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Assessment of the barriers towards more rapid development of solar power: the case of Lithuania

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Many countries in the world pay special attention to the development of energy from renewable energy sources. However, the efforts made are still insufficient to ensure the desired pace of development. Moreover, independence from fossil fuels is more important than ever in the context of the war in Ukraine. Solar-photovoltaic energy production solutions are particularly attractive for achieving the desired scale of development due to their relatively simple deployment. However, to involve a larger number of prosumers – individuals and communities, it is necessary to further reduce the barriers to such an activity. Although researchers pay considerable attention to the development of energy from renewable energy sources, the topic of solar energy is not so well explored. In addition, it is noted that research on barriers that prevent development should be linked to the situation in a particular country. Therefore, the goal of the research presented in this work is to assess the importance of solar-photovoltaic energy development barriers specific to Lithuania.

The literature review was carried out to consider specific barriers to solar energy development and to analyse barriers typical for the development of other sorts of renewable energy. This review allowed us to distinguish barriers relevant to more rapid solar-photovoltaic energy development in Lithuania, dividing them into five groups: (1) economic and financial, (2) policy and regulation, (3) institutional and administrative, (4) information, awareness, and social, and (5) technological barriers. An assessment of the barriers was based on the expert interview method. The individual evaluations of barriers and their rating determined their importance toward more rapid solar-photovoltaic power development in Lithuania. The results obtained during the research made it possible to single out the following main barriers specific to Lithuania: grid capacity and integration into electricity distribution grids; spatial planning and/or zoning rules; permitting, licensing, and approval procedures; changing and/or unclear policies; grid usage fees and their regulation; low electricity price and/or cost of other sources of electricity. In addition, insights into to the ways of their neutralisation or at least reduction were provided pointing out that it should be considered at both the state and municipal levels.

Keywords: renewable energy, solar power, solar-photovoltaic power, barrier, assessment

INTRODUCTION

The modern world is facing unprecedented challenges. Many of them, such as global warming and some geopolitical issues, are caused by dependence on fossil fuels. One of the means to reduce dependence on fossil fuels is a more rapid transition toward energy dominated by renewable energy sources. According to the European Sustainable Development Report [3], Lithuania's achievements in the field of sustainable development and implementing the goals set by the United Nations are not good enough. According to the Lithuanian Energy Agency, 27.36% of the final energy consumption in Lithuania was met by renewables while the target was set at 30% by 2020 [1]. Lithuania has set an even more ambitious target which is 45% of renewable sources in final energy consumption by 2030 [2]. The overall European Union goal is to reach at least 40% by 2030.

In the light of the dependence on fossil fuels of many countries of the world and European countries in particular, renewables have become even more important than ever in seeking to achieve energy independence, which is prioritised in the recent geopolitical context. In order to address the issues and achieve a strategic transformation, countries have to review the current situation and adapt it for the fastest possible transformation toward rapid renewable energy development. This can be achieved through the widespread deployment of renewable energy installations owned by prosumers: individual consumers and communities. Solar-powered energy generation is very attractive for becoming a prosumer because of the relatively easy deployment. Wind and solar energy are seen as particularly promising for electricity production in terms of future development [3] toward climate neutrality. Nevertheless, in Lithuania, solar-powered energy generation took only a small share of 5% of total electricity generated using renewables in 2020 [4].

Compared to other sources of energy, the transition toward renewables, in particular solar-photovoltaic power, has not been extensively analysed. The authors explore a wide variety of policies and their implementation, support models, the drivers fostering [5] and the barriers preventing faster transition [6] toward renewables. However, many studies are limited to one or a limited number of barriers [5] (shortage of grid capacity, process of permissions issuing, regulative issues, lack of information, etc.) without analysing a larger number of barriers and their impact on renewable energy development. In practice, the European Union is looking for solutions that could be universal and suitable for many countries. However, some authors point out that it is important to analyse the barriers in the case of each country [7]. This approach not only allows for the identification of common problems, but also overlooks important country-specific features that can be crucial for successful development. The latter single-country approach is applied by many authors who analyse wind energy [8], biomass waste [9], and combined wind and solar [3].

The study presented in this paper aims to fill the gap in the identification, systematisation, and assessment of the importance of barriers to solar-photovoltaic energy development specific to Lithuania. Taking this into account, the following problem is formulated: what are the main barriers to be eliminated or reduced considering their importance in seeking more rapid solar-photovoltaic energy development in Lithuania.

THEORETICAL SUBSTANTIATION OF THE MAIN BARRIERS TOWARD MORE RAPID SOLAR-PHOTOVOLTAIC ENERGY DEVELOPMENT

The development of solar-photovoltaic energy is understood as business development. However, researchers and practitioners have different understandings of business development. The latter primarily emphasise the pursuit of value creation for all parties involved [10]. Scientists maintain that business development, in addition to direct value creation, includes a preparation phase, characterised by analysis [11]. The authors also emphasise that business development decisions do not include strategic and specific decisions regarding the implementation of business opportunities [12].

One of the main tasks of the aforementioned analysis is to identify possible barriers to business development [13]. The understanding of barriers to business development has more consensus among different authors than the understanding of the development itself. The dominant definition

states that a barrier is something that prevents a new entrant from entering a market [14] and imposes costs that are not incurred by other businesses already operating in the market [13].

Also, many authors agree that to overcome barriers to renewable energy business development, it is first necessary to identify them [15] and then assess their importance [16]. A review of other studies has shown that there are a large number of potential barriers that could and it is worth grouping them. Some authors distinguish only three groups (financial, informative, and related to risk and uncertainty issues) [6] of barriers. Other authors distinguish more: four [17] or even five [7, 15] groups of barriers paying attention to financial, technical, regulative, awareness building, proper information spread, managerial issues, market failures etc. Depending on the most recurrent groups of barriers found in other studies and on the nature of these barriers, they can be divided into the following five groups: economic and financial barriers; policy and regulative barriers; a group of barriers attributable to institutional and administrative issues; a group of barriers attributable to informative, awareness building and social issues; technological barriers.

Economic and financial barriers. In many analysed studies, the authors distinguish a group of economic [15] and financial [6] barriers, which can include the following: high up-front investments [18], finance and economics of the project [19], financing of solar-photovoltaic projects [20], electricity price and cost of other sources of electricity [21]. The barriers of this group are very closely interrelated and at the same time have a potentially significant influence. The likely long payback period and not all groups of society having equal opportunities to invest are of particular importance for the penetration of technology [7].

The group of barriers that is most often distinguished is related to policy [15–17], activity regulation [7, 15], and associated institutional and administrative [7] issues. This group may fall into two groups separating higher level (policy and regulation) and a level of implementation (institutional and administrative issues) [22].

Policy and regulative barriers. The group of policy and regulation barriers consists of the following: government subsidies and incentives [19], a policy of support to other energy sources [20], changing and unclear content of the policies [23], lack of communication among stakeholders [24], and involvement in the development of energy policy [23].

Institutional and administrative barriers. The group of institutional and administrative issues associates with procedures of issuing permission, licence and approval [25], rules of spatial planning and zoning [26]. The barriers of this group are tightly related to the implementation of the policy measures on both state and municipal levels.

Informative, awareness-building, and social barriers. In addition, some authors emphasise information, awareness, and social (availability of skilled labour) [16] issues, which can include the following barriers: perception and acceptance of technologies [18], lack of skilled labour [24], shortcomings in management and lack of proper business skills [8], shortcomings in informing [27] various stakeholders, and lack of public and institutional awareness [28]. The growth of skilled labour is slow and lags behind the development of renewable energy. This causes concern and negatively affects solar-photovoltaic business [15]. It is worth mentioning that although the development of solar-photovoltaic energy has been going on for some time, there is a lack of developed business models in order to make this technology more popular among individual customers and communities for them to become prosumers [7]. Shortcomings in informing the stakeholders [29], and lack of public and institutional awareness [30] are also proved to be important by the results of other studies.

Technological barriers. The group of technological barriers [17] is also seen to be important [15] when considering more rapid solar-photovoltaic energy development [7]. This group is associated with the following barriers: grid capacity and possibilities to integrate the growing number of solar-photovoltaic projects [8], efficiency, and reliability of the solar-photovoltaic project [31]. Grid capacity and the possibility to integrate newly-built solar-photovoltaic power plants together with grid usage fee and its regulation are considered one of the most important technological barriers [5], as it can completely stop development. According to Mateo et al. [5],

smart grids and energy storage systems should be considered as alternatives to grid development.

In order to obtain as complete a picture as possible, all barriers identified as potential are included in the subsequent assessment. Grouping barriers according to their nature allows a large number of barriers to be systemised and the whole puzzle to be seen in a structured way. Structuring also makes it possible to identify more clearly which institution, organisation, or cooperation between them may be necessary to address the identified problem areas.

RESEARCH METHODOLOGY

Lithuania was chosen to assess the importance of the barriers in response to the recommendation found during the literature review that it is worthwhile to assess the barriers in a specific country. This allows to identify what works for a specific country instead of looking for universal but less impactful barrier-reduction insights. This single-country [32] case study approach adequately ensures reliability [33] of the study and responds to the goal to identify the main barriers to be eliminated or reduced when seeking more rapid solar-photovoltaic energy development in Lithuania.

Combining several research methods in the empirical study contributed to a more detailed exposure of the phenomenon and display of the research problem being solved [34]. The first method applied was external desk research analysing the national state of the art (public reports, statistics etc.) [35] trying to demonstrate the applicability and importance of the singled-out barriers to Lithuania. The external desk research method was coupled with the expert interview that was chosen to conduct barrier assessment. The reason was that only individuals with knowledge in this area could constructively discuss and evaluate the possible barriers to the development of solar-photovoltaic power plants. In addition, the experts had to be able to identify the barriers, if any, which were not identified during the literature review. Therefore, selection of experts was based on their expertise in the field [36] of renewable energy development, particularly focusing on solar-photovoltaic energy development. In the case of the method of the semiquantitative interview (requesting qualitative insights about the presence of other barriers and quantitative assessment of identified barriers), strict sampling rules are not applied [37]. Some authors believe that it is enough to interview three experts [38] to ensure the reliability of the results. Other authors indicate that five to seven experts [39] should be interviewed to ensure reliability and saturation of information. Therefore, six experts who are decision-makers (project, investment, strategic development managers, and CEOs) with no less than three years of experience in renewable, particularly focusing on solar-photovoltaic energy development participated in the interview. A Likert scale was used to evaluate the relative importance [40] of each barrier. This scale is an appropriate tool to assess the predefined [41] barriers.

An expert interview questionnaire consisted of three parts. The first part was dedicated to the assessment of the importance of each of 18 barriers and was based on a widely used Likert scale ranging from 1 to 7, where 1 is the least important, 4 is moderately important, and 7 is the most important. The second part asked experts to identify additional barriers, and the third part of the questionnaire aimed to prioritise barriers among one another in accordance with their importance from 1 to 18, where 1 is the most important. Later, the results of both assessments were recalculated by switching to a seven-point Likert scale.

The study was conducted following the recommendations provided by the European Code of Conduct on research ethics [42]. The data collected were prepared for analysis by coding to facilitate the identification of trends [43] and to draw generalisations and insights important for the study. The data were analysed using quantitative interpretation of the Likert scale and qualitative content analysis [40] to identify the prevailing understanding of importance of the identified barriers.

ASSESSMENT OF THE BARRIERS RELEVANT TO MORE RAPID SOLAR-PHOTOVOLTAIC ENERGY DEVELOPMENT: ANALYSIS AND DISCUSSION

The external desk research analysis showed that not all barriers identified during the theoretical review as potentially important were covered by the results of previously conducted research.

In addition, a number of the barriers analysed are similar or close in nature, but the full lists of barriers are not identical. However, the barriers could be assigned to one of the five groups of barriers according to their essence.

The results of the previously conducted research [44] show that the assessment of the relevance of the barriers classified as economic and financial varies from 4.17 (moderately important) to 6.67 (close to the most important) points. The lack of financial resources was identified as particularly important, even though the costs of solar-photovoltaic modules decreased more than twice from 2005 to 2020 [45]. Interview results obtained during the study show that economic and financial barriers are found not so important compared to previous study by Žičkienė et al. [44]. The importance of these barriers varies from 3.83 (high up-front investments close to moderately important) to 5 (both electricity price and cost of other sources of electricity are important). The financing of solar-photovoltaic projects (4.5) was evaluated as the second most important among the economic and financial barriers. However, this rating (4.5) is significantly lower than the similar barrier of scarce financial resources to support renewable energy sources and energy saving projects (6.67) [44]. This difference could occur since the barriers are not identical, and the priorities of the experts could also change due to the significantly changed environment.

Analysing the group of policy and regulation barriers, several previously conducted studies [44, 46] identified the importance of the lack of communication among stakeholders and involvement in the development of energy policy. The barriers attributable to these issues were rated from 4.67 to 6.17. The importance of the barriers attributable to changing and/or unclear policies was rated as less important. The importance of these barriers varies from 3.07 to 5.79 (close to very important). It is worth mentioning that the barriers related to the engagement of municipalities in the policy development and consideration of the competence of municipalities in their abilities to implement policy measures were among the most important in the given group. Interview results identified quite similar outcomes. The importance of the barriers of this group varies from 2.67 (policy of supporting other energy sources) to 5.5 (changing and/or unclear policies). Lack of communication among stakeholders and involvement in the development of energy policy together with limiting and not fully adopted policies were given the same score of 4.67. The limiting and not fully adopted policies was the barrier that was not identified during the literature review and emerged during the interviews.

The group of institutional and administrative barriers was covered by the study prepared by the Ministry of Energy [46] focusing on the regulatory obstacles from the perspective of electricity prosumers. The permission issuance process was rated 4.21, and the restrictions on land use received a higher score of 5.43. The latter barrier received almost the same rating from the experts (5.5). Meanwhile, the experts rated spatial planning and/or zoning rules as the most important barrier within this group: it received a score of 5.83. This difference in assessment may be due to the fact that experts are better informed and have a broader understanding compared to professional users.

The results of the previously conducted research [44] show that the assessment of the importance of the barriers classified as information, awareness, and social barriers varies from 4.33 to 4.67 points. In addition, these barriers are mainly attributable to shortcomings in information and a lack of public and institutional awareness. Based on the experts' interview results, a lack of skilled labour was singled out as the most important barrier within the group, with a score of 4.67. Other barriers were rated as less important. The rating varies from 3.33 (perception and acceptance of technologies) to 4.67 points.

The last but not the least is the group of technological barriers. One of the barriers in this group, grid capacity and integration into electricity distribution grids, is discussed in several studies that consider the Lithuanian situation. The key outcome of the discussion is the technically poor status of some parts of the existing grid [46]. The importance of the barrier of grid capacity and integration into electricity distribution grids received a score of 4.67. The barriers of the technological capabilities to connect new solar-photovoltaic power plants and the efficiency

and reliability of the plants were not evaluated. In addition, grid service usage fees and their regulation were identified as a new possible barrier. Based on the experts' interview results, the latter barrier received a score of 5.33. This identifies the relevance of this newly distinguished barrier. The barrier of the grid capacity and integration into electricity distribution grids received a score of 6.5. This score is the highest among technological barriers and much higher compared to the assessment made in the previous study. With the experts' score of 3, the efficiency and reliability of the new solar-photovoltaic power were found not so important. One of the experts drew attention to the decreased installation speed and increased prices due to changes in global demand and supply chains. The expert rated this barrier with 5 points.

As mentioned earlier, the experts rated all the indicated barriers from the most to the least impactful. Therefore, a barrier named in one of the interviews does not fall under the assessment covered by all experts. The Figure shows a comparison between the barriers assessed individually and the overall assessment of importance comparing the barriers between themselves.

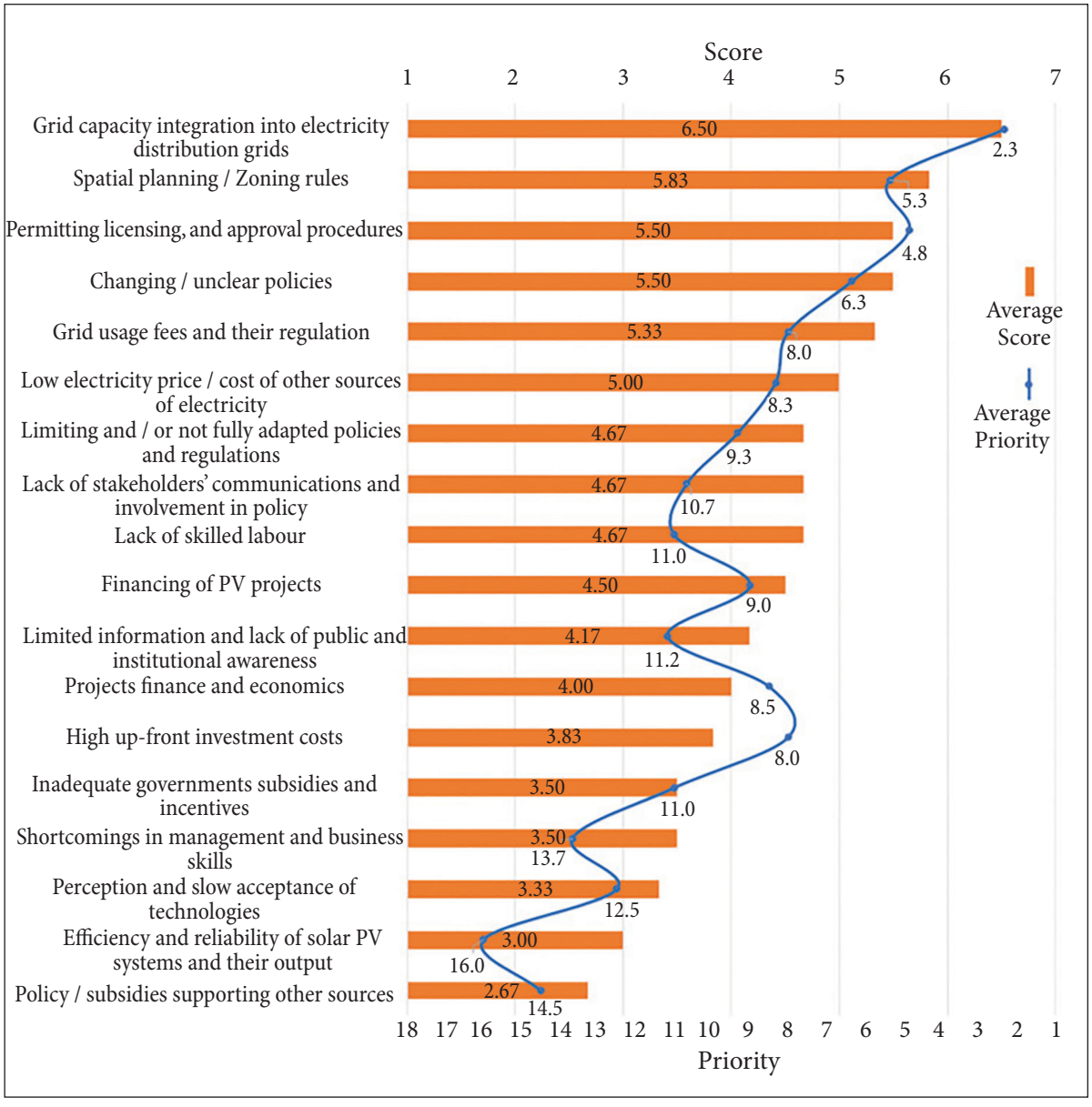

Figure. Comparison of expert assessment of barriers individually and all at once

When comparing the results of both evaluations, it is important to note that the assessment of the importance of the first five barriers in both evaluations coincided. A few inconsistencies can also be noticed. Two barriers, lack of skilled labour and lack of communication among stakeholders jointly with the involvement in the development of energy policy, appeared to be more important when evaluated individually by the experts than when they were later ranked among themselves. However, these barriers remain moderately important. This was shown by the calculation performed after the scales of 1 to 7 and 1 to 18 were levelized. Another somewhat larger inconsistency is seen with the barriers of high up-front investments and the finance and economics of the project. Although these two barriers were not individually assessed as very important, their relative importance became evident when comparing the barriers with each other. This could happen because the cost of solar-photovoltaic technology is decreasing. At the same time, the project needs to accumulate significant financial resources or borrow from financial institutions that promise to raise loan interest rates.

It is clear that removing or at least reducing all the barriers analysed toward more rapid solar power development requires a considerable effort and time. Therefore, it is imperative to start from the most important barriers, which are the following: grid capacity and integration into electricity distribution grids; spatial planning and/or zoning rules; permitting, licensing, and approval procedures; changing and/or unclear policies; grid usage fees and their regulation; low electricity price and/or cost of other sources of electricity. It is worth observing that none of the information, awareness, and social barriers were rated among the most important.

It is necessary to note that overcoming the most important barrier, grid capacity and integration into electricity distribution grids, requires not only time and effort, but also financial resources. The elimination of this barrier is also influenced by the presence of other barriers. For example, the challenges of the global supply chain can have a significant impact. Some barriers cannot be overcome by the efforts of Lithuania alone. Among these, we can mention the price of electricity, which depends heavily on changes in fuel markets. Overcoming other barriers, such as policy and regulation, may require the involvement of many groups of stakeholders.

However, many barriers identified as the most important, such as spatial planning and/or zoning rules, permitting, licensing, and approval procedures, changing and/or unclear policies, and grid usage fees and their regulation can be overcome through local efforts.

CONCLUSIONS

Even though the share of energy from renewable sources in the total amount of energy consumed is growing, this growth is not sufficient to become independent from fossil fuels. The share of solar-photovoltaic energy among the electricity produced in Lithuania is still very small, although this type of energy production is attractive to prosumers due to its simple deployment. One of the reasons for the slower than desired development of solar-photovoltaic energy in Lithuania is the barriers that must be eliminated or at least reduced.

A comprehensive literature review made it possible to compile a list of barriers relevant to more rapid solar-photovoltaic energy development and divide them into five groups: economic and financial (high up-front investments, finance and economics of the project, financing of solar-photovoltaic projects, electricity price and cost of other sources of electricity); policy and regulation (government subsidies and incentives, a policy of supporting other energy sources, changing and unclear content of the policies, lack of communication among stakeholders and involvement in the development of energy policy); institutional and administrative (procedures of issuing permission, licence and approval, rules of spatial planning and zoning); information, awareness and social barriers (perception and acceptance of technologies, lack of skilled labour, shortcomings in management and lack of proper business skills, shortcomings in informing and lack of public and institutional awareness); technological (grid capacity and possibilities to integrate the growing number of solar-photovoltaic projects, efficiency and reliability of the solar-photovoltaic project). The first stage of the empirical research confirmed the relevance

of the singled-out barriers for Lithuania. After this research stage, the group of policy and regulation barriers was complemented by the barrier of limiting and not fully adopted policies.

The research conducted suggests that most of the barriers are very or moderately important to more rapid solar-photovoltaic development, but the barriers of four groups (economic and financial; policy and regulation; institutional and administrative, technological) were rated among the most important. Two barriers each from the institutional/administrative and technological barrier groups were classified as the most important. The barrier of a grid capacity and integration into electricity distribution grids was rated 6.51, spatial planning and/or zoning rules 5.65, permitting, licensing and approval procedures 5.57, and grid usage fee and their regulation 4.93.

The barriers arising from the grid situation may be solved through a network upgrade and reinforcement, a transformation toward a smart grid, and a faster development of new energy storage systems. It is worth mentioning that transparent and easily accessible information on the possible grid connection points and further development of the grid would significantly improve the level of information. Preparation and approval of spatial development plans that clearly identify the areas of potential location of solar-photovoltaic projects and public disclosure of the plans would contribute to more rapid solar-photovoltaic energy development. In addition, analysis of administrative processes and their optimisation seeking to solve the most critical and time-consuming issues making them easier and faster to overcome would significantly lessen the institutional and administrative burden.

The study can be replicated in other countries, which also aim to facilitate more rapid solar-photovoltaics development. It would also be valuable to conduct a comparative analysis that could reveal the scope of similarities among different countries. This would enable synergies to be exploited in similar problem areas. It would also be worth considering the possibility of developing and adopting pan-European solutions. The conducted study is valuable on both national and municipal levels. The results of the study provide important information for measures of state policy needed to reduce the existing barriers. This would help to accelerate the achievement of renewable energy development goals and reduce dependence on fossil fuels. However, in order to achieve the objectives set by the state, municipalities also need to be involved as they are responsible for important issues such as the territorial planning and related activities. Decisions at both levels, national and municipal, will create the conditions to attract new investment in innovation and high-tech activities.

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KLIŪČIŲ, TRUKDANČIŲ SPARTESNEI SAULĖS ENERGIJOS PLĖTRAI, VERTINIMAS REMIANTIS LIETUVOS PAVYZDŽIU

Santrauka

Daugelis pasaulio šalių skiria išskirtinį dėmesį atsinaujinančių išteklių energijos plėtrai. Tačiau dedamų pastangų vis dar nepakanka norimam plėtros tempui užtikrinti. Be to, nepriklausomybė nuo iškastinio kuro yra kaip niekada svarbi karo Ukrainoje kontekste. Saulės fotovoltinės energijos gamybos sprendimai dėl sąlyginai paprasto diegimo yra ypač patrauklūs siekiant kuo didesnio plėtros masto. Tačiau norint, kad įsitrauktų didelis gaminančių vartotojų skaičius, būtina dar labiau sumažinti tokią veiklą apsunkinančius barjerus. Nors atsinaujinančių išteklių energijos plėtros temai tyrėjai skiria gana daug dėmesio, vis dėlto saulės energijos tematika šio dėmesio stokoja. Be to, pažymima, kad plėtrą apsunkinančių barjerų tyrimus verta sieti su konkrečios šalies situacija. Todėl šiame straipsnyje pristatomo tyrimo tikslas yra nustatyti pagrindinius saulės fotovoltinės energijos gamybos plėtrą apsunkinančius barjerus, kad būtų galima paspartinti šios energijos gamybos plėtrą Lietuvoje.

Siekiant minėto tikslo atlikta literatūros apžvalga, kuri leido išskirti penkias plėtrą apsunkinančių barjerų grupes: ekonominių ir finansinių; politinių sprendimų ir reguliavimo; institucinių ir administracinių; informavimo, žinomumo ir socialinių bei technologinių. Kiekvienai grupei priskirti Lietuvos atvejui būdingi barjerai ir atliktas barjerų vertinimas nustatant jų svarbą spartesnei saulės fotovoltinės energijos įveiklinimo plėtrai. Tyrimo metu gauti rezultatai leido išskirti Lietuvai būdingus pagrindinius ir svarbiausius barjerus – tinklo pajėgumai ir integravimas į elektros skirstomuosius tinklus; teritorijų planavimo ir (ar) zonavimo taisyklės; leidimų išdavimo, licencijavimo ir patvirtinimo procedūros; besikeičianti ir (ar) neaiški reguliacinė aplinka, politiniai sprendimai; mokėjimai už naudojimąsi tinklu ir jų reguliavimas bei elektros energijos kaina ir (ar) kitų elektros energijos šaltinių kaina – ir pateikti praktines jų neutralizavimo ar bent jau sumažinimo įžvalgas.

Raktažodžiai: atsinaujinanti energija, saulės energija, saulės fotovoltinė energija, barjeras, vertinimas