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Sustainable Energy Development and Climate Change Mitigation at the Local Level through the Lens of Renewable Energy: Evidence from Lithuanian Case Study

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Abstract: The penetration of renewable energy is one of the main challenges for sustainable energy development. Local governments across the European Union commit to development and implementation of the Sustainable Energy (and Climate) Action Plan. This paper focuses on the case of Lithuania—a Central and Eastern European country. Almost one-third of Lithuanian municipalities have joined the Covenant of Mayors and prepared the plans that include SWOT analysis. However, there is a lack of information on how those plans contribute to climate change mitigation and sustainable energy development. This study identifies the links between key policy financial instruments, increasing energy efficiency. The Strategic Action Plans aimed at reducing GHG emissions and energy consumption in Lithuanian municipalities are analyzed. The challenges in promoting the renewable energy generation in Lithuanian rural regions are discussed. Moreover, the importance of strengths, weaknesses, opportunities, and threats identified is elicited at the local level. The study uses a combination of methods, such as expert surveys and SWOT analysis, that complements the tools used for regional energy climate planning and allows for overarching analysis. The expert survey shows that priority is given for renovation of buildings and modernization of energy infrastructure, making them more sustainable and more energy efficient. The results also show that, in the case of Lithuania (and possibly elsewhere in the post-Soviet countries), conditions and opportunities should be created beforehand to increase energy efficiency. Once this is achieved, the policies should focus on energy transition by switching to sustainable energy resources.

Keywords: sustainable energy development; financial instruments; SWOT; energy efficiency; local level

1. Introduction

The penetration of renewable energy is one of the two main challenges for sustainable energy development. There have been studies on energy planning across different regions [1–4]. The European Commission supports the development of sustainable energy in the regions, including both: promotion of the use of energy from renewable sources and encouragement of improvements in energy efficiency leading to climate change mitigation. The European Green Deal Communication launched a new growth strategy for the EU that aims to transform the EU into a fair and prosperous society with a modern, resource-efficient, and competitive economy. Achieving these targets leads to the EU’s headline target for sustainable energy development set by Climate and Energy package three targets: 20% cut in greenhouse gas emissions (from 1990 levels), 20% of EU energy from renewables, and 20% improvement in energy efficiency. Key targets set by Climate
and Energy framework for 2030 are: at least 40% cut in greenhouse gas emissions (from 1990 levels); at least 32% share of renewable energy and at least 32.5% improvement in energy efficiency. As part of the European Green Deal, the Commission proposed in September 2020 to raise the 2030 greenhouse gas emission reduction target, including emissions and removals, to at least 55% compared to 1990.

The local government plays a crucial role in implementing the major objectives of the renewable energy transition. Indeed, local government is often responsible for local heating systems and construction plans that, eventually, relate to the energy production and consumption. Moreover, the decisions taken at the local level influence business operation [5] and pollution [6]. Therefore, the local governments play an important and versatile role in the energy and environmental planning.

In order to achieve and exceed the EU climate and energy targets, the Covenant of Mayors was launched in 2008 in Europe. When joining the Covenant of Mayors, local governments commit to developing and implementing a Sustainable Energy (and Climate) Action Plan. There are several studies dedicated to the analysis of Sustainable Energy (and Climate) Action Plans implemented in various countries; however, framework for the analysis of these plans is necessary in order to systematize and compare the main policies and measures at local level as different municipalities are following different approaches.

Almost one-third of sixty Lithuanian districts have joined the Covenant of Mayors and prepared the plans; however, these plans require deeper analysis to be integrated in state policies promoting energy efficiency and use of renewables and climate change mitigation in Lithuania. The paper aims to analyze Sustainable Energy (and Climate) Action Plans conducted in Lithuanian municipalities by applying the developed framework aiming at systematizing of implemented measures and to perform SWOT analysis of energy efficiency and use of renewables and climate change mitigation on local level based on Lithuanian case study. This will be useful for regional energy and climate planning in Lithuania and other Central and Eastern European countries. The SWOT approach has been applied in energy planning studies across different regions [7,8] and combined with multi-criteria analysis [9,10]. In this study, we follow a strand of more qualitative nature as we seek to derive an overarching SWOT analysis combining similar analyses used for developing Sustainable Energy (and Climate) Action Plans in Lithuanian municipalities.

The paper is structured in the following way: Section 2 reviews literature on the policies to promote energy efficiency and renewables, amid the climate change mitigation considerations at the local level. Section 3 presents methods and data. Lithuanian case study is discussed in Section 4. Conclusions and policy implications are provided in Section 5.

2. Literature Review

Sharp et al. [11] see the climate change initiatives at a local level more as a result of a pressure from the central government or interest groups, but not as an environmental consciousness of citizens. Harker et al. [12] offers to change it by introducing a multi-level governance of climate change policies with significant empowerment of local authorities. This is supported by Costa [13], who sees new multi-level governance mechanisms as a suitable tool for achieving climate change mitigation goals among local communities. Markkanen and Anger-Kraavi [14] draw attention to social and economic outcomes at the local level of climate change mitigation policies, which may be harmful to particular more vulnerable parts of the society. The manifestation of negative effects of climate change mitigation measure may compromise these initiatives in the eyes of citizens. It is supported by Palermo et al. [15], who analyzing the policy implications of the Covenant of Mayors initiative conclude that local transformation to a more climate neutral approach may be sustainable if the local citizens clearly experience its benefits. The theoretical foundations for expansion of the renewable energy sources in local areas have been proposed by del Rio and Burguillo [16]. The potential energy mix of RES for rural regions has been
discussed by Woldeyohannes et al. [17]. Benedek et al. [18] go further proving, that development of RES in rural regions can be one of the drivers for the economic development. The motivation of local communities to act in favor of climate change mitigation is focal to Ramos-Castillo et al. [19]. Aguiar et al. [20] state that local community’s inclination toward climate change mitigation is also influenced by the severity of climatic anomalies (severe floods, droughts, etc..) it is prone to experience. Funfgeld [21] propose a new revolutionary way of coordination of climate change actions at local level—a multinational local networks, where the main executive role would belong to local community network instead of centralized authority.

Another theoretical sprout is aimed at evaluating local climate change plans. Tang et al. [22] found that although most of local climate change mitigation plans typically show high awareness level, they rarely contain specific measures and performance indicators to follow. Quite contrary findings were revealed by Damsø et al. [23] who argue that local climate action plans are versatile documents providing both directions and specific targets to be met by each local community to achieving climate change mitigation goals.

Duguma et al. [24] propose a new land use practice as a way to solve climate change goals in rural communities. Gil et al. [25] propose new agricultural strategies, especially related to manure management and the use of nitrogen fertilizers as a way to lower environmental impact on the local rural communities. Tang [26] recommend increasing the biodiversity as a possible climate change mitigation strategy in rural environment. Christis et al. [27] suggest a wider implementation of circular economy at the local level as a tool for achieving climate change goals.

The climate change mitigation in cities has become one of the most important indicators in ranking cities achievements, sometimes even considered at pair with its economic performance [28]. Due to different issues faced, such as heat island mitigation [29], challenges posed by a traffic congestion [30], residential heating and its losses [31], etc., the literature on climate change mitigation in urbanized localities have evolved into a different theoretical course and significantly diverged from the overall literature on the climate change mitigation efforts at local level. This is also due to the fact that urban localities are considered to have one of the best environments to quickly transform to climate neutral economic systems or at least to significantly moderate the negative impact of climate change [32]. In addition, it is considered that municipal councils are more effective in implementing climate change mitigation measures in their respected areas compared to more centralized central government agencies due to higher flexibility, greater local knowledge, situation awareness [33], and possession of social bonds with local opinion leaders [34,35].

Climate change actions in urban areas are relevant through the lens of improving public health [36–39] or public security [40]. Campbell-Lendrum and Corvalán [41] investigate the specific public health risk factors, associated with climate change and possible solutions.

The policy measures and possible actions of governments of local cities aimed at reducing GHG emissions in cities dominate Khreis et al. [42] research. Good governance practices helping to reduce GHG’s in cities are presented by Bulkeley et al. [43]. The actors, who should participate in implementation of climate change mitigation actions in cities, and their roles are focal in Landauer et al. [44] research. This research approach is supported by Brown [45] who provides a clearly defined, both administrative and socially motivated roles of government actors involved in increasing climate change-oriented actions. The importance of involvement of all the stakeholders in climate change mitigation actions in urban locations is investigated by Holgate [46]. Symonds et al. [47] provide a novel tool for quantifying GHG’s emissions in cities and show its usefulness in policymaking.

The social dimension of the climate change mitigation policies is also represented in research. Campbell-Lendrum and Corvalán [41] found that measures lowering climate change impact in cities positively affect the social stratification and equity in a society, as
in urban localities less affected by a severe consequences of pollution and GHG emissions there is less motivation to richer people to relocate into suburbs or other places with healthier environment. Leal Filho et al. [48] even proves that properly undertaken transformative actions in cities may not only significantly reduce environmental footprint of the particular urban locality, but also help to solve sharp socio-economic problems, such as eradicating poverty, social exclusion, discrimination.

Various urban planning approaches, helping to reduce environmental impact are also in focus of scientific research. Nero et al. [49] observe an increase in urban green as a possible solution for climate change mitigation issues within city limits. Challenges arising in the process of implementing measures aimed at reducing urban heat into legislative urban planning documents are mentioned by Corburn [50].

Problems of citizens’ engagement into climate change mitigation actions in cities are also investigated. Sethi et al. [51] show that more than ¾ of all possible GHG abatement solutions in urban locations are related with the demand side. This insight positions citizens as the main determining actors in lowering environmental footprint of cities. Sarzynski [52] offers a multi-level governance as a tool for overcoming initial negative attitudes toward climate change mitigation actions. This view is supported by Engberg [53] providing solid empirical evidence. Community-government partnership is preferred by Iftikhar et al. [54]. The use of social networks in promoting environmental awareness of urban citizens is documented by Sari and Prayogo [55].

Economical aspects of promoting climate change mitigation actions in cities are focal to Junghans and Dorsch [56]. Financing issues are revealed by Peterson [57]. The need for entrepreneurial activities in lowering urban environmental footprint is stressed by Nino and Burch [58] (2018). The strategies, how to make the transition to low carbon cities economically attractive are described by Gouldson et al. [59]. The main milestones in the development of the knowledge of possibilities of climate change mitigation at the local level are presented in Table 1.

| No. | Reference | Main Contribution |
|-----|-----------|--------------------|
| 1   | [46]      | A more holistic approach, involving a broader spectre of stakeholders into the climate change mitigation is proposed. |
| 2   | [16]      | Theoretical foundations for sustainable implementation of renewable sources in local areas. |
| 3   | [50]      | Reveals legitimation issues in the promotion of climate change mitigation. |
| 4   | [24]      | Introduction of new land use practices aimed at decreasing climate change effect in rural regions. |
| 5   | [21]      | This study starts a discussion about significant power shift from central to local authorities in the execution of climate change mitigation activities. |
| 6   | [18]      | Revealed the potential of RES to became a driver for the economic development. |
| 7   | [20]      | Discloses some of the most important intrinsic motives for local communities to participate in climate change mitigation activities. |
| 8   | [45]      | The demarcation of roles and responsibilities of all actors responsible for climate change mitigation at local level. |
| 9   | [14]      | Novel insights on the previously neglected negative outcomes of climate change mitigation policies. |
| 10  | [13]      | Introduction of novel government—local municipalities interaction mechanisms aimed at promoting a green energy. |
| 11  | [15]      | Solidifies understanding that climate change mitigation is possible only with presentation of its benefits to local communities. |
3. Methods and Data

As the study aims to determining how GHG reduction strategies are being developed at the municipal level, what are the main obstacles to their implementation, the research methodology includes several studies.

First of all, using systematic and comparative literature analysis, the GHG reduction plans of Lithuanian municipalities are evaluated. The evaluation of the above-mentioned plans resulted in a SWOT analysis that highlights the greatest strengths and weaknesses. The SWOT analysis is quite often used as a research tool in an academic research [60] applied in such complex areas as digital business [61], hydrology [62], higher education [63], as well as in climate change-related studies [64,65] (Pesonen and Horn, 2014; Wang and Li, 2016). In addition, in order to assess the support, regulatory, and other measures applied at the municipal level to reduce GHGs, all measures used at the municipal level in Lithuania were summarized.

A questionnaire was developed in order to determine the appropriateness of the elements of the SWOT analysis and to find out which of the strengths, weaknesses, opportunities, and threats are the most important in Lithuania and at the municipal level, and to determine which financial and regulatory measures are most appropriate at the municipal level.

The questionnaire for the experts listed all the strengths, weaknesses, opportunities, and threats identified in the study and asked the experts to rate them from 1 to 7, with 1 being the least significant and 7 being the most significant. The effectiveness and appropriateness of GHG reduction measures in municipalities were also asked to be assessed. Evaluations also used a Likert scale from 1 to 7, with 7 being the most effective measure. The expert group consisted of six people, three of whom were researchers (working in the field of GHG assessment for at least 5 years) and three randomly selected municipal employees (from geographically different territories of Lithuania) who prepared or participated in the preparation and implementation of GHG reduction plans for the municipality. According to the requirements, there are not so many experts in this field in Lithuania, therefore six strong experts were enough to determine the depth of the problem, the efficiency rating of SWOT statements and measures. According to [66], six experts are sufficient to achieve an accuracy of at least 90%. After receiving the completed questionnaires, both the SWOT statements and the measures were ranked and a relatively high compatibility of the respondents was established, which does not allow us to doubt the reliability of the study and the experts. The ranked strengths, weaknesses, opportunities, and threats allowed to supplement the theoretical information and determine the depth of the problem, to adjust the SWOT, while the ranking of measures allowed to check and compare the main theoretical and practical differences in Lithuania and the post-Soviet region as a whole.

3.1. Analysis of Sustainable Energy Action Plans: Lithuanian Case Study

Lithuania (65.3 thousand km², ca. 3 million inhabitants) is divided into three layers of administrative divisions. The first-level division consists of ten counties, which are subdivided into 60 municipalities (out of which 9 are city municipalities), which in turn are further sub-divided into over 500 smaller groups, known as elderships. Out of them only the municipalities are self-governed and the mayor is selected directly by the residents in a majority vote in run-off election. Municipalities compile and approve their own budget. The functions of municipalities are related to local government, public administration, and provision of public services. In the area of energy development municipalities:

1. Prepare and, in coordination with the Government or an institution authorized by it, approve and implement action plans for the development of the use of energy from renewable sources (taking into account the minimum targets set by the government for the use of energy from renewable sources).
2. When organizing the supply of heat energy in its territory, seek to use renewable energy resources for the production of heat energy.

3. Taking into account the national transport plan, develop sustainable mobility plans, promoting the development of cycling infrastructure, encouraging public use of public transport, reducing the negative impact of transit flows on urban transport systems, developing and modernizing urban and suburban bypasses, planning financial funds for the renewal of vehicles and the purchase of clean vehicles.

4. Develop and implement public information and awareness-raising measures, provide advice and develop training programs on the practical possibilities and benefits of developing and using renewable energy sources.

These competences and responsibilities of the municipalities are practically reflected in the main country’s document for the energy development—National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030 [67], which was prepared by the national government, which was prepared by the national government on the basis of Regulation (EU) 2018/1999 of the European Parliament and of the Council on Energy Union and Climate Action (11 December 2018).

Municipalities also make an important contribution to reducing GHG emissions through their participation in the Covenant of Mayors—an initiative, which contributes to (1) reducing greenhouse gas emissions in a certain territory, (2) increasing resilience and preparing for the adverse impacts of climate change, and (3) tackling energy poverty as one key action to ensuring a just transition [68]. In Lithuania 16 municipalities have joined the Covenant of Mayors and 14 of them have prepared sustainable energy action plans for their territories [69]. Plans of all non-city municipalities (11 in total) have been included in this study as they are the main target of this research.

A thorough analysis of Sustainable Energy (and Climate) Action Plans of Lithuanian local governments (Covenant of Mayors) has been performed to ground the further steps of the evaluation of the effectiveness of those plans. Four main groups of measures, dominating in energy plans of municipalities, can be distinguished:

1. Measures to increase energy efficiency;
2. Measures to increase the share of RES in the fuel/energy balance;
3. Measures in the transport sector;
4. Measures in education and training;
5. Other measures.

The increase of the share of RES in the fuel/energy balance is planned to be achieved via acting in two directions. First, a significant share of resources will be allocated to reconstruction and renovation of boiler-houses in order to transform them to reduce the share of fossil solid resources used for fuel by replacing it with biofuels [70–75]. Second, RES power plants are (are going to be) constructed. The analysis of the plans revealed that wind power plants are the most popular alternative of RES and are/will be constructed in the majority of Lithuanian districts, participating in the Covenant of Mayors [72,75–78]. The plans to develop other RES (solar power plants, geothermal energy systems, hydroelectric power plants) are expressed only in a few districts. However, it must be mentioned that investments in solar energy in Lithuania is getting more and more popular among individual investors. A number of private small-scale solar power plants (up to 30 kilowatts (kWh)), whose electricity can be sold to electricity grids, has been growing very fast in the last decade. This tendency has been stimulated by an attractive electricity purchase rate for small-scale solar plants. Such an investment pays off in about seven years. The development of solar collectors in individual houses is also increasing fast, especially since governmental support has been provided for installation of them.

The other broad group of measures comprises means to increase energy efficiency. One of the most important measures is modernization of the districts’ heating and electricity generation sector (modernization of heating networks (pipelines) to ensure smaller heat losses, installation of economizers, replacing old boilers with the ones more efficient
from an ecological and economic point of view, etc.). The other important direction in increasing energy efficiency is through renovation of buildings: reconstruction of the buildings of municipality budgetary institutions, aiming to increase energy efficiency, renovation, and/or reconstruction of heating and hot water supply systems of these buildings; and renovation of residential multi-apartment buildings, increasing their energy characteristics. The third direction of energy saving has been implemented by modernizing urban street lighting systems: mercury lamps will be changed by frugal light sources, and automatic control systems for outdoor lighting will be embraced. All these measures have been foreseen in the plans of all the districts.

Measures in the transport sector include (1) increasing the share of renewable energy sources in transport through fuel blending, and (2) improving energy efficiency in public transport (replacement of morally and physically worn-out buses with buses complying with EURO-2, EURO-3, EURO-4 standards; and purchase of hybrid public transport buses).

The other (supplementary) measures in Sustainable Energy (and Climate) Action Plans are mainly devoted to encouraging people to travel in a sustainable way, saving fuel, etc. This is done mainly by installation of bicycle paths. Several districts also emphasize the importance of educating people and allocate financial funds for systematic dissemination of information and education activities, distribution of educational materials, sharing and dissemination of good practices and other activities [70, 71, 75, 77, 79].

If the above-mentioned measures are implemented, the emissions in individual municipalities could be reduced by as much as 63% (in Elektrėnai municipality).

The majority of the measures described in Sustainable Energy Action Plans (measures to increase energy efficiency, measures in the transport sector and supplementary measures) are not directly related to agricultural sector (Table 2). However, agriculture is important for implementation of the first group of measures, increasing the share of RES in the fuel/energy balance, especially where biofuels are concerned. Agricultural sector is one of the main providers of biomass, necessary for production of biofuels. Agricultural production wastes (manure, feed residues, animal carcasses, plant residues) and energy crops (corn and perennial grass silage, sugar beet or fodder beet) are typically used for biogas production. Biomass energy resources can be supplemented with straw, which can be burned directly in boilers or used for the production of biofuels (pellets and briquettes).
Table 2. Main measures for the climate change mitigation foreseen in Sustainable Energy Action Plans of Municipalities of Lithuania.

| Measures                                                                 | Municipalities                                                                 |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Reduction of energy consumption in buildings                              | Kaunas                        | Akmenė | Jurbarkas | Anykščiai | Elektnai | Pakroja | Trakai | Utena | Vilkaviškis | Šiauliai | Šilutė |
| Building renovations                                                      | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| in municipal budget institutions for indoor lighting                      | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Cost-effective lighting schemes                                           | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Embracing frugal light sources and automatic control systems for outdoor lighting | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Electricity savings in residential buildings by using frugal lighting and energy efficient appliances | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Modernization of the heating and electricity generation sector in the district | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Installation of economizers in boiler houses using natural gas for heat production and thus reducing fuel consumption | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Renovation of heating networks to reduce heat loss                         | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Modernization of boiler houses—changing usage of fossil solid fuels (coal, shale oil) into biofuels | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Reconstruction-modernization of small boiler houses of budgetary institutions by changing the type of fuel used: from solid fuel to biofuel | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Wind power plants                                                          | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Solar power plants                                                         | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Geothermal energy systems                                                  | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Biogas cogeneration plants                                                | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Hydro-energy plants                                                       | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Construction of RE power plants                                           | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Acquisitions of new and ecological public transport                       | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Installation of cycling paths                                             | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Transport measures                                                        | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Training of the specialists of municipal budget institutions              | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Systematic information-educational activities, dissemination of educational material, dissemination of good practice | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Afforestation                                                             | +                             | +     | +         | +         | +        | +       | +      | +     | +         | +        | +     |
| Note: the district municipalities are considered (as opposed to the city ones). Source: [80]. |
Large amounts of agricultural wastes may encourage large farms (especially livestock, pigs and poultry) to install biogas production generators. However, the production of biofuels, although increasing, is still quite low and should be stimulated [67]. Other forms of the usage of RES in agricultural sector are very rare. Moreover, there is a serious lack of attention in the plans of municipalities of how to encourage the usage of RES in this sector.

3.2. Swot Analysis of Sustainable Energy Use and Renewable Energy Sources at the Municipality Level

Sustainable energy and renewable energy sources (RES) development is regarded as one of the priority directions of Lithuanian Energy Strategy [67]. The basic legal framework and support system are set up for the development of RES. There is a well-developed energy infrastructure for the development of renewable energy. These factors stimulated the formation of the market of renewable energy. Due to increasing energy demands for the business development and growing prices of imported energy (according to EUROSTAT data, Lithuania’s energy dependency rate in 2020 was almost 75%), energy companies and various businesses are interested in investing in sustainable energy and renewable energy projects. Highly qualified specialists work in all branches of the energy sector thus enabling implementation of high-quality RES projects. All these factors have stimulated the development of RES in Lithuania (in the period 2010–2019 the share of energy from renewable sources has grown from 19.6% to 25.5%).

On the other hand, this development could have been faster. For example, according to the Ministry of Energy of the Republic of Lithuania [81], in 2018 there were 40 biogas power plants operating in the country, while the European Commission’s Joint Research Center argues that depending on the amount of manure accumulated and collected, 157 and 212 biogas plants with a capacity of between 100 kW and 3 MW could be built in Lithuania [82]. Municipalities have identified several main problems, inhibiting faster expansion of RES usage. First of all, subordinate legal acts related to the competence of municipalities, their actions and responsibility in drafting and implementing renewable energy development plans are insufficient [76]. Moreover, municipalities are not included directly in the promotion of the use of RES policy. Second, the funds allocated to support RES and energy saving projects are scarce, while the costs of sustainable energy and renewable energy projects are high. The access to credit for renewable energy project financing is also limited. The research needed for rapid, efficient, and sustainable energy development and innovation is not adequately funded either. Third, there is a lack of cooperation between government institutions, businesses, and rural communities in the development and use of sustainable energy and renewable energy projects. The information about the dissemination of best practices through the introduction of energy-saving and renewable energy projects in Lithuania and abroad is insufficient. More educational activities on the topic are necessary, including promotion of public and local government staff’s knowledge and understanding of the energy savings and RES use of technology and benefits. Forth, part of the energy infrastructure is physically and morally worn out [75]. The information system in support of operational monitoring of sustainable energy development and promotion system is underdeveloped. There is also a lack of reliable statistical information on the use of energy resources, not collected information on the use of RES in municipalities (Table 2).

The situation of RES usage in agricultural sector is similar to the general situation in the country described above. The country’s rural development policy encourages farmers to engage in sustainable energy production activities providing support for installation of energy generating plants. Many municipalities have high biomass resources that could be used for energy purposes (Table 3). According to Eurostat, the domestic extraction of biomass in Lithuania per capita is on average 122% higher than in the EU during 2010–2020. Relatively large areas of not-in-use agricultural land (from 8% to 10% (Eurostat, 2022), especially in remote areas and less favored areas, could be used for RES projects. There
are several good practices of farms/agricultural companies, which have installed bio-gas plants. However, these examples are quite rare. The costs of installing bio-gas plants are high and it is economically worthy only for large-scale farms and agricultural holdings, which constitute a very little share (less than 3%) of all Lithuanian farms. The participation of farmers in other RES development projects is very low. Although some farmers are educated, proactive, and actively participate in seminars and trainings on the use of RES, the majority of them lack knowledge on the benefits and usage of RES [83].

Table 3. SWOT analysis of RES development in Lithuania.

| Strengths       |                               |
|-----------------|--------------------------------|
| Political       | Sustainable energy and renewable energy sources (RES) development is regarded as one of the priority directions of Lithuanian Energy Strategy. |
|                 | Lithuania has set up the basic legal framework and support system for sustainable energy and development of RES |
|                 | The country’s rural development policy encourages farmers to energy production activities |
| Economical      | There is a renewable energy market. |
|                 | Energy companies, businesses interested in investing in sustainable energy and renewable energy projects. |
|                 | The area has high energy biomass, municipal and industrial waste resources that could be used for energy purposes. |
| Social          | Highly qualified specialists work in all branches of the energy sector. |
|                 | There are examples of good practice in RES projects. |
| Technological   | There is a well-developed energy infrastructure for the development of renewable energy. |

| Weaknesses       |                               |
|-----------------|--------------------------------|
| Political       | Subordinate legal acts related to the competence of municipalities, their actions and responsibilities in drafting and implementing renewable energy development plans are insufficient. |
|                 | The municipality is not included directly in the promotion of the use of RES policy. |
| Economical      | Scarce financial resources to support RES and energy saving projects. |
|                 | High costs of sustainable energy and renewable energy projects. |
|                 | Unfavorable to the banks of the renewable energy project financing. |
|                 | The research needed for rapid, efficient, and sustainable energy development and innovation is not adequately funded. |
| Social          | Lack of educational activities on sustainable energy. |
|                 | Administrative (human) resources of energy analysis, energy-saving measures in the implementation of RES deployment are insufficient. |
|                 | Insufficient public and local government staff knowledge and understanding of the energy savings and RES use of technology and benefits. |
|                 | Lack of cooperation between government institutions, businesses, and rural communities, in the development and use of sustainable energy and renewable energy projects. |
|                 | There is insufficient information about the dissemination of best practices through the introduction of energy-saving and renewable energy projects in Lithuania and abroad. |
| Technological   | Underdeveloped information system in support of operational monitoring of sustainable energy development and promotion system. |
|                 | Part of the energy infrastructure is physically and morally worn out. |
| Other           | There is a lack of reliable statistical information on the use of energy resources, not collected information on the use of RES in municipalities. |

| Opportunities    |                               |
|-----------------|--------------------------------|
| Political       | There are opportunities to use EU Funds for the development of RES. |
| Economical      | Increasing energy demand from a growing housing stock and business development. |
|                 | The prices of imported energy are increasing. |
Relatively large areas of not-in-use agricultural land, especially in remote areas and less favored areas.

Educational and research institutions have enough potential to develop sustainable energy and RES projects.

The growing integration of RES into the biofuel market in electricity and heat networks.

Major energy supply system depends on import of energy resources and the volatility of their prices may have a significant negative impact on the whole economy.

Relatively higher costs of energy from renewable sources, so only part of them can compete with ordinary energy resources.

Unstable RES and final energy pricing.

Emigration of skilled workers can complicate the introduction of modern technologies and lead to a shortage of skilled workers in the energy sector and in science and research.

Source: compiled by authors based on the Covenant of Mayors action plans of Lithuanian rural municipalities.

4. Results of the Expert Survey

After assessing the significance of the strengths and weaknesses of RES development in Lithuania, it turned out that the most important strengths in Lithuanian conditions are governmental high prioritization of directions of Lithuanian Energy Strategy and a well-developed energy infrastructure for the development of renewable energy (Table 4).
The country’s rural development policy encourages farmers to energy production activities 4.00 2.10

| Activity                                                                 | Score | Description                                                                                           |
|-------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------|
| There is insufficient information about the dissemination of best practices through the introduction of energy-saving and renewable energy projects in Lithuania and abroad. | 4.67  | 1.97                                                                                                  |
| Highly qualified specialists work in all branches of the energy sector  | 4.00  | 1.67                                                                                                  |
| Part of the energy infrastructure is physically and morally worn out.    | 4.67  | 1.21                                                                                                  |
| There is a renewable energy market                                      | 3.83  | 1.47                                                                                                  |
| The research needed for rapid, efficient and sustainable energy development and innovation is not adequately funded. | 4.50  | 1.52                                                                                                  |
| Administrative (human) resources of energy analysis, energy-saving measures in the implementation of RES deployment are insufficient. | 4.50  | 1.87                                                                                                  |
| max                                                                     | 6.33  | 2.10                                                                                                  |
| Lack of educational activities on sustainable energy.                    | 4.33  | 1.97                                                                                                  |
| Unfavorable to the banks of the renewable energy project financing.     | 4.17  | 0.75                                                                                                  |
| Underdeveloped information system in support of operational monitoring of sustainable energy development and promotion system. | 3.50  | 1.05                                                                                                  |
| There is a lack of reliable statistical information on the use of energy resources, not collected information on the use of RES in municipalities. | 3.50  | 1.05                                                                                                  |
| min                                                                     | 3.50  | 0.52                                                                                                  |
| max                                                                     | 6.67  | 2.16                                                                                                  |

Although one of the strengths has been identified as a sufficiency in a renewable energy market, according to experts, this strength is the least important, or still there is no practical access to a sufficiently well-developed market in Lithuania.

To summarize, the scatter of expert opinions in assessing strengths was not uniform, as evidenced by a standard deviation ranging from 0.82 to 2.1. There is a particularly strong consensus on the direction of the energy strategy toward renewable energy as a key national strength.

Meanwhile, the main and essential weakness in the context of Lithuania’s energy efficiency is scarce financial resources to support RES and energy saving projects. The dispersion of opinions was extremely small (st. dev is equal to 0.52). All experts of the survey unequivocally agreed with the importance of this weakness. In addition, one of the most important weaknesses was the lack of accompanying legislation related to the competence of municipalities, their actions and the involvement of municipalities in RES policy, although Lithuania’s basic legal framework for sustainable energy and development of RES was identified as essential and a key strength. This means that there is a lack of coherence between the Lithuanian legal framework and the accompanying documents of municipalities, as well as real needs from bottom-up method. In addition, weaknesses such as an unfavorable banks attitude toward renewable energy project financing, underdeveloped information system in support of operational monitoring of sustainable energy development, and promotion system or a lack of reliable statistical information on the use of energy resources are insignificant as experts identified them as not having significant impact on the country energy efficiency (Table 5).
Table 5. Importance of opportunities and threats of RES development in Lithuania, mean and standard deviation.

| Opportunities                                                                 | Mean  | St. Dev. | Threats                                                                 | Mean  | St. Dev. |
|------------------------------------------------------------------------------|-------|----------|------------------------------------------------------------------------|-------|----------|
| The prices of imported energy are increasing.                                | 6.67  | 0.52     | Major energy supply system depends on import of energy resources and the volatility of their prices may have a significant negative impact on the whole economy. | 5.17  | 1.60     |
| The growing integration of RES into the biofuel market in electricity and heat networks. | 6.00  | 0.63     | Relatively higher costs of energy from renewable sources, so only part of them can compete with ordinary energy resources. | 4.50  | 2.26     |
| Increasing energy demand from a growing housing stock and business development. | 4.67  | 1.37     | Unstable RES and final energy pricing. | 4.50  | 1.64     |
| There are opportunities to use EU Funds for the development of RES.           | 4.33  | 1.21     | Changes in EU funding. | min | 3.33  | 1.60|
| Educational and research institutions have enough potential to develop sustainable energy and RES projects. | 4.33  | 0.82     | Emigration of skilled workers can complicate the introduction of modern technologies and lead to a shortage of skilled workers in the energy sector and in science and research. | 3.33  | 1.75     |
| Relatively large areas of not-in-use agricultural land, especially in remote areas and less favored areas. | 3.33  | 1.51     | min | 3.33  | 1.60|
| min                                                                              | 3.33  | 0.52     | max | 5.17  | 2.26     |
| max                                                                              | 6.67  | 1.51     | |

Assessing the significance of the possibilities of RES development in Lithuania, the opinions of experts were in many cases particularly similar. The most important aspect in terms of opportunities is the unequivocally increasing prices of imported energy (6.7 points out of 7) and the growing integration of RES into the biofuel market, in electricity and heat networks (6 out of 7 points). To date, however, the possibility of relatively large areas of not-in-use agricultural land, especially in remote areas and less favored areas, which could serve as alternative energy sources, has not been sufficiently appreciated. It is considered that agricultural land should nevertheless primarily serve agricultural products intended for human consumption.

Experts assessed the threats quite differently and heterogeneously. However, it can be assumed that the biggest threat in Lithuanian conditions could be that the major energy supply system depends on the import of energy resources and the volatility of their prices may have a significant negative impact on the whole economy. Such a threat as the loss of high-level professionals is described as the least significant.

The above-mentioned assessment of the significance of SWOT is also justified by the experts’ rating of GHG reduction measures applied in Lithuania. The main aspect of which is based on the fact that the entire real estate economy of the country needs to be restructured, i.e., renovation of public buildings and apartment residential houses, providing cost-effective lighting schemes in municipal budget institutions for indoor lighting, embracing frugal light sources and automatic control systems for outdoor lighting, reconstruction-modernization of small boiler houses of budgetary institutions, and so on, and only then look for new sources of energy from renewable sources. In other words,
people need to change themselves, redirect themselves for energy-saving solutions, reduce consumption and growing dependence on energy resources, than invest heavily in any energy production, including renewables (Table 6).

Table 6. Results of the ranking of GHG reduction measures.

| Measure                                                                 | Mean | St. Dev. |
|------------------------------------------------------------------------|------|----------|
| Renovation of public buildings and their energy network to increase energy efficiency | 6.67 | 0.52     |
| Renovation of multi-apartment residential houses                       | 6.50 | 0.84     |
| Cost-effective lighting schemes in municipal budget institutions for indoor lighting | 6.17 | 1.17     |
| Embracing frugal light sources and automatic control systems for outdoor lighting | 5.83 | 0.98     |
| Reconstruction-modernization of small boiler houses of budgetary institutions by changing the type of fuel used: from solid fuel to biofuel | 5.33 | 1.37     |
| Electricity savings in residential buildings by using frugal lighting and energy efficient appliances | 5.17 | 1.33     |
| Installation of economizers in boiler houses using natural gas for heat production and thus reducing fuel consumption and renovation of heating networks to reduce heat loss | 5.17 | 1.33     |
| Modernization of boiler houses—changing usage of fossil solid fuels (coal, shale oil) into biofuels | 5.00 | 2.00     |
| Wind power plants                                                      | 4.33 | 0.82     |
| Solar power plants                                                     | 4.17 | 1.94     |
| Biogas cogeneration plants                                            | 4.00 | 0.89     |
| Afforestation                                                          | 3.50 | 1.05     |
| Acquisitions of new and ecological public transport                    | 3.17 | 1.33     |
| Training of the specialists of municipal budget institutions           | 3.17 | 1.17     |
| Systematic information-educational activities, dissemination of educational material, dissemination of good practice | 2.83 | 0.75     |
| Geothermal energy systems                                             | 2.67 | 1.21     |
| Installation of cycling paths                                          | 2.17 | 1.47     |
| Hydro-energy plants                                                   | 2.00 | 0.63     |
| min                                                                    | 2.00 | 0.52     |
| max                                                                    | 6.67 | 2.00     |

It must, however, be noted, that the analysis of the results of the expert survey has shown that several elements of SWOT contradict each other. For example, a political strength “Lithuania has set up the basic legal framework and support system for sustainable energy and development of RES” is at least partially contradicted by political weakness “Subordinate legal acts related to the competence of municipalities, their actions and responsibilities in drafting and implementing renewable energy development plans are insufficient” (both identified as having a more than average score of importance). Other such potential collision of strengths and weaknesses lies between the strength “Sustainable energy and renewable energy sources (RES) development is regarded as one of the priority directions of Lithuanian Energy Strategy” and the weakness “Scarce financial resources to support RES and energy saving projects” (both indicated as of highest importance). If the priority is given for the development of RES, it logically should be backed by financial resources, otherwise the question arises if such a priority without financing can be considered as a strength. Such contradictions lead to a conclusion that the SWOT of the
analysis of sustainable energy development situation in Lithuania needs further refinement.

5. Conclusions and Policy Implications

The results of the research clearly indicate the quite puzzling interconnectedness between costs, associated with the development of RES in Lithuanian rural regions, which serves both as an opportunity and a threat and even a weakness, the incoherence in state and municipal legal acts and energy security objectives. The study disclosed that the potential of the renewable energy in Lithuanian rural regions cannot be fully exploited not only because of costs-related issues, which can only be partially controlled by the authorities, but also due to state and local legislative issues, which is under direct control of the government or municipal councils.

It is revealed that the main barrier as well as driver of the development of renewable energy in Lithuanian rural regions is cost. Analyzing it from the classical theoretical economics point we can say that the current equilibrium state can be affected both by increased prices for competing goods (imported energy) or by lowering prices for the renewable energy to make it more competitive, thus increasing demand and fostering its generation in rural areas. If prices for the imported energy will rise, we can expect shift toward renewables [84]. Although increased energy prices are undesirable due to its negative effect on state’s economy as a whole [85]. So, the decrease in prices of renewable energy is a more favorite choice for the government. This may be achieved by various subsidies or other cost-coverage mechanisms allowing to achieve the competitive price for the renewable energy. Increasing environmental awareness of the population coupled with increasing living standards in Lithuania (Statistics Lithuania, 2020) allows to expect demand for the renewable energy in Lithuania may increase even if renewables will not reach the competitive price parity with energy derived from fossil fuels.

The discussed incoherence between state and local legislative has deeper roots than it may look alike from the first glance. It can be attributed to the division of the authority in Lithuania, which is embedded in constitution and serves as a prerequisite for democracy [86]. Lithuania is characterized by a quite rare phenomenon, when ruling parties in the central governments and local municipalities are not only different, but even represent the completely opposite political ideology [87]. This is also represented in legal acts issued by the respective central or local authorities resulting in incongruity of the legislation.

The research showed that another factor which can drive the development of the RES in Lithuanian rural areas is the seek for national energy security. As it is mentioned in the literature, government striving to achieve state’s security goals may show some irrelevance to the costs [88]. This approach could help to mitigate both higher costs for RES and incoherence in legislation factors, as in state security matters all legislation must be subordinated to the higher authority [89]. Although such way of subsidizing of RES is quite questionable from the EU legislation point of view [90]. This possibility is relevant not only to Lithuania, but to a wider Eastern European context struggling with energy security as a national-level issue [91].

The disclosed importance of the need for a wide-scale building renovation is also considered important in a wider Central and Eastern European context, which is considered a legacy of a soviet era residential planning [92] which results a manifestation of the similar challenges for the CEE countries.

The analysis of potentially the most effective GHG reduction measures revealed that the most potent are considered measures, aimed at decreasing the overall consumption of energy in Lithuania (renovation of public buildings and energy infrastructure, renovation of apartment blocks) but not at switching the generation of energy from fossils to renewables. It is because now Lithuania is consuming 30% more energy compared to Sweden or Finland which are located on the same or even northerly latitude [93]. This is attributed to the energy-inefficient residential buildings in Lithuania. Due to this fact it can be ex-
pected that much of the government attention will be directed to actions aimed at reducing overall energy consumption, but not to the changes in Lithuanian energy generation portfolio.

The present study features certain limitations that should be taken into consideration. On the major caveats is the very SWOT approach that involves subjective statements. This is alleviated to some extent by considering a sample of municipalities in this study. The limitation of the current study may be considered the selected research approach. Moreover, generalization of the results to different contexts should be carried out with caution.

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