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The Energy Transition from Plant Operators' Perspective—A Behaviorist Approach

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Abstract: The implementation of many small power stations compensates the closing of powerful large power plants as part of the German Energy Transition is compensated. It is unclear how site decisions are made, which actors are involved, and which economic, ecological, and social consequences occur. The quantitative study consists of a written postal survey of renewable energy plant operators, concerning central aspects of project development. The study found strong regional disparities concerning the entrepreneurial behavior of plant operators of renewable energies, a low importance of socio-institutional and socio-cultural parameters, a great relevance of micro-social environment during site planning of renewable energy plants, and that plant operators are highly influenced by economic and individual desires. It may be concluded that the perspectives operators have on the Energy Transitions must be more systematically included into the discourse regarding the sustainable deployment of renewable energies, as they reveal significant disparities with topics that are emphasized by the public (e.g., landscape aesthetic, citizens' participation). It was shown that the challenges and problems that arise in the context of regional energy transformation cannot be generalized beyond regional circumstances; rather, they must be regarded as specific regional phenomena that have to be overcome by means of regionally adapted energy concepts.

Keywords: Energy Transition; plant operator; renewable energies; site factors; socio-institutional embeddedness

1. Introduction

Germany is amid the transition from a fossil-nuclear to a renewable energy system. This transformation is connected to significant spatial consequences, as—in contrast to a centralized energy system, which, by means of a few big plants, is able to ensure the energy supply for large areas—a regenerative energy system is based on the decentral placement of numerous low-performance plants [1,2]. In view of the German withdrawal from the nuclear energy program by year 2022, the seven remaining nuclear plants, whose total installed capacity amounts to 10 GW [3], must be mainly substituted by wind-, solar-, and bioenergy. However, the capacity of only seven present nuclear plants exceeds the total installed biogas capacity (4.2 GW) in Germany, as supplied by 9200 small-scale plants, by the factor 2.4 [4]. Similarly, 29,844 wind energy plants and 1.64 million solar energy plants provide an installed capacity of 56.2 GW and 43 GW, respectively [5,6]; however, due to weather conditions, that capacity cannot be nearly exploited. Taking these facts into account and given the low energy density of renewable energies, it must be expected that the substitution of the fossil-nuclear plants by regenerative technologies will be spatially extensive. Of one year's total 8760 h, the wind and solar energy sites in Germany only have 1750 and 920 full load hours. In contrast, nuclear energy has 7640 full load hours, hence feeding into the grid almost throughout the whole year, which makes it a reliable energy source that can steadily supply large urban or industrial areas. With

6050 and 8000 full load hours, respectively, the biomass and geothermal energy show high values, hence being very important for the stabilization of regenerative energy systems [7] (p. 21), [8].

Apart from weather-dependent shortages, many energy plants are needed, because renewable energies show very low energy densities [9] (p. 6). Presuming a mean power of 2 mega-watt (MW) per wind power plant, 3000–3500 plants would be necessary to replace the energy production of a single nuclear plant that is the size of Gundremmingen C with a power of 1344 MW and an annual energy production of 10.5 terawatt hours (TWh) [10] (p. 17). While wind power plants with greater performance, such as the Enercon E-126 with an installed capacity of 7.58 MW and a greater spatial efficiency, will be able to reduce the spatial requirements for regenerative energy systems [11], their greater heights of up to 200 m will still aggravate the problem of landscape "deformity" [12] (p. 551).

The low energy densities of renewable energies and their weather-dependent volatility, when paired with the withdrawal from the nuclear energy program as well as the continuously very high annual energy consumption per person in Germany of 155 giga-joule (GJ) [13] (p. 59), raise a central question: on which sites and in which regions of Germany is this area-intensive energy transformation taking place? Bridge et al. [14] (pp. 332–334) emphasize that, after having mainly addressed the investment cost of the energy transformation for a long time, public discourse increasingly calls for information regarding the transformation's spatial targets. No industrial sector has ever had to face the question of site selection to this extent—the demand for energy and the spatial organization of its supply concerns every single layer of a society's spatial scale, from the single household to local, regional, and national dimensions or continental and intercontinental networks. Hence, answering the question of site will strongly influence how people will react to infrastructural measures that are taken to promote sustainable societies.

How far site acquisition has kindled discreditation of the Energy Transition has been discussed by numerous studies. The selection of energy-related conflicts in the federal state of Brandenburg, as presented by Becker et al. [15] (p. 52), reveals relevant opposition to renewable energies, especially and increasingly to wind and biogas plants. Besides conflicts on a smaller scale, grid deployment and subterranean carbon dioxide storage are also in the focus of criticism. The actual reasons for the formation of many citizens' initiatives against new technologies are manifold and not only the result of suboptimal site selections. For instance, Van der Horst [16] (p. 2712) points out that there are people who generally object to renewable energies and will, in the sense of a "post-justification", always find new reasons to take action against the Energy Transition. Moreover, there are citizens' attitudes that, while being well-disposed towards renewable energies in general, egoistically react with opposition if being personally afflicted. However, both this so called NIMBY ("Not-In-My-BackYard")-effect and "post-justification" are social exceptions [17] (p. 49). The predominant feature is an objective, environment-focused weighing of cost and benefit that Bell [18] (p. 463) calls "qualified support". Regarding this kind of factual analysis, great influence regarding the acceptance of the Energy Transition must be accredited to the way that operators of renewable plants chose their sites. However, problematically, there are large gaps in the knowledge of the causes of opposition to projects. There are plenty of studies investigating the social acceptance of renewable energies, but most of them focus on the motives of residents [19–21]. However, their reactions are the result of decisions that are made beforehand by the operators of renewable energy plants. Therefore, it seems advisable to ascribe greater importance to these primary decision-makers' perspectives. Yet, studies with a focus on plant operators exist almost only for single technologies and based on qualitative analyses [22], which renders a generalization impossible. A more profound understanding of the way that operators of renewable energies are affected by their milieu, how they in turn actively exert influence on their milieu, and what motives, schemes of thought, values, knowledge, and patterns of behavior these processes are based on, has not yet been obtained. When considering that, since the passing of the Renewable-Energies-Act (REA) in the year 2000, site decisions for projects of biogas, wind power, and solar energy have been made in five-digit quantity [4–6], this lack of insight seems rather problematic. All of the above-mentioned micro-decisions cumulatively result in a highly significant effect on society;

however, little is known regarding that effect's character. Therefore, this study aims at analyzing the behavior of operators of wind and solar energy and biogas plants, and for the first time focusing on the perspective of the operators themselves, based on a regional comparison between the investigated regions Augsburg (Bavaria) and Lausitz-Spreewald (Brandenburg).

Two points were considered: on the one hand, the reasons why operators chose to operate a specific kind of power plant, and on the other hand, why plants are allocated to specific sites. Core motives and patterns of action and thought in this context must be determined. In doing so, the degree of rational orientation by economic parameters and the impact of the embeddedness in socio-cultural and socio-institutional networks are to be explored. It will also be examined to what extent plant operators are exposed to social conflicts, which issues dominate these conflicts, and what actors become the decisive supporters or antagonists, respectively. All of these points will have to be analyzed both regarding the selection process of technology and site as well as the time after the start of the plant's operation. The question of whether a project's conflict potential is to be understood as the result of a deficient consideration of social and ecological contexts or rather of a lack of access to relevant information is another topic of the study. Finally, the operators' attitudes concerning the acceptance of their plants must be investigated. Eventually, the plant operators' point of views needs to be strongly included in the academic discussion, as they are an essential part of the spatial distribution of renewable energy plants.

2. Theory and Methods

2.1. Theoretical Background

An energy-economic comparison of the planning regions Augsburg and Lausitz-Spreewald primarily aim at identifying spatial disparities while also giving special emphasis to the question of site represents the classic approach of economic geography [23]. According to the spatial economic perspective, it would be only about finding out which site preferences operators of renewable energies have and how far spaces are able to satisfy these demands. This paradigm is still strongly present in planning-oriented studies [24–27]. However, these studies focus on restriction analyses and distance calculations only depict the theoretical site patterns that are obtained from profit-maximizing behavior. Even studies that approach the planning of renewable energies with great sensitivity for social aspects [27] (p. 235) end up reducing their analyses to easily quantifiable characteristics of space (e.g., average annual wind speed) as well as spatial distances (e.g., distance to settlements). The complex behavior and the interrelations of operators from a spatial perspective are beyond that approach's methodical range [28]. Yet, behavioral science has taught us that the image of the rationally acting human being is not sufficiently complex; it must be replaced by concepts that likewise accredit economic relevance to individual reflexes, values, abilities, habits, and information [29]. Subjectivity also influences the choice of technology and site [30] (p. 60), with a strong variance especially regarding the ability of obtaining and processing information [31]. Suboptimal entrepreneurial behavior is the rule, not least because of these effects [32]. This explains the fact that surprises Sunak et al. [26] (p. 51) and Höfer et al. [27] (p. 240) as representatives of many other planning-oriented studies when evaluating their findings: that the sites actually used hardly concur with those identified as being optimal according to the authors' conceptions. Therefore, integrating social scientific perspectives seems appropriate, since the deployment of renewable energies is, at the same time, the result of a social construct [20] shaped by the relationships between individuals, operators' consortia, companies, as well as formal and informal institutions [2,33,34].

In this paper, the evolution-economic perspective of socio-institutional embeddedness is of special significance [28]. It emphasizes that economic acting is always embedded in trustful social relationships that needs to be understood as the result of long-term experience [35]. Due to this mechanism, a plant's operator is not an isolated acting individual; rather, he proceeds within an alliance with shared traditions, values, and routines [22]. In this sense, site factors are not fixed quantities, but variable outcomes of repeated negotiation processes that are shaped by power relations [23]. Influencing their environment through their personality and, being part of a territorial network, promoting both solutions and conflicts of energy economy, entrepreneurs become decisive players [36] (p. 96). In his theoretical considerations of economic development, Joseph Alois Schumpeter has already pointed out that the capability of creating innovation is primarily the result of an entrepreneur's willpower and readiness to take risks [37] (pp. 129–130). Yet innovative processes are also linked to specific preconditions of localized production systems as well as the entrepreneurs' socio-institutional embeddedness therein [38]. On the other hand, Faller [22] underlines that a relational perspective does not necessarily provide a sufficient understanding of energy transformation, as long as it only focuses on the role of institutions. Rather, an approach that considers the theory of practices is crucial, which is able to identify those individual and collective practices representing the origin of the institutions. Yet, solely reducing energy regions to the dimension of actions again omits the fact that political and administrative frame conditions largely guide concrete planning processes. For example, the usage of wind energy in Germany is determined by the designation of clearly delimited spatial planning areas [39] (p. 578). Still, the compulsory effect of spatial planning does not necessarily apply to private persons, who have gained great significance in the development of renewable energies as entrepreneurs and decisively influence local energy economy by their individual behavior [40] (p. 129–130).

The analytic dimensions of entrepreneurial behavior that are deduced from these theoretical considerations are diverse: for one, the questions arise as to how far spatial economic approaches are able to explain the economic acting of renewable energies' operators. In this regard, an analysis of the impact of distance-related as well as natural site factors (e.g., transportation costs, energy potential) representing the orientation of entrepreneurial behavior by rational criteria would provide deeper insight. However, the relevance of classical, well quantifiable economic parameters also depends on the actual extent to which operators are both willing and able to obtain and process information (e.g., consultation of energy atlases). Furthermore, it depends on how they are affected by their embeddedness into social interrelations (e.g., micro-social environment, socio-institutional involvement). Besides, what impact is to be attributed to other regional actors and their practices regarding the plant operators' patterns of thought and action must be clarified. The entrepreneurial influence of adjacent operators (e.g., concerning the selection of site and technology) is of special interest, but likewise the influence exerted by licensing authorities, local preservation societies, citizens' initiatives, etc. on the planning and project development of renewable energy plants.

2.2. Methods

The study's methodical foundation consists of a written standardized survey of renewable energy plant operators (Appendix A). The quantitative assessment was directed to any person operating a biogas plant or open space photovoltaic plant (PV) or wind park within the planning regions Augsburg or Lausitz-Spreewald (cf. Figures 1 and 2). The first part of the survey comprised general questions regarding the energy plant, its performance, and the initiator of its implementation. The second part consisted of data about the choice of location, such as the distance between the operator's residence and the location of the power plant, the reasons for the choice of location, how many people were involved in this choice, the perimeter of search for suitable locations, the importance of proximity to the energy plant, actors involved in this process, and location factors that played an important role. The last thematic part contained questions about the choice of plant. The participants were asked to state why they decided to use a biogas, pv, or wind plant, how they acquired information, which aspects played an important role, and estimation about the suitability of the energy plant for the specific chosen location. The survey finished with some personal information about the plant operator. The questions were posed as closed (72%), open (17%), or scale-based questions (11%). In the beginning the surveys were sent out to the plant operators, were they had the possibility to fill it out on paper or electronic. In order to increase the response rate, the plant operators were visited and the survey was filled in together.

The two survey regions were selected because of their strong differences regarding natural and cultural aspects, as well as energy economic structures and aims. This selection makes it possible to perform a regionally nuanced analysis of the deployment of renewable energies. Moreover, attention was given to ascertaining that the case study also covers the historical political contrast between West and East Germany, including the divergent energy political prioritizations that are highly influential within both regions: on the one hand, the emphasis is on nuclear energy, which is low in emissions and hardly perceptible in landscapes, on the other hand, on coal-based electricity, which has high emissions and alters the landscape. Therefore, the two regions' preconditions for the energy system's transformation are utterly different. Their main characteristics are stated below.

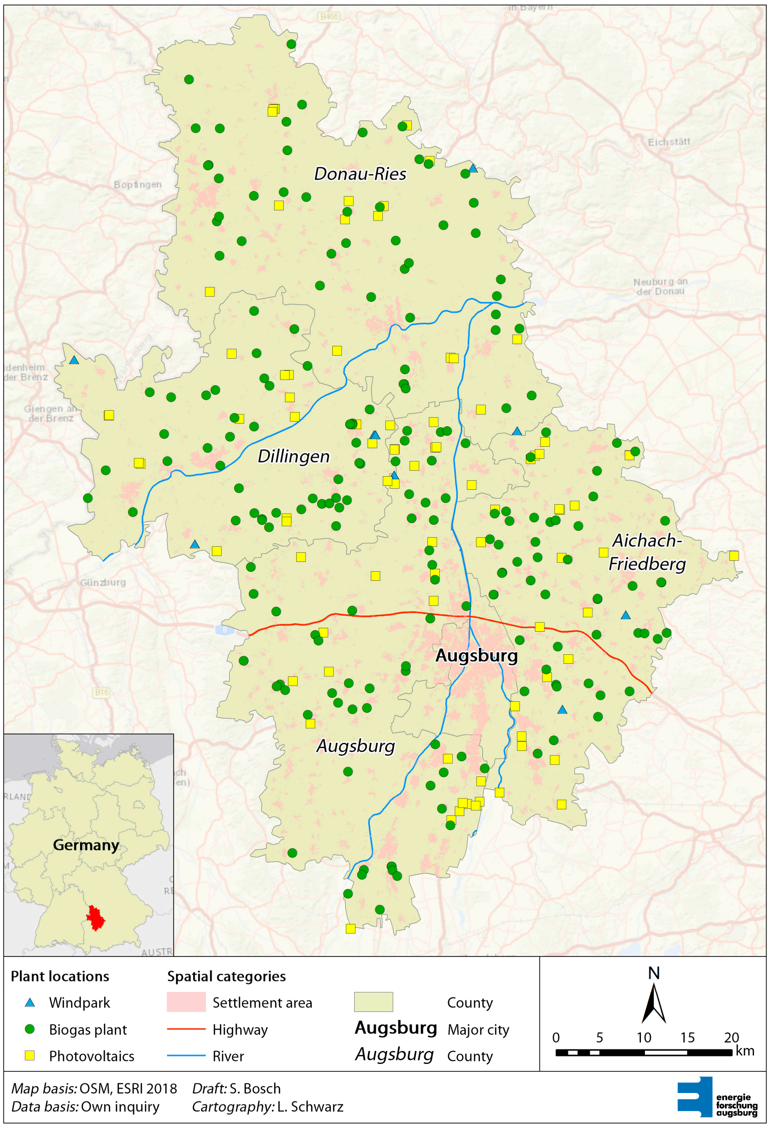

Figure 1. Spatial distribution of renewable energies in the region Augsburg.

The survey region of Augsburg comprises an area of 4066 km^2, hosting 885,000 inhabitants that are distributed to the administrative districts Aichach-Friedberg, Augsburg, Dillingen, Donau-Ries, as well as the independent city Augsburg. Significant for the energy economy are the numerous water power, biogas, and PV-plants; moreover, the region is provided with electricity from the nuclear plant Gundremmingen. Due to the "10 H-Policy", which stipulates very large distances between wind power plants and settlements, wind power plays a subordinate role [41]. The planning region's energy strategy is derived from the overall Bavarian strategy, which intends to enlarge the share of renewable energies within the power production to 70% until 2025 [42].

In the survey area of Lausitz-Spreewald, 597,366 inhabitants live in an area of 7179 km^2, being distributed to the administrative districts Dahme-Spreewald, Elbe-Elster, Oberspreewald-Lausitz, Spree-Neiße, as well as the independent city Cottbus. The Lieberose Heather, which is situated in the north of Cottbus and does not only make a significant contribution to biodiversity, but also hosts Germany's second biggest solar park on a former Soviet military training ground. Apart from renewable energies, the extraction of brown coal strongly shapes the area's energy economy. Brandenburg's Energy Strategy 2030 ascribes a core role to coal-based electricity as bridging technology intended to facilitate the integration of renewable energies, whose percentage of the primary energy consumption should be increased to 32% by 2030 [43,44].

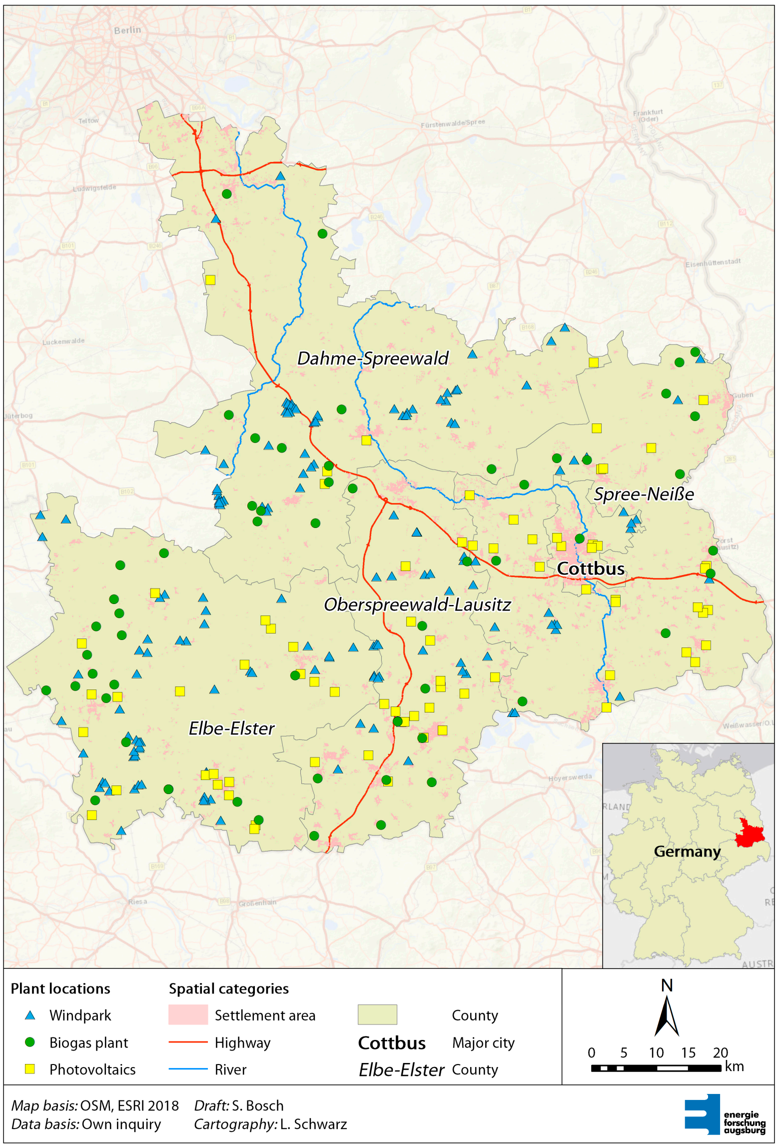

Figure 2. Spatial distribution of renewable energies in the region of Lausitz-Spreewald.

The plants' sites, not the operators' residences, defined the survey areas. Thereby the residences and also the places of interrogation are partly situated outside of the survey areas, as the site of residence and plant do not necessarily correspond. Regarding the analyzed plants, 9.2% of those within the survey area of Augsburg are operated by persons residing outside of the region, and 51.4%

of those within Lausitz-Spreewald. In order to be able to conduct the interrogation, in a first step, every renewable energy plant within the survey areas was exactly identified using digital energy portals and regional Geographic Information Systems (GIS). The main methodological difficulty of the survey was that the identification of the plants' operators—including personal postal data—could not be achieved through official channels: for reasons of data protection, neither the Federal Network Agency, nor the federal and regional associations of renewable energies would hand out that information. Still, we succeeded in obtaining a solid data basis. The starting point was the plant cadaster, which, while being almost completely without attributes, at least provides information regarding the exact sites of wind power, biogas, and ground-mounted PV-plants. These coordinates are not linked to address data, but, if ever, to strongly generalized information of low significance, e.g., the plant's capacity or annual power production. Proceeding from this plant cadaster, the strategy was to gain access to further information and lastly to the address data by the use of cross-connections, such as regional newspaper reports, the communities' homepages, internet articles by citizens' initiatives, business registers, experience reports, personal regional knowledge, telephone calls, and so on. The internet and phone-based research that has been conducted for this purpose made it possible to find out most of the addresses, thus allowing for a written postal conduct of the survey. Next, an eight-page questionnaire consisting of 53 questions concerning the above-mentioned topics was sent to the operators. Simultaneously, a phone campaign was launched informing the recipients of the survey's purpose and motivating them to participate.

The study population is made up of all the operators running a wind park, a PV-plant, or a biogas plant within the planning region Augsburg or Lausitz-Spreewald. For the overall survey area, the study population counts 586 plant operators, of which there are 164 wind park operators, 169 operators of PV-plants, and 253 biogas plant operators. The actual number of plants is a little higher, as several wind power plants forming the entrepreneurial unit of a wind park were pooled as one operator's site. In total, a response rate of 23% was achieved. Accordingly, the sample size is $n = 135$. In interpreting the findings, one must consider that the response rate was the highest for biogas plant operators and the lowest for those of wind power plants. The first are significantly more frequent in Augsburg, the latter in Lausitz-Spreewald.

In the course of data evaluation, as presented below, a general overview of each specific topic is followed by an analysis aimed at two different aspects: On the one hand, a trans-regional overall examination of data concerning the operators' behavior regarding project aims, information acquisition, selection of technology and site, site search area, duration of search, and conflicts, while differentiating the analysis for the respective kinds of technology (biogas, wind power, PV). On the other hand, the data are analyzed regarding their regional differentiation to be able to identify potential region-specific influences on the operators' behavior. Due to the amount of data, the empirical-analytical part of the study focuses on prominent phenomena, such as major divergences that are specific for a technology or region.

3. Results – Empirical Findings on Entrepreneurial Behavior

In order to better understand the entrepreneurial behavior of renewable energy operators within the selected survey areas, their project aims and access to information, their central factors for the selection of technology and site, the size of their search areas, the duration of the search processes, as well as their relationship with other local actors are examined.

3.1. Project Aims

The analysis of the project aims (cf. Figure 3) offers an insight into the operators' specific system of motivation, as well as personal and societal values. It turns out that profitability is given top priority, but personal entrepreneurial passion, as well as minimizing production, cost are also highly relevant for a large part of the respondents. Moreover, 73.4% of the operators state the importance of their plant being able to feed energy into the electricity or heat grids for many hours during the year (full load hours) and 54.8% of the respondents want this to be possible without restrictions depending on weather conditions (baseload capability). Almost two-thirds of the operators try to optimize their projects regarding spatial efficiency, nature protection, as well as regional value added. Long-term aims that are relevant for society, such as intergenerational fairness and dismantling capacity, are not given much thought. Furthermore, it is remarkable that landscape aesthetic is considered by only about one-third of the operators. This is surprising insofar as in recent years, the topic of the renewable energies' impact on landscape appearance has dominated the discussions regarding the compatibility of the Energy Transition, strongly restricting the Transition's spatial options [45–48]. It was even more surprising that civic participation is given the least importance by plant operators. After all, participation is regarded as a core agent for the improvement of the Energy Transition's acceptance [34,49,50].

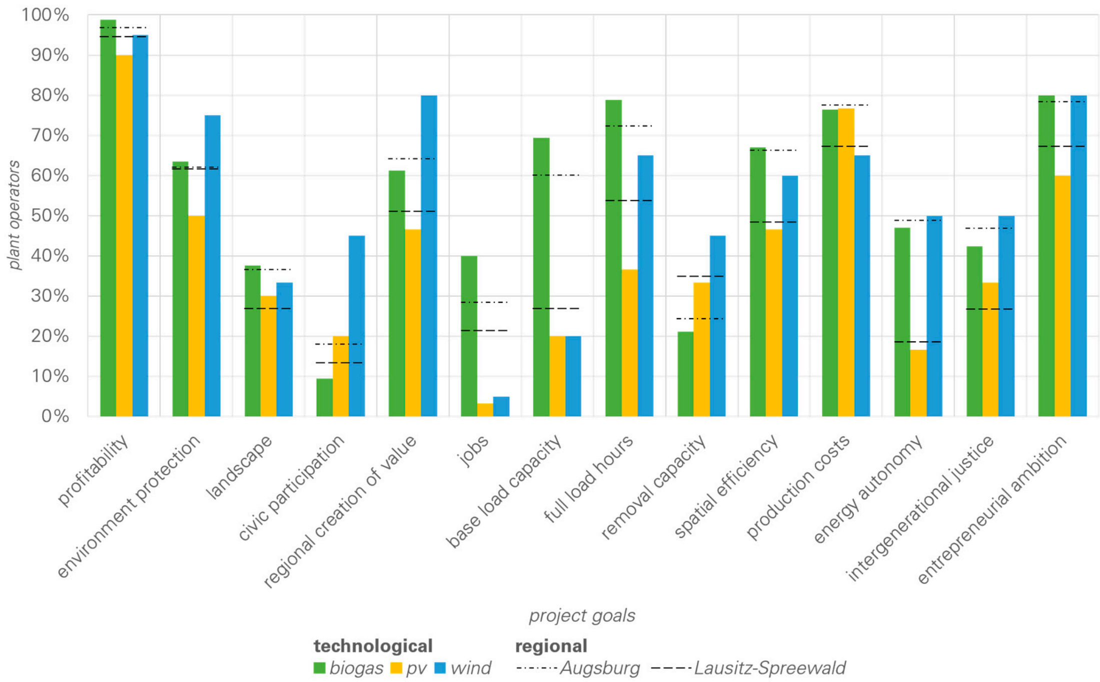

Figure 3. Relevance of Project Goals (n = 135).

In analyzing the operators´ specific project aims, it becomes apparent that the operators of wind energy place more value than average on nature protection and regional value creation, while operators of biogas plants are rather motivated by economic aims: base load capability, full load hours, and profitability. The interregional comparison shows that the operators from Augsburg have a wider range of aims than those from Lausitz-Spreewald, while placing much greater emphasis on base load capability, energy autonomy, spatial efficiency, and intergenerational fairness. It is also interesting that, in Augsburg, more than half of the operators classify civic participation as an irrelevant project aim.

3.2. Information Acquisition

How far project aims can be achieved does not least depend on the kind of information that potential operators of renewable energy plants possess (cf. Figure 4). According to Pred [31], entrepreneurs can be overburdened with the acquisition and processing of information, thus making suboptimal decisions. Especially with smaller companies, the level of information on site conditions decreases with growing distance to the operator's own daily area of action [51]. The survey at hand reveals that operators usually make use of several sources of information. Regardless of the energy technology, personal contact with existent operators of the same respective kind of energy, as well as contacts in the form of talks and discussions, had the greatest importance (Figure 4). Concerning this, Faller [22] stresses the fact that biogas operators very much appreciate direct contact with other, technologically experienced biogas operators as sources of knowledge with great relevance for practice, according to the principle of 'learning by interacting'. Hence, spatial proximity plays an important role in information acquisition.

Exhibitions as well as informative events concerning renewable energies have relatively high relevance for operators of biogas and wind energy plants. In contrast, PV plant operators inform themselves much less thoroughly and make much less use of brochures than those of other energy forms. The usage of the internet as a source of information is limited, with wind energy operators most frequently employing this medium (e.g., digital energy portals). Likewise, the interest in scientific papers is moderate. So far, only wind plant operators pay substantial attention to the academic perspective. Television and radio are practically irrelevant. From a regional point of view, it must be highlighted that informative events play a much bigger role in Augsburg, while in Lausitz-Spreewald, the contact with operators of other energy technologies is appreciated a lot more.

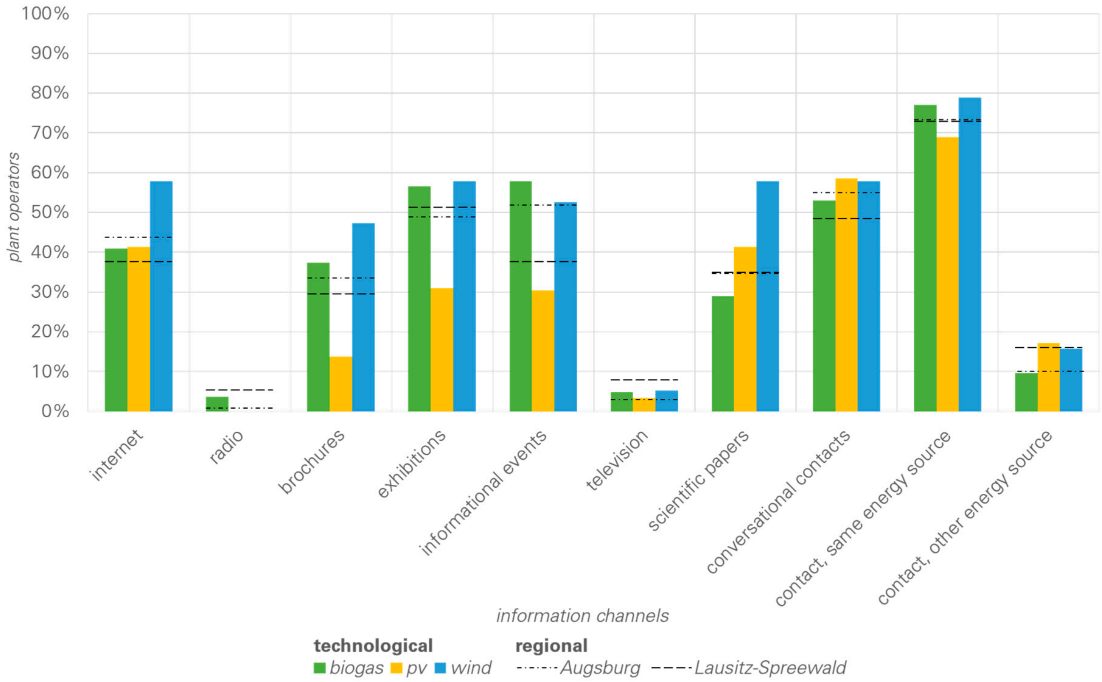

Figure 4. Relevance of information channels (n = 135).

A statistically relevant correlation of the operators' level of information and their satisfaction with their plant's project planning could not be ascertained. Moreover, no definite link between the form of information acquisition and the conflict potential of projects could be discerned. This may be regarded as a hint that the relevance of information must be primarily interpreted in the context of the respective local circumstances.

3.3. Technology and Site Related Factors

The most important factor regarding technology selection is the energy potential, which includes the size of the technology-specific natural potential (theoretical potential) as well as its technical exploitability (technical potential). The size of the subvention that is to be obtained by the REA is in second place. It seems plausible that the decision for one certain technology is primarily influenced by the potential to be unlocked and by the size of subventions. Yet, it would be wrong to deduce that operators make largely rational decisions: personal preferences play a decisive role for 61.3% of the sample. It is also remarkable that only 36.6% of the operators regard social acceptance is regarded as important. This is surprising as the factor acceptance is known to be a requirement of successful planning [20]. Being accredited with relevance by only 8.9% of the operators, possible impacts on the appearance of the landscape, which are closely related to a technology's acceptance, have even lesser meaning. This fact supports Cowell's [52] (p. 223) assessment, who pointed out that the energy transformation's quality regarding landscape is not given enough credit when choosing a technology. Similarly, only 11.6% regard the socio-institutional environment—the Chambers of Industry and Commerce, energy agencies, professional associations, plant operators—as well as the embeddedness in networks and production systems to be relevant.

For operators of biogas plants, the subvention by the REA is the main factor, being closely followed by the technology specific potential (cf. Figure 5). In contrast to operators of other energy carriers, those of bio gas plants also regard both, transportation costs, and the proximity to ancillary enterprises, as rather important. With photovoltaics, the personal preferences make up the most important technology factor. However, energy potential and subventions are also highly relevant for solar plant operators. Regarding the technology factor landscape appearance, photovoltaics rank far above average, although with a low percentage. This may be explained by photovoltaics being well integrable into the landscape, hence being considered as a suitable technological choice for sensitive landscapes [53] (p. 1251). In consequence, it is not surprising that the impact on the landscape plays almost no role with wind energy: after all, wind power plants gravely alter the appearance of landscape due to physical principles that require the towers to be of great height, so that this technology cannot be an option if landscape integration is a high priority. What is more, there is juridical talk of 'disfigurement' with regard to wind energy [54] (p. 525). The main factors for operators of wind power plants are energy potential, subventions, and—only in third place, but still at 72.2%—personal preferences. Moreover, with wind energy, acceptance was most frequently regarded as a significant factor for the selection of technology. A positive effect on acceptance is expected when operating wind power plants, which may be due to several quantitative studies attesting wide social approval to wind energy [55], although Aitken [56] considers the underlying methodical approaches to be deficient.

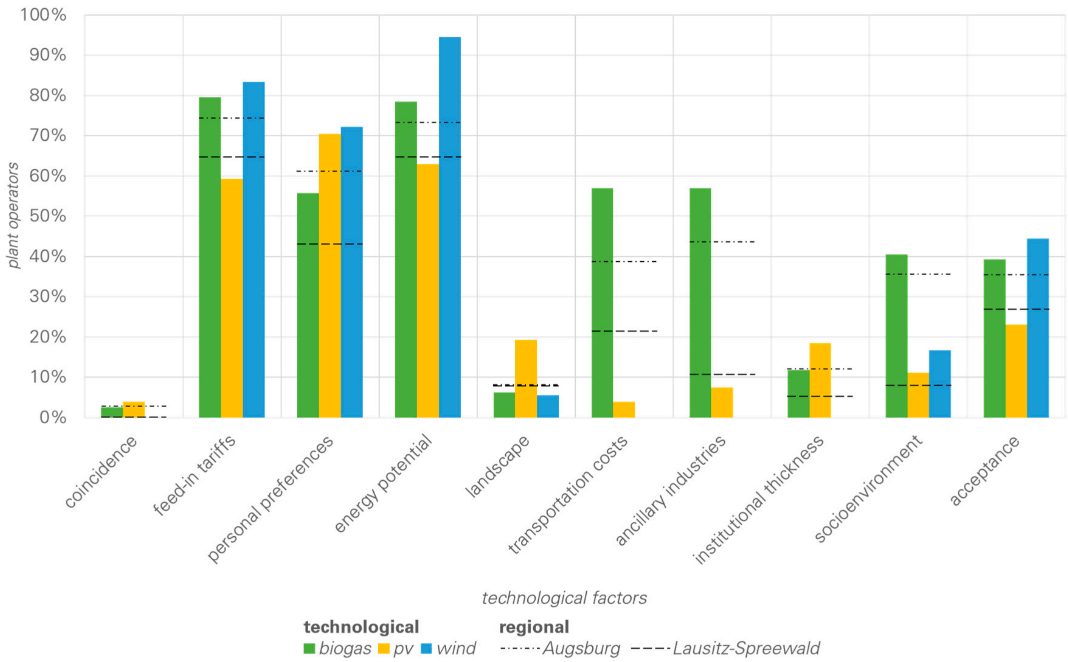

Figure 5. Relevance of technological factors (n = 135).

As to the regional importance of factors of technology selection, personal preferences and the social environment have greater meaning in Augsburg. However, economic factors, such as energy potential and subventions, are also considered. Transportation costs and ancillary networks play a much bigger role than in the case of Lausitz-Spreewald.

Apart from technological factors that are listed in the questionnaire, other aspects may play a role; the option of extending the pool of factors was offered to the operators. 27 times, biogas operators pointed out the advantage of their chosen technology's ability to be integrated into the closed material cycle of an agricultural holding, while also serving as waste recycling. Next to this, it was stated that biogas made it possible to diversify an agricultural enterprise's income thirteen times. Given the low and highly volatile producer prices in the food and animal feedstuff production sector, this opens a lucrative alternative of earnings for farmers. Few (four) operators of biogas plants additionally stated that the generous subventions that are offered by the REA decisively influenced their technology selection. Operators of PV plants stressed the great importance of profitability as well as its dependence on the local conditions of irradiance nine times. Four operators also said that they chose photovoltaics because they owned suitable areas. Furthermore, photovoltaics' low demand for space was named as a decisive factor twice. With wind energy, there were no clusters of answers; rather, the operators had a great variety of motives: spatial efficiency, profitability, but also specific knowledge of wind energy technology, personal conviction, advantageous regional area designations, as well as the suitability of sites were mentioned.

Besides choosing a certain technology, the operators must decide which site is suitable and what factors must be considered regarding site selection (cf. Figure 6). In general, the most important site factor is energy potential, which is in congruence with potential analyses for renewable energies that most heavily weight this factor [27] (p. 233). Considered by 59% of the sample, transportation costs (transportation of energetic and non-energetic materials) are in second place. However, regarding these, the various technologies remarkably diverge. Personal preferences are not quite as important in the context of siting as it is the case with technology selection. Nevertheless, in contrast to choosing a technology, the operators attribute greater significance to acceptance when choosing a site.

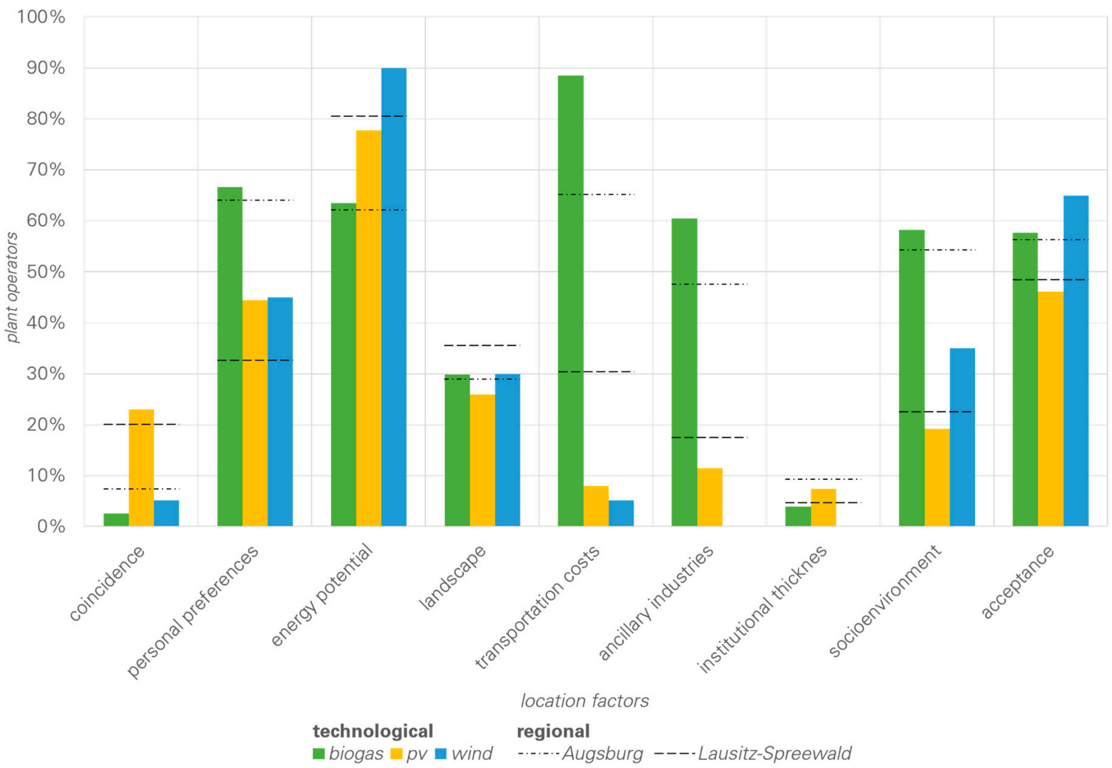

Figure 6. Relevance of location factors (n = 135).

It is also interesting that the social environment is more often taken into consideration when it comes to deciding on a site than a technology. Kumar et al. [57] (p. 600) has already highlighted the prominent influence of the micro-social environment on the entrepreneurial decision for a site.

Today, the regenerative energy sector confirms that the link between the site of an enterprise and the entrepreneur's place of living is very strong. This may be explained by the fact that integration into landscape, and thereby acceptance, may be greatly improved by considerate siting [58]. Very little importance is ascribed to the institutional environment, quite contrary to the importance of networking with local and regional ancillary enterprises, although the significance of the two latter aspects strongly depends on the given technology.

If differentiated by the type of plant, the data reveal that the central factor of siting for biogas plants are transportation costs, while for photovoltaics as well as wind energy, the respective energy potentials are essential (Figure 6). The fact that, according to the findings of this study, the transportation costs play a minor role for wind energy, differs from Höfer's et. al. [27] (pp. 229–230) model assumptions, which accredit great relevance to this factor. Apart from that, ancillary enterprises play a major role in the biogas sector, a smaller one for photovoltaics, and none for wind energy. Faller [22] confirms that biogas operators strive for proximity to specialized service enterprises that, for example, can conduct the permanently necessary maintenance work. In contrast, wind energy operators are more interested in acceptance. The choices of site made by photovoltaics operators are again characterized by coincidence playing an above-average part, which meets with the above-mentioned finding of an access to information below average with PV plant operators.

The regional comparison shows that subjective aspects have much greater influence in Augsburg. Here, the social environment is a crucial factor for siting for 55% of the operators; for 69%, personal preferences are decisive. According to the greater prevalence of the biogas technology (Figure 1), the site factors transportation costs, as well as ancillary enterprises, are highly relevant in Augsburg. Contrarily, in Lausitz-Spreewald, more emphasis is put on the sites' energy potential and landscape integration. The slightly higher importance of landscape appearance can be explained by the stronger deployment of supraregional visible wind power plants (cf. Figure 2).

Apart from the site factors that are given by the questionnaire, the operators had the possibility to name additional factors. For biogas operators, it became apparent that ownership of land and simultaneously the operator's own agricultural holding's vicinity to these areas are highly important (89 statements). Moreover, the opportunity of heat usage and the associated necessity of the proximity of residential buildings, stables, and biogas plant was pointed out 47 times. Few statements regarded the infrastructural features of the site, its accessibility in the case of technical malfunction, local value creation, short hauls, as well as the lack of alternative sites. With photovoltaics, the importance of land ownership was highlighted 17 times; seven statements mentioned the availability of suitable areas. Other statements dealt with specific subventions, as well as acceptance of the respective sites. In the case of wind energy, the relevance of average annual wind speed and the corresponding site-specific yield was mentioned. Besides, the central role of site designation on the part of spatial and regional planning was specified. Seven wind energy operators named idealism as their essential motive, which was to be understood as the support for sustainably acting communities, as well as the valorization of endogenous local potentials.

3.4. Site Search and Duration

Furthermore, how large areas of site search for renewable energies was analyzed, what motives are behind the respective degree of spatial flexibility, and how far the size of search areas can be taken as the result of other operators' site search behavior. To do so, the operators were asked to give the distance between the sites of their plant and their residence (cf. Figure 7). It is striking that the biogas plants are hardly ever further than one kilometer away from their operators' residence, which is not at all true with photovoltaics that showed a great variety of distances. For wind energy, the distance varies greatly, while it is rarely below one kilometer and above average over 50 km. After all, extraregional entrepreneurs operated 80.8% of the wind energy plants that were analyzed in Lausitz-Spreewald and 60% of those in Augsburg.

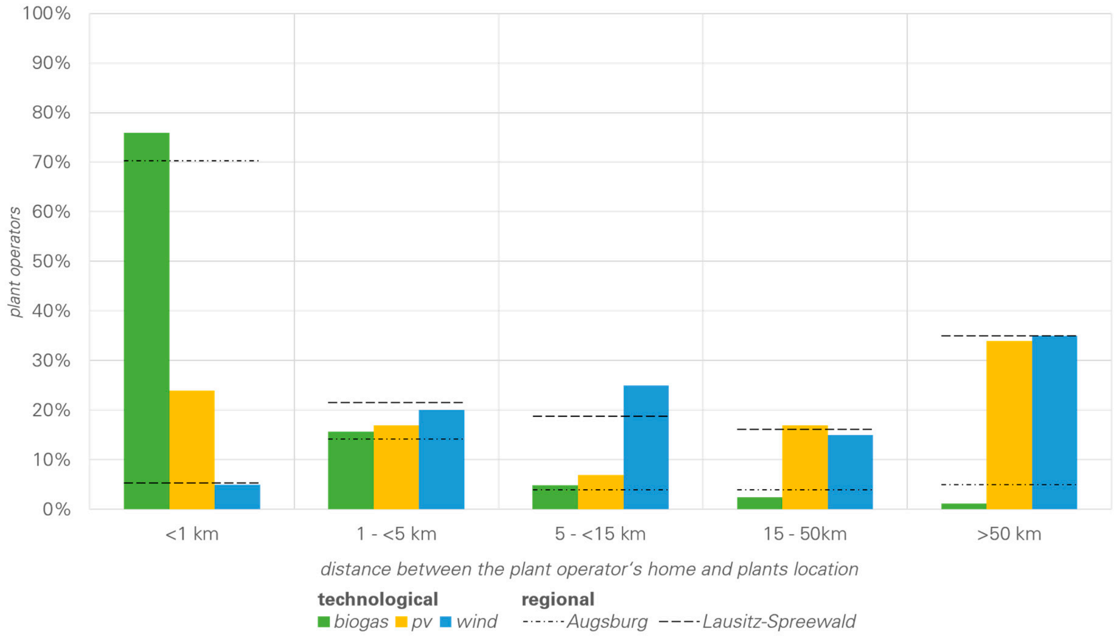

Figure 7. Distance between site of residence and plant (n = 135).

These findings are congruent with the operators' statements regarding the importance of the plants' and residence's proximity. For 60% of the biogas plant operators, proximity is extremely important, for a quarter of them, it is very important. 46.6% of PV-operators take proximity as an important characteristic, 30% not at all. With wind energy, the assessments are distributed relatively homogeneous. This might be explained by the fact that the investigated wind power plants are operated by a greater variety of ownership forms: it is assumed that smaller enterprises have a stronger spatial relatedness, whereas bigger consortia approach project planning with a higher degree of spatially detached professionalism. This is supported by the survey, since both, regarding the potentially conceivable and factual site search area and regarding the chosen distance between the site of the plant and the residential site, smaller businesses show smaller spaces of action and vice versa— with both correlations being statistically highly significant. Moreover, it was found that smaller-scale operators hold proximity to be more important than larger-scale operators. Here, the influence of the micro-social environment again takes effect [57], leading to small site search areas with small enterprises. Additionally, the limitations of time, information, and financial means must be considered [59] (p. 78), which, according to Bathelt and Glückler [23], considerably aggravate the smaller companies' risk of making wrong decisions. Despite the high estimation of spatial closeness, there is no statistically significant correlation between the distance to the plant and the operators' satisfaction with their projects.

The regional comparison clearly shows that the average distance between the residence and plant site is much smaller in Augsburg. Most of the operators live in the plant's immediate vicinity. Quite in contrast, more than half of the sample from Lausitz-Spreewald live at least 15 km away from the plant's site, about one-third is even further than 50 km away. This great regional difference can be explained by biogas plants, which are usually closely linked to agricultural holdings, being much more frequent in Augsburg. Contrarily, wind energy operators, who are characterized by a higher spatial flexibility, are more common in Lausitz-Spreewald. These facts are reflected by the maximum size of the site search, being: 85% of the operators in Augsburg did not look for suitable sites further away than 5 km from their residence, while this was true for only 31% in Lausitz-Spreewald. In the latter region, 20% even conducted their search for an appropriate site within a radius of up to 1000 km, which only 5% did in Augsburg. These findings are congruent with the operators' statements concerning the importance of proximity, which is regarded as being more essential by Augsburg's operators.

The ousting processes did not play a relevant role in site acquisition, as only 2% of the sample stated they had to concede their favored site to a competing bidder. Generally, the behavior of other operators did not have great influence. Only 13% adjusted their choice of site to existent sites of those operators while using the same technology: 10% strove for proximity to those sites and 3% were careful to keep a distance to them. The position relative to sites of other energy technologies than the operator's own was taken into consideration by only 3%, with 2% emphasizing spatial closeness, 1% greater interspaces to these other sites.

Regarding the duration of processes of site selection, it can be stated that the choices of site are made quickly (cf. Figure 8). Irrespective of the form of technology, most of the operators did not need more than three months to settle for a site. When differentiating between technologies, it is striking that biogas operators make their decisions a lot faster than others and that the selection process lasted longer than one year in none of the investigated cases. In contrast, there are wind energy and photovoltaics operators who took up to two years to select their site. There is no distinct correlation between the duration of the site selection process and the number of people partaking in the process. Still, it is striking that none of the cases in which more than ten persons participated took more than three months to choose a site, while there are cases of much smaller groups needing much more time.

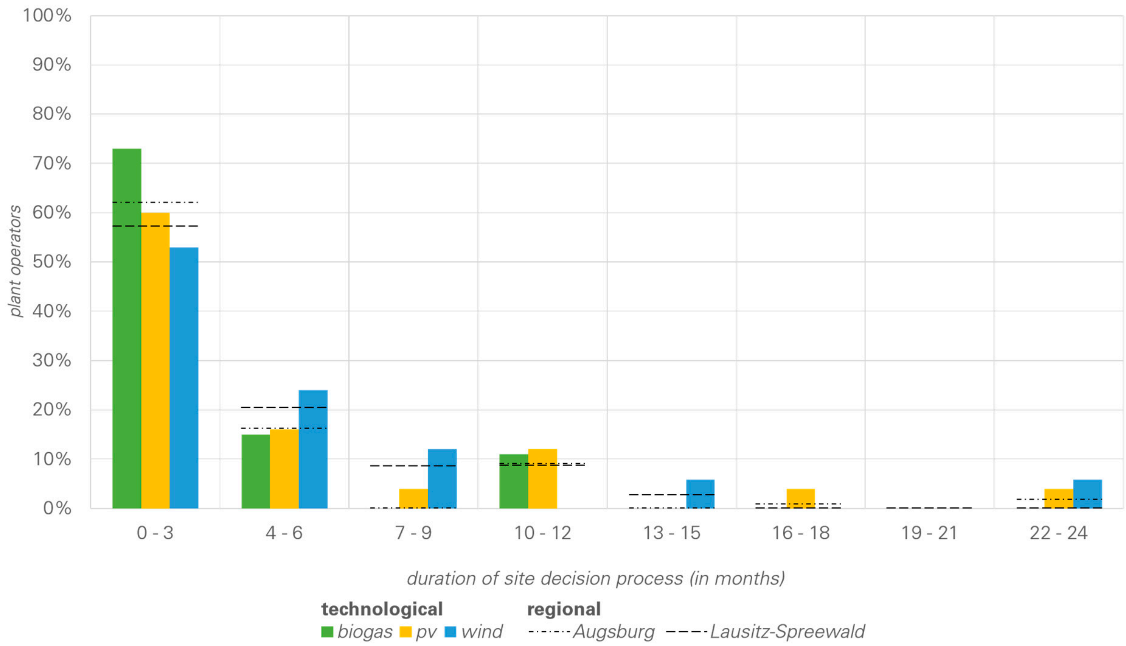

Figure 8. Duration of site selection processes (n = 135).

The fact that the average site search area in Lausitz-Spreewald is larger may be an explanation for the average time that is needed to select a site being longer in that region. Larger search areas aggravate the complexity of decisions due to a bigger amount of information, demanding more time in order to process it. However, closer analysis reveals that the correlation between the size of the site search area and the time needed to select a site is very weak.

3.5. Challenges and Actors

In a last step, it was analyzed what difficulties occur before and after site selection and how far this must be put into the specific context of the players that are involved in the process of choosing a site. Regarding site search, it must be stated that licensing procedures most frequently hamper operators. Nature protection impeded the selection process for 37% of the operators. Hardly any significance in this context was ascribed to touristic questions as well as to the access to information that is relevant for decision-making.

In the course of site search, wind energy is confronted with the most difficulties of every problem category (cf. Figure 9). The domains acceptance, species protection, spatial planning, and grid access stand out. Especially concerning wind energy's grid access, there is dissent in scientific literature regarding its exact relevance, as the maximum distances recommended vary between 2000 m and 20,000 m [60,61]. This illustrates how difficult the determination, even of a well quantifiable factor, can be. Site selection processes of biogas operators are least impeded. As in Lausitz-Spreewald, wind energy is much more frequent, and biogas is much less common, with difficulties during processes of site selection being notably greater in that region.

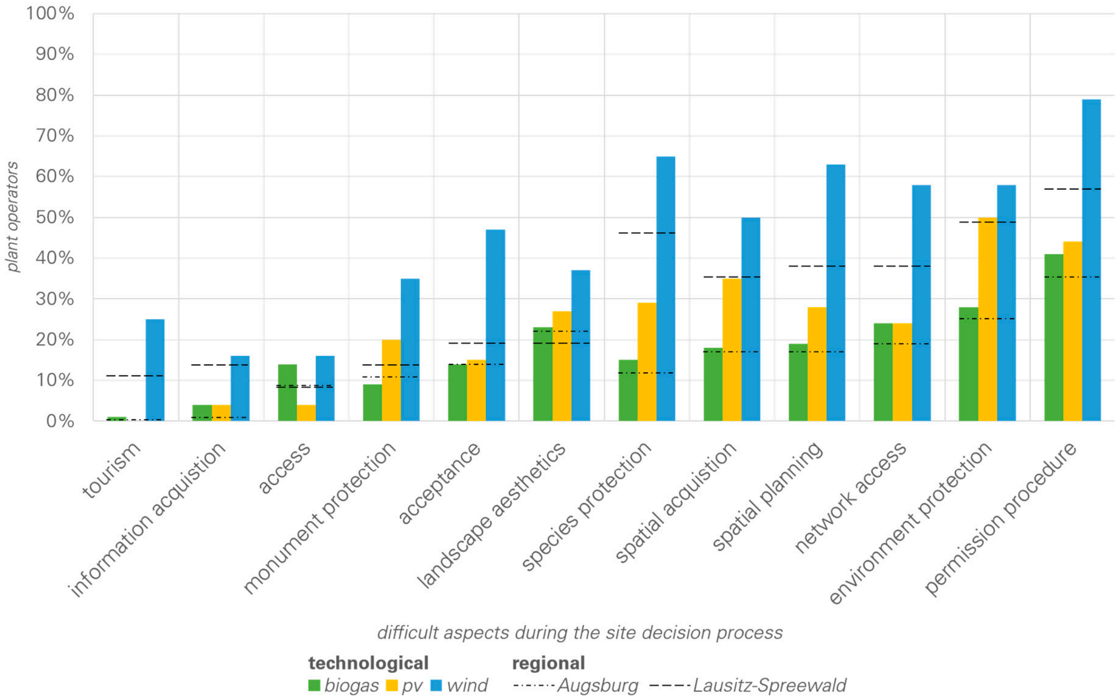

Figure 9. Difficulties during the site selection processes (n =135).

The analysis of the decisive actors as well as their interrelations shows that the respective plant operators are embedded in various social contexts, from which multiple opportunities and conflicts arise. The most important actors that plant operators are confronted with in both positive and negative sense are representatives of communal administration and nature protection (cf. Figure 10). Citizens' initiatives acting as actors do so rather as opponents than as supporters of energy projects. While taking the specific influence of single actors into account, it can be stated that touristic aspects frequently hamper those site selection processes in which the protection of historical monuments strongly influences project planning. Road access to the plant is made difficult for those operators that are affected by local preservation societies. Moreover, local heritage preservation has the most influence whenever the aspects of landscape aesthetic are rendered problematic in the course of site selection. Licensing procedures are regarded as difficult if citizens' initiatives that are in favor of the renewable energy plant, as well as species and nature protection, are strongly involved.

In view of the numerous difficulties with site selection from the operators' perspective, the question arises as to what conflicts have resulted and what intensity these have reached. 52% of the sample had hardly any conflict. For 43% of the biogas operators, 37% of the PV-operators, and 5% of the wind energy operators, there were no spatial conflicts at all. However, one-fifth of the sample said that site search was severely hampered by conflicts. This is mainly true for wind energy—one-fourth of the operators faced severe and 15% very severe conflicts. 80% of the wind energy operators had to deal with conflicts of medium severity during site search, while only 3.7% of the PV-operators and 3.8% of the biogas operators were exposed to very severe conflicts. In this context, which actors strongly influence the processes of decision-making if these are or are not conflict-laden was also analyzed. In 68% of the rather conflict-laden projects, nature protection exerts strong influence. Another major position is taken up by communal authorities with a percentage of 64%. Species protection and opposing citizens' initiatives are prominently involved in 40% of the conflicts. Strikingly, projects that are less conflict-laden are much less influenced by external players. If there is any influence on them, then it is exerted by communal authorities.

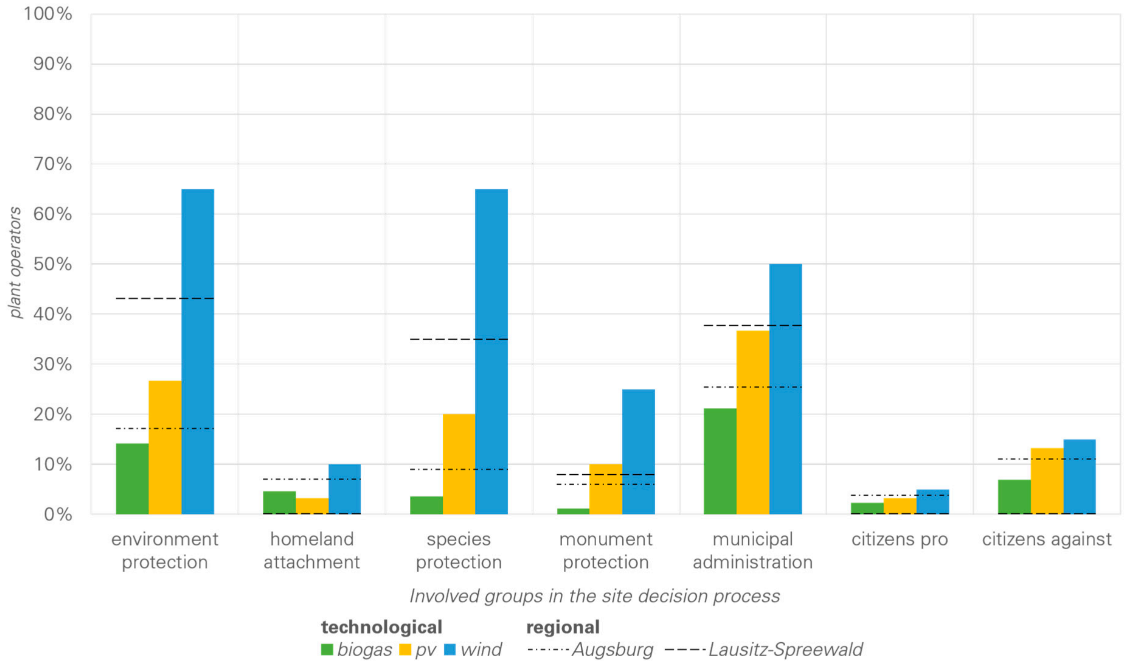

Figure 10. Involved actors (n = 135).

After site selection has been completed and the plant is operational, operators are still confronted with various problems at the site (cf. Figure 11). Grid access and profitability are shown to pose the biggest challenges. However, it also remains challenging to deal with difficulties regarding acceptance, sound emission, transportation traffic volume, and area consumption. Ecological problems play a minor role in comparison. It becomes apparent that operators of wind energy plants are facing the most, and operators of PV plants the least, problems at their respective sites. By far the most prominent challenges in the wind energy sector are grid access, profitability, climate balance, acceptance, competition, as well as ground erosion and compaction. Those problems of wind energy strongly that are addressed by the scientific discourse—concerning landscape appearance [47,62,63], sound emissions [64,65], biodiversity [66–68], and transportation [69,70]—are perceived to be less acute by the operators themselves. Area consumption is no longer thematized at all once the site has been chosen. Biogas operators are facing above-average problems with transportation traffic volume, sound emissions, area consumption, landscape appearance, and eutrophication. Surprisingly, ground compaction and soil erosion—phenomena that agriculture is often accused with [71]—are irrelevant. PV-operators, who are confronted with few problems at their sites, only rank above average regarding biodiversity.

From a regional perspective, the problems are bigger in Lausitz-Spreewald, not only concerning site selection, but also after the start of the plants' operation. Especially regarding grid access and profitability, there are very big problems in Lausitz-Spreewald; moreover, the region manifests comparatively bad values regarding soil degradation, biodiversity, and climate balance. Augsburg's bigger difficulties comprise area consumption, sound emissions, eutrophication, as well as transportation traffic volume.

Despite the numerous problems, most of the operators rank the suitability of their plant's site as very high and are also content with their projects, while both aspects are marked more positively in Augsburg. Yet, when asked whether initiating further energy projects is an option, operators from Lausitz-Spreewald display greater enthusiasm: 59% affirmed this and said that they would choose the same energy carrier again. In Augsburg, only 17% would consider doing so and 50% do not want to initiate any further project at all, which is true for only 17% in Lausitz-Spreewald. However, regarding their plant's profitability operators from Augsburg are more satisfied: 27% stated that profitability exceeded their expectations. In Lausitz-Spreewald, only 11% shared that opinion, while 22% are disappointed with the economic outcome, as opposed to only 14% in Augsburg. Yet, for most operators from both regions, the overall economic yield is within the scope of prediction during project planning.

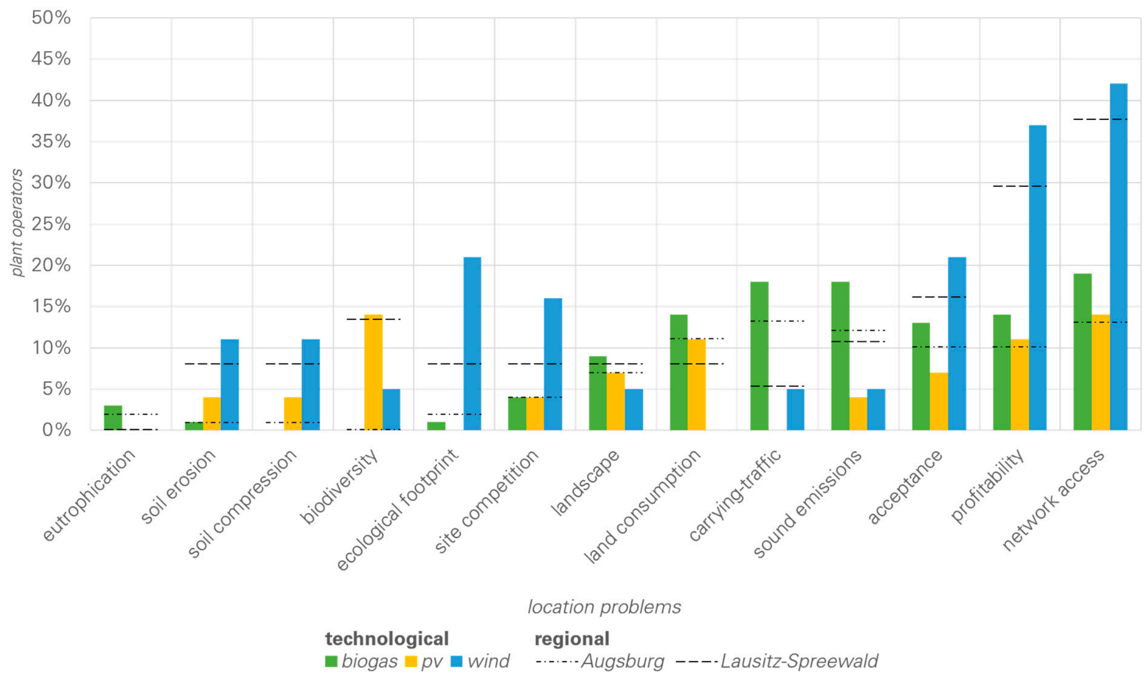

Figure 11. Location problems after start of operation (n = 135).

3.6. Acceptance

It is remarkable that, according to the operators, acceptance from the public increased with time, i.e., from the beginning of the plants' planning processes until the start of their operation. This supports the empirical evaluation that was presented by Warren et al. [19] (p. 863), who described this positive effect, especially for inhabitants in the closer vicinity of wind power sites. Regarding the overall regional acceptance, it becomes apparent that it has successively improved in Lausitz-Spreewald. In Augsburg, acceptance first declined during the project's implementation phase—which points to strong controversies occurring during licensing procedures—but strongly increased again once the project was completed. The operators were also asked if and by what measures they would alter their plant's project planning from today's point of view in order to achieve greater public acceptance. It turned out that 69% of the operators would not change anything about their line of action. The measures possibly taken by the remaining 31% who question their own past proceedings and would consider acting differently today are diverse. 29% of them would see to it in the future that their plant is better integrated within the given local circumstances of planning and infrastructure, e.g., by providing an access to the heat network early on. Another 29% particularly recognize the technical and constructional deficits of their plant, which, from today's perspective, they would no longer disregard. The implementation of sound absorbers as well as shifting parts of a biogas plant's processing steps to outside of the village are examples of suitable measures in this respect. Moreover, 23% of those operators willing to reconsider feel that the foundations for better acceptance are rather to be laid in advance of a project and that this may be achieved by investing into better elucidation. Another 10% of this group see a considerable potential of optimization, especially concerning project planning, yet without further elaborating this point. Some operators also point out that the need for action to improve acceptance does not fall into their own responsibility, but rather into that of the critical residents, who had to overcome their deprecating sentiments, such as envy.

4. Discussion

4.1. Increasing Complexity of Project Planning

The study was able to show that the behavior of operators is both influenced by a rational endeavor for economic optimization and by individual desires. It was found that profitability represents the most important project aim, with other economic parameters also being significant, which does at least partially explain the initially criticized focusing of planning-oriented studies on natural site factors and spatial distances [24,27]. Still, more than three-fourths of the sample said that they were driven by the will to personally evolve as an entrepreneur. The social environment, especially in the course of site selection, plays another major role with mainly small operators striving for spatial closeness to their residence. Still, to this group of operators, economic factors are no less important; rather, they display high significance in the context of subventions and transportation costs. Regarding the operators' embeddedness in social networks, the image is equally diverse. On the one hand, the personal contact with operators of the same energy technology, as well as on the integration into ancillary networks, is emphasized, which stresses the importance of practice-theoretical approaches that are highlighted by Faller [22] and may be understood as evidence for the imitation effects in the context of industrial site selection, as thematized by Kulke [72] (p. 99). On the other hand, the operators act almost completely detached from the socio-institutional frame conditions that are created by federal, regional, and professional associations, plant producers, and chambers of industry and commerce. Similarly, personal contacts with operators of other technologies as well as the choices of site made by other operators, have hardly any impact on entrepreneurial behavior. The two parameters that are taken to be so important by industrial district research—'institutional thickness' and 'embeddedness'—therefore do not significantly influence the industrial agglomeration of small and medium-sized plants [23], at least within the two regions that were investigated by the study. Only those actors are relevant for the operators who actively and thus directly interfere with the site selection process, thereby representing the origins of social conflicts. In both regards, communal authorities play a central role. As keepers of the complex licensing procedures, they may be core actors of local energy systems.

Hence, the study illustrates that the deployment of renewable energies calls for more complex research approaches than has been the case hitherto. Relational, socio-technical, practice-oriented, and constructivist perspectives provide profitable insight in this respect, but fall short if separated regarded. Moreover, it becomes apparent that, due to the renewable energies' decentralism as well as their basic physical principles, the focus on distances and natural site factors has regained importance and that the integration of these aspects should not be dismissed as obsolete. Consequently, future project planners are facing increasing complexity of the factors to be considered.

4.2. Landscape Aesthetic as a Factor

Furthermore, the empirical findings reveal that, from the operators' perspective, the factor landscape aesthetic plays a minor role. Neither when naming project aims, nor when choosing technology and site, are entrepreneurial decisions affected by the plants' impact on the landscape. This is surprising insofar as visual impacts on landscape have dominated the scientific discourse over the last years, with this aspect, according to Cowell [52] (p. 223) and Höfer et al. [27] (p. 223), having evolved into the crucial social parameter of the Energy Transition. Research on the Energy Transition has not least paid great attention to this aspect [45,47,73]. The spectrum of perspectives on energy landscapes includes the focus on the actual physical objects of landscape [58], landscape ideals [74], as well as approaches of constructivist energy and landscape research [75]. The appraisal of landscape aesthetic is not only based on the visual impression of material elements and traits, rather it is about sociocultural and emotional implications that single landscape elements as well as the overall structure of landscape are being attributed with [14] (p. 335). Similarly, Devine-Wright [76] (p. 130) takes visual, physical landscape parameters, such as a plant's size, color, and spatial distances to other objects of space to be overrated; only social distance, which is hard to grasp, was important. A central dimension of social distance is represented by fairness, which, being a social construct, can hardly be depicted using strictly quantitative GIS-based concepts. Regarding this, Zoellner et al. [50] (pp. 4139–4140.) emphasize that the acceptance of a planning process increases with how fair it is perceived. Therefore, the afflicted citizens' estimation of the impact on landscape is also dependent on the costs for mankind and the environment attributed to it by the people [77] (p. 128). In contrast, v. d. Horst [16] (p. 2709) concludes that opposition to renewable energies is recruited from people who have transferred their residence to rural space for reason of lifestyle, thus bearing no relationship with the traditional regional economic sectors that are rooted there. This implies a notable shift in the relation of residence and surroundings: rural space no longer ensures the means of existence, rather it serves the social status of an individual and comfortable way of life [9] (p. 9).

Concerning the operators, it must be stressed that, especially the perspective of social constructivism might raise their hope that the negative assessments of energy landscapes were temporal phenomena. Accordingly, Kühne and Weber [20] (p. 211) point out that landscapes dominated by renewable energies are perceived as modern and familiar by the younger generation. The negative connotation of the term energy landscape, which conflicts with the established romantic ideal of landscape [74] (p. 12), may be replaced by an increasingly positive interpretation.

4.3. Regional Characteristics

Regional comparison showed that operators in the region of Augsburg display a much bigger scope and greater variety regarding their entrepreneurial aims. Surprisingly, however, more than half of the Augsburg operators ranked participation on behalf of the citizens as a negligible goal (vs. only one-third of those from Lausitz-Spreewald). This is remarkable as numerous studies highlighted the significance of the factor participation [77–79]. The factors of technology similarly manifest remarkable regional differences: personal preferences and the social environment play a much more prominent role in Augsburg, yet economic factors, such as subventions and energy potential, are no less taken into entrepreneurial consideration. Furthermore, it became apparent that subjective aspects have higher relevance in the region Augsburg also concerning site factors, while in Lausitz-Spreewald, more emphasis is put on the site-related energy potential as well as landscape integration, which not least points to the importance of wind energy in this region.

Distance analyses have revealed that the mean distance between the sites of residence and plant is much larger in Lausitz-Spreewald: more than half of the operators live at least 15 km away from their plant's site, one-third of them even more that 50 km. The numerous, predominantly extraregional wind energy operators are particularly characterized by a high degree of spatial flexibility, which is quite in contrast to the biogas plant operators, whose places of residence mostly coincide with the plants' sites. Additionally, about 20% of the operators who chose a site in Lausitz-Spreewald had conducted their search for a suitable site within a radius of 1000 km, which is true for only 5% of the Augsburg operators. This confirms the statement by Bathelt and Glückler [23] that bigger enterprises, among which most of the investigated wind projects must be counted with respect to their installed power and operator characteristics, include more space-related information into the considerations of site selection, as opposed to the smaller biogas projects.

Regarding the importance of regional actors, nature and species protection are a lot more present in Lausitz-Spreewald and communal authorities exert stronger influence on site selection processes.

Augsburg only shows higher values for regional heritage preservation and the involvement of citizens' initiatives. Difficulties that arise both during site selection and after the start of the plant's operation are throughout bigger in Lausitz-Spreewald than in Augsburg. In the East German region, particularly big problems occur regarding the plants' grid access and profitability. Soil degradation, biodiversity, and climate balance also represent comparatively big challenges. In Augsburg, operators are more severely confronted with difficulties regarding area consumption, sound emissions, eutrophication, and transportation traffic volume.

5. Conclusions

If knowledge regarding the views and planning approaches of plant operators exists, then it can be introduced into policy-making. Therefore, it may be concluded from the study's findings that the perspectives that operators have on the Energy Transition must be more systematically included into the discourse about the sustainable deployment of renewable energies, as they reveal significant disparities with those topics that are emphasized by the public (e.g., landscape aesthetic, citizens' participation). As landscape aesthetics are not important for plant operators but are discussed as a key aspect for local acceptance in academic literature, policy-makers need to create incentives, so that such factors can be increasingly considered in the planning paradigm.

Moreover, it was shown that the challenges and problems that arise in the context of regional energy transformation cannot at all be generalized beyond regional circumstances; rather, they must be regarded as specific regional phenomena that have to be overcome by means of regionally adapted energy concepts. Not least, the study demonstrated that the constellations of actors, the operators' technological and spatial preferences, the conflictive situations, the value systems, as well as routines—and with these the planning processes for renewable energies—substantially vary from region to region. Hence, a concept for deployment omitting these regional characteristics is always at danger of failing due to a lack of acceptance and applicability. It cannot be recommended to argue in favor of nation-wide policy making, but the responsibility needs to lie with the regional authorities, as they have the higher competence to solve spatial problems at a local level. Especially for regional planning associations, this entails the great challenge of avoiding the reduction of energy planning for the respective planning regions to the rigid dichotomy between areas free of restrictions and restricted areas; rather, the regional diversity of economic, social, and ecological conceptions which lead to utterly different technological and site planning related ideals and practices, must be observed. This may also be understood as a research desideratum, as it has not yet been resolved how this kind of planning approach must be conceptually designed, institutionally reinforced, and implemented in the practice of planning. Additionally, as the complexity of planning processes is increasing, policies need to aim towards the wide access to information, harmonization of spatial data, and the enhanced integration of GIS-based applications.

In particular, the broad variety of regionally relevant parameters and their high degree of dynamic suggest that transferring these variables to spatial planning would increase the complexity of planning processes. However, the effort seems worthwhile, since hitherto, the concepts of regional planning for the deployment of renewable energies have not consistently contributed to creating a bond between the new technologies and the people living in their vicinity. Therefore, a critical examination of the present regional deployment concepts seems advisable and promising with respect to improving acceptance of the Energy Transition.

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Conflicts of Interest: The authors declare that there is no conflict of interest.

Appendix A

Relevant questions from the survey of plant operators

Question 10: What was the main reason for the choice of location? *open question*

Question 11: How many people were involved at the final choice of location?

☐	1	☐	2–5	☐	6–10	☐	11–50	☐	>50

Question 12: How far is the average distance between the energy plant and people that were involved in the process of site selection? *Please choose only one of the following answers.*

☐	<=1 km	☐	2–5 km	☐	6–15 km	☐	16–50 km	☐	>50 km

Question 13: In which maximum perimeter was the search for a suitable site conducted? *Please choose only one of the following answers.*

☐	within municipality of residence (perimeter approx. 5 km)
☐	within municipality of residence + neighboring municipalities (diameter approx. 15 km)
☐	within county (diameter approx. 50 km)
☐	within district (diameter approx. 100 km)
☐	within federal state (diameter approx. 300 km)
☐	within Germany (diameter approx. 1000 km)

Question 14: Why did you concentrate on the specific perimeter (cf. question 13)? *open question*

Question 15: In which perimeter to your residence can you imagine the location of your energy plant? *Please choose only one of the following answers.*

☐	within municipality of residence (perimeter approx. 5 km)
☐	within municipality of residence + neighboring municipalities (diameter approx. 15 km)
☐	within county (diameter approx. 50 km)
☐	within district (diameter approx. 100 km)
☐	within federal state (diameter approx. 300 km)
☐	within Germany (diameter approx. 1000 km)

Question 16: How important is the spatial proximity between the plant's location and your place of residence?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5	6	7	8	9	10
very unimportant					neutral					very important

Question 19: How many months did the process of site decision take?

Question 20: How high is your satisfaction with the chosen location?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5	6	7	8	9	10
very unimportant					neutral					very important

Question 21: How strong did the following groups of actors influence the process of site selection?

	not at all	little	neutral	strong	very strong
environment protection	☐	☐	☐	☐	☐
homeland attachment	☐	☐	☐	☐	☐
species protection	☐	☐	☐	☐	☐
monument protection	☐	☐	☐	☐	☐
municipal administration	☐	☐	☐	☐	☐
citizen's initiative pro	☐	☐	☐	☐	☐
citizen's initiative against	☐	☐	☐	☐	☐

Question 23: How conflict-laden was the process of site selection?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
0	1	2	3	4	5	6	7	8	9	10
not conflictive					neutral					very conflictive

Question 25: Which role did the following aspects play during the site selection?

	insignificant	little importance	neutral	important	very important
coincidence	☐	☐	☐	☐	☐
personal preferences	☐	☐	☐	☐	☐
energy potential	☐	☐	☐	☐	☐
landscape	☐	☐	☐	☐	☐
transportation costs	☐	☐	☐	☐	☐
ancillary industries	☐	☐	☐	☐	☐
institutional thickness	☐	☐	☐	☐	☐
socio-environment	☐	☐	☐	☐	☐
acceptance	☐	☐	☐	☐	☐

Question 26: How important were the following factors during the planning of the energy plant?

	insignificant	little importance	neutral	important	very important
profitability	☐	☐	☐	☐	☐
environment protection	☐	☐	☐	☐	☐
landscape	☐	☐	☐	☐	☐
civic participation	☐	☐	☐	☐	☐
regional creation of value	☐	☐	☐	☐	☐
jobs	☐	☐	☐	☐	☐
base load capacity	☐	☐	☐	☐	☐
full load hours	☐	☐	☐	☐	☐
removal capacity	☐	☐	☐	☐	☐
spatial efficiency	☐	☐	☐	☐	☐
production costs	☐	☐	☐	☐	☐
energy autonomy	☐	☐	☐	☐	☐
intergenerational justice	☐	☐	☐	☐	☐
entrepreneurial ambitions	☐	☐	☐	☐	☐

Question 28: How easy/difficult were the following factors during the site selection process?

	very easy	easy	neutral	difficult	very difficult
spatial acquisition	☐	☐	☐	☐	☐
permission procedure	☐	☐	☐	☐	☐
spatial planning	☐	☐	☐	☐	☐
environment protection	☐	☐	☐	☐	☐
landscape aesthetics	☐	☐	☐	☐	☐
species protection	☐	☐	☐	☐	☐
monument protection	☐	☐	☐	☐	☐
tourism	☐	☐	☐	☐	☐
acceptance	☐	☐	☐	☐	☐
access	☐	☐	☐	☐	☐
network access	☐	☐	☐	☐	☐
information acquisition	☐	☐	☐	☐	☐

Question 36: How big were the problems concerning the following factors at the chosen site?

	no problems	**little problems**	**neutral**	**problems**	**big problems**
soil erosion	☐	☐	☐	☐	☐
eutrophication	☐	☐	☐	☐	☐
soil compression	☐	☐	☐	☐	☐
biodiversity	☐	☐	☐	☐	☐
ecological footprint	☐	☐	☐	☐	☐
land consumption	☐	☐	☐	☐	☐
sound emissions	☐	☐	☐	☐	☐
carrying-traffic	☐	☐	☐	☐	☐
acceptance	☐	☐	☐	☐	☐
profitability	☐	☐	☐	☐	☐
network access	☐	☐	☐	☐	☐
landscape	☐	☐	☐	☐	☐
site competition	☐	☐	☐	☐	☐

Question 40: Where did you gather information about the type of energy plant? *You can choose multiple answers.*

☐	internet	☐	television
☐	radio	☐	scientific journals
☐	Brochures	☐	conversations
☐	exhibitions	☐	contact to plant operators (same type of plant)
☐	information events	☐	contact to plant operators (other type of plant)

Question 41: Which role did the following aspects play during the choice of energy plant?

	insignificant	**little importance**	**neutral**	**important**	**very important**
coincidence	☐	☐	☐	☐	☐
feed-in tariffs	☐	☐	☐	☐	☐
personal preferences	☐	☐	☐	☐	☐
energy-potential	☐	☐	☐	☐	☐
landscape	☐	☐	☐	☐	☐
transportation costs	☐	☐	☐	☐	☐
ancillary industries	☐	☐	☐	☐	☐
institutional thickness	☐	☐	☐	☐	☐
socio-environment	☐	☐	☐	☐	☐
acceptance	☐	☐	☐	☐	☐

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