

# Knowledge and Sources of Information on the Energy Efficiency of Devices in Farms in Poland

Arkadiusz PIWOWAR

Wrocław University of Economics and Business, Wrocław, Poland; arkadiusz.piwowar@ue.wroc.pl

**Abstract:** The paper presents the results of empirical research on the sources of information on the energy efficiency of electrical devices used by farmers, both in economic and living activities. The study was conducted using the questionnaire method in Poland, and the research sample consisted of 480 farms. As the research shows, there is a clear diversification of the sources of knowledge with regard to the purchase of equipment for living and production purposes. The most important source of information is the advisor at the point of sale of devices (indications of 78.8% of respondents in relation to home electronics and appliances and 58.9% in relation to agricultural equipment). The Internet, as a source of knowledge on the subject matter under study, was more often indicated in relation to equipment used for living purposes. The research shows that a significant part of the respondents did not know the energy efficiency class of electrical equipment used in both household and agricultural equipment.

**Keywords:** energy efficiency; equipment; farmers' households; farms; sources of knowledge

**JEL Classification:** Q12; Q49; R20

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## 1. Introduction

Improving energy efficiency, which, apart from significant economic benefits, brings measurable environmental effects, should be a priority in modernizing the economy (Ayres et al., 2007; Brockway et al., 2021). Improving energy efficiency should concern various spheres and areas of the economy, ranging from the energy system, through the sectors of agriculture, industry and construction, to activity at the household level (Piwowar & Dzikuc, 2019; del Mar Solà et al., 2021; Chen et al., 2021).

In this paper, the main area of interest are farmers' households in the context of equipping them with technical equipment/devices and sources of information on the effectiveness of devices used for production (agricultural) and living (in the farmer's household) purposes. The importance of the topics results from the existing research gap in the spatial scope of research. There are not many items in the scientific literature regarding the sources of knowledge of buyers/users about the energy efficiency of devices, especially farmers' knowledge. Most often, the subject of agricultural (agronomic) knowledge sources is taken up and in this context the importance and role of individual sources is characterized, including traditional ones – press, television, etc., and modern ones – the Internet (Kalinowski & Prymon, 2011; Janc, 2013; Solon, 2014). There is also little research in the literature on the equipment of farmers' households with electrical equipment. The analyses mainly concern the equipment of farms with plant production equipment (Maciulewski & Pawlak, 2014; Pawlak, 2018). Secondly, the studied

issue is an important point of contact between the issues of energy efficiency and consumer behaviour (Gaspar & Antunes, 2011; Umit et al., 2019). In this context, learning about the determinants of behaviour and taking action to change consumer behaviour can significantly contribute to reducing environmental degradation (Stern, 1999; Pawaskar et al., 2018; Kácha & van der Linden, 2021). As emphasized by Pizło and Mazurkiewicz-Pizło (2010), farmers' households constitute a specific group of households due to the relatively free flow of funds allocated for investment and consumption. In this context, the analysis in this group is particularly interesting from the cognitive point of view.

The constant increase in the demand and use of electricity in rural areas in Poland is confirmed by many years of research conducted, among others, by the Central Statistical Office. Tab. 1 presents data on the number of consumers and electricity consumption in Poland in 2018-2020, broken down into urban and rural areas.

**Table 1.** Electricity consumption in Poland in 2018-2020 (Statistics Poland, 2020; 2021)

Specification	2018	2019	2020
<b>Electricity consumption (annually) in GWh</b>	30,506.20	30,613.20	31,534.80
<b>cities</b>	17,953.40	17,936.00	18,499.00
<b>rural areas</b>	12,552.80	12,677.10	13,035.80
<b>Electricity consumers in thous. (as of December 31)</b>	15,398	15,588	15,799
<b>cities</b>	10,244	10,400	10,556
<b>rural areas</b>	5,154	5,188	5,243

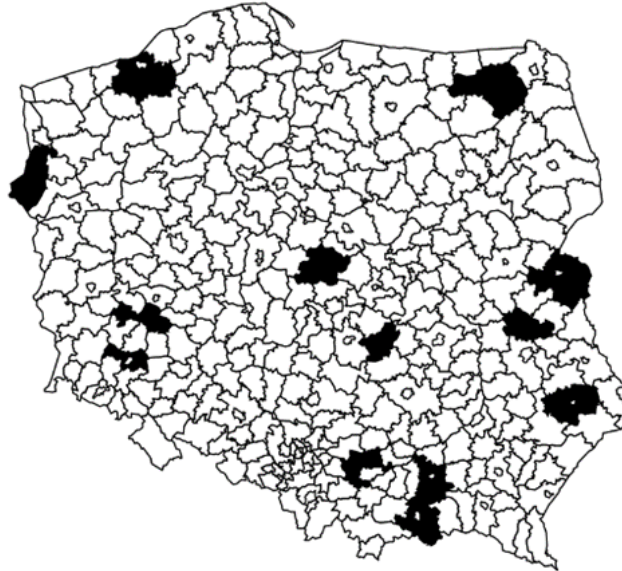
As can be seen from the data in Table 1., in 2018-2020, both the number of electricity consumers in rural areas (by 55 thousand) and electricity consumption (by 483 GWh) increased in Poland. Electricity consumption (per year) per capita in rural areas in Poland in 2020 amounted to 849.1 kWh and was 44.8 kWh higher than in cities.

Therefore, rural areas in Poland are particularly important from the point of view of analyses in the area of energy efficiency (Piwowar, 2021; Bielski et al., 2021). The studied issue is an important element of the economization of agricultural production and the sustainable development of agriculture. The improvement of energy efficiency is associated not only with the reduction of energy consumption for generating a production unit in agricultural activity, but also savings made in the context of energy consumption for living purposes in farmers' households (Kaya et al., 2021). Technical equipment, especially qualitative aspects, are an important element of the sustainable economic and social development of farms and farmers' households (Stępień et al., 2021).

The main purpose of this study was to learn about the sources of information on the energy efficiency of electrical devices used in agriculture, both in economic and living activities. Additionally, the results of research on the equipment of the surveyed farms with electrical equipment used for household and agricultural purposes are presented.

## 2. Methodology

The study was conducted among farmers' households in Poland in the period: October 2019 – March 2020. The size of the group was 480 people, including agricultural producers from six voivodeships in Poland (Figure 1).



**Figure 1.** Spatial scope of empirical research

A two-stage survey was conducted. The first-degree research was carried out among households with a user of an individual farm. The size of the research sample was 480 farms where one of the members is a user of a farm with an area of at least 5 ha of agricultural land. The study was performed in three randomly selected counties in the area of six randomly selected voivodeships (80 questionnaires from each of the six voivodships). The second stage of the research involved an extended survey of 10 farmers in each voivodeship who participated in the basic research. In this paper, selected results from basic research were analysed.

Research on the condition of equipment and sources of knowledge regarding the energy efficiency of electronic equipment was carried out using the questionnaire method supported by the proprietary questionnaire. The survey was anonymous and included socio-economic and technical questions. This paper analyses some of the questionnaire questions concerning household and agricultural equipment of the respondents, as well as sources of knowledge on the energy efficiency of household and agricultural devices (machines). The novelty in this study is not only the quantitative analysis (the issue of having the selected type of equipment on the respondents' farm), but most of all the qualitative characteristics (the issue of energy efficiency of the equipment owned). The research was carried out before the entry into force of the regulations changing energy classes for selected product groups (European Commission, 2021). From 2021, the "pluses" used in the energy efficiency class "A" have been abandoned in the European Union. Currently, the A energy class is the highest, and the G class is the lowest.

### 3. Results and Discussion

An important area of research under the project (indicated in Acknowledgment) was the material resources of households and farms, conditioning the fulfilment of basic living, social and production needs that affect the formation of energy poverty. In the area of the household, these include goods directly related to household work (refrigerators, microwave ovens, vacuum cleaners, washing machines, etc.). In the survey, respondents answered questions about household equipment with the following household appliances and audio/video devices: boiler, central heating furnace; refrigerator; freezer; fridge-freezer; automatic washing machine; washer-dryer; an electric heater; vacuum cleaner; dishwasher; microwave; oven and electric cooker; oven and gas-electric stove; electric kettle; iron; air conditioner. Table 2 presents the results of analyses with regard to the equipment provided by at least half of the surveyed farms' households.

**Table 2.** The respondents' declarations regarding the age and energy class of electrical appliances owned by the household (own study based on questionnaire surveys (N = 480))

Specification		1*	2*	3*	4*	5*	6*	7*	8*
		[%]							
Equipment age	Up to 5 years	20.4	26.4	44.4	42.9	57.9	31.1	64.0	49.2
	5-10 years	40.2	54.0	40.3	39.5	38.2	42.9	28.6	38.1
	Over 10 years	39.2	19.6	15.3	17.6	3.9	26.0	7.4	12.7
Energy class	A+++	2.4	7.6	16.0	7.7	9.7	4.8	7.1	5.9
	A++	5.8	22.1	27.6	19.9	34.0	19.2	18.7	19.5
	A+	7.1	25.0	20.8	20.9	24.3	15.1	22.9	20.1
	A	7.1	9.2	10.0	11.1	6.5	10.9	11.1	10.0
	Other	13.6	2.4	2.0	2.6	3.1	14.1	7.1	3.3
	I do not know	64.0	33.7	23.6	37.8	22.4	35.9	33.1	41.2

Note: 1\* boiler, central heating furnace, 2\* fridge-freezer, 3\* automatic washing machine, 4\* vacuum cleaner, 5\* dishwasher, 6\* oven and gas-electric stove, 7\* electric kettle, 8\* iron

According to the research, the three most popular devices among those mentioned in the survey were: an iron (owned by 478 households, i.e. 99.6% of respondents); a vacuum cleaner (468 households, i.e. 97.5% of the surveyed) and an automatic washing machine (457 households, i.e. 95.2% of the surveyed). The least frequently indicated equipment was an air conditioner (indicated by only 3 respondents, i.e. 0.6 of the research sample). The respondents also indicated the age of the equipment and the energy efficiency class. The highest percentage of indications of relatively new equipment (up to 5 years) was recorded in the case of the electric kettle (64% of responses), while the boiler and central heating furnace were often indicated in the "oldest" category (over 10 years). With regard to the energy efficiency class, it is worth noting that in the entire study (all product categories), the percentage of respondents who did not know the energy efficiency class of these devices on their farm was 37.9%. Taking into account individual appliances, a high percentage of respondents who indicated "I do not know" in this question was recorded in the following products: stove, boiler (64%). The respondents' knowledge in this area was the most complete

in the following categories: automatic washing machine and dishwasher. In these two categories, there were also declarations of having equipment with the highest energy efficiency classes (A+++ and A++).

The respondents were also asked to indicate the age and energy efficiency of selected electrical devices directly related to agricultural production (milking machines, coolers, dryers, irrigation devices). The respondents could also add and evaluate three other categories indicated by them. The results of this part of the analyses are presented in Table 3.

**Table 3.** The respondents' declarations regarding the age and energy efficiency assessment of electrical appliances owned by the farm (own study based on questionnaire surveys (N = 480))

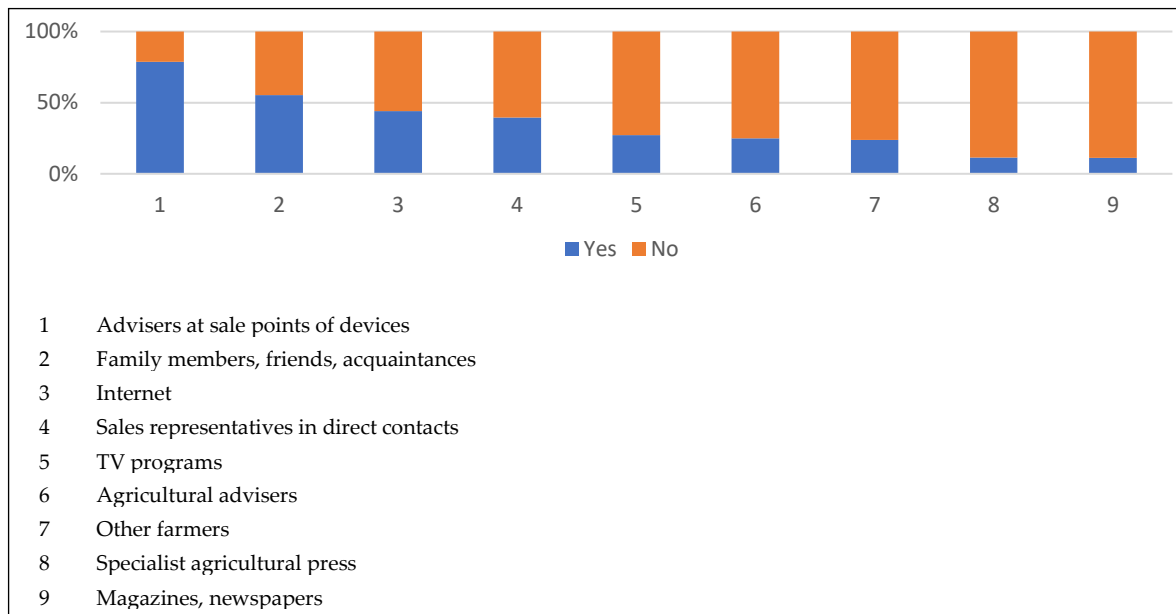
Specification		Milking machines	Coolers	Other	Dryers	Irrigation devices
		[%]				
Equipment age	Up to 5 years	7.7	10.8	9.1	17.4	41.7
	5-10 years	37.6	34.2	30.9	34.8	41.7
	Over 10 years	54.7	55.0	60.0	47.8	16.6
Energy efficiency assessment	Very good	5.1	3.6	10.9	21.7	0,0
	Good	44.4	38.8	25.4	26.1	33.3
	Hard to say	41.0	42.3	41.8	39.1	58.3
	Rather bad (energy-consuming)	8.6	14.4	16.4	4.4	0.0
	Bad (highly energy-consuming)	0.9	0.9	5.5	8.7	8.4

The analyses show that more than half of the selected equipment used on farms in the categories of milking machines, coolers, dryers was over 10 years old. A high percentage also concerned the category "other", in which the respondents indicated, among other things, grinders, saws, welders, mixers, blowers, coolers, heaters, crusher. As in the case of household goods, respondents had difficulty in determining the energy efficiency of the appliances. The most frequently given answer was "hard to say". Negative responses (rather bad and bad – i.e. energy-consuming and highly energy-consuming) concerned coolers and equipment from the "other" category.

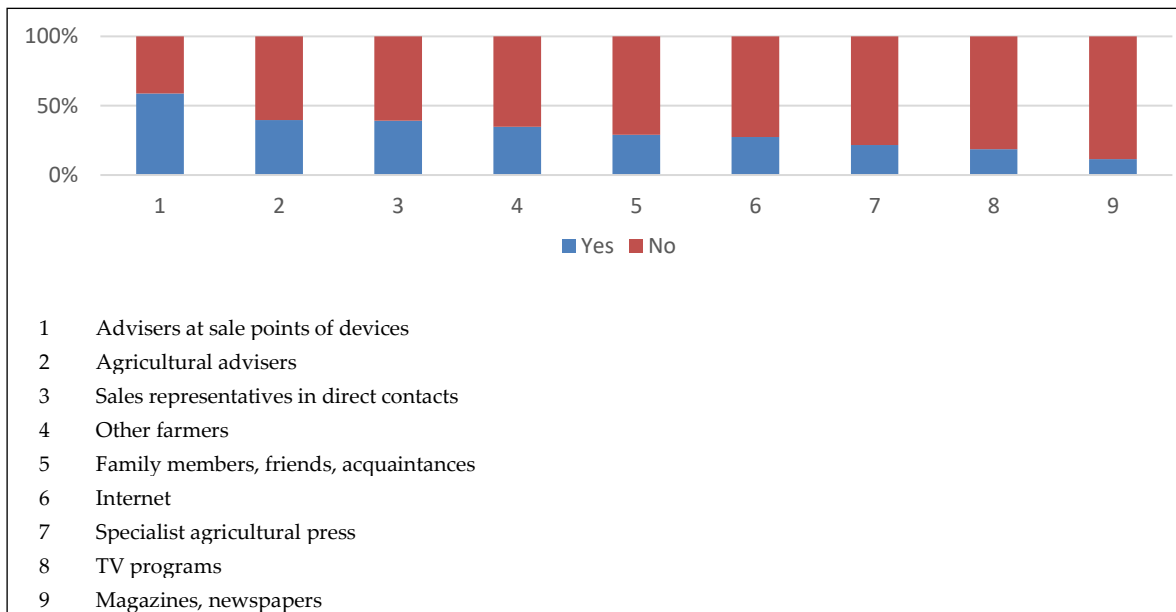
One of the research threads taken up in the survey were the sources of knowledge about the energy efficiency of devices (machines) used in households and farms of respondents. The results of these analyses are presented in Figures 2 and 3, with regard to household equipment (washing machines, refrigerators, etc.) and production needs in agriculture (milking machines, coolers, etc.), respectively.

The research shows that the most important source of information on energy efficiency (both household appliances and audio/video devices as well as devices used in agricultural production) is that provided by advisers at points of sale. In the following places, taking into account the importance of information sources, the respondents indicated other categories, depending on whether it concerned devices used for living purposes or for production purposes. A significant percentage of the respondents, considering household goods, indicated information obtained from family members, friends and acquaintances. The

respondents indicated magazines and newspapers as the least important sources of information in both categories of electrical equipment.



**Figure 2.** The respondents' declarations regarding the most important sources of information on the energy efficiency of devices (machines) used in the household (own study based on questionnaire surveys (N = 480))



**Figure 3.** The respondents' declarations regarding the most important sources of information on the energy efficiency of devices (machines) used in the farm (own study based on questionnaire surveys (N = 480))

#### 4. Conclusions

In the era of changing farming conditions, including strong pressure in the area of reducing negative externalities related to agriculture, requiring adaptation and innovation, the agricultural community needs easy access to knowledge and information on effective, pro-environmental farming practices in farming and appropriate, pro-ecological behaviour

as part of running a household. One of the key aspects, important both at the farm and household level, is the use of highly energy efficient appliances.

The author's own research shows that the equipment improving the performance of household activities was characterized by medium and high saturation in the researched farms' households. The research shows that the respondents hardly know the energy efficiency class of household appliances. Similarly, the respondents assessed the energy efficiency of equipment used in agriculture. The most common answer was "hard to say". The respondents' current knowledge of energy efficiency should be assessed negatively. There is a significant information gap between farmers and producers of durable goods, which are the equipment of farmers' households. As the financial situation of these farms improves, technologically obsolete equipment will be gradually replaced with equipment with higher technical values. With the passage of time and the persistence of the epidemic situation (Covid-19), the importance of the Internet as a source of knowledge on the subject matter may increase. Currently, this source of information is relatively rarely indicated, especially in relation to equipment used for production purposes. Nevertheless, internet sources still dominate traditional media, especially magazines and newspapers.

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**Conflict of interest:** none

## References

- Ayres, R. U., Turton, H., & Casten, T. (2007). Energy efficiency, sustainability and economic growth. *Energy*, 32(5), 634-648. <https://doi.org/10.1016/j.energy.2006.06.005>
- Bielski, S., Marks-Bielska, R., Zielińska-Chmielewska, A., Romaneckas, K., & Šarauskis, E. (2021). Importance of agriculture in creating energy security—A case study of Poland. *Energies*, 14(9), 2465. <https://doi.org/10.3390/en14092465>
- Brockway, P. E., Sorrell, S., Semieniuk, G., Heun, M. K., & Court, V. (2021). Energy efficiency and economy-wide rebound effects: A review of the evidence and its implications. *Renewable and Sustainable Energy Reviews*, 110781. <https://doi.org/10.1016/j.rser.2021.110781>
- Chen, Y., Wang, M., Feng, C., Zhou, H., & Wang, K. (2021). Total factor energy efficiency in Chinese manufacturing industry under industry and regional heterogeneities. *Resources, Conservation and Recycling*, 168, 105255. <https://doi.org/10.1016/j.resconrec.2020.105255>
- del Mar Solà, M., de Ayala, A., Galarraga, I., & Escapa, M. (2021). Promoting energy efficiency at household level: a literature review. *Energy Efficiency*, 14(1), 1-22. <https://doi.org/10.1007/s12053-020-09918-9>
- European Commission. (2021). Press corner IP/21/818. [https://ec.europa.eu/commission/presscorner/detail/en/IP\\_21\\_818](https://ec.europa.eu/commission/presscorner/detail/en/IP_21_818)
- Gaspar, R., & Antunes, D. (2011). Energy efficiency and appliance purchases in Europe: Consumer profiles and choice determinants. *Energy Policy*, 39(11), 7335-7346. <https://doi.org/10.1016/j.enpol.2011.08.057>
- Janc K. (2013). Źródła informacji dla rolnictwa – analiza powiązań między serwisami WWW. *Wiś i Rolnictwo*, 3, 168-181.
- Kácha, O., & van der Linden, S. (2021). The moderating role of moral norms and personal cost in compliance with pro-environmental social norms. *Current Research in Ecological and Social Psychology*, 2, 100020. <https://doi.org/10.1016/j.cresp.2021.100020>
- Kalinowski, J., & Prymon, K. (2011). Znaczenie internetu jako źródła informacji rolniczych. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, 13(2), 186-190.

- Kaya, O., Klepacka, A. M., & Florkowski, W. J. (2021). The role of personal and environmental factors in rural homeowner decision to insulate; an example from Poland. *Renewable and Sustainable Energy Reviews*, 150, 111474. <https://doi.org/10.1016/j.rser.2021.111474>
- Maciulewski, B., & Pawlak, J. (2014). Wyposażenie gospodarstw rolnych w sprzęt do produkcji roślinnej. *Problemy Inżynierii Rolniczej*, 22(3), 19-30.
- Pawaskar, U. S., Raut, R. D., & Gardas, B. B. (2018). Assessment of consumer behavior towards environmental responsibility: A structural equations modeling approach. *Business Strategy and the Environment*, 27(4), 560-571. <https://doi.org/10.1002/bse.2020>
- Pawlak, J. (2018). Emisja gazów cieplarnianych na skutek zużycia energii w rolnictwie polskim a wyposażenie w ciągniki rolnicze. *Woda Środowisko Obszary Wiejskie*, 18(62), 57-68.
- Piwowar, A., & Dzikuć, M. (2019). Development of renewable energy sources in the context of threats resulting from low-altitude emissions in rural areas in Poland: A review. *Energies*, 12(18), 3558. <https://doi.org/10.3390/en12183558>
- Piwowar, A. (2021). The problem of energy poverty in the activities of agricultural advisory centres in Poland. *Plos One*, 16(10), e0258366. <https://doi.org/10.1371/journal.pone.0258366>
- Pizło, W., & Mazurkiewicz-Pizło, A. (2010). Wyposażenie gospodarstw domowych rolników, robotników i przedsiębiorców w Polsce (w latach 1993-2008). *Zagadnienia Ekonomiki Rolnej*, 4, 104-121.
- Solon, B. (2014). Tradycyjne media (prasa, radio, telewizja) jako źródła wiedzy rolniczej. *Studia Obszarów Wiejskich*, 35, 273-291.
- Statistics Poland. (2020). *Energy economy and gas industry in 2019* [Data set]. Retrieved January 3, 2022, from <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/gospodarka-energetyczna-i-gazownictwo-w-2019-roku,11,3.html>
- Statistics Poland. (2021). *Energy economy and gas industry in 2020* [Data set]. Retrieved January 5, 2022, from <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/gospodarka-energetyczna-i-gazownictwo-w-2020-roku,11,4.html>
- Stępień, S., Polcyn, J., & Borychowski, M. (2021). Determinanty zrównoważonego rozwoju ekonomiczno-społecznego rodzinnych gospodarstw rolnych w Polsce. *Ekonomista*, 1, 56-86. <https://doi.org/10.52335/dvqigjykfff2>
- Stern, P. C. (1999). Information, incentives, and proenvironmental consumer behavior. *Journal of Consumer Policy*, 22(4), 461-478. <https://doi.org/10.1023/A:1006211709570>
- Umit, R., Poortinga, W., Jokinen, P., & Pohjolainen, P. (2019). The role of income in energy efficiency and curtailment behaviours: Findings from 22 European countries. *Energy Research & Social Science*, 53, 206-214. <https://doi.org/10.1016/j.erss.2019.02.025>