that solar energy would develop its capacity at the fastest rate in the next years, followed by wind, hydropower, and biofuels. China, the European Union (EU), and India are predicted to see the biggest increase in terms of nations/regions [51]. Investment in renewable energy has also begun to rise in Russia and the Arab nations, which runs counter to existing energy production and consumption trends. Depending on each country's economic position, energy mix, resource availability, and methods and efficiency of energy consumption, significant variances may be seen across the European Union's member states. Germany and Denmark are largely the flagship nations for these procedures. Along with the economic and political advantages, significant reductions in energy imports may be accomplished in addition to reaching the EU's climate protection and emission reduction objectives via energy savings and increasing use of renewable energy sources [52, 53]. 13.975 GtOE (585 EJ) [54] was the total amount of energy used by our globe in 2019, which is a 60% increase from 1990. The household sector contributes significantly to this, making up 27% of the EU's overall energy consumption, of which 36% is natural gas, 24% is electricity, 18% is renewable energy, and 11% is oil [8, 9]. 64% of home use was for heating, with over 25% coming from renewable sources. 13.975 GtOE (585 EJ) [54] was the total amount of energy used by our globe in 2019, which is a 60% increase from 1990. The household sector contributes significantly to this, making up 27% of the EU's overall energy consumption, of which 36% is natural gas, 24% is electricity, 18% is renewable energy, and 11% is oil [55], while 64% of home energy usage was for heating, with over 25% coming from renewable sources.

About 10 million more direct employment in the EU are anticipated to be created by the widespread use of renewable energy by 2050 [56, 57, 58] in transportation, heating, and cooling. More than one-fourth of the world's use of renewable energy is now accounted for by the EU nations, whose consumption has increased by more than 10% yearly on average in recent years [59]. Based on the aforementioned information, it can be stated that the widespread adoption of renewable energy sources has substantial potential for lowering family energy costs, using sustainable amounts of energy, and maintaining income. Additionally, a crucial factor in lowering greenhouse gas (GHG) emissions would be to engage the home sector as effectively as feasible and to promote renewable energy sources [60]. In the next step, based on previously defined criteria, 417 indexed articles were included. Based on the keywords indicated as leading in the indexed publications, a map of relationships was prepared, which is shown in Figure 1.

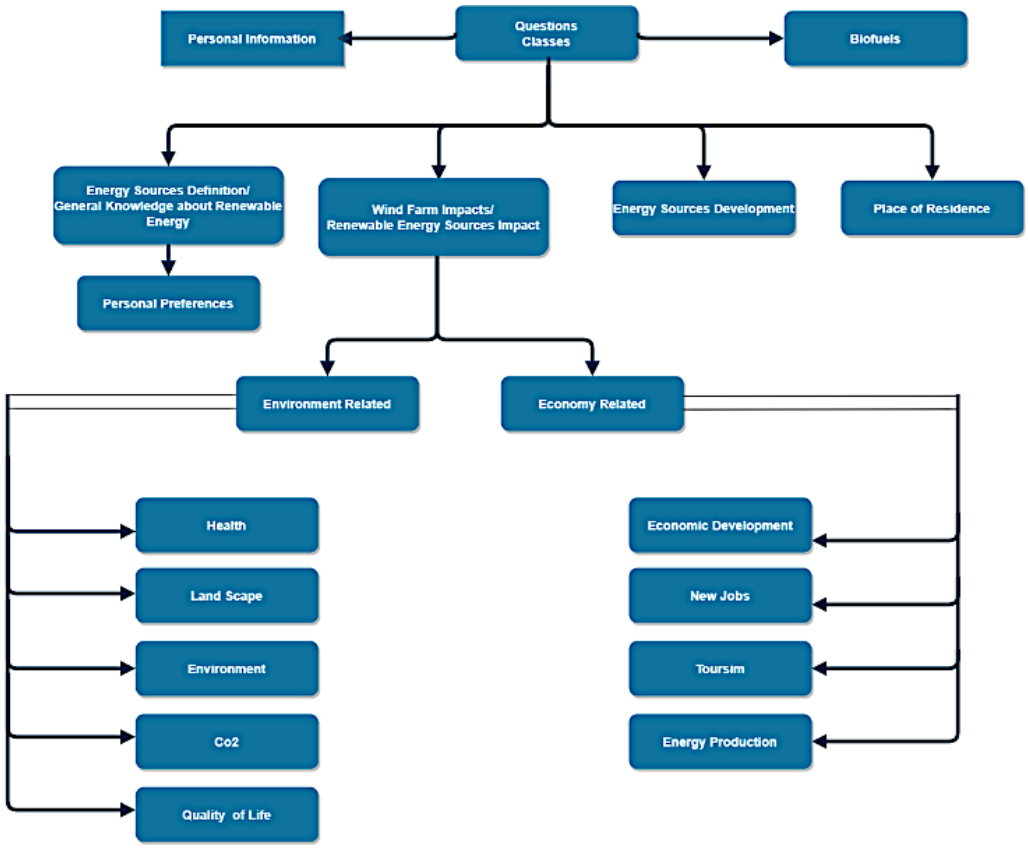

Fig. 1 Survey Questions Classes

An analysis of publications concerning consumer awareness of the use of renewable energy was made. The Scopus database has over 400 publications on this subject. During the analysis, there are several very similar keywords, however, what is interesting for our research is the analysis of the countries from which the research and publications come from. As shown in Figure 1, (page 4) only a few countries are interested in this analysis. In Europe, the UK is the leader, and research in Germany and Poland is also noticeable. Therefore, conducting research in the territory of the EU is justified, and indeed highly recommended.

METHODOLOGY

The research used the CAWI questionnaire [56, 57]. The aim of this study is to analyze households' renewable energy awareness as well as find out about their expectations. More precisely, their expectations regarding the quality of life being improved as a result of RE driving down the emissions of greenhouse gases and air pollution are enhanced. With this aim, we developed our methodology; we tried to develop correlations between the different questions of the survey. The minimum sample size was determined and the method of communication with respondents was also determined. Due to the timing of the pandemic and the size of the sample, the questionnaire was made available online. The survey was conducted from April 2021 to June 2022. There were 17030 respondents, of which 34% were women and 66% were men. The research was dominated by respondents aged 31–40 years (38%), inhabitants of cities with higher education. Seven European nations were selected for the study: the Czech Republic – 26%, Slovenia – 12%, France – 14%, Portugal – 11%, Spain – 13%, Austria – 10%, and Germany – 14%. After the research, the results were analyzed and conclusions were formulated. The research questionnaire contained 34 targeted questions, solving the research problem (appendix). The methodology is composed of three parts. Firstly, we divided the questions of the survey into main branches, and then, when applicable, we divided these branches into further classes. This should help in categorizing different questions under the same class if they are related to each other, and then facilitate analyzing the answers of households to these questions and finding the correlations between them. The third part is to make statistical confirmation. Figure 2 shows the structure of these classes.

Secondly, we tried to find the potential correlations between questions. These potential correlations could be classified as cause and effect or contradiction (Table 1).

The cause-and-effect category includes the following groups of questions (Question 6, Question 8, and Question 11) and (Question 22, Question 25, and Question 29), while the contradiction category includes (Question 12 and Question 13), (Question 16, Question 19, and Question 20). An interesting group of questions is (Question 4, Question 5, and Question 7), which fall into both categories.

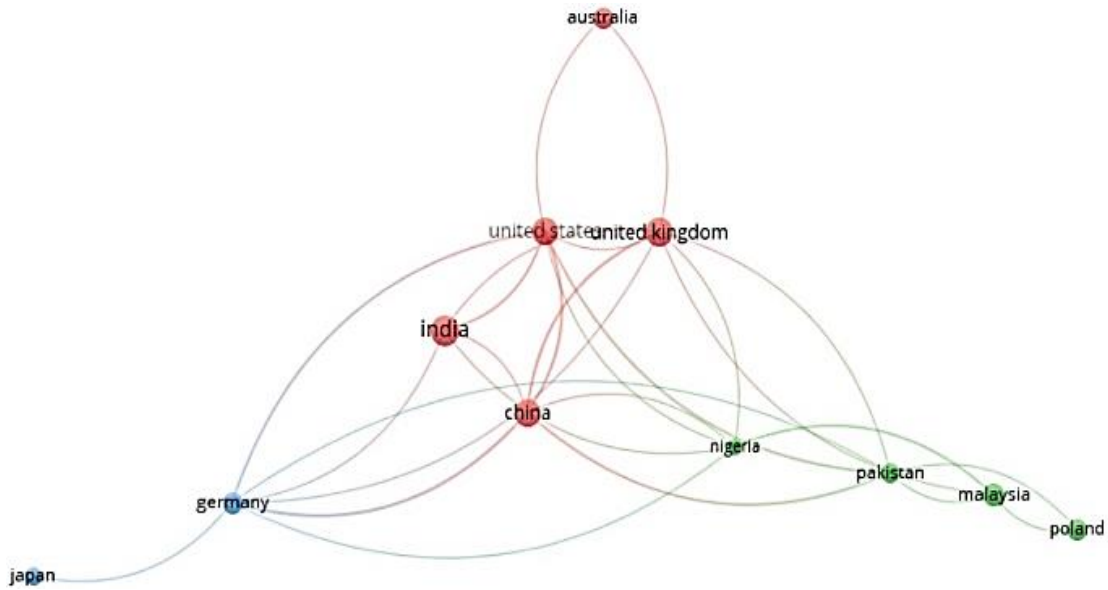

Fig. 2 A map of relationships of publications concerning consumer awareness of the use of renewable energy

Table 1

Frequencies Of Answers Per Category

Category	Question	Answer	Freuency	%
Cause and Effect	6	Positive	971	5.70%
		Negative	12480	73.28%
		Indifferent	3579	21.02%
	8	Positive	1678	9.85%
		Negative	9573	56.21%
		Indifferent	5779	33.93%
	11	Positive	73	0.43%
		Negative	14201	83.39%
		Indifferent	2756	16.18%
	22	Favorable	1640	9.63%
		Unfavorable	1230	7.22%
		Will not	2324	13.65%
		I don't know	11836	69.50%
	25	Definitely yes	0	0.00%
		Definitely not	0	0.00%
		no	9787	57.47%
		I don't know	7243	42.53%
	29	Yes	1656	9.72%
		No	4236	24.87%
		I don't know	11138	65.40%
Contradiction	12	Positive	723	4.25%
		Negative	3543	20.80%
		Indifferent	12764	74.95%
	13	Positive	6515	38.26%
		Negative	1288	7.56%
		Indifferent	9227	54.18%
	16	Definitely yes	8791	51.62%
		Probably yes	6173	36.25%
		Definitely not	284	1.67%
		Probably not	189	1.11%
		I don't know	1593	9.35%
	19	Yes	1684	9.89%
		No	1672	9.82%
		I don't know	6943	40.77%
		It doesn't matter to me	6731	39.52%
	20	Positive - it means that the region is developing	29	0.17%
		Positive - environmental protection is very important to me	154	0.90%
		I would not attach importance to it	1603	9.41%
		I would give up my stay due to the nuisance of the windmill	3571	20.97%
		I would give up my stay, I want to enjoy the beautiful landscape	11673	68.54%
Both Categories	4	Positive	12067	70.86%
		Negative	3929	23.07%
		Indifferent	1034	6.07%
	5	Positive	8375	49.18%
		Negative	3945	23.17%
		Indifferent	4710	27.66%
	7	Positive	572	3.36%
		Negative	14197	83.36%
		Indifferent	2261	13.28%

Question 6, Question 8 and Question 11

This group of questions has gained value because a large proportion of households have expressed the importance of landscape and tourism as deciding factors when a household wants to choose their place of residence, which will undoubtedly affect their life quality. The conducted research showed that as many as 73.28% of respondents believe that the construction of a wind farm will have a negative impact on the landscape; 56.21% of respondents believe that the construction of a wind farm will have a negative impact on tourism and recreation; and as many as half of the respondents (83,39%) believe that building a wind farm will have a negative impact on the quality of life.

Question 22, Question 25, and Question 29

This group of questions should give insights regarding the level of knowledge households have about the impacts of applying sources of renewable energy (i.e. solar energy) in a residence accommodation context. The research results showed that as many as 69.5% of the respondents do not know whether heating water with solar energy will affect the quality of accommodation services. 57.47% of respondents have never encountered a tourist facility that uses energy from renewable sources. 65.4% of the people who answered have never used biofuels in their daily lives. This knowledge is expected if households are already aware of any nearby facilities that have been adapting such strategies, and this is actually what we will be trying to measure.

Question 12 and Question 13

Creating new jobs in a certain country is highly correlated to its economic development. One would expect that new jobs would mean a higher distribution of credit among the population, leading to increased purchasing power and, therefore, a higher level of wealth for capital owners, who will have the opportunity to widen the scope of their investments, which should naturally lead to economic development. The analysis of the answers to the questions showed that the respondents believe that the wind farm has no impact on new jobs (74.95%) and has no impact on the economic development of the country (54.18%). By looking at this set of questions, we try to find out how aware households are of these changes.

Question 16, Question 19 and Question 20

As has been observed from the literature review, renewable energy generation is one of the very effective tools that governments over the globe right now utilize to protect the environment. However, governments by themselves can't succeed in this mission if individuals don't follow this path. By exploring the answers of individuals to these three questions, we are trying to understand how important the environment is to people and if they are ready to translate this interest into actions. Research has shown that environmental aspects are important to respondents, but it turns out that they do not have enough knowledge to say whether tourism facilities should invest in renewable energy (40.77%). Respondents also said they would like to spend their vacation away from the wind turbines (68.54%).

Question 4, Question 5 and Question 7

CO_2 emissions, the environment, and health form an equilateral triangle. The absence of any of each would cause a glitch in the others. Hence, we try to observe if households agree with the theory that renewable energy (and particularly windmills) could decrease emissions and, as a result, improve the environment and health.

It turns out that 70.86% of respondents believe that the construction of the wind farm has a positive impact on CO_2 emissions on the environment (49.518%), while 83.36% believe that the wind farm has a negative impact on health.

QUALITATIVE, NUMERICAL ANALYSIS AND RESULTS

For each group of the questions indicated previously in the methodology, we plot the number of respondents per option per question. Chart types are either bars, lines, areas, pie or an integration of more than one type. These differences are natural as each group could have a different number of questions, different options, and most importantly, different scope.

Question 6, Question 8 and Question 11

Even if people are expecting a good future for wind energy, they don't prefer to have it within 1 km of their residence, but they would prefer to have other energy sources that have less impact on the landscape

surrounding them. Indeed, people have expressed that the two most important factors they care about in their residence are the landscape and tourism. This could explain why a high percentage of the surveyed people think that wind energy could have a negative impact on the quality of life because it would spoil what they consider factors of attraction in their residence place (Fig. 3).

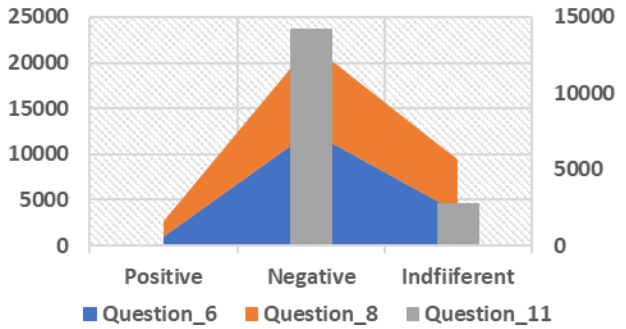

Fig. 3 Windfarms construction effects over landscape, tourism, and life quality

Question 22, Question 25 and Question 29

A wide sector of the surveyed people are not really aware if any renewable energy sources are already implemented by tourist facilities they have passed by or been to, they are also not aware of the added value solar energy can bring if used to heat water in accommodation, which raises questions about how people get informed about renewable energy sources and their implementations. The majority indicated that the internet is their main way to get information with regards, besides that, many also believe that their state is playing an effective role in informing people about the increasing importance of adapting renewable energy resources.

Question 12 and Question 3

A contradiction is presented by the view of wind energy as a positive driver for the economy, however, it is thought by a huge number of people that it would lead to a decline in the number of available job opportunities (Fig. 4).

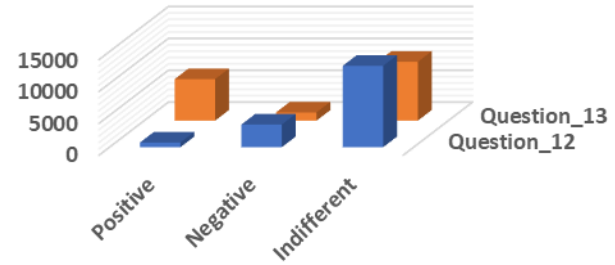

Fig. 4 Wind farms impact on Jobs and economy development

Question 16, Question 19 and Question 20

Interestingly, while 88% of the surveyed people declare that environmental aspects are important to them (36% claim probably yes, and 52% claim definitely yes) and that they can observe the pollution caused by human activities around them, a significant percentage of the surveyed people express behaviors that may not be aligned with the environmental protection values they hold (Fig. 5). In other words, this group of people believes that touristic facilities shouldn't invest in renewable energy.

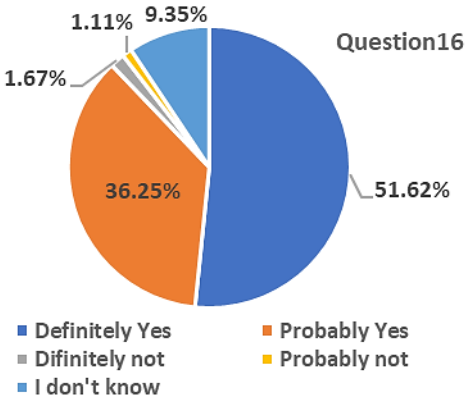

Fig. 5 Environment Importance to Households

Furthermore, they clearly explain that they may be keen to change their vacation spot if they realize that it uses renewable energy sources (Fig. 6, 7). Actually, more than 73% of respondents confirmed that they are not willing to pay more for a service that makes use of renewable energy sources.

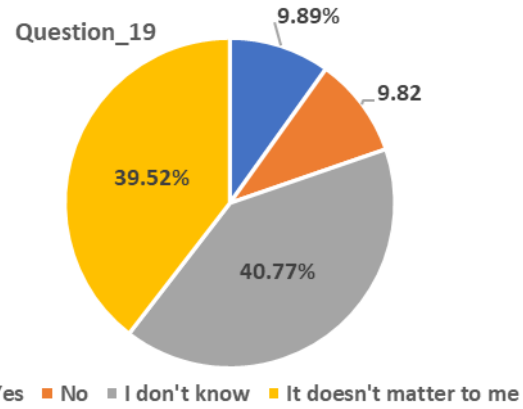

Fig. 6 Tourism Facilities Investments in Renewable Energy

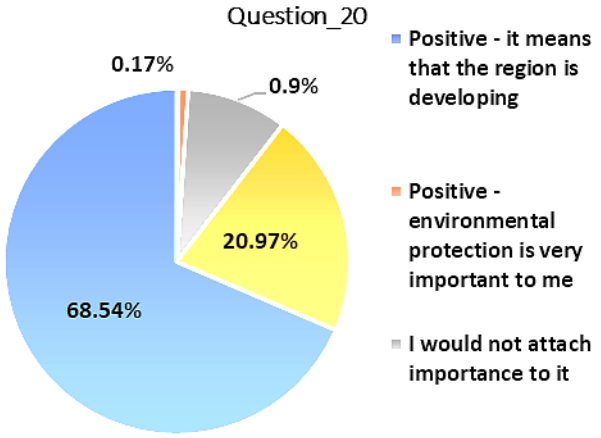

Fig. 7 Wind Farms Effect on Touristic Facilities

Question 4, Question 5 and Question 7

A notable contradiction is presented in this area. While people believe that the level of Co_2 will go down and a positive impact will result on the environment when

renewable energy sources are utilized, they still believe that their health will be negatively affected (Fig. 8).

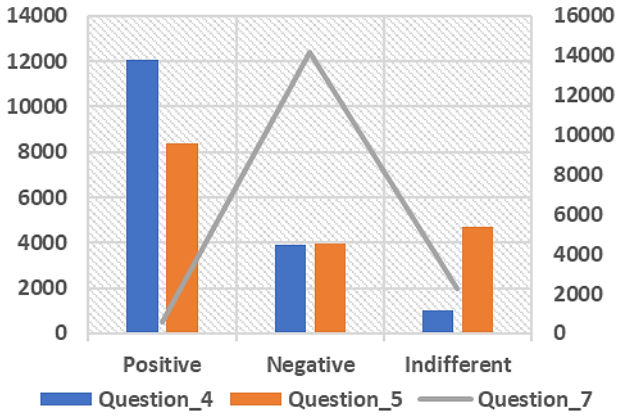

Fig. 8 CO_2, Environment and Health Correlations

STATISTICAL CONFIRMATION

Conducting research and analyzing the obtained content, it can be stated that it is necessary to analyze the factors between which the relations take place in the research. The analysis was prepared using the χ^2 test, on its basis the C-Pearson coefficient was calculated, which determines the strength of the relationship between the qualitative factors (Table 2).

Table 2
The results of the C-Pearson coefficient

Relationship between variables	C-Pearson's coefficient	The strength of dependence
I am for the development of renewable energy/ I have a renewable energy source at home	0.64	Strong
I have a renewable energy source at home/ environmental aspects are important to me	0.82	Very strong
I have a renewable energy source/ I would like a renewable energy source to be created within 1 km from my house	0.68	Strong
Environmental aspects are important/I would be willing to pay more for a product using RE	0.61	Strong
You learn about RE/environmental aspects are important to you	0.84	Very strong

The relations constitute the basis for inference for the conducted research. The analysis showed that there are strong and very strong relations, which proves the correctness of the research assumptions and the necessity to conduct conclusions in this regard. The Table 2 shows five relationships that show the relationship between consumer awareness and the use of renewable energy.

DISCUSSION AND CONCLUSION

Since the home sector contributes significantly to the economy's total energy consumption, it should take a leading role in efforts to enhance environmental quality. Renewable energy must be included in the long-term planning of the energy industry in order to ensure a shared future. Public awareness, failed policies, and market categorization all have an impact on how renewable energy is implemented in a nation. A nation's economic and social development are significantly and absolutely dependent on energy. One way to mitigate climate change is via the use of renewable energy. Governments all over the globe are relying less and less on the last remaining fossil fuel sources of energy and are focusing on the deployment of low-carbon energy sources, notably renewable energy sources, to minimize carbon emissions into the environment. Concerns about energy security and the diminishing and rising cost of fossil fuel supply are the two key drivers behind the widespread shift to the usage of renewable energy [61, 62]. Growing use of renewable energy results in considerable drops in carbon emissions and a smaller ecological impact overall. Therefore, encouraging the use of renewable energy is necessary for the mitigation of climate change. The function of educational institutions is important in spreading knowledge about renewable energy, notwithstanding its difficulties. It is recommended that students study about renewable energy in elementary school in order to provide them a foundational knowledge, awareness, and understanding of the subject before moving on to higher education institutions like technical colleges and universities [63].

Research has shown that respondents have basic knowledge of renewable energy but their awareness is low. It turns out that environmental aspects are important to respondents, but most of them do not want to pay more for services that use renewable energy and thus contribute to a better environment. The research also showed that only 16% of respondents have a renewable energy source in their household. This is probably related to the high installation costs [64]. Respondents expect service facilities to invest in renewable energy but do not want such activities to be reflected in rising prices for services. Research has also shown that respondents see the need for the country they live in to increase their educational activities related to renewable energy. Respondents also believe that the production of biofuels and the reduction of greenhouse gas emissions are necessary. Moreover, the respondents are involved in activities for the protection of air and water. Wind energy is expected to grow, but with fewer opportunities than atomic energy. Even if people see the improvement of wind energy as a way to protect the environment from CO_2 emissions, they still believe that it is a double-edged weapon as it would negatively affect other aspects of life, such as tourism, and it would ruin the environment. Although many people believe that the environmental aspect is important to them, they still wouldn't be keen on seeing such solutions adopted near their residence or by touristic facilities they are visiting, especially if they are seen to negatively impact the landscape and tourism. Enriching the internet content with information about renewable energy sources may be potentially helpful to convince more people to adopt renewable energy sources or accept their adaption by other service providers. The main aim of the paper is to provide a qualitative analysis of households' renewable energy awareness as well as find out about their expectations. Household energy awareness is low, but most

of the respondents indicated their willingness to use alternative renewable energy sources. Based on the information given, it can be assumed that more research is needed to find out what households know about RE and what they expect from it. The authors decided that the next step would be to compare countries to determine global trends connected with RE as well as the evaluation level of university education towards RE.

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