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Investments in Renewable Energy Sources in Basic Units of Local Government in Rural Areas

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Abstract: The main purpose of the study was to identify the level and factors influencing investments in renewable energy sources (RES) in basic local government units in rural areas. The specific objectives were to define the conditions for the development of renewable energy sources in Poland, to determine the directions of changes as well as the importance of renewable energy in Poland, to present the relationship between the level of expenditure on renewable energy and budget components in rural and rural-urban communes. The Świętokrzyskie voivodeship (Voivodship—a unit of the highest administration level in Poland, since 1990 a unit of the primary territorial division of government administration, since 1999 also a unit of local government, there were 16 voivodships in Poland), which is one of the centrally located voivodeships in Poland, was purposefully selected for the research. The research period covered the years 2016–2019. The sources of materials were the literature on the subject, as well as empirical materials obtained at the Voivodeship Statistical Office. The following methods were used for the analysis and presentation of materials: descriptive, tabular, graphical, Gini concentration coefficient, Lorenz concentration curve, Kendall's tau correlation coefficient and Spearman's rank correlation coefficient. Poland is one of the countries with quite high dependence on hard and brown coal. Changes in the structure of energy sources are slow. Investments in renewable energy are necessary. The problem in this respect is the lack of a proper law. Despite this, investments in renewable energy are being made in rural areas. In the Świętokrzyskie voivodeship, only 28% of communes made such investments. It was found that only in urban rural communes the amount of investment expenditures in renewable energy sources was related to the level of budget expenditures and property expenditures of the commune. The amount of support from the European Union aid funds was positively correlated with the level of expenditure on investments in renewable energy. Therefore, it can be concluded that without the support from EU funds, it is not possible to invest in renewable energy in local government units.

Keywords: renewable energy sources; investments in renewable energy sources; energy policy; local development

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Citation: Klepacki, B.; Kusto, B.; Bórawski, P.; Bełdycka-Bórawska, A.; Michalski, K.; Perkowska, A.; Rokicki, T. Investments in Renewable Energy Sources in Basic Units of Local Government in Rural Areas. *Energies* **2021**, *14*, 3170. https://doi.org/10.3390/en14113170

Academic Editor: Piotr Gradziuk

Received: 17 February 2021
Accepted: 10 May 2021
Published: 28 May 2021

1. Introduction

Investments after a certain (usually long) period should not only assume a return on costs but also bring specific benefits [1]. The subject of investment efficiency is very complex, based on a large number of effects that these investments generate. Most often, research focuses on the economic efficiency of investments. Environmental and social efficiency of investments are also important [2–4]. Environmental efficiency is a particularly new concept [5,6]. Environmental efficiency was already defined slightly earlier, but it referred to the agricultural sector [7–9] or industry [10–12]. Today, only some renewable energy technologies have achieved a competitive level similar to fossil-based technologies. The most important feature of renewable energy sources (RES) is providing energy with zero or almost zero emissions of both air pollutants and greenhouse gases [13–15].

Investments in renewable energy and the resulting CO_2 emissions are usually the most important investment evaluation criteria. Efficiency is the most frequently used technical criterion for assessing energy systems. Additionally, attention is paid to the power of energy devices, investment cost, operation and maintenance costs, land use, job creation and social acceptance [16–20]. The achievement of the assumed goals concerning the share of renewable energy in the total energy consumption requires financial support. Investments in renewable energy and the coordination of these activities require a good use of the Structural Funds and framework programs allocated for this purpose. Funding should come from multiple sources, such as the European Investment Bank and other public financial institutions, grants, loan support schemes, etc. Better coordination of the community and national funding and other forms of support is also needed. Actions to support initiatives to invest in renewable energy should also be coordinated at the national level [21–24]. Different EU countries use different combinations of instruments supporting the development of the use of energy from renewable sources. The primary support instruments include feed-in laws, TGCs certificates, and tendering. In turn, the secondary support instruments include: investment subsidies, fiscal incentives, soft loans [25–27]. From the investor's perspective, investment outlays in renewable energy include investment costs, i.e., costs of technology, land, construction and project development (permits, grid connection agreements, consultancy, etc.). The second group is the cost of financing, i.e., the cost of capital determined by the debt interest rate, the required return on equity. The cost of producing renewable energy also includes operating expenses, i.e., fuel and maintenance costs as well as the costs of service contracts, guarantees and insurance after the start-up of the power installation [28–31].

There are differences in the definition of rural areas from country to country. In Australia, rural areas include small towns with a population ranging from 200 to 999 people. There are three types of rural areas in China. They are a major village (1000–3000 inhabitants), medium village (300–1000 inhabitants), small village (up to 300 inhabitants). In the USA, rural areas are all territory outside of defined urbanized areas and urban clusters, that is, open country and settlements with fewer than 2500 residents, with population densities as high as 386 people km^2 [32–34]. The definition of rural areas proposed by the Organization for Economic Cooperation and Development (OECD) has been adopted in the few national and regional RDP programs (Rural Development Program). According to OECD, a rural area should be understood as an area where over 50% of the population lives in rural municipalities. Rural communes are those where the population density does not exceed 150 inhabitants per km^2 [35]. In Poland, the Central Statistical Office determines rural areas on the basis of the administrative division of the state, and rural areas are areas located outside the city limits, i.e., rural communes and rural areas of urban-rural communes. This approach is related to the administrative division of Poland and three types of communes: rural (which consist only of villages), urban (in which territory is occupied by the city) and urban-rural (those that have at least one city within their territory) [36]. It is the administrative division that will be the basis for the research in the presented study.

Renewable energy is an energy source that is constantly regenerated. Such sources include solar energy, wind energy, water, including river currents, sea and ocean waves, energy from biomass, biogas, or bioliquids. Renewable energy is also the heat obtained from the ground (heat pumps, geothermal energy), air (aerothermal), and water (hydrothermal) [37–42]. The share of renewable energy is systematically growing. There is no one universal source of renewable energy. Different countries and regions use various renewable energy sources. For example, in Poland in 2018, the primary carrier of renewable energy used in heating was biomass (90.5%), and the share of heat pumps was only 0.4% [43]. This is strange because using a ground source heat pump to heat the building was more economically effective than biomass and a system powered by fuel oil [44]. Investments in photovoltaic installations grew particularly rapidly, as their payback period was short.

Additionally, such investments were subsidized from various types of European funds [45]. Local governments play a unique role in such undertakings, and, apart from promoting renewable energy, they should also invest in installations, especially in public utility facilities [46]. Due to the dispersed nature and use of local resources, RSE may be an element enabling, to some extent, increasing energy security (especially in the regional perspective) and reducing energy costs. The RSE share in the energy balance of individual communes and even voivodships is significant [47]. Due to their quantitative and qualitative potential, rural areas are predestined to produce energy raw materials or energy; hence, the Rural Development Program (RDP) provides funds for the development of renewable energy [48]. The undertaken research topic is vital due to the enormous possibilities of renewable energy production in rural areas. For this purpose, investments are necessary, especially by local government units such as municipalities.

The main aim of the research was to identify the factors related to investments in renewable energy sources in basic local government units in rural areas. Additional objectives were to define the conditions for the development of renewable energy sources in Poland, to determine the directions of changes on the use of renewable energy, as well as the importance of renewable energy in Poland, to present the relationship between the level of expenditure on renewable energy and budget components in rural and rural-urban communes. A research hypothesis was formulated in the work: the amount of investment expenditure in renewable energy sources was corelated with budget expenditure and property expenditure of the commune.

2. Materials and Methods

The first stage of the research focused on Poland. Historical conditions for the consumption of individual energy sources are presented, as well as assumptions concerning the development of renewable energy. Changes in the production of energy from various sources were shown. Legal conditions in the field of renewable energy and strategic documents for the development of this area of energy production were also examined. Particular attention was paid to Regional Operational Programs offering the possibility of supporting investments in renewable energy. The differences between individual voivodeships in terms of supporting investments in renewable energy are also presented.

In the second stage, the Świętokrzyskie voivodeship was selected for research using the purposeful selection method. Its characteristics in terms of socio-economic parameters are presented. Opportunities and barriers in the development of renewable energy sources are shown. This voivodeship is a relatively less developed region, with a large share of non-urbanized areas. The large share of rural areas was the main reason for selecting this voivodeship for research. However, the voivodeship was not a leader in the development of renewable energy in Poland. However, it did have the potential to develop renewable energy in rural areas. It is an area naturally predestined for the construction of renewable energy installations, due to its upland and mountainous nature (good wind conditions to drive windmills and sunny slopes for the use of photovoltaic installations). The research was carried out in 27 basic units, i.e., rural and urban-rural communes of the Świętokrzyskie voivodeship, which in 2016–2019 made investments in renewable energy sources. All rural and urban-rural communes that did not invest in renewable energy were omitted, as well as urban communes.

In the last stage, non-parametric tests were used to establish the correlation between the variables. The main barrier to the development of renewable energy is high investment expenditure [48]. Therefore, the parameters related to investment expenditure on RES, total expenditure of the commune and the amount of investment support from public funds were used. The variables and extent to which they are correlated with investment expenditure in RES were determined. The following variables were taken into account:

- average annual total expenditure of the commune in 2016–2019 (PLN),
- average annual capital expenditure of the commune in 2016–2019 (PLN),
- average annual share of property expenditure in the total expenditure of the commune in 2016–2019 (%),
- average annual total income of the commune in 2016–2019 (PLN),
- average annual income of the commune per capita in 2016–2019 (PLN),
- value of the co-financing of renewable energy investment projects in municipalities in 2016–2019 (PLN),
- share of co-financing in the value of investment projects related to renewable energy sources in municipalities 2016–2019 (%).

The relationships for rural and urban-rural communes together, rural communes as well as urban-rural communes were presented. From among 102 communes of the Świętokrzyskie voivodeship, 27 communes were included in the research (13 rural communes and 14 urban-rural communes). These were communes where investments in renewable energy were made under the Regional Operational Program of the Świętokrzyskie Voivodeship for 2014–2020. The expenditure related to measure 3.1. supporting the production and distribution of energy derived from renewable sources. In the first years of the Program's operation, investments expenditure in renewable energy was practically not incurred. The capital expenditure was incurred in 2014–2019. Data for 2020 were not available at the time of the study.

The first is Kendall's tau correlation coefficient. It is based on the difference between the probability that two variables fall in the same order (for the observed data) and the probability that they are in different order. This coefficient takes values in the range $<-1, 1>$. Value 1 means full match, value 0 no match of ordering, and value -1 means the complete opposite. The Kendall coefficient indicates not only the strength but also the direction of the relationship. It is a good tool for describing the similarity of the dataset orderings. Kendall's tau correlation coefficient is calculated by the formula [49]:

$$\tau = P[(x_1 - x_2)(y_1 - y_2) > 0] - P[(x_1 - x_2)(y_1 - y_2) < 0] \tag{1}$$

Kendall's tau is estimated by the given formula on the basis of a statistical sample. All possible pairs of the sample observations are combined, and then the pairs are divided into three possible categories:

P—compatible pairs, when the compared variables within two observations fluctuate in the same direction, i.e., either in the first observation both are greater than in the second, or both are smaller,

Q—incompatible pairs, when the variables change in the opposite direction, i.e., one of them is greater for this observation in the pair, for which the other is smaller,

T—related pairs when one of the variables has equal values in both observations.

The Kendall tau estimator is then calculated from the formula:

$$\tau = \frac{P - Q}{P + Q - T} \tag{2}$$

Additionally,

$$P + Q + T = \binom{\mathrm{N}}{2} = \frac{\mathrm{N}(\mathrm{N}-1)}{2} \tag{3}$$

where:

N—sample size

The pattern can be represented as:

$$\tau = 2\frac{P - Q}{\mathrm{N}(\mathrm{N}-1)} \tag{4}$$

The second non-parametric test is Spearman's rank correlation coefficient. It is used to describe the strength of the correlation of two features. It is used to study the relationship between quantitative traits for a small number of observations. Spearman's rank correlation coefficient is calculated according to the formula [50]:

$$r_S = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)} \tag{5}$$

where:

d_i—differences between the ranks of the corresponding features x_i and feature y_i (i = 1, 2, . . . , n).

The correlation coefficient takes values in the range $-1 \le r_S \le +1$. A positive sign of the correlation coefficient indicates a positive correlation, while a negative sign indicates a negative correlation. The closer the modulus (absolute value) of the correlation coefficient is to one, the stronger the correlation between the examined variables.

The sources of materials were the literature on the subject, Eurostat data, as well as empirical materials obtained at the Voivodeship Statistical Office. Descriptive, tabular and graphical methods, Kendall's tau correlation coefficient and Spearman's rank correlation coefficient were used for the analysis and presentation of materials.

3. Results

Poland is not a leader in shifting the energy sector towards increasing the use of renewable energy sources. In 2019, the share of RES in the gross final energy consumption was only 12.2%, against the assumed target of 15%. In 2019, the share of RES in the energy sector was 14.33%, in heating—15.98%, and in transport—only 6.12%. These results deviate from the adopted targets; however, recently there has been a significant acceleration of photovoltaic installations, which leads to the assumption that the general target, a 15% share of renewable energy in Poland, may be achieved in 2021 or 2022. In Poland, energy from renewable sources includes energy from solar radiation, water, wind, geothermal resources, energy generated from solid biofuels, biogas and liquid biofuels, as well as ambient energy obtained by heat pumps. The energy obtained from renewable sources in Poland in 2019 comes predominantly from solid biofuels (65.56%), wind energy (13.72%) and liquid biofuels (10.36%) [51].

Coal, especially hard coal, has been the dominant source of energy for decades in the Polish energy sector (Figure 1). The other sources were of less importance. Until the mid-1960s, hard coal was practically the only energy carrier used in power plants. In the following years, due to the launch of the mine and the commencement of lignite mining, combustion of this raw material also increased rapidly. In the following years, several hydroelectric power plants were built on artificial lagoons, which increased the importance of hydropower. It was not until the 21st century that natural gas began to be used as a source of energy in power plants, and even later the construction and operation of windmills began, only in 2006. The changes are slow, but the direction is right. The aim is to systematically increase the share of renewable energy sources in Poland's energy balance [52]. Detailed data for the years 1990–2019 are presented in Table 1.

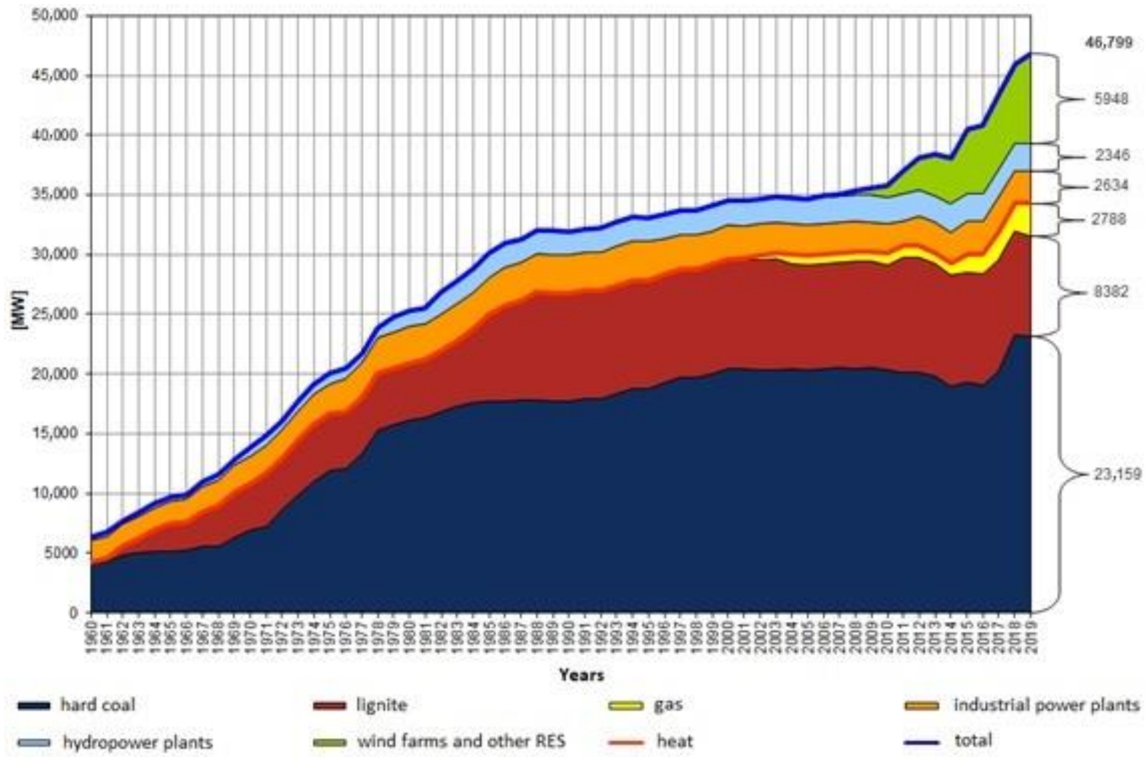

Figure 1. Sources of energy installed capacity in Poland in 1960–2019. Source: Raport 2019 KSE. Zestawienie danych ilościowych dotyczących funkcjonowania KSE w 2019 roku https://www.pse.pl/dane-systemowe/funkcjonowanie-kse/raporty-roczne-z-funkcjonowania-kse-za-rok/raporty-za-rok-2019 (accessed on 19 November 2020).

Table 1. Electricity production in Poland in 1990–2019.

Years	The Level of Energy Production in Power Plants [GWh]					Share of Wind Farms and RES (%)
	Total	Coal	Hydropower Plants	Industrial	Wind Farms and Other RES	
1990	136,336	124,899	3300	8137	0	0
1995	138,701	126,362	3814	8525	0	0
2000	144,417	139,348	3984	7655	0	0
2005	156,024	144,029	3587	8407	0	0
2006	160,848	149,676	2822	8216	69	0.04
2010	156,342	142,839	3268	8923	1312	0.84
2015	161,772	139,640	2261	9757	10,114	6.25
2019	158,767	131,791	2454	10,178	14,344	9.03

Source: Raport 2019 KSE. Zestawienie danych ilościowych dotyczących funkcjonowania KSE w 2019 roku. https://www.pse.pl/dane-systemowe/funkcjonowanie-kse/raporty-roczne-z-funkcjonowania-kse-za-rok/raporty-za-rok-2019 (accessed on 22 November 2020).

The rapid development of wind energy has been hampered by legal regulations. Over three quarters of RES installations planned to be connected in the period from 2015 to 2017 were not completed as a result of investors' resignation or their applications for reducing connection capacity. Many companies have abandoned investments due to low prices of green certificates, a limited number of wind farm locations, and an increased burden of real estate tax on the value of wind turbines. The 2016 Wind Farm Act did not resolve conflicts of interest between local communities reluctant to invest and the need to develop renewable energy sources. It seems that in Poland it is possible to develop solar energy (photovoltaic and solar) rather than wind energy [53,54].

In the opinion of the Supreme Audit Office, in many recent years there has been no consistent state policy in Poland regarding renewable energy sources. The government has not prepared a comprehensive, up-to-date document shaping the state's policy in this respect. However, RES goals and targets were not completely left out. They are defined in several documents, the most important of which are the following [55]:

1. Strategy for Responsible Development (with a perspective until 2030),
2. Strategy for Energy Security and Environment—perspective until 2020,
3. Poland's energy policy until 2030,
4. National action plan in the field of energy from renewable sources,
5. Directions of development of agricultural biogas plants in Poland in 2010–2020.

The development of energy from renewable sources is expensive, so it is important to support investments in renewable energy with European Union funds. In 2019, the value of investments in renewable energy in Poland amounted to approximately EUR 3.5 billion. At the voivodship level, these funds are transferred under Regional Operational Programs. In the budget for 2014–2020, Poland obtained EUR 82.5 billion from EU funds, which are spent under several national operational programs, namely: Infrastructure and Environment (I&E OP), Intelligent Development (ID OP), Knowledge, Education, Development (KED OP), Digital Poland (DP OP), Eastern Poland (EP OP), Technical Assistance (TA OP), as well as in 16 regional (voivodeship) operational programs [56].

There was a considerable regional variation within the Regional Operational Programs. The largest amount of funds for investments using renewable energy sources was expected in the highly industrialized Śląskie voivodeship (about EUR 796.8 million), and the least in the agricultural Lubuskie voivodeship (EUR 108 million). It is interesting that in the Śląskie voivodeship as much as 22.92% of expenditure on regional development in general was allocated to investments related to renewable energy (11.9% in Lubuskie). In the Świętokrzyskie Voivodeship, these investments amounted to EUR 192.5 million, of which 14.12% was allocated to RES (EUR 152.4 thousand per capita) [57].

Regions also differed in the priorities in the use of EU funds. The EU Commission classifies energy investments as follows: electricity (storage and transmission), renewable energy (wind), renewable energy (solar), renewable energy (from biomass), other types of renewable energy (including hydroelectric, geothermal and marine) and integration renewable energy (including storage, gas-to-electricity conversion and hydrogen-based renewable energy generation infrastructure). According to this classification, the largest expenditure on the development of wind energy is expected in the Mazowieckie voivodeship (EUR 167.4 thousand per 1000 inhabitants), although it is not the region with the best wind conditions in the country. On the other hand, the development of solar energy is predicted the most in the Lubelskie voivodeship (EUR 582.6 thousand), biomass—in the West Pomeranian voivodeship (EUR 305.5 thousand), and other types of renewable energy—in Łódzkie voivodeship (EUR 122.9 thousand). It can therefore be concluded that the authorities of individual regions adopted different development strategies, not always related to their potential natural conditions (wind, sun) [57,58].

Apart from the European Union finances, the funds of the National and Voivodeship Funds for Environmental Protection and Water Management play an important role in financing the development of renewable energy. The purpose of the Funds is to implement environmental policy based on priority programs, developed on the basis of an analysis of environmental needs and available financing sources. The National Fund for Environmental Protection and Water Management co-finances the following projects: photovoltaic systems, obtaining energy from geothermal waters, small hydropower plants, biomass-fired heat sources, agricultural biogas plants, generating electricity from high-efficiency biomass cogeneration, as well as the construction of energy networks to connect wind energy generation sources. Utilization of available funds was low and decreasing. For example, payments for this purpose in 2015 amounted to PLN 271.9 million, in 2016—PLN 105.4 million, and in the first half of 2017, only PLN 27.7 million, i.e., in 2015, 60.1% of funds, and in 2016 only 21.1% [55].

Świętokrzyskie voivodeship is located in south-eastern Poland, covers an area of 11,710.50 km^2 and is inhabited by about 1.23 million people. It is one of the 16 voivodeships established in Poland in 1999. The voivodship consists of 13 poviats and one city with poviat rights. There are 102 communes in counties, including five urban communes, 38 urban-rural communes and 59 rural communes. Świętokrzyskie voivodeship has an industrial and agricultural character. There is a clear division here into the industrial north and the agricultural south.

Świętokrzyskie voivodeship is one of the regions of Poland that use the least energy resources. The development of technologies related to the energy sector is quite slow. The total capacity generated by renewable energy installations in this voivodeship (36 hydroelectric power plants, 12 wind power plants, three biogas plants, two biomass plants, two installations generating biogas from sewage treatment plants) in 2014 accounted for about 6% of the power generated by RES installations in Poland.

In the Świętokrzyskie voivodeship, there are suitable conditions for the development of most of the available renewable energy technologies. The main source of energy production is biomass, especially on fallow and set-aside lands, the total area of which is about 82 thousand hectares. Additionally, about 50 thousand hectares of permanent grassland (meadows and pastures) have been abandoned. On these lands, energy-oriented agricultural production can be restored efficiently and without major expenditure. One of the barriers to the development of renewable energy sources in the Świętokrzyskie voivodeship were complicated administrative and legal procedures, the implementation of which is necessary for the construction of an installation for generating electricity from renewable sources. Another barrier was the uncertainty of the legal environment. As part of the financial resources allocated to the Świętokrzyskie voivodeship, measures were taken in the "Regional Operational Program for 2014–2020" to increase the capacity of small hydropower plants by modernizing and expanding the existing water channels. The energy infrastructure of the Świętokrzyskie voivodeship also required significant expenditure on its modernization [59].

To establish the relationship between the value of investment expenditure in renewable energy and parameters of financial management in rural and urban-rural communes of Świętokrzyskie voivodeship, Kendall's tau correlation coefficient and Spearman's rank correlation coefficient were calculated (Tables 2 and 3). $p = 0.05$ was adopted as the border value of the significance level. Significant results are marked in bold in the table. The study tried to check the correlation, which does not indicate that a given factor affects another, but a strong or weak relationship between them.

In Kendall's tau correlation, significant and strong positive correlations were found only for the value of co-financing of renewable energy investment projects in communes. It was the only important parameter in rural communes. In urban-rural communes, the average positive relationship was also shown between the value of investment expenditure in renewable energy and the average annual capital expenditure of the commune. In rural and urban-rural communes, we additionally found a weak positive correlation with the parameters of the average annual total expenditure of the commune and average annual total income of the commune. The analysis carried out with the use of Spearman's rank correlation coefficients gave very similar results. The strength of the relationship was slightly different. Only the parameter of the average annual capital expenditure of the commune turned out to be irrelevant. Both tests confirm a close relationship between the value of investment expenditure in renewable energy and the value of co-financing renewable energy investment projects in communes. This means that the implementation of this type of investment is highly dependent on the support received from EU funds. Other parameters related to financial management in communes were of less importance or were irrelevant. Additionally, a lot depended on the type of commune. Rural communes, in particular, were dependent on EU funds. Urban-rural communes usually had more financial resources that could be allocated to investment in renewable energy.

Table 2. Kendall's tau correlation coefficients between the value of investment expenditure in renewable energy and parameters of financial management in rural and urban-rural communes of Świętokrzyskie voivodeship.

Tested Parameters	Kendall's Tau Correlation Coefficient					
	Rural Communes		Urban-Rural Communes		Urban-Rural and Rural Communes Together	
	τ	*p*-Value	τ	*p*-Value	τ	*p*-Value
Correlation coefficients between value of investment expenditure in renewable energy and						
average annual total expenditure of the commune in 2016–2019 (PLN)	0.231	0.300	0.253	0.228	0.276	0.050
average annual capital expenditure of the commune in 2016–2019 (PLN)	−0.026	0.855	0.473	0.022	0.276	0.050
average annual share of property expenditure in the total expenditure of the commune in 2016–2019 (%)	−0.154	0.428	0.297	0.155	0.060	0.677
average annual total income of the commune in 2016–2019 (PLN)	0.231	0.300	0.253	0.228	0.276	0.050
average annual income of the commune per capita in 2016–2019 (PLN)	−0.231	0.246	0.033	0.913	−0.060	0.647
value of co-financing of renewable energy investment projects in communes in 2016–2019 (PLN)	0.868	0.001	0.848	0.001	0.835	0.001
share of co-financing in the value of investment projects related to renewable energy sources in communes 2016–2019 (%)	0.055	0.827	−0.295	0.113	−0.128	0.338

Table 3. Spearman's rank correlation coefficients between the value of investment expenditure in renewable energy and parameters of financial management in rural and urban-rural communes of Świętokrzyskie voivodeship.

Tested Parameters	Spearman's Rank Correlation Coefficient					
	Rural Communes		Urban-Rural Communes		Urban-Rural and Rural Communes Together	
	rs	*p*-Value	rs	*p*-Value	rs	*p*-Value
Correlation coefficients between value of investment expenditure in renewable energy and						
average annual total expenditure of the commune in 2016–2019 (PLN)	0.275	0.100	0.371	0.100	0.373	0.050
average annual capital expenditure of the commune in 2016–2019 (PLN)	−0.088	0.100	0.578	0.050	0.319	0.105
average annual share of property expenditure in the total expenditure of the commune in 2016–2019 (%)	−0.203	0.100	0.525	0.100	0.097	0.630
average annual total income of the commune in 2016–2019 (PLN)	0.275	0.100	0.415	0.100	0.383	0.049
average annual income of the commune per capita in 2016–2019 (PLN)	−0.269	0.100	−0.020	0.100	−0.093	0.645
value of co-financing of renewable energy investment projects in communes in 2016–2019 (PLN)	0.965	0.010	0.950	0.010	0.950	0.010
share of co-financing in the value of investment projects related to renewable energy sources in communes 2016–2019 (%)	0.112	0.100	−0.354	0.100	−0.133	0.508

In the case of urban-rural communes, the value of investment projects in renewable energy was on average 20% higher than in rural communes. The situation was similar in terms of support. The share of public support in the value of investment projects in renewable energy in both types of municipalities was similar and amounted to approx. 52.5% each.

4. Discussion

Investments in renewable energy carry risks, mainly political. The future of policy support programs for investment in renewable energy projects is uncertain. As a result, there is great uncertainty about future cash flows. For example, in Spain, Bulgaria, Greece and the Czech Republic, feed-in tariffs have been retroactively lowered for solar farms. As a result, the profitability of the investment significantly decreased [60–64]. In turn, attracting investments in renewable energy is influenced by e.g., tax incentives and properly designed feed-in tariffs [65–70]. About 80% of countries with high and higher than medium level of development offer support for renewable energy investments [71,72]. In general, risk and reward issues in renewable energy projects were addressed, inter alia, by Mignon et al. [73,74], and Wüstenhagen et al. [75,76]. Appropriately selected policy instruments can influence investor behavior by reducing the risk of a renewable energy project as well as increasing the return or achieving these effects simultaneously [77–79]. In most European countries, the most used mechanism to support renewable energy investment projects was the feed-in tariff (FIT) [80–82]. For example, in Germany, the FIT tariffs and the introduced marked degression of tariffs were the main reasons for the increase in investor confidence and the broad development of RES projects in the country [83]. On the other hand, in Greece, the weighted average cost of capital was around 12% for onshore wind energy and slightly lower for solar PV projects. Thus, access to capital was limited [84]. The investment risk just differs according to the different renewable energy technologies [85,86]. Typically, the risks associated with investments in obtaining renewable energy from solar radiation are lower than those associated with wind [87]. The investment risk associated with a given country and technology may also change over time [88,89]. The investment risk also decreases with the implementation of new technologies and its increased availability [90]. In economically developed countries such as Germany, Italy and the United Kingdom, investment risk was declining for solar photovoltaics and onshore wind technologies. In these countries, technological and political risk decreased significantly, and price risk became more important [91]. Overall, the effectiveness of policy instruments in implementing renewable energy has been confirmed in many studies, both in Europe and in the USA. Examples of analyzes concerning Europe include studies of Green and Yatchew [92], Haas et al. [93], Klessmann et al. [94], and Dong [95]. Research on the USA includes studies Johnston et al. [96], Smith and Urpelainen [97], Yin and Powers [98], and Wiser et al. [99].

In the study by Ogunrinde [100] it was found that there are differences between regions in the scope of development of renewable energy. The main reason is technological differences. Regions also compete for renewable energy subsidies [101]. In many countries, decisions regarding the development of renewable energy are decentralized. Strategies are developed at the central, regional and local levels [102]. For example, in Germany, Denmark and Spain, strong government intervention at the national level is complemented by regional strategies [103]. Each region has different conditions and focuses on different development opportunities, including renewable energy [104–106].

Research by Ancygier et al. [107] showed very high support for the development of renewable energy sources at the local level in Poland and low acceptance for coal and nuclear energy sources. There was also a lack of cooperation between communes in Poland and other countries in the field of energy, including renewable energy. In Poland, each voivodeship has its own policy in the field of renewable energy. The Lubelskie voivodeship focused on the development of wind energy [108]. The Zachodniopomorskie voivodeship developed any kind of renewable energy, but the most important was wind energy [109].

Wielkopolskie voivodeship had great potential in the production of biomass [110]. Łódzkie voivodeship had a great potential for the production of renewable energy from biomass, geothermal waters and wind [111]. Due to its agricultural character, the Świętokrzyskie voivodeship is predisposed to the production of biomass and biofuels [112]. Similar conditions are in the Podlaskie voivodeship [113]. Hydro and wind energy is developing in the Pomeranian voivodeship [114]. In general, local communities should lead the bottom-up energy transformation. Such involvement increases the use of local resources through horizontal management [115]. However, the role of municipalities must be very clearly defined. The state must provide municipalities with the necessary planning tools, establishing the required strategy, to integrate a decentralized system based entirely on renewable sources [116,117]. Planning at the commune and regional level should therefore be coupled with planning at the country level [118–120].

Another important issue is the difference in investment in renewable energy in rural and urban areas. Rakowska [121] stated that investments in renewable energy in rural areas of Mazowieckie voivodeship differed from investments in other rural areas in Poland. Only wind and solar energy were used in the Mazowieckie voivodeship. Investments were carried out only by local governments and enterprises, while EU funding came only from the regional operational program. Poggi et al. [122] argued that rural areas can specialize as an exporter of green energy to fuel urban areas. This is because rural areas provide the necessary resources and serve as sites for the production of renewable energy [123]. This energy is produced in a decentralized manner and requires a large area [124]. The energy transition in rural areas is the implementation of renewable energy sources, usually on a small scale [125]. It can be concluded that rural, sparsely populated and economically underdeveloped regions become target areas for the installation of renewable energy facilities [126,127]. Renewable energy should use the ecological potential of rural areas [128]. Renewable energy sources will allow the diversification of land use and farmers' income sources. Rural development policy assumes that renewable energy will contribute to the revitalization and revalorization of rural economies [129,130]. Projects implemented by local government rural communities are of particular importance here [131].

Local and regional authorities in the European Union are responsible for the implementation of a significant part of public investments, and their share in total public investments exceeded 50%. Sub-national government in South East Europe also plays a key role in the investment process, with local investment accounting for over 35% of total public investment. On the other hand, local governments in South-Eastern European countries incurred greater costs of transport infrastructure, energy and road sectors than local authorities in Western Europe. The investment capacity of local and regional authorities is of key importance for the absorption of EU funds. In the case of infrastructure projects, municipalities have to provide own contribution (through own revenue, net operating balance or debt financing). The lack of sources of own contribution of communes makes it difficult for them to participate in EU projects [132,133]. This is important when public subsidies have a major impact on renewable energy investments. Such regularities have been confirmed based on the example of many countries [134–136]. In Poland, a relatively low scale of public support for investments in renewable energy sources was found [137]. The main barrier to the development of renewable energy is high investment expenditure [48]. Local governments, however, are able to finance such investments, because as a result new jobs are created and local companies develop [138–140]. However, the scale of the economic impact depends on the participation of local industry in the supply chain [141].

5. Conclusions

In Poland, hard coal and lignite have been the main energy resources for decades. Other energy sources began to gain more importance from the beginning of the 21st century. First of all, wind energy was developed. Hydropower has been used since the 1960s. However, its potential was not developed and energy production from this source was stable for decades. High hopes are associated with investments in photovoltaic devices. Overall, in the case of renewable energy, the biggest problem is the lack of, and variability in, specific legal provisions. The government has not prepared a single comprehensive document on renewable energy. The development of renewable energy is supported at the voivodeship level from the EU funds under the Regional Operational Programs.

Świętokrzyskie voivodeship is a region with a very large number of rural and urban-rural communes. Not all of them implemented investments in renewable energy, and it can even be said that the interest was low (every fourth commune). The amount of support from the European Union aid funds was positively correlated with expenditure on investments in renewable energy. In this case, the dependencies were powerful, regardless of whether it was a rural commune or an urban-rural commune. Therefore, it can be concluded that without the support from EU funds, it is not possible to invest in renewable energy in local government units. These units have many expenses and needs that they have to fulfill for their communities. In the case of urban-rural communes, there was also a weak correlation between the value of investment expenditure in renewable energy and capital expenditure of the commune. Investments in renewable energy were mainly related to the construction of infrastructure for energy production. Therefore, such a relationship is not surprising. Taking into account rural and urban-rural communes together, there was also a weak relationship between the value of investment expenditure in renewable energy and total expenditure of the commune, as well total income of the commune. Both the expenses and the income of individual communes could have impacted investing in renewable energy. Thus, the research hypothesis was partially confirmed, but only for urban-rural communes and only for selected parameters of the financial economy. The strength of the union was fragile. In the case of typically rural communes, the hypothesis was verified negatively.

Based on the conducted research, it can be concluded that the investment in renewable energy in communes was mainly conditioned by the support obtained from EU funds. However, the share of support in the total value of the investment was not significant. Urban-rural communes achieved much higher incomes and had higher expenses than rural communes. Therefore these elements of commune financial management were essential. Probably, in municipalities, a more significant correlation between the income and expenditure of these municipalities and the value of investment expenditure in renewable energy would be possible. However, this issue requires scientific research and may be the subject of detailed analysis in the following study, mainly since the issues discussed in the article were poorly described.

Author Contributions: Conceptualization, T.R.; data curation, T.R., A.P.; formal analysis, T.R.; methodology, T.R.; resources, T.R.; visualization, T.R., A.P.; writing—original draft, T.R., A.P., B.K. (Bogdan Klepacki), B.K. (Barbara Kusto); P.B., A.B.-B., K.M.; writing—review and editing, T.R., A.P., B.K. (Bogdan Klepacki), B.K. (Barbara Kusto), P.B., A.B.-B., K.M.; supervision, T.R.; funding acquisition, T.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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