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Energy Transition as a Local Development Priority: Implications for Municipal Investment Activity in South-Eastern Poland

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Abstract

The article contributes to the discussion on the determinants of local governments' engagement in energy transition-related investment. It aims at identifying the position of the energy transition among the development priorities of local authorities and at assessing the extent to which this factor is associated with actual and planned municipal investment activity in the area of local energy transition. The analysis uses data collected through surveys conducted in cooperation with the Statistical Office in Rzeszów between 2023 and 2025 among all municipalities (160) in the Podkarpackie Voivodeship. Differences in investment activity among municipalities with varying approaches to energy transition were examined using the Mann–Whitney U, Pearson's chi-square (χ^2), and exact Fisher (or FFH) tests. The results suggest that municipalities that prioritised the energy transition allocated a slightly higher share of their investment expenditure to related projects, particularly renewable energy installations, and planned higher future spending in this area. Nevertheless, the research indicates that prioritisation is particularly relevant for planned investments, for which differences between groups were statistically significant, whereas no statistically significant differences were observed for realised investments. The findings highlight the need for a reorientation of the national and EU support, including greater emphasis on raising local environmental awareness of the energy transition benefits.

Keywords: energy transition; municipal investment expenditure; local governments; local development priorities; renewable energy investments; investment barriers

1. Introduction

The term energy transition is most frequently used to describe the process of replacing fossil fuels with renewable energy sources (RES) or other low-carbon energy sources, accompanied by measures aimed at improving energy efficiency, reducing energy consumption, and expanding distributed energy generation [1,2]. From a territorial governance perspective, the energy transition is a process aimed at strengthening energy security at multiple levels of territorial governance, ranging from national and regional authorities to local governments [3]. The mechanism underlying improved energy security involves, among other factors, greater diversification and decentralisation of energy sources, reduced energy consumption through improved energy efficiency, and regional and local energy management based on the balancing of energy demand and supply. Local government units (LGUs) play an important role in achieving these objectives, both as energy producers and consumers, and their involvement is further strengthened by the EU's climate and energy policy.

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The EU has identified the energy transition as one of its strategic development priorities [4–6]. In November 2023, the amended Renewable Energy Directive set a target for RES to account for 42.5% of the EU's final energy consumption by 2030, with an ambition to reach 45% [7]. The Energy Efficiency Directive was likewise revised [8], requiring Member States to incorporate energy efficiency criteria into all key policy and investment decisions, including those taken at the local level. As a result, renewable energy accounts for an increasing share of the EU's final energy consumption, although progress varies across Member States [9,10]. Poland, as well as Slovakia, Hungary, and Czechia, ranked among the countries with the lowest shares (16.7–18.6%) [11], reflecting the ongoing challenges of the energy transition in Central and Eastern Europe.

In response, Poland's Energy Policy until 2040 (PEP 2040) [12], adopted in 2021, identifies renewable energy development as one of the key pillars supporting the national energy transition and sets ambitious targets for 2030, aiming for RES to account for at least 32% of electricity generation, 28% of energy consumption in heating and cooling, and 14% of transport energy consumption [13]. Although the share of RES in electricity generation increased from 17.83% in 2020 to 31.41% in 2025, Poland's energy mix remains dominated by fossil fuels (56.3%) [14], highlighting the need for further transition efforts at all levels of governance, including local governments.

LGUs may contribute to the energy transition through [15–18]: (1) indirect engagement—initiating and supporting activities undertaken by residents and businesses through information-based, organisational, and financial instruments. Examples include educational and awareness-raising campaigns on renewable energy, advisory services for households and firms, support in obtaining external funding, and local grant programmes. Although such activities influence energy-related decisions made by households and businesses, they do not involve direct municipal investment; or (2) direct engagement—implementing energy investments independently or under a public–private partnership model [19]. These projects are financed or co-financed by municipalities and typically involve the installation of renewable energy systems, energy-efficiency upgrades in public buildings or the modernization of municipal energy infrastructure. This study focuses on the direct engagement of local governments in the energy transition through municipal investment projects.

Although the energy transition is a strategic priority at both EU and national levels, local governments differ considerably in their commitment to related activities. This raises the question of which factors determine municipal engagement in investments supporting the energy transition. Previous studies [20–23] have highlighted the importance of financial, technological, procedural, planning, and social barriers; however, limited attention has been paid to the role of the energy transition within local governments' development priorities. Therefore, the primary objective of this study is to identify the position of the energy transition among local development priorities and to examine whether its perceived importance is associated with both actual municipal investment activity and planned future engagement in energy transition projects.

Local government engagement in the energy transition may be shaped not only by various investment barriers but also by residents' preferences regarding basic technical and social infrastructure. As these preferences influence municipal investment decisions and the allocation of limited public resources, it is assumed that the priority assigned to the energy transition within local development agendas is associated with the level of municipal investment activity in this area. Specifically, municipalities assigning a higher priority to the energy transition are expected to devote a larger share of their investment expenditure to energy transition projects. To address this main hypothesis, two specific research questions were formulated: 1. Is there any association between the priority assigned to the energy transition and the share of energy transition expenditure in actual

municipal investment spending? and 2. Is there any association between the priority assigned to the energy transition and the share of planned energy transition expenditure in total municipal investment spending? Distinguishing between actual and planned investments enables a more nuanced assessment of potential differences between local authorities' priorities, declared intentions, and investment behaviour.

Existing studies have concentrated mainly on the role of LGUs in promoting and advancing the energy transition and on the factors determining investment in RES [24–28]. However, multifaceted assessments of barriers to municipal investment in the energy transition remain underexplored, particularly those that consider not only the identification of such barriers but also their relative importance in shaping local authorities' investment preferences. This article seeks to fill this research gap by examining municipal investment activity alongside local authorities' attitudes towards energy transition projects.

The issue is analysed using Poland as a case study, considering that the country is currently undergoing an intensive energy transition process, accompanied by growing engagement from local governments [18,29–31]. Examining the experience of Polish municipalities provides insights relevant to countries and regions in Central and Eastern Europe facing similar transition challenges. The empirical part of the study focuses on municipalities in the Podkarpackie Voivodeship, a NUTS 2 region located in south-eastern Poland. The Podkarpackie Voivodeship offers favourable conditions for renewable energy development, but at the same time faces the challenge of energy poverty [32] and has a substantial share of its territory designated as protected areas (approximately 50%). The region's proximity to the Ukrainian border further underscores the importance of energy security and the role of public authorities in supporting the energy transition.

The analysis uses data collected in collaboration with the Statistical Office in Rzeszów between 2023 and 2025 through surveys conducted among all municipalities in the Podkarpackie Voivodeship, supplemented by data from Statistics Poland's Local Data Bank. To examine differences in investment activity among municipalities with different strategic approaches to the energy transition, the Mann–Whitney U test (U M-W), Pearson's chi-square (χ^2) test of independence, and exact Fisher (F) test (or Fisher–Freeman–Halton (FFH) test) were used.

This study builds on the authors' previous research into the involvement of local governments in the energy transition in Poland. That research addressed: (i) the identification of funding sources, barriers, and determinants of municipal investments in the energy transition, based on a relatively smaller sample of municipalities in south-eastern Poland [19]; and (ii) an analysis of the impact of the financial condition of local government units (municipalities and counties) on the scale and direction of investment in this area [33]. Building on these findings, the present article examines the significance of the energy transition as an investment priority for local authorities and investigates whether the position assigned to this objective among competing development priorities is associated with municipalities' actual and planned investment activity. The contribution of this study lies in demonstrating that, alongside financial and institutional conditions, the strategic importance assigned to the energy transition by local authorities may constitute an important factor differentiating municipalities' investment engagement in this area.

The following section reviews the literature on the determinants of the energy transition, with particular reference to local authorities. This is followed by a presentation of the research methodology and the empirical material used in the study. The next section presents and discusses the empirical findings. The article concludes with the main findings and recommendations arising from the analysis.

2. Literature Review

In many countries, local authorities play an active role in shaping local development, seeking to align it as closely as possible with the principles of sustainable development. Investment in the energy transition is an important component of these efforts. There is a broad consensus in the literature that local governments can play a key role in implementing the energy transition at the local level. Local authorities can initiate and invest in renewable energy projects, while also acting as energy producers and end users [18,30,34–36].

In practice, however, LGUs in EU countries are not legally required to undertake many energy transition activities, including the development of RES [17]. In Poland, municipalities' direct involvement in energy supply is generally limited to public buildings and public road lighting, while both municipalities and counties are responsible for local public transport [37]. At the same time, their role has evolved from passive energy consumers into active architects of the transition. Municipalities are responsible for preparing the *Assumptions for the Plan for the Supply of Heat, Electricity and Gaseous Fuels*. They align climate policies with spatial planning, designating specific areas for renewable energy projects. Local governments initiate and support the establishment of energy clusters and energy cooperatives, and may also actively promote prosumer energy generation through the implementation of umbrella schemes (programmes) for renewable energy investments [19,38].

Since many local government responsibilities related to the energy transition are not mandatory, it is important to determine the extent to which these responsibilities rank among municipal authorities' investment priorities and whether local authorities' attitudes are reflected in actual investment activity in this area, thereby potentially constraining progress toward the energy transition. A better understanding of the various barriers and constraints affecting local government activity can provide a basis for the development of effective policies to support the energy transition at the local level.

Research shows that the scale and scope of municipal investment in the energy transition are influenced by both spatial and strategic planning [39,40]. At the same time, effectively aligning the energy transition with spatial planning remains a major challenge in most countries [41]. Investment in the energy transition is constrained by the absence of appropriate strategic documents, including general and sectoral strategies required for the planning and delivery of such projects, and by the high costs associated with their preparation. In contrast, LGUs that do have such documents rarely update them, which restricts their capacity to respond to current challenges and opportunities related to the energy transition [1,42]. Furthermore, investment in the energy transition is often land-intensive and may affect areas of high environmental value [43,44]. As a result, projects in protected areas must undergo stringent environmental impact assessments and obtain the necessary environmental approvals.

In implementing energy transition measures, local governments encounter regulatory, administrative, and bureaucratic barriers. Key barriers are those that make the planning procedures outlined above inflexible, protracted, and costly. Modern distributed energy systems are also constrained by overly complex and inflexible procurement procedures and by lengthy, complicated processes for securing grid connections [1]. Frequent changes to energy legislation, the regulations governing minimum-distance requirements for wind energy projects, and EU rules such as the RED III Directive create additional difficulties for project implementation [45,46]. In Poland, obtaining all the necessary approvals for photovoltaic projects takes approximately three years [47].

Local governments across the EU often face similar challenges, including complex administrative procedures, unstable regulatory frameworks, lengthy environmental approval processes, and poor coordination of development policies across local, regional,

and national levels [22]. Rather than blocking the energy transition outright, these challenges significantly delay its progress by complicating the planning and implementation of long-term investments and creating high fixed costs. Uncertainty over how existing regulations should be interpreted is also common and increases investment risk for local governments. Local governments in the EU most commonly address administrative and regulatory barriers by establishing local partnerships, such as energy clusters and energy cooperatives, sharing risk with experienced public or private investment partners, as well as seeking external expert support [38,48].

A bottom-up and decentralised energy transition cannot succeed without the involvement of the local community [31]. Engaging residents, non-governmental organisations, and the business sector in the planning and implementation of energy projects is essential. The energy transition is widely regarded as an important component of municipal development strategies and plans, while related projects should be implemented in ways that avoid social conflicts [39]. Such conflicts can be triggered by large-scale wind and solar projects and new power lines located too close to populated areas [49]. In many cases, local conflicts surrounding renewable energy installations, particularly wind energy projects, have delayed or even halted their implementation. Social resistance stems from concerns about rising energy costs, job losses in traditional sectors, conflicts over the location of renewable energy projects, and low environmental awareness [24–27]. In regions that are heavily dependent on fossil fuels, the issue of a just energy transition arises, as local communities need to be protected from the adverse effects of economic change [50,51]. Citizens are often not directly involved in decision-making processes, with their role largely limited to being informed about decisions that have already been made [52]. Public participation can improve acceptance of local government policies, yet the complexity of the energy transition, particularly its technical dimension, raises questions about whether citizens should participate directly in decision-making or whether decisions should be left to experts [52]. However, there is a general consensus on the need to build public awareness of the climate and environmental challenges that underpin the energy transition. Local communities should also receive information on the objectives, benefits, and costs of specific projects undertaken as part of the energy transition within a given LGU.

Another important and multidimensional group of barriers to local government investment in the energy transition comprises economic (financial) factors. Both academic research and practical experience indicate that one of the most significant barriers is the high capital expenditure required to implement projects, particularly in the renewable energy sector, as such expenditure often exceeds the budgetary capacity of local governments [17,22,29,33,53]. In Poland, the scale of municipal investment in the energy transition is strongly linked to the level of operating surplus and the capacity to generate own-source revenue [28]. A further constraint is posed by high debt levels and debt-servicing costs [33,54]. As a result, the need to raise capital for projects that would create a long-term debt burden for local governments reduces local authorities' willingness to adopt solutions designed to improve energy efficiency. The problem is further exacerbated by the specific financial risk profile of energy transition projects, which involves greater risk than that associated with conventional infrastructure investments [55]. An additional barrier is the limited capacity of some energy transition projects to generate revenue or savings, which may undermine their economic viability [19,53,56]. One example is the deployment of hydrogen buses in several large cities in Poland and numerous cities abroad, including in the United Kingdom, Belgium, France, Japan, and Australia. Due to high purchase and operating costs, limited fuel availability, and reliability problems, these investments offer little realistic prospect of generating an economic return [57,58].

In this context, the implementation of energy transition investments by local governments is often contingent on access to external sources of finance. Local authorities rely in particular on additional non-repayable funding in the form of national government grants or EU funds [19,33,54,59]. Although public funding available for energy transition projects in the EU is increasing, it remains limited. In addition, securing investment grants entails complex application and reporting procedures and frequently requires beneficiaries to pre-finance expenditure from their own funds, since grants are generally disbursed by way of reimbursement of eligible expenditure (incurred for the entire project or for particular stages of implementation). Local governments' access to non-repayable national and EU funding is further limited because many energy transition programmes are managed centrally by government agencies or the European Commission, meaning that local needs and conditions are not always fully taken into account [60]. As a result, funding may favour projects that reflect the priorities of funding bodies rather than those of local authorities.

The literature also identifies a lack of human capacity and expertise as a barrier to municipal investment in the energy transition [61,62]. According to the report by Szymański and Świerkula [1], Polish municipalities face shortages of various specialists, including municipal energy managers, renewable energy practitioners capable of assessing the energy efficiency of proposed solutions, and individuals with experience in managing energy cooperatives. Municipalities' difficulties in recruiting specialists are largely attributed to the low salaries offered by LGUs, resulting in greater reliance on outsourced services. Kozera et al. [54] found that a higher proportion of councillors with a university education increases the likelihood that rural municipalities will implement low-carbon economy projects supported by EU funding. This may reflect these councillors' greater knowledge of sustainable development, innovation, and green technologies, as well as a stronger capacity to identify local environmental needs.

Although the barriers discussed above may limit municipal involvement in the energy transition, local investment activity is likely influenced by a combination of factors rather than by any single constraint. Against this background, the present study examines whether the priority that local authorities assign to the energy transition is associated with municipal investment activity in this area. Specifically, the main hypothesis assumes that municipalities assigning a higher priority to the energy transition allocate a larger share of their investment expenditure to related projects. To test this hypothesis, two auxiliary hypotheses were formulated:

H1. *A higher priority assigned to the energy transition is associated with a greater share of energy transition expenditure in actual municipal investment spending.*

H2. *A higher priority assigned to the energy transition is associated with a greater share of planned energy transition expenditure in total municipal investment spending.*

The hypotheses formulated above do not undermine the importance of the procedural, planning, social, financial, and other barriers discussed earlier. It was assumed, however, that these barriers are primary in nature and collectively translate into the low position of the energy transition among local authorities' development priorities, thereby constituting a direct barrier to investment in this field.

3. Materials and Methods

Achieving the main research objective required the use of primary data. The data were collected through a questionnaire survey conducted in cooperation with the Statistical Office in Rzeszów. The survey was conducted in three rounds, in 2023, 2024, and 2025, each time in late August and early September. Respondents were asked to report not only on

the current situation in their municipalities but also on investment activities undertaken during the preceding four-year periods, namely 2019–2022, 2020–2023, and 2021–2024, respectively. A comparable set of questions was used in each round, ensuring consistency in the measurement of key variables across successive surveys. However, the composition of the participating municipalities varied between survey waves. Thus, the results allow for the identification of similarities and differences in municipal investment activity over time; however, the study should be regarded as a series of repeated cross-sectional surveys rather than a longitudinal panel study.

In each year, the study took the form of a census survey: an electronic questionnaire was sent to all municipalities in the Podkarpackie Voivodeship (N = 160) for completion by an authorised representative. Additional statistical data for 2019–2024 were obtained from Statistics Poland's Local Data Bank. Responses collected across all survey waves were used in a qualitative analysis aimed at identifying the specific characteristics of municipal investment activity. Data from the most recent survey wave (2025), which achieved the highest response rate (65.6%), were used for an in-depth quantitative analysis.

A key element of the research procedure was to divide the municipalities studied into two groups based on whether energy transition investment was identified as a priority within their development policy. This enabled an analysis of variation in investment activity between municipalities differing in their approach to this category of expenditure.

To specify the investment priorities, respondents were asked to select 5 out of 16 areas that constituted an investment priority in the municipality. Response categories covered by the question are presented in Table 4. The question allowing the identification of municipal investment priorities was introduced solely in the questionnaire used for the 2025 survey. It was introduced following an analysis of 2023 and 2024 surveys, which suggested that some determinants of investment direction choices were missing. Therefore, the priorities set in the previous periods are unknown, which limits the possibility of analysing the temporal relationship between development priorities and energy transition expenditures to the priorities identified by municipalities in 2025 and the average expenditures observed in 2021–2024. This limitation opens an interesting avenue for future research.

The question allowed for both ranking investment priorities across the municipalities (by determining the percentage of municipalities that identified a given priority) and dividing municipalities into two groups (according to whether they identified energy transition as a priority or not).

The classification allowed to test differences concerning:

- A share of investment (based on a question: '*What was the structure of investment expenditure incurred by your entity in the years 2021–2024?*', where respondents declared the shares for 11 specified areas, among which was the energy transition);
- Types of energy transition investments (based on a question: '*Which energy transformation investments did your entity implement in 2021–2024*'—the list of types of investment is presented in Table 6);
- A share of planned investment (based on a question: '*Please specify the planned share of the aforementioned investment in the entity's investment expenditure structure for the near future (the next 2–3 years)*');
- Barriers to investment (based on a question: '*What do you perceive as the greatest risks to the implementation of the aforementioned investment? (Please rate each response on a scale of 1 to 5, where 1 indicates the least significant factor and 5 indicates the most significant factor)*'—the list of barriers is presented in Table 9).

Differences between the two groups were tested for statistical significance using the non-parametric Mann–Whitney U test (U M-W), which compares the distributions of variables between two independent samples. Pearson's chi-square (χ^2) test of independence

was used to analyse associations between categorical variables. In a case of very small cell count in a contingency table (less than 5), the exact Fisher (F) test was used (when the contingency table exceeded 2 × 2 dimensions, the Fisher–Freeman–Halton (FFH) test was used). This approach provided a comprehensive picture of the scale, structure, and factors shaping municipal investment in the energy transition and enabled the research hypothesis to be tested.

Respondent Characteristics

Across the three survey waves, responses were received from 64 to 105 out of the total population of 160 municipalities in the Podkarpackie Voivodeship. Although full population coverage was not achieved, the response rate increased from 40 to 43.8% in 2023–2024 to 65.6% in 2025 (Table 1), which may be regarded as a relatively high level of participation for a voluntary survey targeting public institutions. However, the participating municipalities were not identical in each survey round. A total of 32 municipalities participated in all three surveys, 47 municipalities took part in two survey waves and 48 municipalities participated in only one wave. In contrast, 33 municipalities (20.6%) did not participate in any of the surveys. Overall, 79.4% of municipalities participated in at least one survey wave, indicating broad coverage of the target population. However, variation in sample composition across survey waves limits the possibility of drawing conclusions about longitudinal trends at the level of individual municipalities.

Table 1. Survey participation by municipality type: respondents versus non-respondents.

Municipality Type	Population (N)	Survey Waves								
		2023			2024			2025		
		Respondents		Non-Resp.	Respondents		Non-Resp.	Respondents		Non-Resp.
		n	%	n	n	%	n	n	%	n
Urban	16	5	31.3	11	7	43.8	9	9	56.3	7
Urban–rural	36	17	47.2	19	13	36.1	23	22	61.1	14
Rural	108	48	44.4	60	44	40.7	64	74	68.5	34
Total	160	70	43.8	90	64	40.0	96	105	65.6	55
χ^2 (*p*-value)		0.5451			0.8414			0.5093		

n—number; %—response rate. Source: Own elaboration.

Rural municipalities accounted for the largest share of respondents in each survey wave, reflecting their predominance in the regional municipality population (Table 1). To assess the potential risk of non-response bias, responding and non-responding municipalities were compared according to municipality type. Pearson's χ^2 tests revealed no statistically significant differences in the distribution of municipality types between respondents and non-respondents across any of the survey waves (Table 1). These findings suggest that survey participation was not systematically associated with municipality type.

In each survey wave, municipalities from all land counties of the Podkarpackie Voivodeship were represented among the respondents. This spatial coverage suggests that no part of the region was systematically excluded from the study, thereby reducing the risk of non-response bias related to geographical location.

To evaluate whether responding municipalities differed systematically from the non-responding municipalities, two key financial indicators reflecting the municipalities' overall financial condition and investment activity were analysed: the proportion of municipalities reporting a budget surplus and the share of investment expenditure in total expenditure (Table 2), with both indicators referring to the fiscal year preceding the respective survey wave.

Table 2. Comparison of selected financial indicators between responding and non-responding municipalities in the Podkarpackie Voivodeship.

Financial Indicator	Responding Municipalities			Non-Responding Municipalities			*p*-Value		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Percentage of municipalities with a budget surplus	42.9	15.6	34.3	45.6	24.0	41.8	0.7332	0.2019	0.3483
Investment expenditure as a share of total expenditure	17.7	27.2	26.9	18.3	29.7	26.0	0.7154	0.1478	0.6379

p-value for Pearson's χ^2 test for a budget surplus; *p*-value for U M-W test for an investment share. Source: Authors' own elaboration based on data from Statistics Poland (GUS) and the authors' own survey research.

The comparative analysis (Table 2) indicates that the financial characteristics of responding municipalities were similar to those of non-responding municipalities in the Podkarpackie Voivodeship. Statistical tests revealed no significant differences in the proportion of municipalities reporting a budget surplus. Overall, the findings suggest that respondents and non-respondents were comparable with respect to budget status.

Similar conclusions were obtained for investment activity. The differences in the share of investment expenditure in total expenditure reported by responding and non-responding municipalities were statistically insignificant throughout the study period, as indicated by the Mann–Whitney U test (at the 0.05 significance level).

Altogether, these findings provide no evidence of systematic non-response bias associated with municipalities' financial condition, investment activity, municipality type, or geographical location. Therefore, the responses obtained appear to sufficiently reflect the diversity of municipalities in the region and provide a reliable basis for analysing municipal engagement in the energy transition and its determinants.

4. Results

4.1. Scale and Patterns of Local Government Investment

Between 2022 and 2024, municipalities in the Podkarpackie Voivodeship allocated, on average, between 17.7% and 29.7% of their total expenditure to investment (Table 2). Most investment focused on basic technical infrastructure, especially road infrastructure and water and sewerage systems, which together accounted for around 60% of the total (Figure 1).

In contrast, investment expenditure on the energy transition accounted for only a small share of total investment expenditure, ranging from 2.7% to 7% (Figure 1). As shown by respondents' answers (Figure 2), one possible explanation is the importance of external non-repayable funding, especially EU funding, for the energy transition investments. In this context, differences observed across survey waves may be associated with changes in funding availability, including the completion of the EU 2014–2020 financial perspective and the delayed implementation of programmes for the 2021–2027 programming period. The relatively limited importance of the energy transition as a determinant of municipal investment activity (Figure 2) may likewise have contributed to the observed differences in the scale and composition of investment. The latter potential relationship is examined in the following section.

Between 2019 and 2024, municipal investment activity in the energy transition in the Podkarpackie Voivodeship was concentrated mainly on modernisation projects and measures to improve energy efficiency by reducing energy consumption (Table 3).

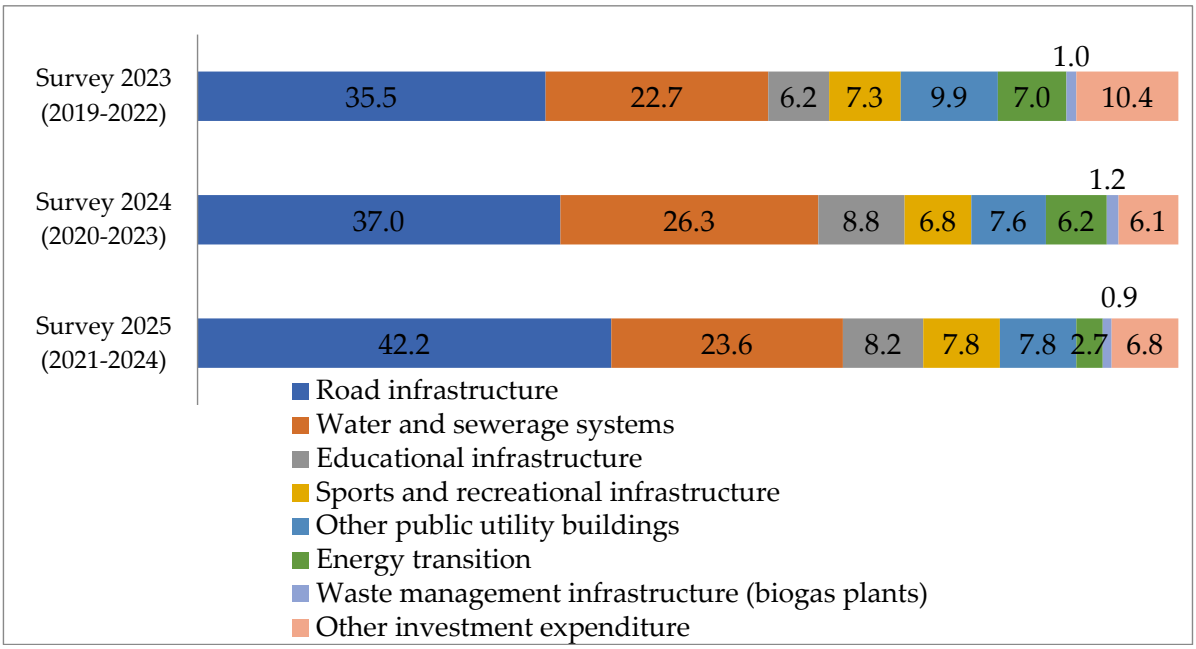


Figure 1. Structure of investment expenditures of the surveyed municipalities. Source: Own elaboration.

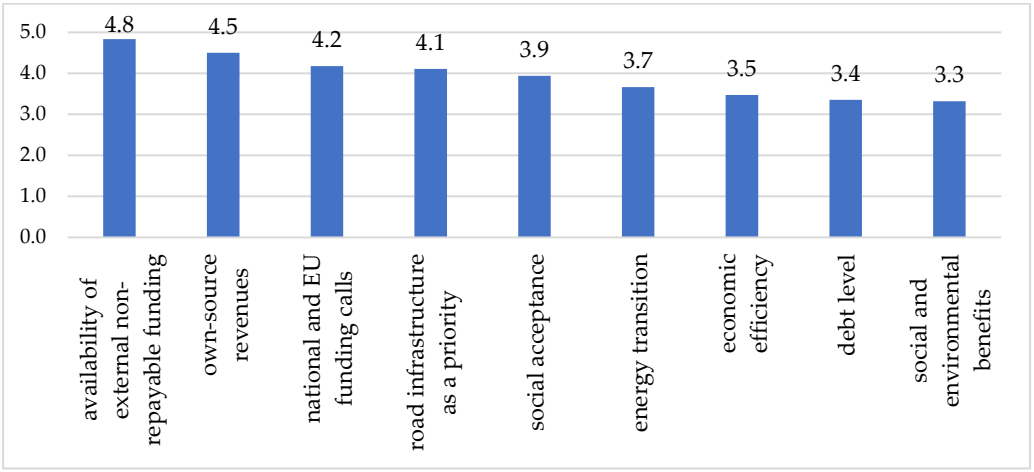


Figure 2. Factors determining the scale and structure of investment undertaken by the municipalities studied in 2019–2024 (mean rating on a 1–5 scale, where 1 = very low and 5 = very high importance). Source: Own elaboration.

The most common measures were those with low entry barriers and low risk, which were easier to organise and implement and yielded relatively rapid economic returns, including the following (Table 3):

1. Upgrading street lighting to energy-efficient systems;
2. Energy-efficiency upgrades to municipal buildings;
3. Installation of renewable energy systems on municipal facilities (e.g., photovoltaic systems on schools and hospitals);
4. Upgrading heating systems in public buildings.

Other energy transition projects, especially those requiring substantial capital investment, such as biogas plants, power generation facilities, and energy management systems, were undertaken by only a handful of municipalities.

Table 3. Types of energy transition investment undertaken by municipalities in the Podkarpackie Voivodeship (percentage of municipalities).

Specification	Survey 2023 (n = 70) (2019–2022)	Survey 2024 (n = 64) (2020–2023)	Survey 2025 (n = 105) (2021–2024)
Upgrading street lighting to energy-efficient systems	54.3	64.1	86.1
Energy-efficiency upgrades to municipal buildings	55.7	65.6	58.8
Installation of RES on public facilities (schools, hospitals, etc.)	47.1	68.8	56.9
Upgrading heating systems in public buildings	35.7	40.6	33.7
Purchase of energy-efficient equipment for subordinate municipal units	12.9	15.6	8.9
Purchase of environmentally friendly buses	1.4	9.4	4.0
Implementation of energy management systems in municipal facilities	1.4	6.3	4.0
Construction of photovoltaic (PV), wind, or hydropower plants	0.0	0.0	4.0
Construction of a biogas plant at a landfill site or wastewater treatment plant	1.4	9.4	2.0
Construction of a biogas plant or biomass heating plant using municipal waste	0.0	1.6	0.0
Other	0.0	4.7	3.0

Source: Own elaboration.

In the 2025 survey, unlike in the earlier 2023 and 2024 surveys, some municipalities reported initiatives to develop their own medium-sized photovoltaic, wind, or hydropower plants. These installations were intended to meet the energy needs of multiple public buildings while also generating surplus electricity that the local government could feed into the grid. This indicates a strategic shift in municipalities' role in the energy transition, from that of consumers or small institutional prosumers to that of energy producers, primarily serving their own needs but operating on a larger scale than is possible with renewable energy micro-installations on public buildings. Such initiatives, however, remain relatively uncommon among municipalities. Given their high capital requirements and the need to secure the necessary resource base, the development of such projects requires cooperation among several LGUs, and sometimes also between LGUs and private-sector partners. The feasibility of such cooperation is demonstrated by Krośnieński Holding Komunalny (KHK), which cooperates with 27 municipalities in the southern part of the Podkarpackie region, primarily in waste management. KHK is implementing a project that involves using waste to generate electricity and heat. This example shows that some of the municipalities studied are involved in the energy transition indirectly, through their participation in an integrated municipal services system. Such cooperation facilitates more efficient waste management, enables economies of scale, and improves access to public funding for environmental and energy-related investment [63].

4.2. The Energy Transition Among Local Authorities' Investment Priorities

Municipal investment activity should be understood as the outcome of the interaction between financial and institutional constraints and pressure from local stakeholders to implement projects that deliver direct social benefits. The investment activities of local governments are significantly influenced by residents' social expectations and preferences, which shape the decision-making priorities of local authorities and, in turn, determine the allocation of public funds across different areas [64,65]. This mechanism reflects both the

democratic nature of local government and the economic role of LGUs as providers of public goods that respond to local needs. In this context, the results of the 2025 survey provide a more detailed picture of the investment priorities of municipalities in the Podkarpackie Voivodeship and, consequently, make it possible to assess the position of the energy transition among the key areas of local government investment intervention (Table 4).

Table 4. Priority areas of investment expenditure by municipalities in the Podkarpackie Voivodeship—2025 survey (n = 105).

Specification	Percentage of Municipalities
Road infrastructure and transport accessibility for residents (roads, pavements, bridges, park-and-ride facilities, etc.)	87.6
Water and sewerage infrastructure and wastewater treatment plants	81.0
Sports, tourism and recreational infrastructure	46.2
Energy transition, including investment in RES	45.7
Additional equipment for public safety services and the construction of shelters	44.8
Educational infrastructure	37.1
Cultural facilities (e.g., libraries) and heritage sites	33.3
Childcare infrastructure	26.7
Waste management infrastructure	18.1
Climate adaptation infrastructure (flood embankments, retention reservoirs, polders, green spaces, etc.)	13.3
Social infrastructure supporting older people	11.4
Housing and residential development (land for residential construction, participation in housing development)	8.6
Business development (preparation of investment sites with the necessary infrastructure and development of economic zones)	8.6
Expansion and equipping of healthcare facilities	3.8
Public transport (vehicle fleets, fuelling and charging stations, depots, etc.)	1.0
Other	1.9

Source: Own elaboration.

The respondents' answers suggest that the energy transition is one of the more important areas of municipal investment activity. It was identified as a priority by nearly half (45.7%) of the local authority representatives in the municipalities surveyed in the Podkarpackie region (Table 4). It nevertheless ranks considerably below road infrastructure and water and sewerage infrastructure, both of which were identified as priorities by over 80% of representatives of the municipalities studied. At the same time, the investment priorities identified by local authority representatives closely match the pattern of projects actually implemented in 2019–2024 (Figure 1).

One possible explanation for the relatively low priority assigned to the energy transition is that local authorities may perceive other investment areas, such as roads, pavements, water supply systems, and sewerage infrastructure, as generating more immediate local benefits. Previous research by Filipiak and Kluza [65] suggests that local investment decisions may be influenced by political incentives associated with the electoral cycle. In the present study, however, the factors underlying municipal investment priorities were not directly investigated.

4.3. The Importance of Prioritising the Energy Transition for Local Government Investment Activity

An important issue is whether the investment priorities declared by local authorities are actually reflected in practice, as the results show that the scale of investment in the energy transition to date remains limited (Figure 1). The analysis therefore examines whether energy transition investment activity differs between the municipalities studied depending on whether expenditure on the energy transition is regarded as a priority. For this analysis, the municipalities studied were divided into two groups depending on whether they treated energy transition investment as a priority. A total of 57 municipalities did not classify energy transition investment as a priority (Group 0), whereas 48 municipalities considered the energy transition an important area of development (Group 1). The two groups were then compared in terms of their energy transition activities concerning actual investments (scale, types) and planned investments as well as factors perceived as barriers to this kind of municipal engagement. Nevertheless, as not all questions in the survey were fully covered, the data presented below refer only to 101 valid answers (n_0 = 55 for Group 0, and n_1 = 46 for Group 1) that differ from the survey sample (105).

The share of energy transition expenditure in total municipal investment expenditure (Table 5) was found to be higher in the group that prioritised energy transition investment (3.1% versus 2.6%). Nevertheless, the difference was not statistically significant according to the Mann–Whitney U test, reflecting the high degree of variation in the structure of investment expenditure within both groups of municipalities. In the group of municipalities that did not regard energy transition investment as a priority, one municipality allocated as much as 30% of its total investment expenditure to this area. In the priority group, the maximum share was even higher, at 40%, while many municipalities in both groups undertook no energy transition investment whatsoever. The data therefore provide some evidence that prioritising energy transition investment may be associated with a greater scale of actual investment activity; however, the existence of this relationship requires further investigation.

Table 5. Share of energy transition investment expenditure in total municipal investment expenditure in 2021–2024 (%) (n = 101).

Specification	Municipalities (Total)	Group 0 (Non-Priority)	Group 1 (Priority)	U M-W Test
Avg.	2.8	2.6	3.1	
V (%)	209.8	217.3	203.2	
min	0.0	0.0	0.0	U = 1111.0
max	40.0	30.0	40.0	p = 0.3668
Me	0.0	0.0	0.5	
IQR	3.0	2.0	4.8	

V stands for a coefficient of variation; Me—median value; IQR—interquartile range. Source: Own elaboration.

The types of energy transition investments undertaken varied to some extent between the two groups of municipalities with different priorities in this area (Table 6).

For all categories of energy transition investment except building thermal retrofits, the proportion of municipalities undertaking such projects was higher in Group 1, i.e., among municipalities that prioritised the energy transition. Notably, statistically significant differences between the groups were found for renewable energy installations, where the gap exceeded 20 percentage points. In addition, renewable energy installations ranked as the second most common type of investment among Group 1 municipalities. Low-emission bus purchases also ranked higher. Only Group 1 undertook more capital-intensive projects,

such as the construction of biogas plants or the development of district heating networks (category: other). These findings suggest that the priority assigned to the energy transition may be associated with the composition of municipal energy transition investments, particularly with regard to investments in renewable energy installations.

Table 6. Energy transition investments undertaken by municipalities in the Podkarpackie Voivodeship in 2021–2024 (percentage of responses) (n = 101 *).

Specification	Group 0 (Non-Priority)	Group 1 (Priority)	*p*-Value for χ^2 Test	*p*-Value for Exact F Test
Upgrading street lighting to energy-efficient systems	85.5	87.0	0.8278	-
Energy-efficiency upgrades to municipal buildings	61.8	55.3 *	0.5062	-
Installation of RES on public facilities (schools, hospitals, etc.)	47.3	68.1 *	0.0344	-
Upgrading heating systems in public buildings	29.1	39.1	0.2876	-
Purchase of energy-efficient equipment for subordinate municipal units	7.3	10.9	-	0.7282
Implementation of energy management systems in municipal facilities	3.6	4.3	-	1.0000
Construction of photovoltaic (PV), wind, or hydropower plants	3.6	4.3	-	1.0000
Purchase of environmentally friendly buses	1.8	6.5	-	0.3280
Construction of a biogas plant at a landfill site or wastewater treatment plant	0.0	4.3	-	0.2050
Construction of a biogas plant or biomass heating plant using municipal waste	0.0	0.0	-	-
Other	0.0	4.3	-	0.2050

* The number of valid responses for the options "Energy-efficiency upgrades. . ." and "Installation of RES. . ." was n = 102, including n_1 = 47 and n_0 = 55 in Group 1. For all remaining questions, the number of valid responses was n = 101, including n_1 = 46 and n_0 = 55 responses in Group 1. Source: Own elaboration.

Prioritising investment in the energy transition may be linked not only to a range of investment activities undertaken to date but also to the formulation of future development plans (Table 7). The findings show that municipalities treating energy transition investment as a priority planned to allocate 27% of their total investment expenditure to this area, a share 10 percentage points higher than that reported by municipalities that did not treat it as a priority. The differences were statistically significant, suggesting that future municipal investment activity may vary according to local authorities' approach to energy transition investment.

The key finding of the study—that prioritising the energy transition is associated with municipalities' investment plans, but is not reflected in the current scale of investment in the energy transition—calls for consideration of other factors that may potentially condition these relationships. In particular, the hierarchy of investment priorities may be shaped by objective characteristics, such as municipality type or the condition of municipal finances. Therefore, an additional analysis was conducted to verify whether potential differences existed between the two groups of municipalities distinguished on the basis of their declared prioritisation of the energy transition, with respect to their basic characteristics (Table 8).

Table 7. Share of planned energy transition investment expenditure in total municipal investment expenditure over the next 2–3 years (%) (n = 101).

Specification	Municipalities (Total)	Group 0 (Non-Priority)	Group 1 (Priority)	U M-W Test
Avg.	22.4	17.8	27.3	
V (%)	72.2	75.9	64.0	
min	1.0	2.0	1.0	U = 475.5
max	80.0	80.0	70.0	p = 0.0044
Me	20.0	15.0	25.0	
IQR	20.0	10.5	10.0	

V stands for a coefficient of variation; Me—median value; IQR—interquartile range. Source: Own elaboration.

Table 8. Characteristics of municipality groups identified based on prioritisation of energy transition—2025 survey (n = 105 *).

Specification	Group 0 (Non-Priority)	Group 1 (Priority)	p-Value for the U M-W Test	p-Value for χ^2 Test	p-Value for FFH Test
Urban (%)	12.3	4.2	-	-	
Urban–rural (%)	19.3	27.1	-	-	0.2605
Rural (%)	68.4	68.8	-	-	
Percentage of municipalities with a budget surplus	29.8	39.6	-	0.2940	-
Investment expenditure as a share of total expenditure	26.2	29.3	0.2562	-	-

* These general characteristics describe all municipalities surveyed in 2025 (n = 105). Source: Own elaboration.

A comparison of the two groups indicates that municipalities identifying the energy transition as a priority include a lower proportion of urban municipalities and a higher proportion of urban–rural municipalities. This may be related to the existing level of infrastructure development, which in urban areas is often better adapted to energy-efficiency requirements, as well as to more limited spatial opportunities for implementing certain energy transition projects, such as the construction of biogas plants or power plants. In this respect, urban municipalities may often be supported by neighbouring municipalities with lower population densities. The condition of municipal budgets may also constitute a potential confounding factor, as municipalities that prioritise the energy transition are more likely to report a budget surplus and also exhibit somewhat higher overall investment activity. Nevertheless, none of the observed differences is statistically significant. This may point to the multidimensional and potentially interdependent nature of the relationships involved, warranting further investigation in future research.

The analysis also provides no evidence that variation in the prioritisation of the energy transition is attributable to differences in local authorities' perceptions of investment barriers. The individual barriers were rated similarly by municipalities that prioritised energy transition investment (Group 1) and by those that did not consider this investment area a priority (Group 0) (Table 9).

Table 9. Key barriers to investment identified by municipalities in the Podkarpackie Voivodeship (mean rating on a 1–5 scale) (n = 101).

Specification	Municipalities (Total)	Group 0 (Non-Priority)	Group 1 (Priority)	U M-W Test
Absence of, or substantial reductions in, grants from the national budget to support local government investment	4.4	4.5	4.3	U = 1094.0 p = 0.2450
Misalignment between the objectives of programmes and competitive calls financed from EU and national funds and our investment priorities	4.06	4.1	4.0	U = 1102.5 p = 0.5438
Poor economic viability, with investment costs too high relative to the potential returns from the investment	3.24	3.2	3.3	U = 1010.5 p = 0.5001
Lack of public acceptance and opposition from some residents	2.50	2.4	2.6	U = 917.0 p = 0.4642
Low own-source revenues (poor budgetary position)	4.03	4.1	3.9	U = 1087.5 p = 0.5960
High level of municipal debt	2.96	2.9	3.0	U = 987.5 p = 0.9224 U = 926.0
High debt-servicing costs	3.16	3.2	3.1	p = 0.5274

Source: Own elaboration.

Across both groups, the most significant barriers concerned access to external funding and the purposes for which such funds could be allocated. Municipalities that did not identify the energy transition as a priority tended to assign slightly greater importance to these factors, as well as to debt-servicing costs, than municipalities in Group 1. However, the differences between the two groups were not statistically significant.

5. Discussion

The findings presented in this study indicate that local authorities in the Podkarpackie region are interested in investments related to the energy transition, with nearly half of the municipalities surveyed identifying it as a priority. Nevertheless, many municipalities in the Podkarpackie Voivodeship demonstrate a relatively low level of engagement in the energy transition. This may signal a significant discrepancy between the scale of the challenges and the actual development priorities of local authorities [1,33,66]. The low share of expenditure allocated to the energy transition suggests that, in practice, it remains peripheral to municipal investment policy, with priority instead given to more "visible" projects such as road infrastructure and water and sewerage infrastructure. Other studies [67] similarly show that investment priorities result from compromises between residents' needs, fiscal constraints, and political objectives, while the process of setting these priorities is not governed solely by economic rationality [68]. Although some researchers [69] have identified a shift in investment priorities away from basic technical infrastructure towards measures aimed at improving residents' quality of life, investments in basic infrastructure continue to dominate among Polish local governments.

The findings also provide cautious support for the main hypothesis that the priority assigned to the energy transition by local authorities is associated with greater municipal investment activity in this area. Municipalities that identified the energy transition as one of their local development priorities allocated a slightly higher share of their total investment

expenditure to this area between 2021 and 2024. Prioritising the energy transition was associated with differences in certain areas of investment, particularly greater investment in renewable energy installations. Municipalities that treated the energy transition as a priority also planned to allocate a higher share of investment expenditure to such projects over the next 2–3 years.

As noted above, municipalities whose authorities regarded the energy transition as one of their development priorities exhibited a slightly higher share of energy transition-related investments in their overall investment expenditure during 2021–2024. However, the differences between the identified groups of municipalities were not statistically significant, and thus hypothesis H1 could not be confirmed. This suggests that assigning a high priority to the energy transition among development objectives does not automatically translate into a higher level of investment realised over the short term. This finding may be related to the specific nature of local government investment projects, which often require multi-year preparation, the development of project documentation, and the acquisition of external sources of funding.

At the same time, municipalities that identified the energy transition as a development priority reported a significantly higher share of such projects in their planned investment expenditure. This finding provides support for hypothesis H2. These results suggest that the importance assigned to the energy transition by local authorities is currently reflected more clearly in future investment intentions than in investments already implemented, thereby providing only partial support for the main research hypothesis. These findings indicate that the strategic priorities of local governments may constitute an important factor differentiating municipalities' future investment engagement in the area of the energy transition, although their relationship with past investment activity appears to be weaker.

Therefore, the findings reveal an important difference between the role of energy transition prioritisation in realised and planned investments. This suggests that declared priorities do not necessarily translate into actual investment behaviour, as municipalities face a variety of barriers in their investment activities. The results also raise the question of whether the priority assigned to the energy transition is merely declarative or whether planned investments are sufficiently grounded to be implemented in the future. Alternatively, the observed pattern may reflect response bias, as the questionnaires were completed by municipal officials who may have overstated their municipality's commitment to the energy transition agenda.

Other research [19] indicates that local governments do not act as independent investors in the energy transition; instead, their activity is largely reactive and dependent on support policies. Local-level energy transition is not primarily the result of a stable long-term strategy pursued by local governments, but is largely determined by their ability to obtain non-repayable or preferential funding, such as low-cost loans under the EU *Recovery and Resilience Facility* [19,54,70]. According to Standar et al. [28], local government involvement in the energy transition in Poland is neither widespread nor systematic. Rather, it takes the form of isolated "islands of activity", with some local governments cooperating with others in integrated investment partnerships. Key barriers remain the budgetary constraints faced by LGUs, the high capital intensity of energy projects, their long payback periods, and the associated regulatory risks. The current research indicates that an additional barrier may be the low priority assigned to the energy transition among the priorities of local government authorities. These factors collectively discourage local governments from investing in this area, leading to activity that is uneven and non-systematic—dependent on funding cycles [19,30,71].

Municipal energy transition investments vary in nature, although projects requiring relatively lower financial outlays and shorter implementation periods clearly predominate.

One possible way to overcome financial and other constraints is cooperation between local governments in implementing more complex, larger-scale, and more capital-intensive projects with longer payback periods. However, the literature identifies gaps both in cooperation between local governments in the field of the energy transition and in cross-sector cooperation between local governments and the private sector. The main constraints include inadequate coordination among stakeholders, as well as regulatory and financial barriers [1,72,73].

In this respect, good practices should be promoted. Examples of effective cooperation between local authorities in the energy transition in the Podkarpackie region include the activities of Krośnieński Holding Komunalny, which uses waste to generate electricity and heat [63], and the Podkarpacka Komunikacja Samochodowa Association of Municipalities, which is involved in the green modernisation of the public transport fleet [74]. Such good practices may provide fresh impetus for the energy transition in the region. They demonstrate that municipalities can pursue energy transition objectives by cooperating with one another in this area, for example through purpose-specific inter-municipal associations or integrated partnership-based investment projects. In this way, municipalities can reduce the barriers associated with this type of investment, especially those of an economic nature, as well as procedural, planning, and other constraints. Local governments can also make use of institutional arrangements such as energy clusters and energy cooperatives. However, such institutional forms of partnership and cooperation in energy production and distribution have only relatively recently emerged in Poland. Many local governments are only beginning to recognise the opportunities and potential benefits associated with engaging in such institutional arrangements [2,75].

6. Conclusions

The extent to which municipalities engage in the energy transition is associated not only with the availability of funding and local needs but also with the political decisions and investment priorities of local authorities. Energy transition-related projects tend to rank relatively low among the priorities of many local authorities. As a result, local governments often continue to prioritise projects related to the development of "traditional" technical and social infrastructure, which are perceived as more directly addressing residents' immediate needs.

The lower priority assigned to the energy transition within municipalities' development priorities also results from a range of other barriers, including financial, strategic, planning, administrative/legal, social, capacity-related (staffing), and technological constraints. All of these barriers, however, are reflected in the cautious approach adopted by many local governments towards investment in the energy transition. As a result, such investments are often disadvantaged in the allocation of limited financial resources compared with other development priorities. This leads to the following conclusions:

1. The findings point to a relatively low priority given to the role of energy transition in sustainable development by local authorities, including its role in improving energy security at the local and regional levels;
2. The results suggest that, alongside addressing financial and organisational barriers, greater attention may be needed to strengthen the position of energy transition objectives within local development strategies. In this context, EU and national authorities could place greater emphasis on raising local awareness of the potential benefits of energy transition projects.

The findings presented in this study provide only partial support for the main hypothesis that the priority assigned to the energy transition by local authorities is associated with municipal investment activity in this area. An important conclusion of the study

concerns the asymmetry identified between the role of energy transition prioritisation in shaping municipalities' future investment plans and its relationship with past investment expenditure. Municipalities that regarded the energy transition as a development priority did not differ significantly from other municipalities in terms of the share of energy transition-related investment expenditure incurred during the period under analysis. In contrast, they declared significantly higher planned investment expenditure in this area for the coming years. This finding suggests that assigning a high strategic priority to the energy transition is not sufficient in itself to translate into higher investment activity in the short term. Instead, its effects appear to be reflected first in the sphere of investment intentions and development planning, while their translation into actual expenditure is mediated by financial capacity, access to external funding, administrative procedures, and the multi-year implementation cycle of municipal investments. Consequently, the results indicate that local governments' strategic priorities may be regarded as an important factor differentiating future investment engagement in the energy transition, rather than a direct determinant of investment expenditure already incurred.

Mitigating the barrier posed by the relatively low priority assigned to the energy transition in municipal investment decisions requires external intervention. Bottom-up mechanisms alone, such as measures designed to enhance local authorities' knowledge of the challenges and benefits associated with the energy transition and to develop their competencies in the preparation and implementation of energy projects, may not be sufficient. External incentives are needed in the form of appropriate regulations, financial incentive schemes, and simpler and faster administrative procedures for energy transition projects.

Local governments cannot pursue the energy transition in isolation, as the effectiveness of their actions frequently depends on support from national or EU-level institutions. Limited local budgets and technical capacity often constrain the implementation of more capital-intensive projects. Both vertical cooperation (with central and regional authorities) and horizontal cooperation (with other LGUs and across sectors) are necessary to mobilise additional financial and technological resources, reduce planning and administrative barriers to energy transition investment, and support the implementation of comprehensive solutions in this field.

The study made it possible to identify the position of the energy transition within the hierarchy of local authorities' development priorities in the Podkarpackie region and to assess the significance of this prioritisation for municipal investment activity. Nevertheless, the study is limited by its regional scope, and its reliance on self-reported data regarding local authorities' development priorities. Furthermore, the lack of information on municipal priorities in earlier periods limits the possibility of examining the temporal relationship between development priorities and investments related to the energy transition. Future research should extend the analysis to municipalities in other regions of Poland and explore more thoroughly the mechanisms linking local development priorities with investment activity in the field of the energy transition. Particular attention should be paid to the temporal dynamics of this relationship and to the role of financial conditions in shaping the position of the energy transition within municipal investment priorities.

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Data Availability Statement: The data supporting the findings of this study are presented within the article. The raw questionnaire dataset is not publicly available due to confidentiality and data protection considerations. Requests for further information regarding the data may be directed to the Faculty of Economics and Finance, University of Rzeszów, Poland, subject to applicable data protection and institutional policies.

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