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Vital Factors Stimulating Development and Competitiveness of Design and Construction Enterprises of Photovoltaic Farms

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Abstract: The underlying objective of the paper is to identify and evaluate in the research process vital factors that impact the development of design and construction enterprises of photovoltaic farms on the energy markets, in particular narrowed down to renewable energy sources (RES) markets, including energy coming from photovoltaic sources. The first part of the paper, the epistemological one, introduces a scientific discourse pertaining to conditionings and restrictions related to RES markets in the dimensions of sustainable development. This has been done with the use of literature query, legislative and administrative acts, and reports drawn up for the European Commission. In this reference, we summarized the EU's essential measures aimed at promoting the idea of sustainability. The second part of the paper, the empirical one, presents a summary of the results obtained within the research pertaining to "opportunities and threats in managing projects of photovoltaic farms in production enterprises of energy appliances". The research was conducted in a group of 24 design and construction enterprises of photovoltaic farms. The concentration of the research, in the context of the underlying objective of this paper, pertained to the aggregation and evaluation of selected factors that stimulate the development and competitiveness of construction projects and the implementation of photovoltaic farms. We considered the hierarchy of strategic objectives of the investigated enterprises and selected threats to their market position. Two primary criteria were adopted to aggregate and evaluate vital factors that impact the development of design and construction enterprises of PV farms. The first of them is the qualitative one—top scores, weighted averages of respondent evaluations on the five-point Likert scale. The second one is the quantitative criterion—number of indications $N \geq 22$ of the respondents (over 90%). A measurable value of the paper is the scientific discourse pertaining to dimensions of competitiveness of the investigated and analyzed enterprises on the RES market, in particular narrowed down to photovoltaic farms.

Keywords: PV market; PV competitiveness factors; PV; strategic factors of PV development; design and construction enterprises of PV

Citation: Kuceba, R.; Chmielarz, G.; Soltysiak, M. Vital Factors Stimulating Development and Competitiveness of Design and Construction Enterprises of Photovoltaic Farms. *Energies* **2021**, *14*, 3399. https://doi.org/10.3390/en14123399

Academic Editor: Jean-Michel Nunzi

Received: 26 April 2021
Accepted: 5 June 2021
Published: 9 June 2021

1. Introduction

The issues pertaining to climate change and the reduction of environmental threats are the primary focus of all the countries of the world that are aware of the fact that only the implementation of sustainable development principles can, in the long run, produce measurable effects in this area. Thus, recent years have witnessed a rapid development in utilizing the potential of renewable energy sources (RES) such as the Sun, wind, or water for energy generating purposes. This is also largely driven by attempts to transform the energy sector and shift away from generating energy in conventional power plants that use fossil fuels towards clean energy production from environmentally friendly sources. Additionally, utilization of energy coming from RES installations, apart from its unquestionable environmental benefits, contributes significantly to an increase in energy security. This concerns both small-scale local prosumer installations as well as large energy

enterprises and gradually leads to the transition from the centralized model of generating and supplying energy to the one consisting of distributed and dispersed systems. Another factor that promotes the development of the RES market is growing awareness of final customers, who favor energy produced in an environmentally friendly manner [1–3]. All the abovementioned factors create a good market for renewable energy sources. Furthermore, legal regulations and incentives introduced at the national as well as the EU level promote investments into the production of energy from clean sources. The underlying objective of the present paper is to present the analysis of the factors that stimulate the development of design and construction enterprises of photovoltaic farms in Poland. The paper has the following structure. First, we present the EU's most important legislative initiatives that promote the development of RES markets and their influence on the development of the Polish PV market. In the next part, we present the results of our own survey conducted in the group of design and construction enterprises of PV farms. We analyze the results and distinguish the factors that the abovementioned enterprises find to contribute to their development and competitiveness. In the next step, we discuss the obtained results and summarize the paper. The paper's primary value lies in presenting true and unbiased opinions of entrepreneurs who co-create the contemporary market of PV in Poland regarding the stimulants and inhibitors of this market development. In addition, the empirical part of the paper constitutes a source of up-to-date and reliable knowledge pertaining to PV market development. This knowledge does not come from reports drawn up at the national level, but these very market participants, and therefore the paper depicts its current state of functioning.

2. EU's Legislation and PV Market Development in Poland

Ensuring access to affordable, reliable, sustainable, and modern energy for all is the 7th goal of the Sustainable Development Goals by the United Nations. Significant progress towards achieving Goal 7 can be observed worldwide, which means that energy is becoming more sustainable and widely available. Access to electricity in poorer countries has begun to accelerate, energy efficiency continues to improve, and renewable energy is making impressive gains in the electricity sector [4]. The sustainable development of Europe has been to a large extent conditioned by the economic situation and availability of funds that can be destined for these purposes. However, the funds do not have to be understood purely as financial resources. Already in 1971, Georgescu-Roegen proposed his own model in this respect called the fund-flow model. The author believed that two kinds of productive agents must be distinguished: funds and flows. While funds cross processes without deterioration, flows are either input flows that include raw materials and intermediate goods, or output flows—products and waste, but never both [5]. Moreover, in the author's opinion, it is necessary to incorporate thermodynamic and biological teachings into theories and public policy recommendations. Otherwise, states Georgescu-Roegen, economics will only remain an abstract science, having no link with the economy. Proposed by Georgescu-Roegen, bioeconomics has been built around a consistent frame. Its essence is redefining the economic sphere, both as a discipline (economics) and as a set of practices (economy), in relation with its bio-physical environment [6]. The principles of the abovementioned framework are still valid and Europe, seeking a way to face the challenges regarding environmental degradation, has realized that it needs a similar framework in its attempt to make the continent resource-efficient and govern its economy in a modern and competitive, but also environmentally friendly manner. To achieve this objective, it assumed the following changes to its environmental policy:

- by 2050, the emission of greenhouse gases will be balanced to zero,
- economic growth and resource use are treated as separate processes, and
- all persons and places are included.

To make its economy sustainable, the EU introduced a plan called the European Green Deal. The plan involves turning climate and environmental challenges into opportunities and making the transition just and inclusive for all. Generally, the plan specifies investments

needed and financing tools available to ensure a fair and inclusive transition for all EU countries and citizens. This will be achieved, among others, through:

- using resources efficiently, which will be achieved by a transition to a clean, circular economy,
- actions aimed at restoring biodiversity and curbing pollution,
- spending on environmentally friendly technologies,
- supporting innovative initiatives in the industry sector,
- the introduction of green, inexpensive, and healthier forms of private and public transport,
- the decarbonization of the energy sector,
- construction of more energy efficient buildings, and
- collaboration on an international scale so as to improve global environmental standards [7,8].

The European Green Deal aims to introduce measures to protect Europe's natural environment. These measures are supposed to range from reducing greenhouse gas emissions to investing in cutting-edge research and innovation. Basically, its core is climate actions, the first ones of which include:

- European Climate Law, the role of which is to include the objective of achieving neutrality of climate by 2050 into EU law,
- European Climate Pact, which aims to encourage the involvement of citizens and all parts of society in climate-related action, and
- 2030 Climate Target Plan, which is supposed to result in reducing net emissions of greenhouse gas by at least 55% by 2030.

The SET Plans play an important role in the delivery of the Green Deal through its commonly agreed R&I priorities and targets for clean energy solutions. It constitutes an important step towards the achievement of climate neutrality and the implementation of the Next Generation EU program. The alignment of national R&I programs with the common SET Plan vision are supposed to make Europe a global leader of the next generation of clean energy and energy efficiency technologies [9].

It is worth pointing out that the European Union has been striving to achieve the idea of sustainability through the introduction of a number of legislative measures as well as policies. The most important ones are aggregated in Table 1 below.

While analyzing the information included in Table 1, it can be observed that the European Union consistently strives for the reduction of greenhouse gases emission in all the sectors of the economy, perceiving it to be the primary reason for climate change. Furthermore, it can be noticed that the strategies and polices introduced by the EU are supposed to increase the share of clean energy, the one coming from renewable energy sources (RES), in the total amount of energy produced and consumed in the territory of the European Union. This means that all the member states are obliged by the EU's legislation to develop sources capable of producing clean energy. This, in turn, creates a very favorable environment for the development of the green energy market [11]. It is worth mentioning here that there exists a particularly useful tool that can be used to check the latest data on the development of renewable energy sources in the entire European Union. The tool is called the SHARES tool and it focuses on the harmonized calculation of the share of energy coming from renewable sources. The main benefit of making use of the SHARES tool is that member states all have to apply exactly the same method in order to calculate the desired values. In this way, it allows users to avoid any irregularities caused by varying parameters and rules that are used in different calculation methods. The results of the completed SHARES exercises are available in the articles that can be accessed on the tool's website—https://ec.europa.eu/eurostat/web/energy/data/shares (accessed on 17 May 2021) [12].

Table 1. Essential EU measures aimed at promoting sustainability.

Name of Legislative Measure	Brief Characteristics
EU Emissions Trading System (EU ETS)	The essential element of the EU's policy aimed to combat climate change. It is a primary tool to reduce greenhouse gas emissions in a cost-effective manner. It is the first and biggest carbon market in the world. The system limits emissions from over 11,000 heavy energy-using installations (such as power stations and industrial plants) as well as airlines operating within the territory of the EU (including Iceland, Liechtenstein, and Norway). The EU ETS covers around 40% of the EU's greenhouse gas emissions.
National targets	The Effort Sharing legislation defines annual greenhouse gas emission targets, which are binding for member states for the periods 2013–2020 and 2021–2030. These targets pertain to emissions from the sectors that are not covered by the EU Emissions Trading System (EU ETS), such as transport, buildings, agriculture, and waste.
Contribution of forests and land to the fight against climate change	Forests and agricultural lands cover over three-quarters of the EU's territory. They also hold large stocks of carbon, preventing its escape into the atmosphere. Such actions as afforestation or the conversion of arable land into grassland enable the protection of carbon stocks. Therefore, land use and forestry—which include the use of soils, trees, plants, biomass, and timber—can all help to achieve the goals of the climate policy.
Reducing greenhouse gas emissions from transport	Europe's answer to the challenge of reducing emissions coming from the transport sector. It constitutes an irreversible shift to low-emission mobility. As set in the policy, by mid-century, greenhouse gas emissions from transport will be reduced by at least 60% compared to the level from 1990, and ultimately it is supposed to be eliminated entirely. The strategy integrates a broader set of measures which is meant to support Europe's transition to a low-carbon economy and support jobs, growth, investment, and innovation.
Boosting energy efficiency, renewable energy, and governance of EU countries' energy and climate policies	A set of ambitious energy efficiency targets for 2020 and 2030 that aim to reduce primary and final energy consumption. One of the elements of this strategy is the Renewable Energy Directive, which sets rules for the EU to achieve its 20% renewables target by 2020. It also includes plans for the EU member states to meet their 2020 renewable energy obligations. An important element is the EU renewable energy financing mechanism, which is supposed to help the EU countries to collaborate together, hosting or contributing financially to new renewable projects.
Promoting innovative low-carbon technologies	The goal of this strategy is to help businesses invest in clean energy and industry. This is supposed to boost economic growth, ensure the creation of local future-proof jobs, and let Europe remain a technological leader on a global scale. This is achieved through projects focusing, among other things, on innovative low-carbon technologies and processes in energy-intensive industries, capturing and utilizing carbon, innovative renewable energy generation, and energy storage.

Source: own elaboration based on [10].

According to estimations, the development of the RES market is going to continue [13] as on 4 March 2020, a legislative proposal for a European Climate Law was adopted by the European Commission. The legislation will set the objectives that will allow the EU to become climate-neutral by 2050. The Commission also established a framework that will guarantee that these objectives will actually be achieved and will set out emissions objectives for the period between 2030 and 2050. Importantly, the proposed regulation will also require EU institutions and member states to introduce their own climate change measures, which will be assessed by the Commission every five years examining the progress made towards the achievement of the objectives as well as the consistency of national and EU measures with the objectives. If inconsistencies are discovered, corrective actions will be necessary in those member states that fail to comply with the law. On 17 September 2020, the Commission amended the proposal, which now includes the updated 2030 climate target. It is supposed to result in a net reduction by at least 55% with regard to the EU's greenhouse gas emissions compared to 1990 levels. The Parliament adopted its position on 6 October 2020, demanding a 60% reduction of emissions by 2030 [14].

Poland, being a member of the European Union, is obliged to comply with the EU's new legislation in this scope and fulfil its member state duties in the area of sustainable development. This will be achieved primarily through further development of renewable energy sources, which have been developing intensively in our country over the last several years. The latest data regarding this issue are presented in Table 2 below.

Table 2. Installed power of renewable energy sources in Poland in the years 2018–2020.

Type of RES Installation	2018 (MW)	2019 (MW)	2020 (MW)
Installation utilizing biogas	237.618	245.336	255.699
Installation utilizing biomass	1362.870	1492.875	1512.885
Installation utilizing solar power	146.995	477.679	887.434
Installation utilizing wind	5864.443	5917.243	6347.111
Installation utilizing hydro-energy	981.504	973.059	976.047
Total	8593.430	9106.258	9979.176
Growth YOY	55.083	512.828	872.918

Source: own elaboration based on data from the Energy Regulatory Office.

As Table 2 demonstrates, the installed power of RES in Poland has been growing every year. A particular increase can be observed while comparing the years 2018 and 2019. One can see that while the increase in the total installed power of RES in Poland in 2018 was barely 55.083 MW, in 2019, this volume was almost 10 times larger—512.828 MW. The year 2020 was another good one in this respect, with an annual growth that amounted to 872.918 MW [15]. A particularly dynamic development can be observed in the scope of photovoltaic energy. At the end of October 2020, the capacity of the installed photovoltaics in Poland amounted to 3430.608 MW. This is up by 280% YOY compared to the corresponding period of the last year. During the whole of October 2020, the capacity of photovoltaic installations in Poland grew by 286 MW. The total installed electrical power for all sources (conventional and RES) in October 2020 amounted to 49.613 GW, while the share of PV installations themselves is approximately 7%. In the RES sector, photovoltaics hold the second position (outperformed by wind power) where their share amounts to 29% [16]. Further development of the RES market will be stimulated by subsidies for RES investments coming from the funds co-financed by the European Union (e.g., in Poland) from the Operating Programme Intelligent Development, and subsidies from local governments' funds, for instance in Poland, regional installation programs. Additionally, in Poland, according to the energy law in force, the distribution system operator is obliged to purchase energy generated in Renewable Energy Sources.

Undoubtedly, the factor that to a large extent contributed to the development of PV in Poland was the amendment to the law on renewable energy sources. This amendment was passed by Parliament on 19th July 2019, accepted by the Senate on 2nd August 2019, and signed by the President on 9 August 2019. The most important assumptions of the amendment include:

- supporting the achievement of the plan imposed on Poland by the European Union, according to which Poland is supposed to achieve a 15% share of energy coming from renewable energy sources by the end of 2020,
- growth of energy security, as the goal of the introduced changes is to guarantee stable access to energy for final customers. Yet, it needs to be remembered that according to Georgescu-Roegen (1979), from the point of view of the long run, it is only efficiency in terms of energy that counts in establishing accessibility and actual efficiency depends at any one time on the state of the art [17], and
- protecting customers against significant electricity price rises. The goal of the introduced changes is to keep the energy costs at the lowest possible level [18].

In addition, the role of the PV sector is becoming even more important with regard to compliance with the EU's climate policy and the European Commission's requirements, which impose the obligation that the share of RES in the final total energy consumption in Poland should amount to at least 25%. According to the assessments included in the Roadmap of Polish PV Industry Development Until 2023, a significant part of energy coming from RES may be thanks to additional investments into photovoltaics. In particular, this concerns investments into large-scale PV farms and prosumer installations, both private as well as business ones. The PV sector, the potential of which has been growing since 2015, can now continue its investment trends, which already in 2019 reached the level of PLN 3.5 billion and in 2020 exceeded PLN 4 billion, being the highest not only in the RES sector but in the entire Polish electro-energy industry (including coal and gas). As Poland did not achieve the assumed objective of 15% share of RES participation in energy consumption, the continuation of these investment trends would allow Poland to compensate for the deficiencies in achieving the RES objective for 2020. Additionally, further active development of PV sector would also help Poland achieve what is required by the European Commission's Directive on Energy Union Governance; the first indirect objectives of RES in the Roadmap until 2030 (23% or 25%), in particular in control points for 2022, where the required achievement is 18% of the objective from the years 2021–2030 and for 2025 (43% of the objective from the years 2021–2030). With this in mind, the Institute for Renewable Energy prepared an updated scenario of the National Plan for Energy and Climate, which is in line with the climate policy of the EU, requirements of the RES Directive, and the Regulation on Energy Union Governance. This plan considers the current trends, contracted auctioning projects, prosumer support programs, and growing investment and capacity abilities of the PV industry. This plan translates into the growth of installed power in photovoltaics up to 7.9 GW in 2025, including 4.2 GW of prosumers, while in 2030, the installed power is expected to reach 12.9 GW. The development of new powers in the years 2020–2023 is assumed based on the results of RES auctions and current auctioning plans and it also considers that energy production in the PV sector will largely be driven by prosumers. It should be stressed here that this a significant change to the National Plan for Energy and Climate developed in 2019, which only assumed a marginal impact of prosumer installations until 2030 [19]. In light of the above, it is worth emphasizing that prosumer micro-installations have been developing very intensively in Poland. According to the Polish Market of Photovoltaics 2020 Report, in 2019, the capacity installed in micro-installation amounted to 640 MW, which is three times more than the year before. In the first quarter of 2020, only about 300 MW of PV installations were connected to the grid. At the end of 2019, micro-installations constituted over 70% of the total capacity installed in photovoltaics. This is a sign that, despite the global pandemic, prosumers are still interested in investing in photovoltaics and the development of this sector is not slowing down. What definitely makes the Polish PV sector different from

many other European countries is its dispersed nature, which results from the interest of Polish citizens in producing their own energy. This, in turn, stems from the fact that Polish prosumers can enjoy favorable legal regulations and access support programs, also within Regional Operational Programmes financed by the European Union [20].

It is also worth stressing that the pace of solar PV power development in the European Union has not been slowed down by the coronavirus pandemic, which has had a negative impact on the economic situation in a number of EU member states. What may come as a surprise is that the demand for solar power technology in the European Union in 2020 did not drop despite the COVID pandemic, but instead it grew significantly. In 2020, EU member states recorded 18.2 GW of installed solar power capacity, which is an improvement of 11% compared to the 16.2 GW installed in 2019. The leader in this rank is Germany, which installed 4.8 GW, which means that this country became the largest solar market in Europe again. The second place in this rank belonged to the Netherlands with 2.8 GW of installed capacity, followed by Spain, the market leader in 2019, with 2.6 GW of installed capacity. It should be stressed here that Poland's position in the ranking was very high: the fourth position with more than doubled annual solar deployment [21].

Therefore, it can be concluded that the Polish market for photovoltaics is currently at the stage of especially intense development. Importantly, the perspectives of this market's development for the years to come make it a very attractive area for further investments, which will certainly boost its development. A special role will be played by photovoltaics in the National Plan for Energy and Climate until 2030, which confirms that the potential and strength of this sector has been appreciated. This should attract new investors, who can now predict that the return on investment in the sector of photovoltaics will be even more profitable. Now it is the role of the government to create and implement a coherent PV development policy, in line with the EU's policy, and combine it with the investments in the Polish PV market.

3. Factors Stimulating Development and Competitiveness of Projects and Implementations of Photovoltaic Farms

The present paper includes a summary of the results obtained within the research pertaining to "opportunities and threats in managing projects of photovoltaic farms in production enterprises of energy appliances". The primary research with the use of a survey questionnaire was conducted in the period from January to October 2020. The survey questionnaire was provided to 38 contractor companies in the whole of Poland, which constitutes about 60% of the companies that design and construct photovoltaic farms. As a result, we acquired 24 correctly filled-in survey questionnaires. The group of enterprises participating in the research included: 19 limited liability companies, 2 public limited liability companies, and 3 companies classified as others. In addition, 23 of the investigated companies employ up to 49 employees, one company has up to 250 employees. This confirms that presently, companies that design and construct photovoltaic farms are mostly small ones. However, they are frequently subsidiaries or affiliates of large energy corporations [22]. In the group of investigated enterprises, one can observe an interesting breakdown according to the activity classified in Polish Business Classification (PBC). Some of the enterprises do not limit their activity simply to one link of designing and constructing photovoltaic farms [23], which has been visualized in Figure 1.

In reference to the primary subject matter of the paper as well as to the adopted research objective and problem, we summarized selected factors that stimulate the development and competitiveness of projects and implementations of photovoltaic farms. We considered the hierarchy of strategic objectives in the case of design and construction enterprises of photovoltaic farms as well as selected threats to their market position.

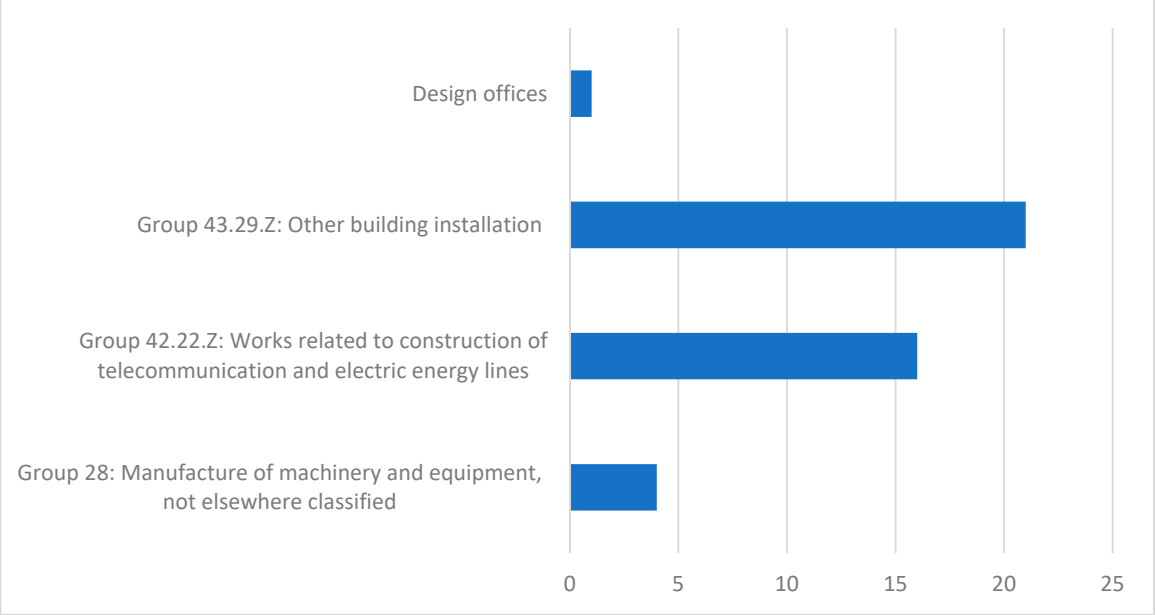

Figure 1. Activity areas of investigated enterprises according to PBC. Source: own elaboration based on own research (multiple choice, sample N = 24).

The identified and summarized factors stimulating the development and competitiveness of design and construction enterprises of photovoltaic farms were subject to quantitative and qualitative analysis in the research process. In the quantitative case, the number of enterprises that selected the summarized factor that was the subject of evaluation has been indicated. On the qualitative side, in turn, we attempted to identify the nature of their impact on the development and simultaneously on the diffusion of setting up new companies or expanding the previous activity of already existing companies (according to the summarized PBC classification in Figure 1) with designing, constructing, implementing photovoltaic farms. In the abovementioned qualitative context, we adopted a point scoring scale—a Likert scale. The selection of this scale can be justified by its common application and easy interpretation of individual scores by the participants of a survey. The scale includes scores in the range from 1 to 5 (from the least to most significant meaning of a given characteristic), by 1 point, and it constitutes the most commonly utilized tool to measure opinions with reference to particular problems.

Table 3 presents a summary of the factors that describe the hierarchy of the objectives in the case of design and construction enterprises of photovoltaic farms, as well as the scores from 1 to 5 that were assigned to them by the survey participants.

It needs to be stressed that in the context of strategic objectives, 100% of the respondents (24 enterprises) emphasized the key role of: profit maximization, increased value of the enterprise, directed development, and growth in competitiveness and innovativeness. In the case of the top indications, the weighted average on the five-point Likert scale amounted to 3.4. The obtained research results also demonstrate that the strategic objectives of the design and construction enterprises of photovoltaic farms that concentrate on increased competitiveness and unique innovativeness were assigned a weighted average of 3.3 (Likert scale). This unequivocally confirms that as these enterprises function on competitive energy markets, RES markets in particular, they primarily adopt strategic objectives of a purely business nature. These objectives are oriented towards maximizing profits and constant development, through the transfer of innovations in the RES area, among other things. In the context of strategic objectives of the design and construction of companies of photovoltaic farms, an interesting research issue was not only to evaluate the economic factors, but also the environmental and social ones [24]. It should be pointed out that the strategic objectives in the scope of reducing the emission of pollutants were only

perceived by 14 companies (58%). However, the scores themselves on the five-point scale were differentiated, and the weighted average of these scores according to the summary in Table 3 amounted to 2.7. Corporate social responsibility was also perceived by only 11 respondents, which constituted 45% of the investigated design and construction enterprises of PV farms. The enterprises whose area of activity could identify them as socially responsible do not perceive these activities as their strategic objectives, which is apparent from the number of indications (11 respondents—45% of the investigated enterprises). CSR was assigned rather low scores, which is shown by the weighted average—2.6 on the five-point scale.

Table 3. Factors describing the hierarchy of objectives in the case of design and construction enterprises of photovoltaic farms—Likert scale 1–5.

Factors That Condition Hierarchy of Strategic Objectives of Enterprises	Likert Scale					Weighted Average	Number of Obtained Responses (Nmax = 24)
	1	2	3	4	5		
	Number of Indications						
profit maximization and increased value of the enterprise	3	3	5	7	6	3.4	24
directed development (growth in potential, market share)	1	4	8	6	5	3.4	24
increase of competitiveness, innovation	3	3	7	5	6	3.3	24
decreased emission of pollutants	8	0	0	0	6	2.7	14
corporate social responsibility (CSR)	0	7	2	1	1	2.6	11
creating the largest enterprise on the market	9	7	3	4	0	2.1	23

Source: own research.

In accordance with the research assumptions, we also identified the factors that condition possibilities of development in the case of the design and construction enterprises of PV farms. The result of their evaluation is presented in Table 4.

While referring to the results summarized in Table 4, it needs to be stressed that in the group of factors that stimulate the development of design and construction enterprises of PV farms, the entrepreneurs distinguished the following heterogeneous resources: financial (24 of the investigated enterprises—100%) and technological—concentrating on innovative RES technologies (22 of the investigated enterprises—91%). The survey participants also appreciate the role of employees' intellectual capital in the context of work efficiency (24 of the investigated enterprises—100%) and the impact of managerial staff commitment (23 of the investigated enterprises—95%). A vital influence, which is confirmed by the highest score of the weighted average on the five-point Likert scale, 4.3, is assigned by the investigated enterprises to investments into new, frequently innovative, technologies adopted in designing and constructing PV farms. Given a diversified portfolio of available subsidies from domestic and European funds to be used to design and construct PV farms, it is worth indicating that, in the opinion of the investigated enterprises, they only moderately stimulate their development. This is confirmed not only by the number of indications (13 of the investigated enterprises—54%), but also a low score resulting from the weighted average on the five-point Likert scale at the level of 1.8.

Only two respondents indicated that the factors that condition the development possibilities of design and construction enterprises of PV farms are technical and environmental requirements [25]. This also confirms the fact that enterprises whose area of activity can be identified as pro-environmental [26] or pro-social do not perceive these elements as stimulators of their development. However, it can be concluded that the factors directly related to commercializing the results of the activity of the investigated enterprises directly condition the possibilities of their development on the new RES markets [27], the PV market in particular.

Table 4. Factors that condition possibilities of development of design and construction enterprises of PV farms—Likert scale 1–5.

Factors That Condition Possibilities of Enterprises' Development	Likert Scale					Weighted Average	Number of Obtained Responses (Nmax = 24)
	1	2	3	4	5		
	Number of Indications						
technological investments and innovations	0	0	3	10	9	4.3	22
economic and financial condition of enterprise	1	0	11	7	5	3.6	24
human and technical condition that influences efficiency	1	0	11	7	5	3.6	24
competences and commitment of managerial staff	1	2	7	10	3	3.5	23
subsidies from domestic and European funds	3	10	0	0	0	1.8	13
development of energy-saving construction technology	6	1	0	1	0	1.5	8
technical and environmental requirements	0	0	0	1	1	4.5	2

Source: own research.

While concentrating in turn on the competitiveness of the investigated enterprises, we identified the factors that stimulate their market attractiveness [28]. The factors that stimulate the competitiveness of design and construction enterprises of PV farms as well as scores attributed to them on the five-point Likert scale are summarized in Table 5.

The investigated design and construction enterprises of PV farms perceive their sources of competitiveness mostly in tailoring their products directly to the needs of final customers—frequently, RES investors. The highest score is assigned to quality of projects, as the weighted average out of 23 indications (95%) of the survey respondents amounted to 4.7 on the five-point Likert scale. The high number of indications and at the same time high scores on the five-point scale were assigned to the price of products and services—a weighted average of 4.4, in the group of 24 evaluations (100% of the investigated enterprises), on the five-point scale.

High scores, with 18 indications of the investigated enterprises (75%), were also assigned by the respondents to relations with customers as a source of competitiveness (weighted average 4.4 on the five-point scale) as well as acquired customer recommendations (weighted average 4.5 on the five-point scale). High scores were also given by the respondents to enterprise's image as a source of competitiveness (weighted average on the Likert five-point scale—4.2) and innovative nature of products or services (weighted average on the Likert five-point scale—3.9).

Additionally, all 24 enterprises (100%) perceived cooperation with R&D institutions and universities as their source of competitiveness. However, the significance of this cooperation is definitely lower (weighted average on the five-point scale—2.8) than factors of competitiveness related to tailoring the products and services as well as their prices to the needs and abilities of customers.

While analyzing and evaluating selected factors that stimulate the diffusion and competitiveness of design and construction enterprises of PV farms, it is also vital to identify and evaluate the factors that inhibit their development—threats to their market position in particular (Table 6).

In the group of threats to the market position of design and construction enterprises of PV farms, all the investigated respondents (24 enterprises—100%) distinguished legal changes resulting from obstacles and costs of adjusting to these regulations. These changes considered to be threats to their market positions were assigned the score of 3.9 as the weighted average of all the evaluations on the five-point Likert scale. It also needs to be stressed that apart from legal factors inhibiting the market position, 23 of the investigated enterprises (95%) perceived threats in environmental restrictions as compliance with them requires incurring additional, external, financial expenses. The ultimate score, as the weighted average of all the evaluations on the five-point Likert scale, amounted to 3.9, similarly to the legal barriers.

Table 5. Factors that stimulate competitiveness of design and construction enterprises of PV farms—Likert scale 1–5.

Factors That Stimulate Enterprise's Competitiveness	Likert Scale					Weighted Average	Number of Obtained Responses (Nmax = 24)
	1	2	3	4	5		
	Number of Indications						
quality of products or services	0	0	1	4	18	4.7	23
price of products or services	1	0	1	7	15	4.5	24
customer recommendations	0	0	0	9	9	4.5	18
good relations with customers and quality of service	1	0	1	5	11	4.4	18
holding quality and environmental certificates	0	0	3	5	10	4.4	18
enterprise's image	0	0	3	8	7	4.2	18
innovative nature of products or services	0	0	4	11	3	3.9	18
competent managerial staff and qualified employees	4	2	0	5	12	3.8	23
utilization of modern technologies	0	4	7	7	5	3.6	23
know-how	0	0	9	4	0	3.3	13
cooperation with research and development institutions and universities	1	10	8	3	2	2.8	24

Source: own research.

Table 6. Threats to the market position of design and construction enterprises of PV farms—Likert scale 1–5.

Threats to Enterprise's Market Position	Likert Scale					Weighted Average	Number of Obtained Responses (Nmax = 24)
	1	2	3	4	5		
	Number of Indications						
legal changes	3	0	6	2	13	3.9	24
environmental restrictions	4	0	1	7	11	3.9	23
large foreign construction companies from outside Poland	0	6	4	12	2	3.4	24
legally and administratively inhibited development of RES technology (collectors and heat pumps)	0	6	0	7	3	3.4	16
other enterprises from the industry	0	4	12	4	3	3.3	23
lack of qualified managerial staff and employees	1	3	4	3	2	3.2	13
small, local construction companies	2	10	9	3	0	2.5	24

Source: own research.

All the investigated enterprises (24 enterprises—100%) indicated, as a serious threat to their competitiveness (in the context of potential, position, competitive advantage), a growing number of investments in the scope of designing and constructing PV farms carried out by large construction companies from outside Poland. In this case, the weighted average of all the evaluations on the five-point Likert scale amounted to 3.4. In addition, the investigated design and construction enterprises of PV farms identified high market concentration as a threat [29] in the group of energy corporations, which, in centralized energy, fulfil the function of, among other things, energy producers in conventional large-scale power plants as well as the function of transmission system operators or distribution system operators. In this case, the weighted average of all the evaluations on the five-point Likert scale amounted to 3.4. While analyzing the threats to the market position of their enterprises, all the respondents (24 enterprises—100%) perceived as potential competition other small, local construction companies. However, their influence compared to large corporations was evaluated at a much lower level, which is shown by the score 2.5 as the weighted average of all the evaluations on the five-point Likert scale.

In the opinion of the respondents, another factor that stimulates the competitiveness of design and construction enterprises of PV farms and is distinguished in Table 3 is competent managerial staff and qualified employees (23 enterprises, 95% of indications, weighted average of 3.8 on the five-point scale). Only 13 respondents representing the

investigated enterprises (54%) perceived direct threats to the market position to be driven by the lack of qualified managerial staff and employees. In this case, the weighted average of all the evaluations on the five-point scale amounted to 3.4.

4. Discussion of Results

The summarized indications and evaluations based on the five-point Likert scale pertain to strategic objectives, factors that condition development, and factors that stimulate competitiveness of design and construction enterprises of PV farms. As the next step, we aggregated and visualized on the radar chart (Figure 2) the factors that, according to the respondents, have the most significant impact on their development and increased competitiveness.

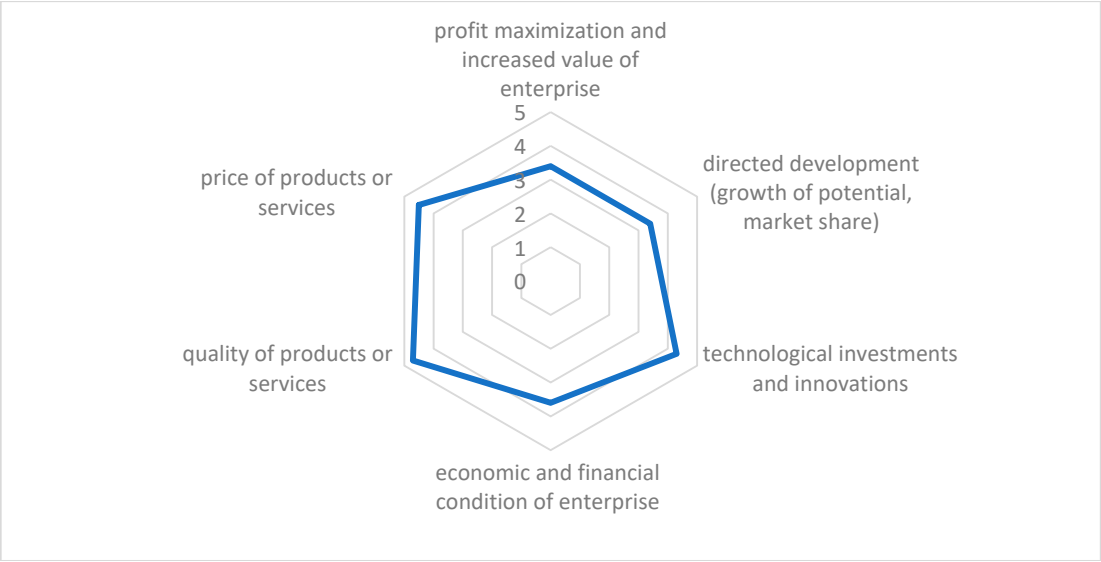

Figure 2. Vital factors that stimulate development and increased competitiveness of design and construction enterprises of PV farms—own research.

The qualitative and quantitative criteria for selecting the most significant factors that stimulate the development and increased competitiveness of design and construction enterprises of PV farms were the highest scores—weighted averages of respondents' evaluation on the five-point scale and number of respondents' indications $N \geq 22$ (over 90% of the investigated enterprises). Adopting these criteria justifies the introduction of vital factors into the portfolio, the ones that are directly related to the quality of products and services—designs and constructed PV farms (weighted average 4.7, number of indications 23 enterprises—95%) with a simultaneous correlation with reduced cost of investment (weighted average 4.5, number of indications 24 enterprises—100%). The stimulant of the growth in market value and competitiveness of the investigated enterprises also comprises technology transfer and innovation, especially investments into new, innovative technologies for photovoltaic farms (weighted average 4.3, number of indications, 22 enterprises—91%), with the consideration of new information technologies implemented in decentralized systems for energy management.

The portfolio of the most vital factors that significantly impact the development and competitiveness of the investigated enterprises in the opinion of the respondents also includes purely economic ones, related primarily to commercialization of products and services in the scope of designing and constructing photovoltaic farms. The three primary economic factors that were indicated by 24 enterprises (100% of indications) include: (1) directing the activity at increasing the share in the market of designing and constructing PV farms, (2) improved economic ratios, especially the improved financial condition of the enterprise, which may ensure that many design and construction investments are

carried out parallelly in the whole RES segment, (3) profit maximization and increase in the economic value of the enterprise.

It should also be stressed here that due to a relatively new area of operation of design and construction enterprises of PV farms, critical problems of these enterprises are being identified, which translate into their needs of support, frequently external support. In general, these needs include the following:

- business needs: branding and communication, customer insights, supplier relations, business models, value chain assessment, intangible and legal assets, and legislation;
- development needs: product design, packaging development, life-cycle assessment (LCA), and service design; and
- production and technological needs: energy optimization, material efficiency, other alternative materials, and IT.

The indication of these needs also justifies the need for research and therefore prospective changes. The investigated enterprises, due to the new area of operation, do not only expect external financial support, which has also been justified in the present paper, but also support in the scope of expert training pertaining to, among other things, transfer of product innovations and business processes, promotion, marketing research, and the segmentation of potential customers.

Finally, it is also worth pointing out that the role of photovoltaics as one of the leading energy sources in the EU's economy is growing alongside an increased share of PV in the electricity mix. For this reason, experts in the field emphasize the fact that it is of key importance for the European Union to develop its regional and local PV value chain. According to the recommendations of the European Solar Manufacturing Council (ESMC), as much as 75% of the PV installations should be manufactured in Europe. The Council also suggests that two thirds of production should be exported outside Europe. This would enable full utilization of the production in Europe by 2026. More importantly, the current trade deficit of PV cells and modules in the amount of 7.4 billion euros would turn into 50 million euros of local PV manufacturing value by 2026 with around 178,000 new jobs being created in the same period [30].

5. Conclusions

To sum up, the aggregated vital factors of development and competitiveness of design and construction enterprises of PV farms demonstrate, based on the indications of the survey respondents, that similarly to other segments of the energy market, the companies involved in the activity related to PV energy sources must strive for incessant improvement of their products and services, environmentally friendliness, and social acceptability, with a simultaneous full economic justification [31]. Moreover, it is worth pointing out that a stimulating factor for further development of the PV enterprises is that products and design and construction services provided by them are perceived in the general and societal perspective as innovative solutions, not only in the indicated technological area, but also in the business and process one. On the other hand, from the perspective of the energy market, narrowed down to the RES market, the design and construction enterprises of PV farms operate according to classic market rules, in which competitiveness depends on, among other things, the innovative potential of these enterprises and their competitive position on the market. This, in turn, is primarily conditioned by the financial condition and ability to incur higher external costs. The survey respondents also emphasize the role of competitive advantage, which, according to them, translates directly into the quality of products and services in correlation with their price being accepted by final customers—investors into RES farms.

Further research of the authors will investigate the similarities and differences between Polish design and construction enterprises of PV farms and the ones in other EU countries. This could provide valuable comparative data regarding motivating factors of their development as well as inhibitors of their successful operations on the scale of the whole European Union.

Author Contributions: Conceptualization, R.K. and G.C.; methodology, R.K. and G.C.; R.K.; investigation, M.S.; resources, R.K. and G.C.; writing—original draft preparation, G.C.; writing—review and editing, G.C.; visualization, R.K. and G.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data used in this study comes from own research, statistical data has been retrieved from publicly available websites that have been stated in the References.

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

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