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## Pro-environmental Behaviors, Energy Efficiency and Sustainable Development in Russia

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# **Pro-environmental Behaviors, Energy Efficiency and Sustainable Development in Russia**

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**Abstracts:** The studies of environmental awareness or the so-called people's pro-environmental behaviors (PEBs) became a popular topic in Europe, North America and Asia, but not yet in Russia. Many studies investigated PEBs revealed that monetary saving and health concern are considered to be the most common influential factors for many PEBs. Because of the lowest electric power and heat tariffs in the world as well as abundant natural resources it can be assumed that the level of environmental awareness in Russia is low comparing to EU. Nowadays this problem can become a barrier for innovative development and diffusion of new energy efficient technologies.

In this paper we present the results of empirical research aiming evaluation of environmental awareness in one of the southern region of Russia – Krasnodar region. In research we also evaluate the informational transparency in the field of ecology in Russia and distinguish the most popular sources of information.

The method of research is medium-scale face-to-face inquiry. The survey involved 112 respondents from one big city (Krasnodar), its suburbs, several small cities and rural areas. Data analysis was performed using StatSoft STATISTICA 10.0. The non-parametric Mann-Whitney tests and Kruskal–Wallis one-way analysis of variance were used to reveal the optimal quantification that describes the relationships between the categorical scores of each variable as well as the relationships between the variables themselves. In order to identify relationships between variables, measured in nominal scales, contingency tables (cross tabulation) were used. In some cases (where it was appropriate) correlation analysis and one-way ANOVA were used.

**JEL Classification:** O13, Q21, Q42, Q51

**Key words:** *environmental awareness, pro-environmental behaviors, informational transparency, sustainable development, regional economy, nonparametric analysis, multiple correspondence analysis*

## **1. Introduction**

To develop the low-carbon society, in addition to the efforts by governments, industrial and commercial sectors, promotion of the level of environmental awareness of people has become one of the key issues. The studies of environmental awareness or, the so-called, people's pro-environmental behaviors (PEBs) became a popular topic in Europe, North America and Asia [1], but not yet in Russia. Russia, as a country with abundant natural energy resources, has inherited a very energy-intensive economy model from the times of plan-based economy and still has one of the lowest electric power and heat tariffs in the world. Currently, the Russian economy stays about two and half times less energy efficient and more carbon intensive than other comparable modern countries. The Russian government has initiated some environmental policies and legislation in order to develop and implement a successful resources savings strategy only in 2009. That's why general population on its own has not yet embraced energy efficiency and other PEBs as a social value.

Many studies investigated some PEBs very carefully [1-2] and basically it was revealed that monetary saving and health concern are considered to be the most common influential factors for many PEBs. In [3-4] it was also shown that even if people do have a high awareness of environmental issues, there are many internal and external barriers to taking actual action. Although people may intend to practice PEBs, various factors such as traditional values, lifestyle, and surrounding circumstances can influence their behavior.

In this paper the purpose of investigation is not only the evaluation of readiness to demonstrate pro-environmental behaviors or external barriers to it, but also the influence of usual information sources on public opinion about the importance of environmental issues and the value of PEBs, including the use of energy-saving and alternative energy technologies.

Part 2 of the paper is devoted to description of methodology of research and the main characteristics of the group of respondents (number, social and age distribution, representativeness). Part 3 presents the results of statistical nonparametric analysis of data dealing with measurement of the level of environmental awareness and its impact on PEBs, mostly energy saving practices. Part 4 is devoted to the study of information sources about new energy efficient and renewable technologies and their impact on energy saving practices. In conclusion some summary of the reasons for low environmental awareness are drawn and some activities aiming promotion of people's pro-environmental behaviors are proposed.

## 2. Materials and Methods

The method of research is medium-scale face-to-face inquiry. In order to encourage a high response rate the questionnaire was designed relatively simple and short, divided into sections with a variety of question formats.

The first part of the questionnaire consists of 7 questions (Q1-Q7) with several (up to 10) options of answer each. Their design meets the purpose of revealing the respondents' attitude to the problems of global climate change, environmental issues, their tendency to demonstrate pro-environmental behavior and determining the main sources of information about environmental problems. The main hypothesis, tested in this part of the inquiry, are following:

H1: The relatively low level of environmental consciousness of Russians is a disincentive to the widespread use of energy saving and renewable technologies in households;

H2: Open sources contain insufficient information to stimulate demand for energy saving and renewable technologies;

H3: High level of centralization of electricity supply makes it difficult to use available energy saving and renewable technologies by individual households.

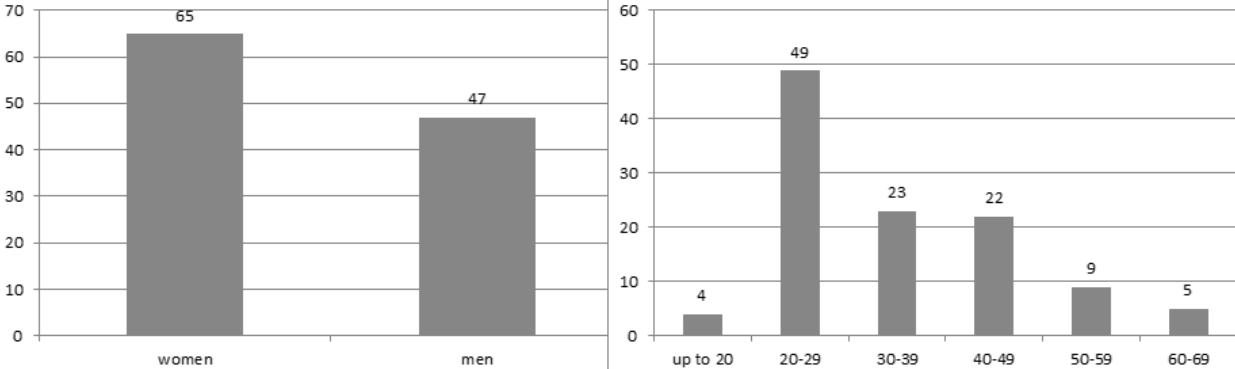
The second part of the questionnaire has 10 statements (S1-S10) about the transparency of environmental information, the economic policy in the country, the level of environmental awareness, the knowledge about energy saving technologies and the level of education in the field of ecology and sustainable development. The degree of respondent's agreement to these statements is scaled in 5-points Likert scale. The third part of the questionnaire has a number of personal questions such as type of accommodation, place of residence, age, gender and profession of responder.

Talking personally to the respondent was considered to be the best way to understand their opinion deeper and ask some additional questions if needed. It gives the survey some features of a case-study. According to Yin (2002) a case study is an empirical enquiry that investigates a phenomenon in a real life context [5]. It can include both quantitative and qualitative paradigms, rely on multiple sources of evidence, use a number of different research tools and benefit from the prior development of theoretical propositions.

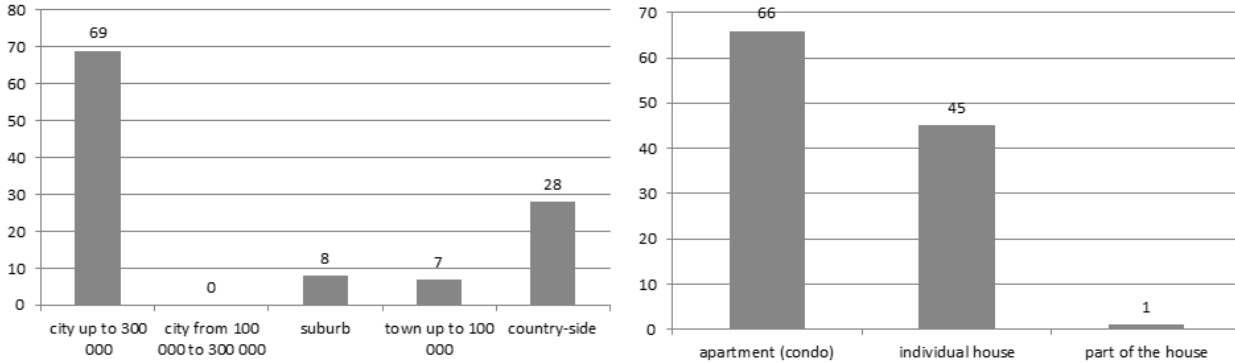
The survey was conducted in the Krasnodar region (Russia). The Krasnodar region has very good natural conditions for the development of all basic renewable energy sources (such as wind, solar, thermal, biomass). Relatively low level of centralization of population and economic activity in the major cities gives the region some extra possibilities to develop pro-

environmental energy saving technologies for individual households. Good environmental conditions are very important for socio-economic development of this southern region, which is currently promoted as a tourist area.

The survey involved 112 respondents, the sampling structure is shown in Fig. 1-2.



**Figure 1. Demography structure of the sample**

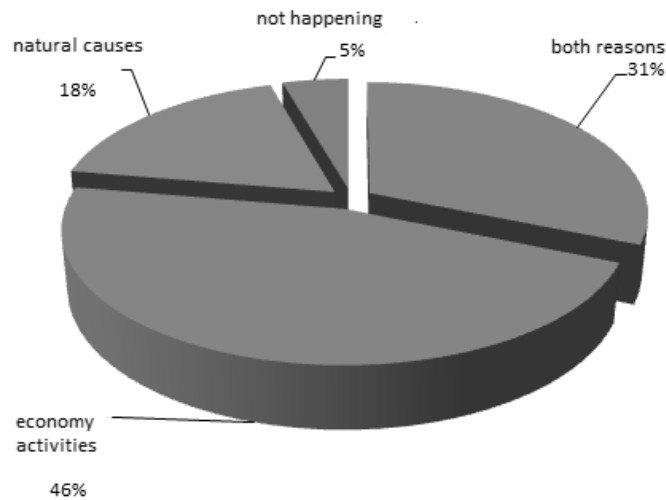


**Figure 2. Social structure of the sample**

Data analysis was performed using StatSoft STATISTICA 10.0. Due to the fact that the data was measured in weak scales, did not meet the normal distribution and the size of the individual groups in the sample was small, the non-parametric Mann-Whitney tests and Kruskal–Wallis one-way analysis of variance were used. These statistical techniques were used to reveal the optimal quantification that describes the relationships between the categorical scores of each variable as well as the relationships between the variables themselves. In order to identify relationships between variables, measured in nominal scales, contingency tables (cross tabulation) were used. In some cases (where it was appropriate) correlation analysis and one-way ANOVA were used.

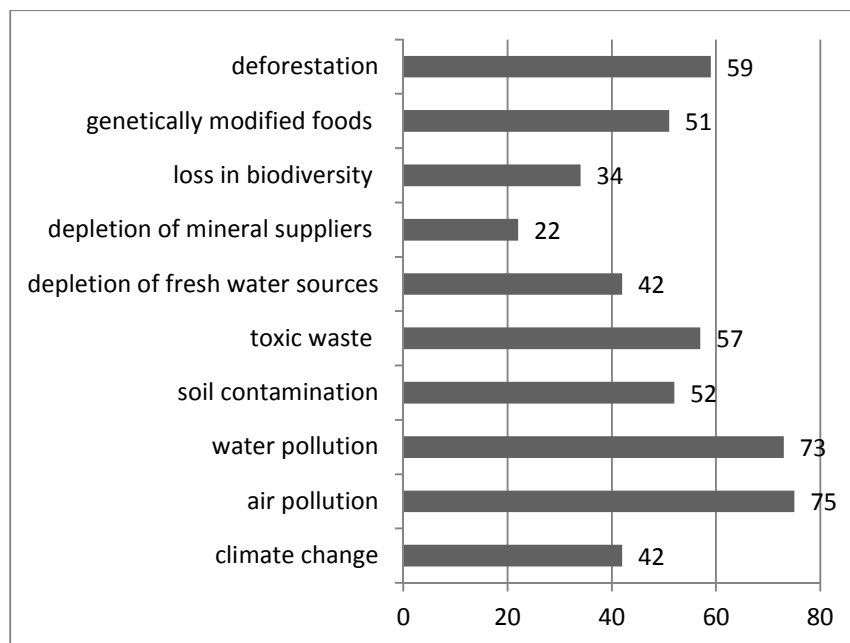
### 3. Environmental awareness and its impact on energy saving practices

The vast majority of respondents (95%) believe that global climate change is indeed taking place, with 46% of respondents believing that the main cause of climate change is in economy activities, 18% tend to associate climate change to natural causes, and 31% of respondents believe that both factors are essential (fig.3).



**Figure 3. The responses on the question about reasons of global climate change**

Again, the vast majority of respondents (98%) expressed their concern about the environment. Only 2 people out of 112 respondents did not indicate any concern to any ecology problems. Most often, respondents noted from 3 to 5 environmental problems (57.1% of respondents), 8% of respondents answered that all 10 environmental problems listed in the questionnaire are a topic of concern. The most frequently cited environmental problems are the air pollution (67%), water pollution (65.2%) and deforestation (52.7%) (Fig. 4). The accumulation of toxic (including radioactive) waste is a topic of concern for 50.9% of respondents, soil contamination and genetically modified foods were mentioned by 46.4% and 45.5% of respondents correspondingly. Least likely respondents mentioned such environmental problems as depletion of mineral supplies (19.6%) and loss in biodiversity (30.3%).

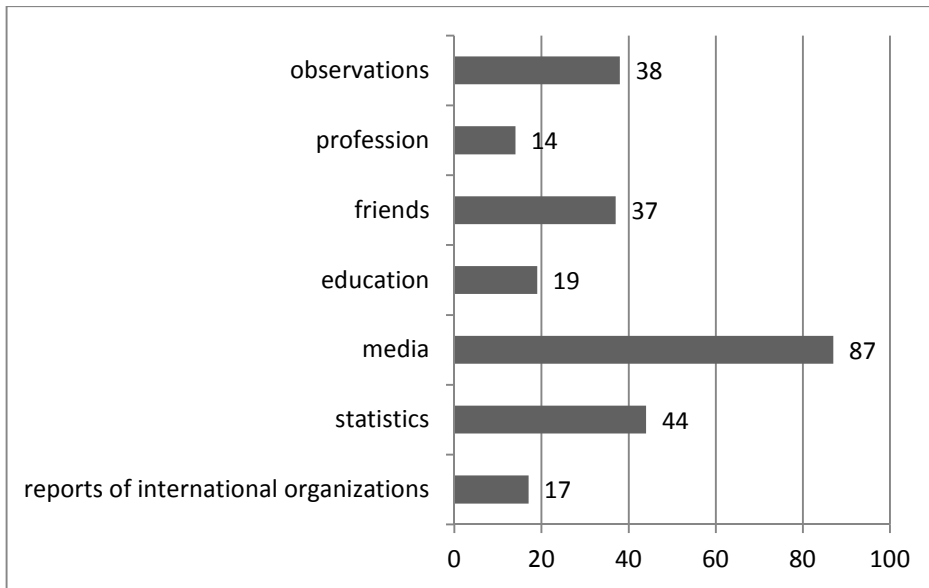


**Figure 4. The responses on the question about the issuers of concern**

Cross tabulation of socio-demographic characteristics and noted ecology problems revealed that residents of a city with population more than 300 000 have higher concern about the water pollution than others (statistical level of Pearson  $\chi^2$  is 0,075).

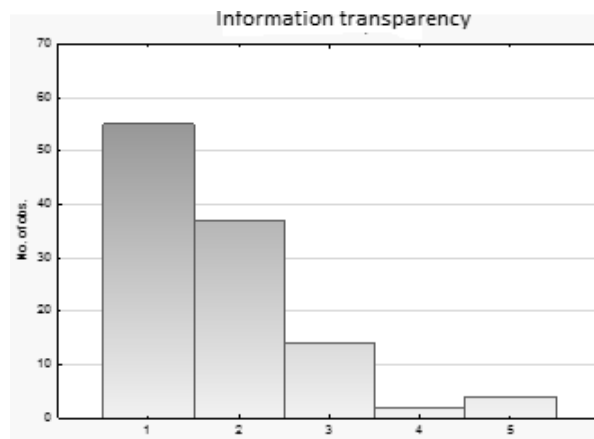
The most popular source of information about the environment, as expected, is the media. 77.7% of respondents indicated that they use this source to get information about environmental problems (fig. 5). The second most popular source is the official statistics (39.3% of respondents noted it). It should be mentioned that many respondents take the data, which is also given in the media, as official statistics rather than gather the information directly from statistical compilations. The least frequently used sources of information are professional activities (12.5% of respondents) and reports of international organizations such as the World Health Organization, the World Bank, OECD and others (15.2% of respondents).

Almost 40% of respondents regularly use two sources of information, 27.6% - three sources of information, 22.3% of respondents - only one source of information. As ANOVA tests have shown, none of the information sources affect the number of environmental problems, highlighted by respondent.



**Figure 5. The responses on the questions about the sources of ecology information**

80% of respondents believe that the regional/federal authorities do not provide enough information about the ecology problems. While 47.8% of all respondents rated the degree of their agreement with the statement “Authorities provide enough information about the environmental issues” in 1 point (minimum). This result can be interpreted as a distrust of the population to the information policy of the authorities (fig. 6).



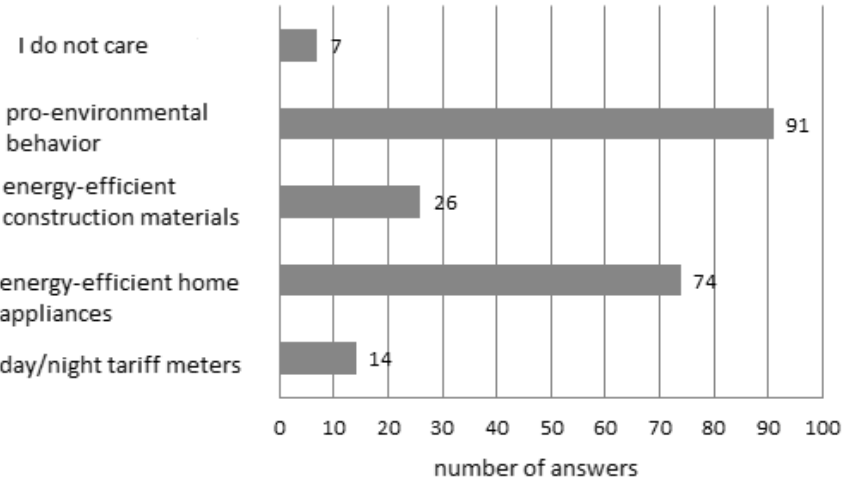
**Figure 6. Degree of agreement with the statement “Authorities provide enough information about the environmental issues”**

However, despite the low level of confidence in the information disseminated by the authorities (mostly by media), respondents do not use alternative sources. This can be interpreted as evidence of weak environmental concerns.



On the question of what methods of saving energy respondents put into practice, the overwhelming number of respondents (81.2%) reported the use of such simple rules as turning off lights, not leaving working appliances without need, etc. It can be treated as pro-environmental behavior, but at the same time it can be an evidence of poverty. To test this hypothesis, we divide the entire set of respondents into two groups - those who practice energy saving (at least one way) and those who do not. As a dependent variable we choose the number of tagged environmental issues by the respondent. Since the size of the number of respondents in the second group is small (only 7 people) the Mann-Whitney test is used. The results with significance  $p = 0.07$  had proved that there is a difference between these two groups of respondents. Thus, the habit of Russians to save energy can be considered as evidence of a sufficiently high level of environmental awareness.

66% of respondents also noted the use of energy-efficient home appliances and lighting appliances, 23.2% - energy-efficient construction materials (Fig. 7).



**Figure 7. Energy-saving practices**

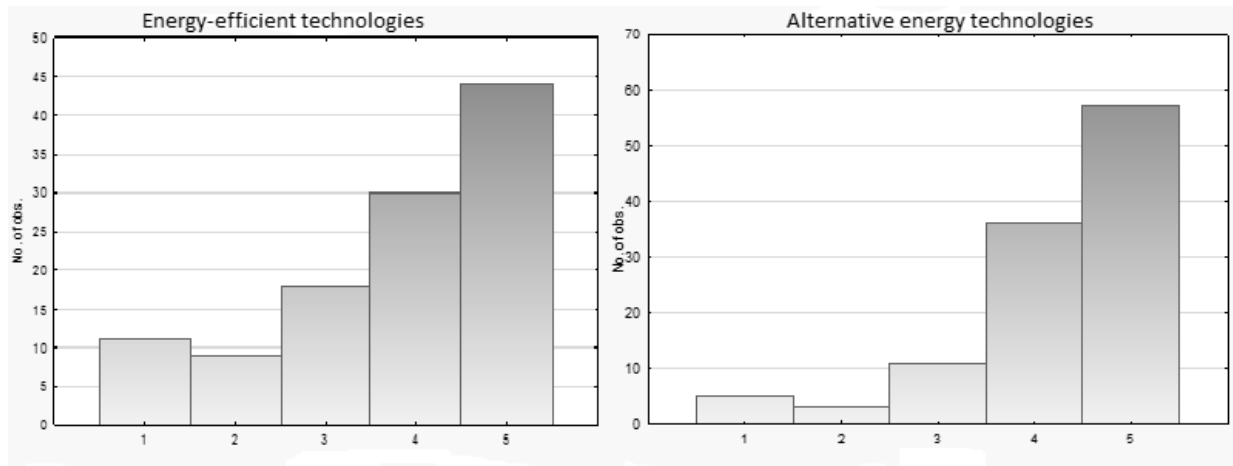
Cross tabulation shows that the frequency of use of energy-saving construction materials depends on the type of accommodation and the gender of the respondent, the frequency of use of energy-efficient lighting devices and appliances on the type of accommodation and residence, and the frequency of use of day/night tariff meters on the type of accommodation and age (table 1).

Table 1 – Main statistics of cross tabulation

Variables	$\chi^2$	P-level	df	Goodman-Kruskal $\gamma$	Kendall's coefficient
“Type of accommodation” and “the use of energy-efficient construction materials”	6.554330	p=0.03774	df=2	0.4785478	b=0.2209766 c=0.1849490
“Gender” and “the use of energy-efficient construction materials”	5.327025	p=0.02100	df=1	0.4789916	b=0.2180888 c=0.1817602
“Type of accommodation” and “the use of energy-efficient home appliances”	4.849897	p=0.08848	df=2	-0.356259	b=-0.175985 c=-0.165179
“Residence” and “the use of energy-efficient home appliances”	9.874204	p=0.01967	df=3	-0.428911	b=-0.231718 c=-0.229911
“Type of accommodation” and “the use of day/night tariff meter”	5.446301	p=0.06567	df=2	-0.661442	b=-0.205253 c=-0.134566
“Age” and “the use of day/night tariff meter”	15.07033	p=0.01007	df=5	0.4173369	b=0.1878627 c=0.1489158

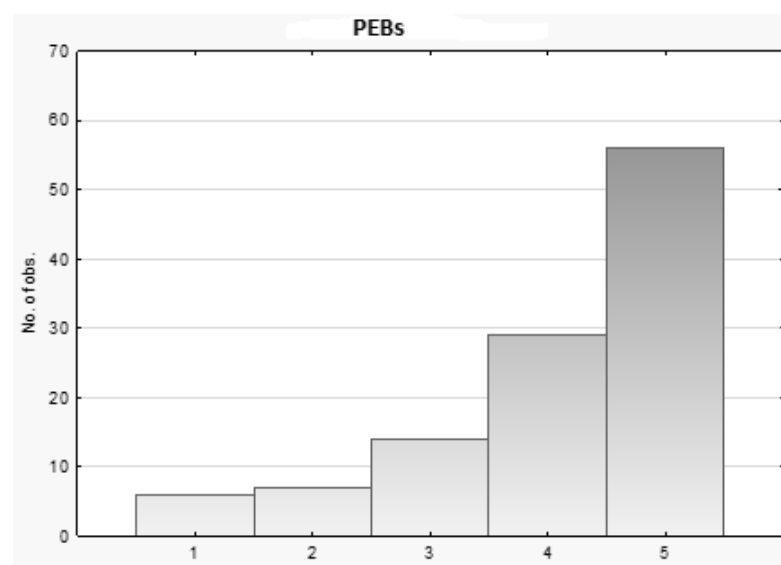
Respondents who live in individual houses are more likely to use energy-efficient construction materials than others. Also men more frequently use energy-efficient construction materials than women. Respondents, who live in an apartment (or condo) are more likely to use energy-efficient home appliances or meters with double tariff. People in the age groups from 30 to 50 are more likely to use day/night tariff meters than youth or seniors.

The expectations of respondents about widespread energy-saving technologies are quite high: 26% of respondents rated them with 4 points, and 38.3% with 5 points. Overall, 64.3% of respondents expect improvement of the environment from the introduction of energy saving technologies. Only 9.6% of respondents do not expect any improvement of the environment with the introduction of energy saving technologies (fig.8a)



**Figure 8. Degree of agreement with the statements: a) “Introduction of energy-efficient technologies can improve environment”; b) “Introduction of alternative energy technologies can improve environment”**

The expectations of widespread alternative energy technologies are even more pronounced: 49.6% of respondents rated it at 5 points, and 31.3% - at 4 points. Total 80.9% of respondents believe that alternative energy will help environment. Only 4.35% of respondents do not expect any improvement of the environment from the introduction of alternative energy technologies (fig. 8b). Expectations of respondents regarding the extension of PEBs are slightly higher than expectations of energy-efficient technologies, but lower than expectations of introduction of alternative energy (fig.9). 73.9% of respondents believe that PEBs can help environment: 25.2% of respondents say they agree with this (4 points) and 48.7% say they strongly agree (5 points).



**Figure 9. Degree of agreement with the statements: “Widespread PEBs can improve environment”**

The number of environmental problems reported by respondents has a weak positive correlation ( $R = 0.2$ ) with the expectations from the introduction of energy saving technologies. The more problems the respondent marked, the stronger his or her agreement with the statement that the widespread introduction of energy-saving technologies can improve the environment. A similar correlation ( $R = 0.22$ ) is observed between respondents' expectations of the introduction of energy-saving technologies and the number of information sources about ecology problems. The greater the number of sources of information the respondent uses, the higher his or her expectations.

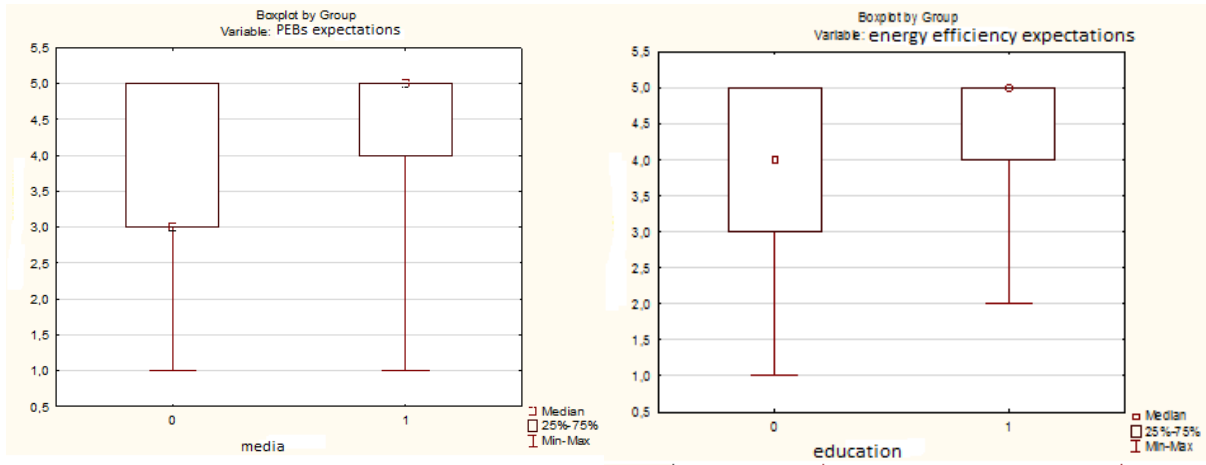
Then we have checked if the sources of information or socio-demographical characteristics affect the degree of agreement of the respondent with the statements S1-S10. The results of Mann–Whitney tests on the statements about expectation of improvement of environmental situation are presented in table 2.

Table 2 - The results of Mann–Whitney tests

<b>Grouping variable</b>	<b>Dependent variable</b>	<b>U</b>	<b>Z</b>	<b>P-level</b>
Media as a source of information	Expectations from PEBs	709.500	-2.63778	0.008345
Education as a source of information	Expectations from introduction of energy-efficient technologies	632.000	-2.03465	0.041887
Residence	Expectations from introduction of energy-efficient technologies (group 1 and 4)	734.000	2.79012	0.00502
	Expectations from introduction of alternative energy (group 1 and 4)	620.500	2.02104	0.04205
	Expectations from introduction of alternative energy (group 4 and 5)	655.000	-2.05113	0.04144

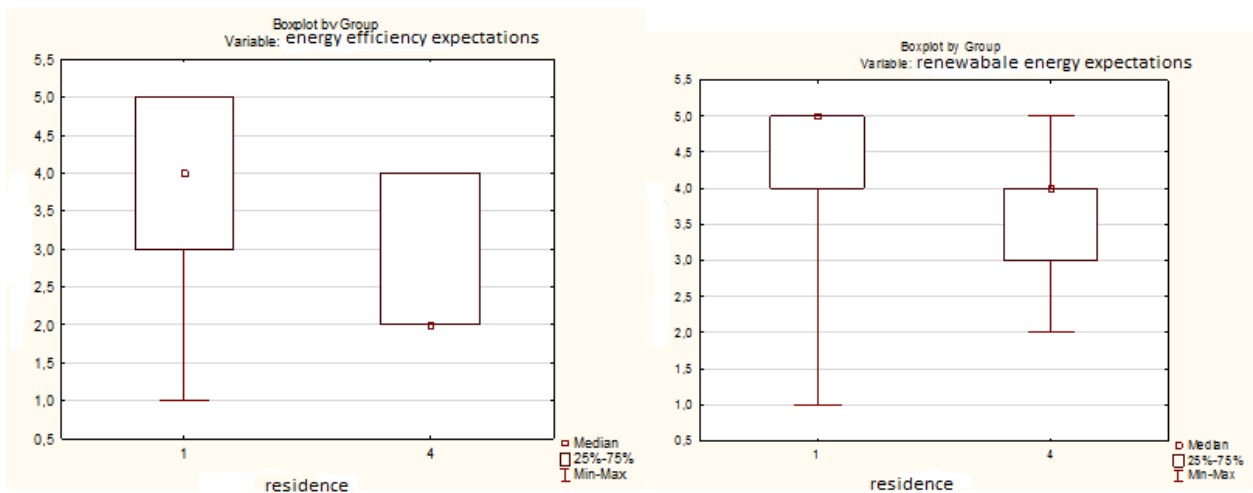
Respondents, who use the media as a source of information about an environmental situation, tend to evaluate their expectations from the widespread introduction of PEBs higher (fig. 10a). Most likely, this is due to context of information messages in the media, which now particularly emphasized the energy savings as the most important PEB. Respondents receiving information about environmental situations during the process of education

(training) tend to evaluate their expectations from the widespread introduction of energy saving technologies higher (fig. 10b).



**Figure 10. The difference in the answers in groups of responders by sources of information**  
**a) media; b) education**

Respondents living in big cities (from 300,000) have higher expectations of introduction of energy saving technologies than residents of small towns (up to 100,000), but variation in opinions is higher. Similar difference between these two groups of respondents is observed in expectations from introduction of alternative energy technologies (fig.11).



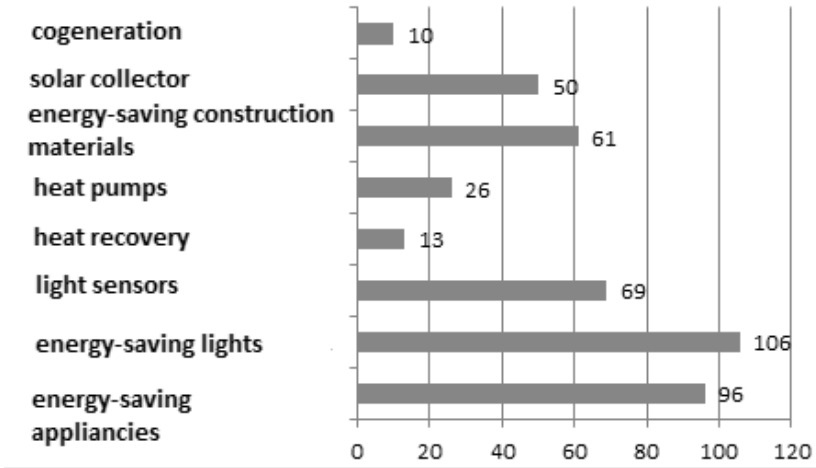
**Figure 11. The difference in the answers in groups of responders by place of residence**

People in rural areas have much higher expectations from the introduction of alternative energy technologies, rather than residents of small towns. Statistically significant

differences in the respondents' answers, divided into groups by variables “age”, “type of accommodation”, “gender” are not found.

**4. Information sources and their impact on PEBs**

The distribution of the answers on Q4: “Which energy saving technologies you aware of?” are presented on fig. 12. The most widely known technologies, as expected, are energy-efficient lighting equipment (95% of respondents) and energy-saving home appliances (85.7 % of respondents). The least known to the respondents were cogeneration (heat&electricity generation) technologies (9%) and heat recovery technologies (11.6%).



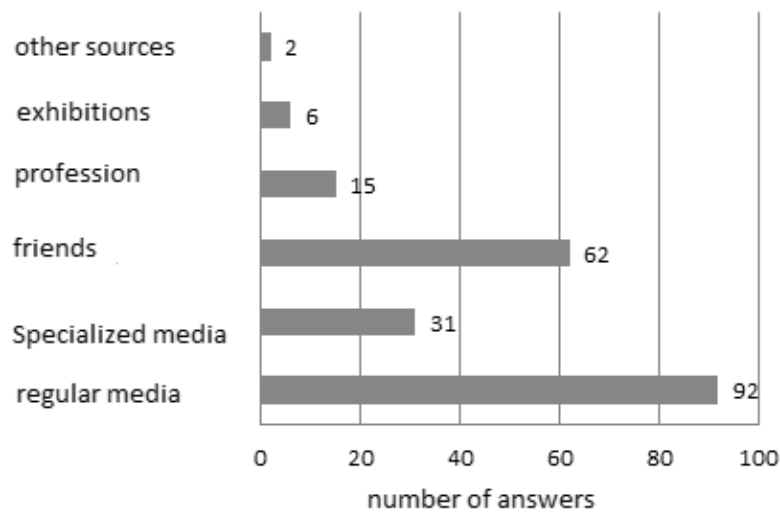
**Figure 12. Distribution of energy-saving technologies by the number of references**

More than half of the respondents chose only 2-3 energy-saving technologies as known to them (52%). All listed in the questionnaire saving technologies known only by 3.5% of respondents. While none of the respondents noted in the "Others" any of the energy-saving technologies that are not listed in the questionnaire. Some respondents mentioned in the "Other " solar panels. In addition, some respondents mixed the concept of "solar collector" and "solar panel" without having a clear idea about it.

Analysis of variance has indicated that there is a statistically significant relationship between the number of known technologies and gender of responder ( $p=0.005$ ) as well as the number of known technologies and the place of residence of the respondent ( $p =0.01$ ). Men and residents of suburbs of large cities know more energy-saving technologies. In addition, there is a weak positive correlation between the number of used sources of information about

the environment and the amount of energy-saving technologies known to the respondent ( $r = 0,2369$ ).

On the question about sources of information about available energy-efficient technologies responses were as follows: 82.14% of the respondents derive this information from conventional media, and 55.36% - and from friends and acquaintances (Fig. 13). Obviously, these two are the main source of information. Specialized media are used by 27.67% of the respondents, exhibitions, conferences and presentations are visited only by 5.3% of respondents.



**Figure 13. Distribution of sources of information on energy-saving technologies by the frequency of mention**

There is a low positive correlation ( $r = 0,31$ ) between the number of information sources about energy-saving technologies and the number of known technologies ( $p=0.05$ ). Furthermore, analysis of contingency tables reveals the existence of correlation between the number of used information sources about energy-saving technologies and use of energy efficient appliances and lighting ( $\chi^2 = 10.3$ ,  $p = 0.035$ ). 60 % of respondents who do not use energy-saving lighting and appliances, have only one source of information, 28.95 % - two sources and 10.53% - three of six sources of information.

In order to determine the influence of specific source of information on the number of known energy-saving technologies ANOVA test was used (Table 3).

Table 3 - Results of ANOVA

Grouping variable	Mean if the first group (code 0 – don't use)	Mean in the second group (code 1 – use)	F-statistics	P- level
Specialized media	3.716049	4.193548	2.0574	0.154307
Profession	3.670103	5.000000	9.8942	0.002133
Exhibitions, conferences, etc.	3.716981	6.166667	15.3410	0.000156

As can be seen from the results of statistical analysis there is little difference in the number of known technologies between respondents who uses specialized media and who doesn't (statistical significance  $p=0.2$ ). Professional activities and visits of exhibitions, conferences and other special events have a significant impact on the number of respondents known energy-saving technologies.

The effect of each source individually for the use of specific of energy saving technologies investigated by using contingency tables (Tab. 4). It turned out that the use of specialized media as an information source only affects the depth of penetration of energy-saving lighting devices and appliances into every-day practice. The effect of visiting exhibitions, conferences and other special events is about the same. But in the case where the source of information is the professional activities of the respondent, it affects the penetration of not only energy-saving lamps and appliances, but also building materials and counters with a double rate into daily practice.

Table 4 - Main statistical parameters of contingency tables between information sources and energy-saving practices

Variables	$\chi^2$	P-level	df	Goodman-Kruskal $\gamma$	Kendall's coefficient
Specialized media and energy efficient lighting and appliances	11.24554	$p=0.00080$	df=1	0.7531306	b=0.3168700 c=0.2684949
Professional activities and counters with double tariff	3.178007	$p=0.07464$	df=1	0.5196506	b=0.1684490 c=0.0758929
Professional activities and energy-saving lighting and appliances	3.751376	$p=0.05276$	df=1	0.5864407	b=0.1710555 c=0.1103316
Professional activities and energy-saving building materials	8.814228	$p=0.00299$	df=1	0.6675462	b=0.2805324 c=0.1613520
Exhibitions and energy efficient lighting and appliances	5.146073	$p=0.02330$	df=1	1.000000	b=0.1704899 c=0.0727041

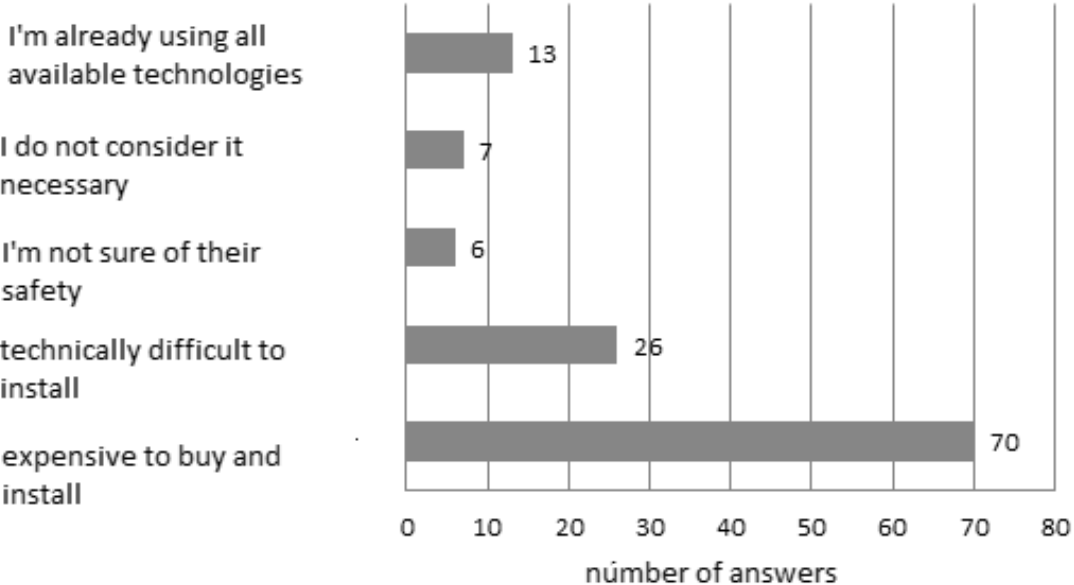


90.32 % of respondents using specialized media as an information source also use energy-efficient appliances and lighting appliances, while only 56.8 % of respondents not using specialized media use the abovementioned technologies. 26.7 % of respondents who reported professional activities as a source of information use meters day/night tariff, whereas only 10.3% respondents whose profession is not related to energy-saving technologies use this type of meters.

86.7 % of respondents using professional activity as a source of information use energy-efficient appliances and lighting appliances. The proportion of respondents using the same technology, but other sources of information is 63 %. Professional activity has a significant impact on the use of energy-saving building materials: 53.3 % of respondents whose profession somehow is related to energy saving use these materials, while only 18.56 % of respondents otherwise.

Energy-efficient appliances and lighting appliances use 100% of respondents attending exhibitions and other massive themed events, while this percentage among respondents who do not attend such events is only 64.15 %.

The last question of the first part of the questionnaire was to identify the main barriers to wider use available on the market energy efficient and renewable technologies in everyday life. The vast majority of respondents (62.5%) noted as the main obstacles that the necessary equipment is expensive to buy and / or install (Fig. 14). The second major obstacle noted is that the necessary equipment is technically difficult to install (23.2% of respondents).



**Figure 14. The main barriers to more intensive use of energy-saving technologies**

Dependence of selected answers from any characteristics of the respondents studied by constructing the cross-tabulation tables (Table 5). The hypothesis that the technical complexity of the installation of energy efficient equipment is a bigger problem for those living in apartment buildings than for those living in individual houses was not confirmed. At the same time, statistical analysis showed that the problem is more significant for the elderly and people living in the suburbs.

Table 5 - Basic statistical parameters of contingency tables between barriers of the introduction of energy-saving technologies and the characteristics of the respondents

Variables	$\chi^2$	P-level	df	Goodman-Kruskal $\gamma$	Kendall's coefficient
The technical complexity of installation and type of housing	4.293323	p=0.11687	df=2	-0.136405	b=-0.057530 c=-0.048151
The technical complexity of installation and location	6.607751	p=0.08551	df=3	-0.322553	b=-0.136595 c=-0.120855
The technical complexity of the installation and age	12.70882	p=0.02627	df=5	0.2703506	b=0.1433759 c=0.1450893

A study of the impact of information sources to evaluation of potential barriers for introduction of energy-saving and renewable technologies showed that professional activities and visits of exhibitions and other special events as sources information on energy-saving technologies contribute to a higher evaluation of the technical complexity of installation of equipment as a potential barrier. The level of statistical significance is  $p = 0.1$  and  $p = 0.05$  respectively (Table 6).

Table 6 - Basic statistical parameters of cross-tabulation between the evaluation of barriers for energy-saving technologies and information sources

Variables	$\chi^2$	P-level	df	Goodman-Kruskal $\gamma$	Kendall's coefficient
The technical complexity of installation and professional activities	2.737672	p=0.09801	df=1	0.4392523	b=0.1563442 c=0.0899235
The technical complexity of installation and visiting of exhibition	6.715136	p=0.00956	df=1	0.7684211	b=0.2448603 c=0.0931122
"I'm already using all available technologies" and professional activities	3.993309	p=0.04568	df=1	-1.00000	b=-0.142500 c=-0.062181

In addition, none of the respondents whose professional activity is connected with energy efficiency pointed out the fact that he is already using all available technologies.

## **5. Conclusions**

The results of empirical studies indicate that the residents of the Krasnodar Region have a fairly high level of environmental awareness, recognize the necessity of PEBs and use energy-efficient lighting, appliances and building materials as well as meters with a double rate. At the same time, some other technologies available in the market for energy saving and alternative energy (such as heat pumps, pellet system, solar collectors, etc.) are out of view of most respondents. Men and people living in suburbs were better informed about the issues of energy saving and renewable energy technologies. It is explained by the presence of better opportunities for the use of "advanced" technologies in the suburbs.

The interesting result of research is that 80% of respondents in Russia believe that the regional/federal authorities do not provide enough information about the ecology problems. However, despite the low level of confidence in the information disseminated by the authorities (mostly by media), respondents do not care to find and use some alternative sources. This can be interpreted as lack of knowledge in the field of modern world information resources, language barriers or an evidence of weak environmental concerns.

The professional activities of the respondent is the most reliable and relevant source of information on available technologies. Other sources of information, including specialized media did not significantly affect the use of "advanced" technologies.

Main factors that cause a difference in practice rate of energy-saving PEBs are the place of residence and the type of accommodation. Respondents who live in individual houses are more likely to use energy-efficient construction materials, while respondents who live in apartment (or condo) are more likely to use energy-efficient home appliances or economy tariffs. Respondents living in the big cities (more than 300,000) have higher expectations of introduction of energy saving technologies and alternative energy technologies than residents of small towns.

Respondents, who use the media as a main source of information about the environmental situation, tend to evaluate their expectations from the widespread introduction of PEBs higher.

Most informed respondents whose professional activity is a source of information about available technologies more clearly recognize the technical difficulties associated with the installation of the necessary equipment. Elderly suburbanites also refer technical difficulties as a barrier of use of energy-saving and renewable technologies. This indicates a lack of market saturation and installation services in the region and proves a significant potential for the development of small businesses in this sector.

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