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Local Spatial Plans as Determinants of Household Investment in Renewable Energy: Case Studies from Selected Polish and European Communes

Krystyna Solarek * and Marta Kubasińska

Faculty of Architecture, Warsaw University of Technology, 00-659 Warsaw, Poland; marta.kubasinska.dokt@pw.edu.pl

* Correspondence: krystyna.solarek@pw.edu.pl; Tel.: +48-22-621-82-81

Abstract: Although many factors affect the investment of individual households in renewable energy sources, we highlight one of them: the local spatial development plan. It is one of the planning tools for implementing development policies at the local level. Since it is on the basis of local spatial plans that investments are carried out on the ground, their role in the implementation of renewable energy sources is one of the most important. This article presents the results of a study of local spatial plans in terms of facilitating, on the one hand, and limiting, on the other hand, the implementation of various renewable energy investments. To a large extent, the focus was on examples of planning acts adopted in Polish communes, but they were compared with examples from other European countries. The authors focused on qualitative assessment, taking into account the regulations applicable to all investors, containing generally binding standards, which specify the development's land use and detailed building principles. The conclusions include recommendations for the provision of local development plans.

Keywords: renewable energy; local spatial plan; urban planning; individual renewable energy systems; Poland

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1. Introduction

In 2018, individual households accounted for 26.1% of final energy consumption in the European Union, but renewable energy sources accounted for only 19.5% [1]. Therefore, this is still an area where much more can be done to reduce greenhouse gas emissions.

The ambitious 2050 greenhouse gas emissions reduction target of limiting the average global surface temperature rise to below 2 °C requires a variety of changes, but one of the most important is increasing energy efficiency. As the use of renewable energy can meet roughly two-thirds of the world's total energy demand, a real transition to this type of energy by 2050 has become crucial [2–5]. While there are political and scientific discussions on the economic and technical aspects of this green revolution [6–9], the importance of renewable energy is highlighted in national and international policies, including in the special directive of the European Union [10]. This initiative is part of the modernization and transformation towards a climate-neutral economy initiated by the European Union [11]. This is one of the elements of the implementation of the Sustainable Development Goals (SDGs), adopted by the United Nations General Assembly (UNGA) in 2015 [12,13].

The European Union Directive recommends a binding EU target of at least 32% of energy from renewable sources. The importance of small-scale installations has been highlighted, as has the fact that supporting them can be very beneficial in increasing public acceptance and ensuring the development of renewable energy projects at the local level. The transition to sustainable renewable heating sources, efficient products, and devices require and will require various types of support in the coming years [10]. Regardless of financial instruments, education and access to information, there is a need to integrate the appropriate regulatory framework at different levels, including at the local level.

Local governments shape their spatial policy to set courses for a more sustainable future and at the same time one that is convenient for inhabitants. Therefore, irrespective of the previously presented justifications related to climate issues, the priority for renewable energy in local policies is to provide residents and potential developers with lower electricity and heating bills and expand the labor market related to this industry [14–16].

We wish to draw attention to a tool for implementing an integrated local policy, the local spatial plan. This kind of plan performs a regulatory and developmental function, including an informational aspect [17], so it can mobilize consumers to modernize the built environment and housing resources, facilitate the implementation of investments or, on the contrary, make them difficult. Determining the location of renewable energy installations is one of the necessary stages of the investment process. This is often carried out based on various types of regulatory plans, hereinafter jointly referred to as local spatial plans or zoning plans. The local spatial plan defines land development and development policy [18,19]. Therefore it is necessary to look at the plans in terms of the decision-making process, i.e., development policy and management.

There is no doubt that the spatial planning system is inefficient or weak in many countries, and the relationship between planning regulations and the reality observed on the ground is often negligible. This is especially noticeable and even acute in countries with weak planning systems and rapid urbanization. Weak planning systems are understood to be inadequate at assisting in the development and implementation of rigid land-use plans [20–24]. A particular situation concerns the issue of renewable energy in spatial planning because EU and national regulations introduced to regulate this thematic area change much more often than local policies, and even more so than regulatory plans which, whilst maintaining the desired flexibility, should be predictable and stable [25–28].

This does not mean that the quality and effectiveness of local plans can be ignored, even though they are the basis of investment and may exert a significant impact on the natural environment, as well as the safety and quality of life of the inhabitants. This seems all the more important as the need for integrated planning is articulated with increasing clarity, which may be the key to an effective spatial development system [29–31]. Part of this system is the energy subsystem, the integration of which with the spatial planning system is necessary at every level and at every scale [32]. Despite widely and loudly declared intentions, many authors note the lack of integration of energy and spatial planning, resulting from the weakness of urban strategies, policies and activities, as well as the inconsistency of regulations and conflicts of various interest groups [33,34]. De Pascali and Bagaini [35] remarked that after an initial period of intense theoretical work, the synergy between energy and the city's physical and functional organization and planning is still far from being realized. They explain this lack of integration by analyzing the significant steps in the last 50 years to outline the current obstacles to achieving a more comprehensive vision of energy and spatial planning [35].

Sharing this view, the authors drew attention to the thematic scope of practical urban planning and noticed a gap in the research at the local level of planning. It can be observed that a considerable interest of researchers, resulting in numerous publications, are either very general issues, in the scale of national, regional and local policies [33,34,36], or very detailed [37–40]. The latter are most often collections of practical principles for designing urban structures and individual buildings or analyses of building regulations and their relationships with the subject of renewable energy. Therefore, there is no intermediate link, i.e., research on this instrument of spatial policy that allows for the implementation of individual investments and building complexes. This link is the topic of the local spatial plan.

The analysis of the current research on energy and spatial planning in Poland is not sufficiently investigated. Mostly, studies on the issues of wind farms and agricultural biogas plants in the context of spatial development and planning were published [41–43]. Some of these studies discuss the legal conditions for the location of RES, but without delving into the issues related to the substantive and formal content of planning studies [44–46].

Until recently, the issue of micro-installations in the context of spatial planning was not considered at all. A breakthrough publication is the latest analysis of the scope of including renewable energy sources in local planning in Poland, containing interesting research results, published by Blaszke et al. [47].

In this study, we checked the scope of individual energy source topics in local plans of selected areas of Europe, relating them to various planning systems and urban practices. For detailed analyses, the case of Poland was chosen, in which activities for the development of renewable energy should be intensified to meet the obligations towards the European Union and increase the safety of citizens. The Polish energy system has so far been based mainly on the combustion of hard coal and lignite and is also very centralized [14]. The roles are clearly separated—the citizen is treated as a passive consumer. Society is usually involved only to a minimal, even symbolic degree in energy production [16]. Therefore, it is necessary to pay special attention to supporting household investment in renewable energy through local spatial planning. Integrating energy issues with the local legal system may help Poland meet European standards, thus improving the energy situation of the whole of Europe as well as improving the climate in an even broader dimension.

2. Materials and Methods

The research consisted of several stages, and the overall methodology is shown in Figure 1.

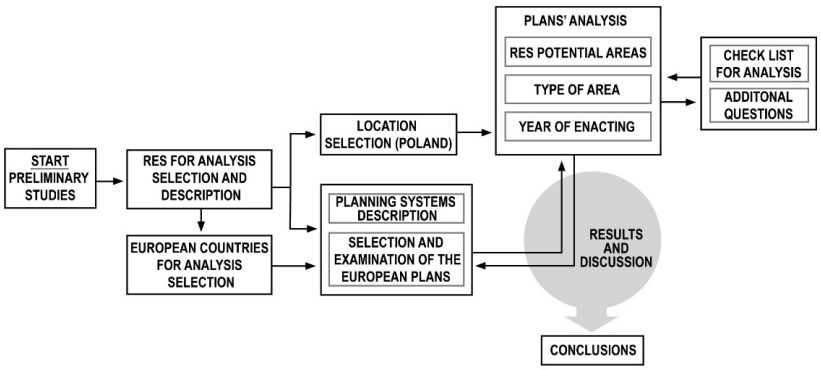

Figure 1. The overall research methodology.

In the first part of the research, we checked what scope of regulations regarding renewable energy sources for individual households is included in local plans in selected European countries. Demonstrative comparisons were conducted based on selected acts of local law in these countries. In the second part of the research, the quantitative analysis method was mainly used to compare the provisions of chosen local spatial plans in Poland in the Mazowieckie Voivodeship. Finally, we analyzed to what extent these plans stimulate or limit RES investments in households.

We took into account the binding plans prepared from the 1990s to 2021. The relationship between the time when the plans were adopted and provisions concerning the RES was noticed. All the analyzed plans concerned land destined for new development with an area of more than 50 hectares.

Obviously, this approach did not make it possible to obtain full knowledge about the planning situation in Poland when it comes to including RES in local planning. However, through in-depth qualitative research, it was possible to respond to those features of planning regulations that affect RES development and formulate guidelines for the future. It can be a good continuation and supplement to the latest published research on the topic of including broadly understood renewable energy sources in local spatial policies in Poland [47].

It should be emphasized that only the text parts of local plan regulations were analyzed. Therefore, the size of the areas covered by the plans did not significantly impact on the

selection of objects for research. However, the scope of influence of individual plans on the implementation of renewable energy is related to the size of the area for which a given plan is valid, although the authors were focused on the approach to the planning records made at different times and in the different types of settlement units. It should also be added that the very adoption of a local plan provides a framework for investment, and the results consisting in the implementation of specific projects may or may not appear on the ground. These effects appear in the short or long term; therefore, the assessment of the actual implementation of local plans is complicated and goes beyond the scope of the research carried out.

2.1. Renewable Energy Sources Included in the Research

In the case of investments at the level of households, which we dealt with in the research, there are two basic sources of renewable energy: solar photovoltaic (PV) and solar thermal as well as heat pumps from the ground, air and water. Planning regulations for these renewable energy sources were therefore taken into account.

Undoubtedly, the use of small individual wind turbines is also a promising future option, but they are considered less efficient than large wind turbines, and their location is usually problematic [48,49]. However, small wind energy accounts for such a small part of the global renewable energy mix that its share is not even included in global renewable energy reports [50]. For this reason, we did not analyze in detail the issues of planning provisions for the location of this type of renewable energy source.

Photovoltaic (PV) and solar thermal systems, the technologies used to convert solar energy into electricity or heat, are the subject of increasing interest from households. To a large extent, this may be due to subsidies from the government and local government programs, encouraged and financed by EU legislation [14,51]. Solar thermal energy has the technical potential to meet the almost unlimited demand for water and space heating. For example, the European Solar Thermal Technology Platform estimates that by 2030 the installed capacity in the European Union (EU) could increase from around 10 to 200 GWh and supply up to 50% of all heating applications requiring temperatures up to 250 °C [52,53]. Solar photovoltaics have become particularly popular in households in recent years. In some European countries, such as Germany and Poland, there is a real boom in photovoltaics [51] (Figure 2). Among all renewable energy sources, solar energy is one of the richest and the most significant potential energy sources globally, and the importance of renewable energy sources (RES) in the energy mix is enormous [54]. Since solar collectors are usually mounted on the roofs of buildings, this type of renewable energy is most closely related to the investment process, which local plans regulate.

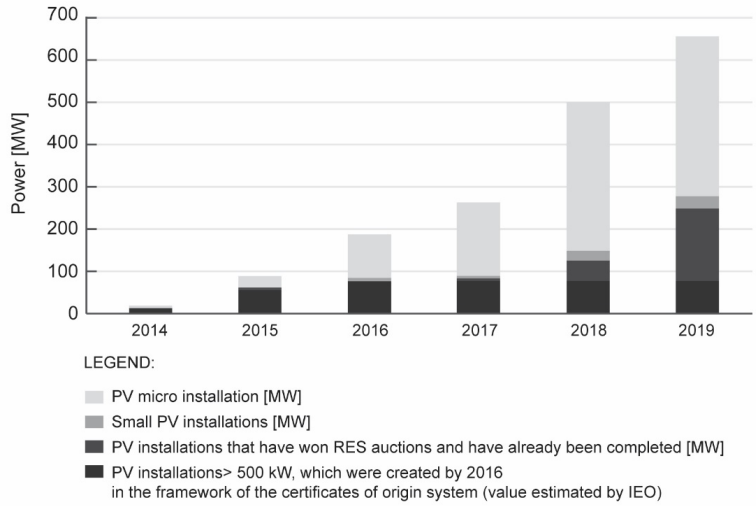

Figure 2. The photovoltaic market in Poland 2019. Source: own study, based on [55].

The research also considered planning regulations for heat pumps, although these devices contribute to direct emissions through refrigerant leaks throughout their life cycle. Many heat pump systems are used in residential buildings worldwide due to the attractive advantages of high energy and environmental efficiency [56]. In those countries and locations that do not have a developed district heating system, heat pumps can replace individual heating installations based on the combustion of gas and solid fuels, which significantly reduces emissions [57].

2.2. Selection of Countries for Qualitative Analysis and Its Scope

Location features may indicate the availability of space to invest in specific energy technologies, while the climatic zone may influence the performance of certain energy measures [53,58]. The adopted fiscal incentives and legal regulations are also of great importance. Nevertheless, it was assumed that when selecting countries for the study of planning documents, neither the geographical criteria nor fiscal conditions would be taken into account, but the practical result was expressed in increases in the installed solar energy capacity in photovoltaic systems in individual countries.

We used online published data on solar installations from 2019 for European Union countries, prepared by the SolarPower Europe association [59]. The most critical factor in the research was the scale of the increases in the installed solar energy capacity in the following years, not their exact size. This list allowed the selection for analysis of those European Union countries in which this increase was the highest over the last four years. These countries are Germany and the Netherlands. Spain was not included as such an increase was only recorded once, in 2019. In addition, we checked the planning situation in Italy, where the most significant increases were observed in 2009–2012, after which the use of photovoltaic panels decreased significantly (Figure 3).

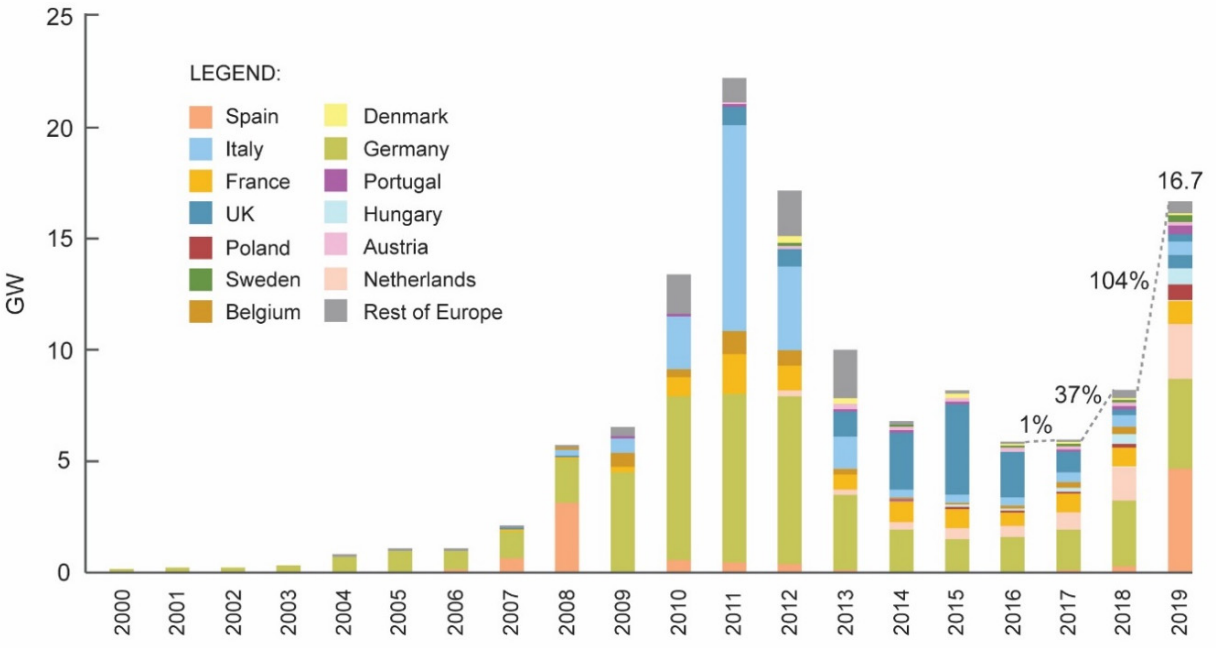

Figure 3. Installed solar power in 2000–2019 with a breakdown by European countries. Source: own study based on [59].

We analyzed local plans for the three selected countries, embedding them in the description of individual planning systems. As this was to define the background and the reference field for detailed studies of the Polish plans, it was not an assessment but rather a qualitative analysis. From among 30 texts of planning regulations, repeating entries or various approaches were chosen. In the paper, we describe or cite the regulations contained

in four local plans in more detail, and draw up conclusions about the scope of introducing planning arrangements for RES in households.

2.3. Methodology of the Polish Local Spatial Plans Analysis and Materials Used

Local spatial plans were studied for selected areas in Poland in the Mazowieckie Voivodeship, as this region includes areas with suitable conditions for the use of various types of renewable energy, including solar, wind, and geothermal energy (Figure 4). This conclusion is echoed in the Spatial Development Plan for the Mazowieckie Voivodeship [60].

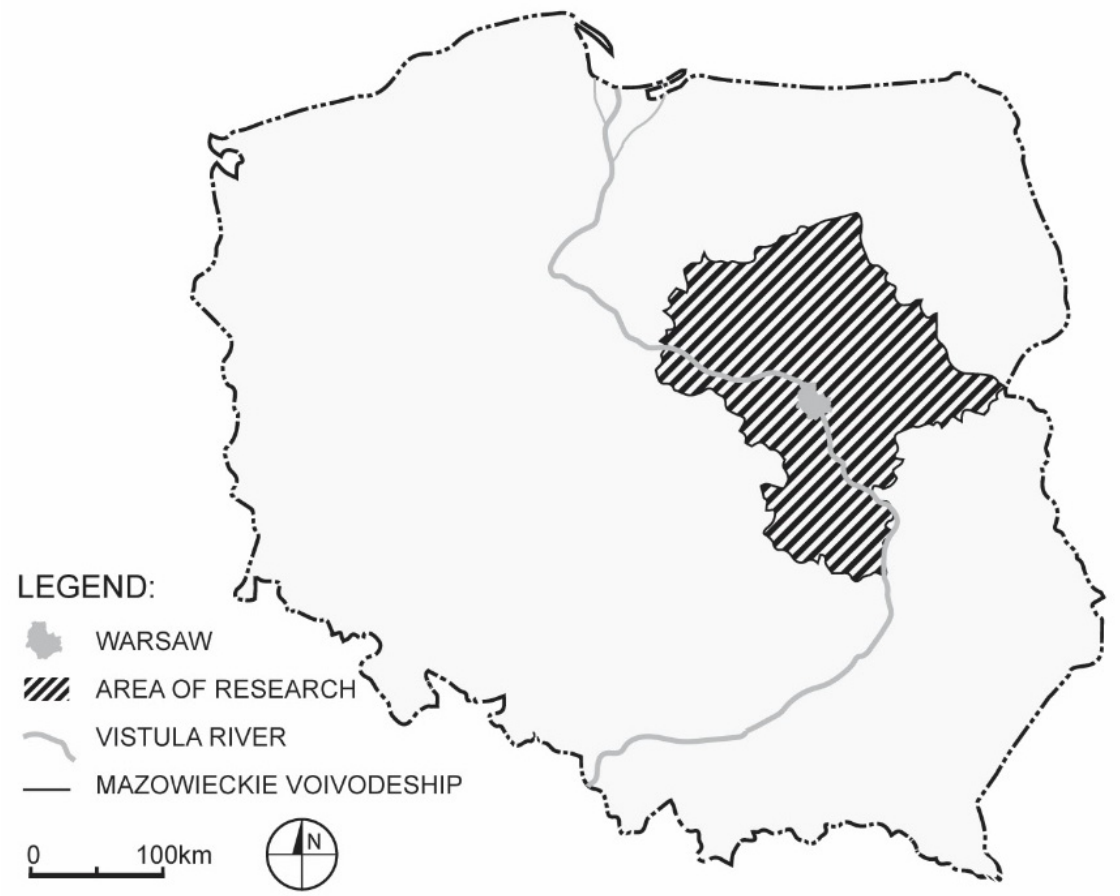

Figure 4. Location of the research area in Poland. Source: own study.

For the analysis, local plans were selected from areas with different characteristics, broken down into (1) rural areas, (2) small towns—population below 20,000 inhabitants, (3) medium-sized cities—from 20,000 up to 100,000 inhabitants, (4) large cities—100,000 or more inhabitants. In addition, the following categories of plan were distinguished: (1) before 2003, (2) adopted in 2003–2015, and (3) adopted in 2016–2021. A specific turning point was the adoption of the Spatial Planning and Development Act in 2003 [61], which introduced new requirements for planning arrangements, and the year 2015, when two acts essential for the development of renewable energy entered into force: the so-called "Windmill Act" [62] and the Act on Renewable Energy Sources [63]. Depending on the number and size of settlement units in individual poviats (districts) and the conditions for solar energy development, one to three plans in individual poviats were examined.

In general, the choice of plans was motivated by the intention to achieve a relatively even distribution among the research groups (size of the local government unit and date of enactment). In total, 71 local development plans were analyzed (Table 1) (Figure 5).

Table 1. The number of analyzed plans in particular groups.

1. Rural Areas			2. Small Towns—Fewer Than 20,000 Inhabitants			3. Medium-Sized Cities—20,000 to 100,000 Inhabitants			4. Large Cities—100,000 Inhabitants and More		
≤2003	2004–2015	≥2016	≤2003	2004–2015	≥2016	≤2003	2004–2015	≥2016	≤2003	2004–2015	≥2016
5	6	6	6	6	6	6	6	6	5	6	7

Figure 5. Location of the studied local plans in the Mazowieckie Voivodeship and individual poviats, showing the division into zones with different potential for the use of renewable energy. Source: own study.

Following the Act on Spatial Planning and Development in force in Poland [61], the local spatial development plan consists of a resolution containing textual planning arrangements, which are a provision of local law, and a graphic appendix to this resolution, relating detailed arrangements to individual areas. If one analyzes planning arrangements for households and not infrastructure for energy production, the drawing/map of the plan does not contribute anything to this analysis; it shows the assignment of individual areas and the lines separating these areas. Therefore, the focus should be on the textual part of the plan. According to the Act mentioned above, the local zoning plan must specify, among other things, the rules that may apply to investments in renewable energy sources.

Therefore, the texts of selected plans were analyzed in terms of these two points. A short checklist was used for the quantitative analysis of the plans, requiring a yes or no answer. It contained four questions:

1. Does the plan contain any mention of RES?

2. Does the plan allow the use of RES?
3. Does the plan prohibit the use of RES?
4. Does the plan introduce any restrictions for RES?

The research was supplemented with a qualitative analysis. The fourth question was further developed to list details on planning constraints for RES. All the plans were additionally checked for the existence of arrangements for supplying households with electricity and heat, answering the following questions:

1. What type of electricity supply is included in the plan?
2. What way of heating buildings is included in the plan?

Appropriately grouped answers made it possible to assess the scope of planning arrangements regarding RES in the individual analyzed groups and changes over time. It also allowed for the reference to the impact of the examined local plans on households' investment in renewable energy in Poland.

3. Results and Discussion

3.1. Planning Regulations Concerning Investments in Renewable Energy Sources for Households in Selected European Countries

There are several types and levels of planning in all the countries surveyed at the local level. Above all, however, there is a division, on the one hand into general plans (comprehensive plans), covering the entire local territory, and, on the other hand, legally binding instruments, such as local development plans for selected territories, with different names and scope of arrangements in individual countries. They all play a regulatory role, determining the functions and intensity of use of individual areas, the basic principles of urban design, and public infrastructure distribution [64]. The research shows that the approach to formulating rules for the use of renewable energy in households in local plans varies somewhat, although there are also similarities.

In Germany, the regulatory function is performed by the binding spatial development plan (B-Plan, Bebauungsplan) [65]. The examined texts of the planning regulations contained in this type of document for several areas in the municipalities of Ursensollen and Haag in the federal state of Bavaria and in the municipality of Laatzen in Lower Saxony showed several similarities in the formulation of guidelines for renewable energy sources. Interestingly, since the 1990s, plans have been enacted containing incentives for the use of energy-saving solutions and renewable energy sources. A sample record for the Kammerstein community Bebauungsplan NrH_2 Ortsteil Haag, Haag-West area 1999 was included in the chapter entitled "Resource Use" and reads as follows: "It is also recommended to use solar energy through active (solar) and passive (building) activities" [66]. The authors also found plans that in the energy supply arrangements only indicate the cable lines underground and the name of the electricity supplier. However, there are guidelines for solar panels in the arrangements for the detailed rules of shaping the building development in terms of the shape of the roof. The plan for the "Rängberg" community of Ursensollen includes the following provisions: "A future-oriented ridge alignment is to be aimed for, since this way solar energy can be used effectively for hot water or photovoltaic technology. It is also advisable to provide for the installation of empty conduits for subsequent upgrading and retrofitting for resource-saving and emission-reducing measures. PV systems are generally permitted. The ridge direction defines the orientation of the roof ridge (ridge for short), which is the name given to the upper cut edge of two roof surfaces" [67]. The incentives for the use of photovoltaics are therefore clear, and only in individual plans did we not find any information on this topic.

In the Netherlands, the most important tool in local spatial planning is the municipal land-use plan (Bestemmingsplan). This plan sets down where construction may occur, what may be built, the size of the structure, and what it may be used for [68].

The examined local plans obtained from the Dutch portal of spatial development plans [69] practically do not contain provisions on the method of supplying facilities in the regulatory part. This is because, as a rule, these plans are devoted to determining

the destiny or function of the land and the rules for its development. Therefore, if they contain arrangements for technical maintenance and power supply of facilities, it is only to indicate areas for their implementation or to define deviations from the rules of shaping buildings, enabling the implementation of certain devices that accompany them. Moreover, such derogations are often provided for wind turbines, with detailed guidelines for their construction for households [70]. The plans include a detailed drawing showing how the rotor diameter is measured for horizontal and vertical wind turbines.

It should be added that local plans in the Netherlands contain an explanation, which can also be called a description, serving to present the planning conditions and goals of preparing the plan. This description also includes an environmental impact assessment. This study is helpful during public consultations, for example. In such descriptions, there are very extensive records on renewable energy. They refer to sectoral programs and higher-level plans, primarily prepared for the entire municipality as a Municipal Structural Vision (Gemeentelijke Structuurvisie). Therefore, in the part of the Almere plan under examination, for example, the following provisions were included: "The approximately 10,000 homes and the additional businesses, offices and facilities that are being built in this area compared to the baseline situation will ensure an increase in energy demand and increased traffic. This will result in an increase in CO_2 emissions. Growth is limited by district heating connection, and some sustainable energy initiatives will be reimbursed, inter alia, giving attention to maximizing the potential for passive and active use of solar energy (flat roofs, sun orientation and avoiding shadows as much as possible in the case of height fluctuations in buildings). (. . .) By approaching the target group and stimulating solar energy, and to a lesser extent wind energy, a more sustainable district heating network will make energy management in the municipality more sustainable. (. . .) The necessary cables and pipes will be installed in the neighborhood for electricity, taking into account the higher exchange rate due to, inter alia, needs for solar panels and electric vehicles". Provided that the plan complies with "Energy Works!" (Energie Werkt!), and assuming that Almere will become energy-neutral in 2022, the plan stipulates that district heating, solar panels, solar collectors and small wind turbines near or on buildings are possible in the area covered by the plan (by way of derogation) [70]. Therefore, signs of the high importance of renewable energy for households are sent to investors, as well as guidelines that are directly related to the construction process.

In Italy, the degree of regional autonomy is high, and the existing planning systems seem to be similar across the country, although the names and scale of these studies vary widely. The actual land use decisions are made primarily at the local level by municipalities under the Municipal Master Plan, in some regions called the Piano Regolatore Generale (PRG) or Piano Di Governo Del Territorio (PGT), for example. If the general planning instrument only outlines the rules for the zoning area, its development must be secured through Local Development Plans, also called Detailed Municipal Regulatory Plans (Piani Attuativi or Piani Regolatori Particolareggiati Comunali—PRPC) [71].

The overall regulatory plan consists of various documents and graphics approved together. The overall regulatory plan shall include, inter alia, a coordinated text of the implementing technical standards, also known as the Technical Rules for Implementation of Building Regulations.

In the surveyed master plans for municipalities from different provinces, for example, Artegna, Palermo and Macerata, we found a completely different approach to the provision of renewable energy sources. Some of the plans did not deal with this topic at all, while others very clearly promoted installations in this field that were included in a document that was part of the master plan—building regulations. For example, for the municipality of Narni, the section of the Master Plan 2001, entitled: "Building and Urban Planning Regulations" [72] includes the following sample requirements:

"1. According to the current planning instrument, the design of buildings in new development areas must include all solutions facilitating energy rationalization and the use of renewable and similar sources.

2. In the concept of integrated energy supply, the same principles apply at the municipal level, for functional areas and at the level of buildings, in relation to individual buildings or their parts, operating both in the design form and in the adopted technologies."

In addition, in the subsequent sections, guidelines on the design and position of buildings are provided to optimize the use of energy recovery in both the active and passive forms. It is declared that before the design stage of roads, buildings, slopes, etc., the sun paths at different times of the year, the shadows created by existing structures on the site or in the vicinity, and by trees must be examined. It is also necessary to determine the direction and intensity of prevailing winds. It is explicitly stated that ensuring optimal access to solar radiation is required for all buildings [72].

Plans made in recent years do not contain restrictions on the location of solar panels. Although plans with such guidelines were adopted earlier, the current legal interpretation does not allow it. An example is the plan for the San Vito al Tagliamento commune, in which photovoltaic panels were allowed for certain zones of the medieval city, provided that they were not visible from public spaces and, in addition, some buildings and areas were excluded from this possibility. A 2018 judgment of the Regional Administrative Court for Friuli Venezia Giulia found that there are no municipal regulatory powers regarding the location of solar PV systems, such as excluding certain areas of the municipal territory from such use or imposing distance restrictions, albeit formally in the exercise of town planning powers [73].

Approaches to spatial planning vary considerably from one European country to another, although at the local level, many similar features can be found in spatial development plans, regardless of the name of the documents adopted. Therefore, it is legitimate to compare the planning records for RES in individual households included in these plans. We observed that European countries with strong traditions of the influence of municipal authorities on local energy and housing issues—namely the Netherlands and Germany—provide clear incentives for the location of RES in residential and service buildings, although existing and planned development areas are equipped with municipal networks. Some provisions are formulated as statements of the importance of these pro-ecological energy sources, others as soft recommendations, provided in the form of postulates, others as a strict obligation. There are practically no restrictions on the use of RES unless they are spatial, but in such cases, specific requirements for applying different types of installations are added. Research has shown that in Germany and the Netherlands, supporting RES through local planning tools is reflected in the scale of application of renewable energy, and, above all, solar systems.

In Italy, on the other hand, there is a significant difference between the content of plans made in different periods and for different provinces. There is no consistent approach to spatial planning in the context of RES. Some plans do not make any reference to RES, while others exhaustively cover the issues of renewable energy and energy efficiency, including the reference of these problems to guidelines for the location of buildings and land development. Such differentiation in the content of plans probably results from considerable disproportions between regions, the lack of up-to-date plans, and the planning system's inefficiency in the context of integrated approaches.

It should be noted here that from the point of view of shaping the spatial order and protection of landscape values, it is justifiable to introduce certain regulations in the field of RES application. Particularly important seem to be regulations that require that all building surfaces can be designed with the possibility of using solar energy. On the other hand, it is essential to require the integration of solar cells and solar collectors into the form and material of the roof covering or to design them as independent, high-quality architectural elements. According to the nature of the site, it may be appropriate to allow the facades to be designed with the possibility of using solar energy, where this is justified in terms of solar orientation.

3.2. The Results of Research on Polish Local Plans in Terms of Arrangements for Renewable Energy Investments for Households

Among the Polish local plans examined, almost half (45.8%) of the plans do not contain any mention of renewable energy, although in accordance with the required regulations, the rules of engineering services, including heating of buildings and electricity supply, are mandatory. In plans enacted before 2003, this approach was, in principle, standard. It was always agreed to supply energy from the power grid, and in terms of heating buildings, to connect to the heating network, if the plans concerned large cities, and in other areas to use local sources. In such cases, the most popular were local boiler plants powered by fuel oil with low sulfur content (0.3%), by electricity, or line gas, which was the most frequently used solution in the case of access to the gas network. There were also plans allowing the use of individual heat sources based on wood and light oil, and even plans allowing solid fuels without any restrictions.

On the other hand, 30.6% of the examined plans contain fragmentary findings in using renewable energy sources, most often in the form of allowing them only for heating houses, but always as a possible alternative. Examples of these provisions are gas, electricity, low sulfur fuel oil, renewable energy sources, or other ecological energy sources that can be used as a source of thermal energy; in the field of thermal energy supply, it is agreed to supply from an own boiler room with the use of heating devices for gas fuel, electricity, fuel oil with low sulfur content (0.3%), and other ecological fuels or renewable heating agents.

A step towards reducing emissions and taking into account alternative energy sources was to include in some plans, from 2003 onwards, prohibitions on the implementation of new heat sources fired with solid fuels and heating oil.

Only 23.6% of the analyzed plans include full provisions regarding the use of renewable energy sources in households. In newer plans, there are clear guidelines for the use of ecological energy carriers—it is recommended to use renewable energy sources, including solar collectors; the supply of electricity from the power grid or individual sources using renewable energy sources is established.

Some provisions are subject to additional restrictions, for example: it is allowed to supply heat from distributed cogeneration sources up to 5 MW; the power supply from the existing power grid plus renewable energy sources is established in the form of micro-installations or small photovoltaic installations with a capacity not exceeding 100 kW. Several plans also prohibit the use of wind energy.

In summary, three recurring types of plans were identified (Figure 6):

1. Plans that do not have any provisions on RES
2. Plans that mention RES only in the context of heat energy
3. Plans that fully address the implementation of RES

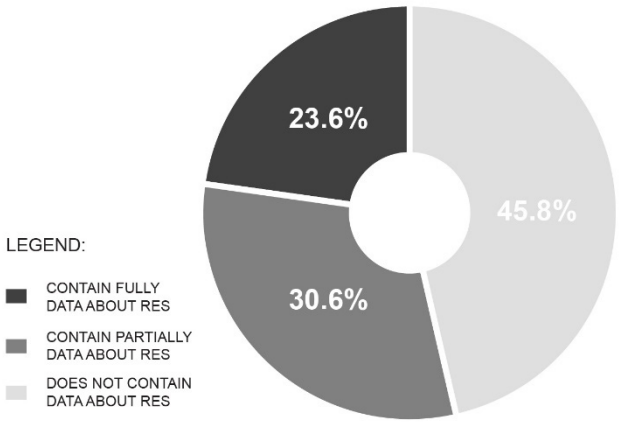

Figure 6. Types of local development plans identified in the research and the scale of their occurrence. Source: own study.

Each type of plan is evidently related to the date it was adopted, at least for the most part, where:

type 1 $\leq$ 2003
type 2 = 2004–2015
type 3 $\geq$ 2016

These changes in time probably resulted from the growing awareness of RES over the years, but also from new technological opportunities and ways of financing these investments. In the conducted research, we focused rather on checking to what extent local plans respond to this situation, thus stimulating its further improvement. The results show that out of 26 plans adopted after 2015, as many as 21 contain complete information on the possibility of using RES (Figure 7).

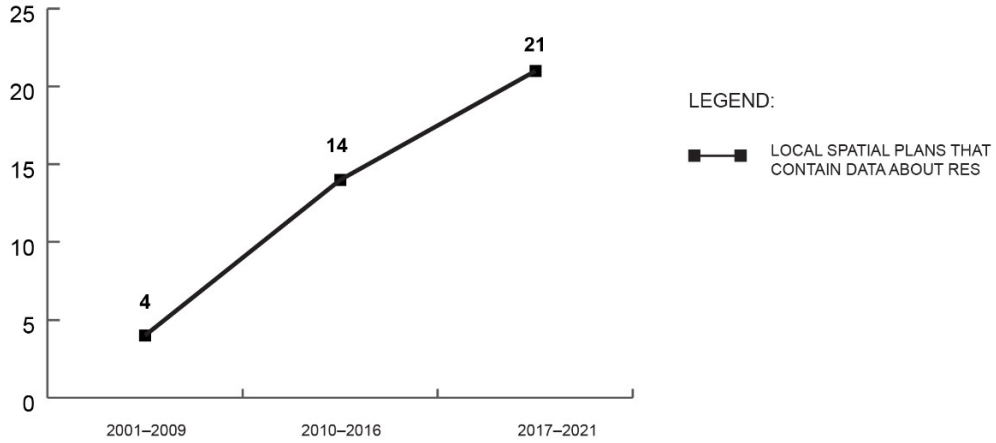

Figure 7. The number of plans containing RES data over time bands. Source: own study.

Considerable differentiation in the approach to the formulation of the plan also results from the location in a community of a certain type and size (Figure 8). The fewest plans containing complete information about RES were adopted in rural areas. This is disadvantageous because these areas are legally not equipped with municipal heating systems, which in the case of obtaining heat energy results in using individual heat sources with high emissivity. On the other hand, extensive power grids in large areas of scattered rural development are energy-intensive. In the largest cities, there is also a relatively large number of plans that do not contain any provisions regarding RES, and the least frequent here also allows RES to heat apartments. It was only after 2015 that plans relating to RES began to prevail.

The studies of the example from Poland show that the quality of planning regulations increases along with the growing interest of households in renewable energy. Both phenomena are mutually related. However, local plans that ignore this subject are still accepted.

Just as in Italy, Polish local plans adopted several (almost 20–30) years ago are not up-to-date, although they are still binding, and the planning system has not kept pace with civilizational changes and public awareness. It is also clear that introducing restrictive obligations in the field of technical equipment and power supply of buildings does not make sense, as changes in this area take place faster than the progress of planning works. Flexible provisions that promote, and therefore permit, specific power sources may be optimal, and such solutions are used in many of the latest local plans. The development of renewable energy investment in households goes hand in hand with improving plans in terms of their application.

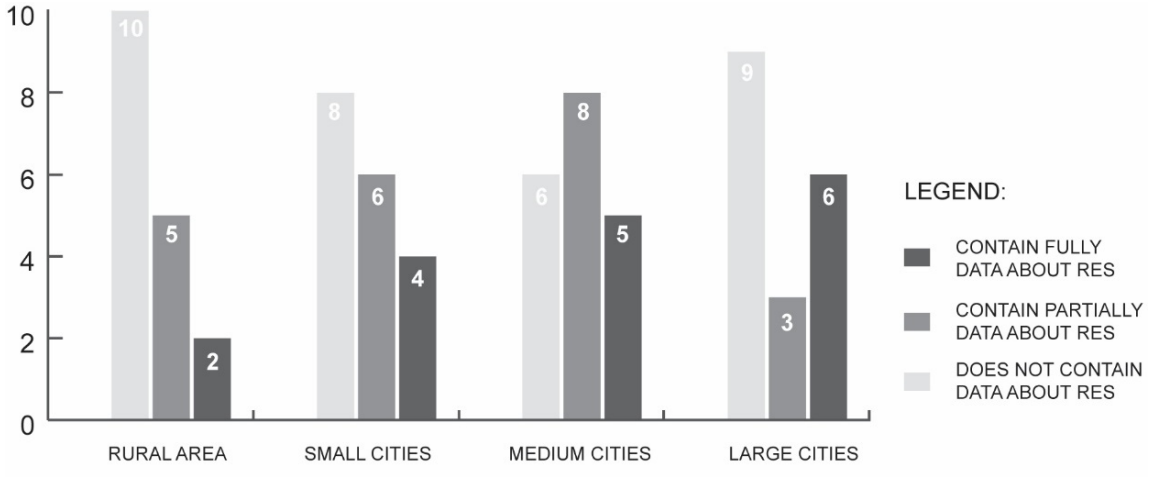

Figure 8. Share of individual identified types of local spatial development plans in communes of different sizes and statuses. Source: own study.

3.3. Threats and Opportunities for the Implementation of Local Spatial Plan Regulations on RES

Renewable energy challenges are multi-scale—from building and micro-installations to cities and regional networks. This is important because macro-scale electricity generation presents itself as an environmentally efficient way of supplying energy that can compensate for the resource scarcity of cities and towns [40]. However, minor investments, such as individual buildings for households, may, in total, generate significant problems or benefits in the field of energy.

The structure of European planning systems proves that local development plans serve to implement spatial policy on the ground and play a prominent role. The conducted case studies, the literature analysis, and the authors' own experience, show the threats to the implementation of spatial policies and local plans, although there are also some opportunities.

One of the new planning tools for supporting investment in RES may be the particular type of development plans—the local and regional revitalization plans. The conversion of already invested land will be one of the most critical challenges of the future [74]. However, the very shaping of the spatial structure of the planned development areas, especially new ones, may contribute to energy savings and the best possible use of renewable energy, according to the area's characteristics. One can even imagine a built environment sustained entirely by renewable energy sources.

The complexity of factors influencing the decisions of investors, developers, housing associations and landlords to adopt or reject sustainable energy technologies cannot be overlooked. This interesting topic is beyond the scope of our research and is the subject of rich research [75–80]. Heiskanen and Matschoss, for example, have identified differences in the legitimacy of renewable energy technologies among European countries. They have proven the dependencies of these differences on expert and professional communities, citizen and social movements, and the media. However, these studies also confirmed that local policies either enable or inhibit the adoption of renewable energy solutions in buildings [81].

Some argue that building regulations alone are not strict enough, although many countries have tightened them to improve the efficiency of heating systems or the insulation levels of buildings. Others believe that excessively strict regulations generate creative ways of avoiding their provisions [38].

Certain countries introduce excessively restrictive regulations on heating methods, which often has negative effects and leads to the rejection of new "green" solutions. Such examples can be found in the analyzed Polish plans. In Denmark (which features strict energy planning), the strict regime in energy planning introduced to promote district

heating as the dominant form of heating is even called "Heat-Planning Stalinism" because of its lack of flexibility over alternative heat sources [38].

Another problem is the lack of adequate local enforcement capacity and the constant regulations changes. This applies, inter alia, to Poland, where the critical problem is the lack of effective planning using available spatial policy tools [23,82–84]. Research has also shown that many binding plans include regulations inconsistent with applicable law and inadequate to current needs, which clearly proves the system's weakness. Even in the Netherlands, which appears to be a leader in introducing green energy solutions, excessively frequent changes to the regulations and the weakness of the enforcement system mean that in practice, little attention is paid to the supervision of Dutch green building projects [38].

A great deal also depends on the stakeholders in the planning processes—the local community, local authorities, officials, entrepreneurs, and planners themselves. It seems that during the process of social participation in creating local plans, the issue of the possibility of using RES is not of primary importance. In the case of local plans prepared in Poland, the owners of land to be transformed for investment purposes rather the least possible number of bans and restrictions, which is confirmed by research [23,85]. From this, it can be concluded that landowners are more willing to accept the admission of various new possibilities for supplying energy and heat to their households than prohibitions on the use of specific sources. There is a significant amount of research on participatory planning in creating local strategic energy planning, which, however, is not the same as the procedure of preparing a local plan [86–89]. This topic is closely related to the repeatedly analyzed, significant issue concerning the possibility of convincing societies to use renewable energy and the methods to achieve this goal [90,91]. The improved knowledge and awareness of each party translates into the activities and attitudes of others. Thus, such activities may indirectly increase interest in the regulations of local plans in the context of provisions on the supply of electricity and heat to households.

Despite the increase in solar and geothermal energy consumption in Poland, the scale of the problem with the energy sector clearly shows the importance of all tools stimulating the transition to "green energy", and local plans may be one of them. The survey conducted in 2019 by Marks-Bielska et al. proves that still more than half of the large group of respondents (52.54%) had never used renewable energy sources [14], and yet the benefits from renewable energy sources are extensive and often featured in scientific publications. In the context of the climate crisis and sustainable development, RES non-emission of harmful substances, their lack of impact on the earth's energy balance, and their wide availability are most often emphasized [14,92–94]. Moreover, the health benefits, energy security and economics of power consumption are often researched and stressed [14,95,96]. On the other hand, the drawbacks of solar energy are, for example, the high cost of installation, seasonality, and problems with storing [14]. Individual heat pumps are expensive installations, and solar panels are not suitable for every type of roof and every location. The state's financial support and proper spatial planning, as well as the provisions of local plans, may assist in minimizing these inconveniences.

Further development of green energy, including in individual households, must be associated with the reconstruction of entire energy systems, and for some countries, it remains a serious challenge [97–100]. In Poland, for example, there is a significant threat to the development of individual solar energy, related to the fact that the electricity infrastructure is not adapted to connecting such a large number of photovoltaic installations. Soon, it may be that it will not be possible to connect these installations to the network in many places, so there will be no point in building them. Even today, energy companies often refuse to connect the planned photovoltaic power plants to the grid due to—as they call it—the lack of "technical conditions". Even already existing photovoltaic installations may experience forced outages in electricity production, for example, when they produce too much of it in relation to current consumption, with increasing frequency. This problem

is so new that it has not yet been scientifically researched, although it has been signaled since mid-2021 in various communications and comments [101].

It is worth emphasizing that all incentives for the use of renewable energy sources by individual households—and in particular solar energy—should be used as long as they are consistent with the policy of the country and the region [102].

This fuller integration will be possible if legislators at various levels also properly include local spatial development plans in this process. Balancing the regulations that may be included in common national regulations, those that will be established as good practices at the local level, and finally, those that should be included in local development plans, is one of the more critical challenges facing energy policy integrated with spatial policy.

4. Conclusions

The scope of the research does not allow the assessment of the scale of local plans' impact on the development of renewable energy in households. However, it enables us to conclude that there is a close correlation between the quality of plans' provisions and trends in the use of RES. Spatial planning is facing several new requirements and challenges, and the creation of local development plans should consider energy policies that include the development of renewable energy investments in households. If local development plans contain provisions promoting RES, then, simultaneously with financial incentives, further growth trends can be stimulated. This research makes it possible to identify gaps and weaknesses in some local plans, while also showing examples of good practices. Hence, we can provide recommendations for local governments responsible for developing and adopting spatial or zoning plans.

Local spatial plans with archaic energy supply arrangements should be changed quickly. Regardless of whether the implementation of RES in a given country is strictly contingent on the arrangements of the plans or whether national or regional regulations regulate it top-down, the fact that outdated plans remain in force leads to legal clutter. It should also not be forgotten that the plans also perform an informative function, so their content should be consistent with the current state of knowledge and awareness of societies.

It seems equally important to introduce strict bans on the use of specific energy sources, such as those contributing to the most significant emissions of exhaust gases. This applies to countries with weak provision of built-up areas with organized power systems, and where the buildings themselves are highly dispersed. This case applies, inter alia, to Poland because solid fuels—mainly hard coal and firewood—are still the most important forms of energy consumption by households, which is an exception in the European Union.

The main message is that the emergence of new opportunities for technological innovation will require innovative approaches to local planning in the future. Local governments should play a facilitating and coordinating role that uses the opportunities created by civilizational and societal changes, weighing the scale of the necessary flexibility of local law and strictness in enforcing pro-ecological solutions.

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