Renewable Energy 194 (2022) 21–27

Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

# The role of financial, social and informational mechanisms on willingness to use bioenergy

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ARTICLE INFO

*Article history:*
Received 25 February 2021
Received in revised form
29 April 2022
Accepted 11 May 2022
Available online 20 May 2022

*Keywords:*
Bioenergy
Bioeconomy
Environmental education and information
Financial mechanisms
Social pressure
Knowledge

ABSTRACT

In order to implement bioeconomy strategy and seek climate change mitigation, the enhancement of bioenergy production and consumption is required. Looking at a bottom-up approach in which a society can choose its renewable energy supplier, it is important to analyze what mechanisms contribute to the willingness to use bioenergy. In this paper, the Lithuania case, when the citizenry got a chance to choose an independent energy supplier, was considered. Applying the structural equation modelling the impact of financial, social and informational mechanisms, knowledge about bioeconomy and about the benefit on the environment and the willingness to use bioenergy was evaluated. The results showed that the financial mechanism and knowledge about bioenergy and the benefit on the environment influenced the willingness to use bioenergy the most. Information mechanism also influenced this intention. Meanwhile, social mechanism had no effect both on knowledge level and intention to use bioenergy. Therefore, this study could contribute to the formation of bioeconomy policy and the enhancement of bioenergy usage in the household sector.



## 1. Introduction

The bioeconomy is one of the EU's main political agendas related to the usage of bioresources and contributes to the implementation of sustainable development goals, circular economy principles and climate change mitigation [1–4]. Bioenergy is one of the main aspects of bioeconomy and it is the leading renewable energy source in EU at present [5–7]. Bioenergy is particularly important in global energy system [8]. Furthermore, Balažentis et al. [9] revealed that bioenergy contributes the most to the reduction of greenhouse gas emissions compared with other renewable energy sources. Thus, countries should further enhance the potential and the usage of bioenergy.

The development of renewable energy and bioenergy sources depends on economic, technical and social factors [10–13]. Countries promote renewable energy production and consumption applying a top-down approach via directives and regulations [14,15]. However, if these initiatives are not accepted by the society, in the absence of a general agreements or changes in politicians, the renewable energy promotion could stop or be refocused on polluting energy. Therefore, the bottom-up approach, when consumers can determine the promotion of renewable energy, is crucial implementing climate change policy [16]. In Lithuania, the liberalization of energy supplier choice enables consumers to enhance the consumption of renewable energy sources via their choice and behaviour. Therefore, the acceptation and willingness of each society to use bioenergy is a very important factor in order to enhance bioenergy production and consumption [17].

Authors in the literature have analyzed the factors of intention rather extensively, including the willingness to pay more for the usage of renewable energy sources [18–22]. However, the determinants of usage of bioenergy were analyzed rarely in the literature. The authors have applied various theories to analyze how internal, social and external factors determined the intention and willingness to use bioenergy [23–27]. Referring to their findings, the authors suggested mechanisms, which could contribute to the promotion of bioenergy consumption. However, to the best of our knowledge, whether the suggested mechanisms really contribute to the enhancement of willingness to use renewable energy was not analyzed by previous authors. In this paper, the main attention was focused on the financial, social and

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https://doi.org/10.1016/j.renene.2022.05.066
0960-1481/

informational mechanisms which respondents selected as the main motivators in choosing this energy source. The inclusion of these mechanisms in one model could reveal which mechanism determine the willingness to use bioenergy the most. In this paper, the effects of financial, social, and informational mechanisms on the willingness to use bioenergy, as well as the impact of knowledge about the bioeconomy and its benefits to the environment were analyzed. This paper illustrates the mechanisms policymakers should highlight in order to promote the willingness to use bioenergy.

## 2. Literature review

Bioenergy promotion covers the three sustainability pillars: social, environmental and economic. Thus, their results can incline decision makers towards those chains that are most beneficial. Bioenergy policies should be aligned with the international initiatives devoted to protecting human beings and nature [8], such as the Paris Agreement on Climate Change, the United Nations 2030 Sustainable Agenda "Sustainable Development Goals" or the Europe Green deal strategy. In today's globalized world, all decisions are interconnected.

### 2.1. The financial mechanisms related to bioenergy promotion

A large number of authors analyzed the willingness to pay more for renewable energy [28–33]. Considering bioenergy, Zailaini et al. [34] explored the willingness to pay for biofuels. The authors revealed that consumers choosing bioenergy or other renewable energy sources should automatically pay more comparing with non-renewable energy. Therefore, Ali et al. [35] highlighted that government support and reward programs are essential for promoting renewable energy consumption. Authors analysing financial mechanisms mainly focused on the production of bioenergy [36–40]. Meanwhile, considering the willingness or intention to use renewable sources, Park [41] found that perceived cost is an important factor for the intention to use green electricity and Irfan et al. [33] revealed that cost has opposite effect on the adoption of renewable energy. Kardooni et al. [42] also stated that the main barrier of renewable energy consumption is high price. Board [43] showed that cost of solar technologies negatively influenced the intention to adopt this technology.

Meanwhile, the impact of financial mechanisms on intention or willingness to use bioenergy was analyzed very scarcely. Yaghoubi et al. [44] analyzed the cost impact on intention to use biofuel and revealed that cost perception did not influence the intention to use biofuel in Iran. Gracia et al. [45] found that factors which determine the intention to use biodiesel differ and depend on the price level. However, regarding how financial mechanism as well as financial abilities, subsidies and other financial incentives contribute to the willingness to use bioenergy has not yet been researched.

### 2.2. The social mechanisms related to the bioenergy promotion

Social mechanism could be perceived as social force or pressure to carry out a particular behavior or choice and is related to subject norms provided in theory of planned behavior. This theory maintains three main components: attitude, subjective norms, and perceived behavioral control, and contributes to the pro-environmental intensions/behavior [46]. Paravantis et al. [47] stated that social acceptance is very important in implementing renewable energy projects. Considering renewable energy in general, Rezaei and Ghofranfarid [17] and Fornara et al. [48] showed an insignificant impact of social norms on intention to use this energy. Meanwhile, Feng [49] and Demimbark and Yilmaz [50] found contrary results. Irfan et al. [33] revealed that the perception of a neighbour's participation positively influenced the intention to adopt renewable energy. The opposite results mainly can depend on a type of society: whether it is individualistic or collectivistic.

Other authors focusing on bioenergy reached different conclusions. Halder et al. [24] revealed that particularly in collectivistic countries such as India, subjective norms have a strong effect on intention to use bioenergy. Zailaini et al. [34] found that social values insignificantly influenced the willingness to pay for biofuels in Malaysia. Dale et al. [51] stated that bioenergy has low social acceptance. However, whether family, friends and colleagues promote the bioenergy consumption and how this social mechanism really contribute to the willingness to use bioenergy was not analyzed by previous researchers.

### 2.3. The informational mechanisms and knowledge related to bioenergy promotion

Environmental education and information are mostly suggested tools assigned to promote environmentally friendly behavior, willingness and intentions to use renewable energy. Regarding bioenergy, Halder et al. [24] revealed that only a small part of respondents know about bioenergy, and a major part of respondents declared critical perception about it. However, how the informational mechanisms as environmental education or the provision of information about renewable energy could contribute to the willingness to use bioenergy to the best of our knowledge was not analyzed. Authors mainly focused on knowledge about bioenergy and the perceived benefit.

Taking into account the renewable energy in general, Park [41] explored how environmental knowledge or perceived benefit of green electricity influenced the intention to use green electricity and revealed that only perceived benefit contribute to the promotion of green electricity. Meanwhile Irfan et al. [33] showed that the perceived benefit neutrally effected intention to use renewable energy and information should be provide in the integrative and coherent way. Kardooni et al. [42] revealed that knowledge significantly contributed to the intention to use renewable energy. Considering bioenergy, Lanzini et al. [52] found that knowledge negatively correlated with willingness to pay for biofuels. Meanwhile Gracia et al. [45] revealed that knowledge is important factor for biodiesel usage. Van Dael et al. [25] showed that knowledge about bioenergy contributes little to positive perception. Yaghoubi et al. [53] found that perceived benefit indirectly effected intentions toward biofuels. In this paper, the impact of knowledge about bioenergy and impact on willingness to use bioenergy was also analyzed. Furthermore, how financial, social and informational mechanism effect these knowledges were explored as well.

## 3. Materials and methods

### 3.1. Survey participants

In order to reveal what mechanism (financial, social and informational) contributes to the willingness to use bioenergy the most and how knowledge influences this behavior, the Lithuanian case was selected. Lithuania is one of the Eastern European Union (EU) countries in which the energy supplier choice is liberalized. Liberalizing the electricity market allows consumers to choose a "green" (or bioenergy) electricity supplier. Therefore, the Lithuanian case is very important, particularly during this period when consumers are enabled to choose their electricity supplier.

To perform this analysis, we referred to the representative survey data gathered at the end of 2017 in Lithuania. An independent institution of public opinion and market research "Vilmorus Ltd"

executed this survey using face-to-face and quota sampling methods, in which the proportion of population age, gender and living place were considered. In the survey, 1005 respondents were interviewed. The respondents were selected randomly using quota sampling method based on proportion size of population by age and gender. According to demographic characteristics of the survey, 47% of participants were males and 53% were females. Citizens aged 18–90 years old were interviewed, and the mean age was 52.2. The largest share of respondents had higher (25.9%), further (24.5%) and total secondary (22.6%) education. 70% of respondents lived in the flats with central heating and almost half of respondents (43.3%) lived in big town (Table 1). Therefore, this data reveals that the largest share of respondents depends on electricity suppliers and the possibility of choosing the electricity supplier is an important aspect in order to enhance bioenergy consumption.

### 3.2. Measurements

In this paper, six constructs (financial, social, financial mechanisms, knowledge about bioenergy, knowledge about bioenergy benefits on the environment and willingness to use bioenergy) were evaluated. All constructs were measured using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The scales of all mechanisms which could influence the willingness to use bioenergy were newly proposed. Constructing these scales, the items were proposed directly related to the promotion of bioenergy consumption. The financial mechanism encompassed the government support and financial abilities; social mechanism - friends, family and colleague's promotion to use renewable energy; informational mechanism included environmental education, information provision and advertisements related to renewable energy.

The knowledge about bioenergy encompassed questions about whether respondents agree that the separate bioenergy source (biomass, biofuel and biogas) is attributed to renewable energy. Meanwhile, knowledge about bioenergy benefits on the environment is related to the reduction of environmental impact caused by bioenergy consumption. The willingness to use bioenergy included all bioenergy sources and encompassed all responses whether, if it is possible, they would like to use bioenergy.

Considering that almost all scales were newly proposed, the scales were constructed by following the major steps suggested by Spector [54]. Therefore, in the first step, the pilot survey was carried out in order to refine and improve the proposed constructs. Using confirmatory factor analysis (CFA) all constructs were validated and refined. Referring to the final survey and results presented in Table 2, the reliability and validity of all constructs were adequate.

**Table 1**
The demographic characteristics of the survey.

| Number (N) | | Percentage |
|---|---|---|
| **Gender:** | | |
| Male | 472 | 47 |
| Female | 533 | 53 |
| **Age:** | | |
| 18–24 | 91 | 9.1% |
| 25–34 | 121 | 12% |
| 35–4 | 127 | 12.6% |
| 45–54 | 182 | 18.2% |
| 55–64 | 189 | 18.8% |
| 65–74 | 178 | 17.7% |
| 75> | 117 | 11.6% |
| **Education level:** | | |
| Primary school | 95 | 9.5% |
| Basic education | 144 | 14.3% |
| Total secondary education | 227 | 22.6% |
| Post-secondary vocational education | 30 | 3% |
| Further education | 246 | 24.51% |
| Higher education | 260 | 25.9% |
| Do not specify | 3 | 0.3 |
| **The type of house** | | |
| Flat with autonomous heating | 35 | 3.5% |
| Flat with central heating | 700 | 70% |
| Own house with autonomous heating | 261 | 26.1% |
| Own house with central heating | 4 | 0.4% |
| **Size of living place** | | |
| Large city | 435 | 43.3% |
| Centre of district | 221 | 22% |
| Small town | 103 | 10.2% |
| Village | 246 | 24.5% |

### 3.3. Proposed model and statistical analysis

CFA was applied to evaluate the measurement properties of financial, social and informational mechanisms, knowledge about bioenergy and benefits on the environment and willingness to use bioenergy. CFA is a factor analysis used to identify factors and test whether measures of scales are consistent by evaluating interrelationships among hypothetical items of the scales [55]. Therefore, the objective of CFA is to analyze whether the data of the survey fit a hypothesized measurement mode.

By applying the structural equation modelling (SEM) the proposed model presented in Fig. 1 was analyzed. This covariance-based statistical technique allows us to evaluate the hypotheses about causal relationships of a large number of constructs including interactions and moderating effects of predictor variables. The CFA and SEM analysis were performed by the AMOS computer program, version 26.

In order to evaluate the fit of the models, the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were evaluated. The CFI index should exceed the level of 0.9 and RMSEA should be lower than 0.08 [56,57]. The reliability of constructs was assessed applying the coefficient of Cronbach's alpha, and the internal consistency of the factors was evaluated using the composite reliability (CR) coefficient. The coefficients of these indicators exceeded 0.7, showing the strong reliability among constructs [58,59]. The convergent validity was assessed referring to standardized loading items and the average variances extracted (AVE) values. The convergent validity is adequate when the standardized loading items exceeded 0.6 and AVE values are higher than 0.5 [60]. The discriminant validity was evaluated referring to correlation coefficients. All the correlation coefficient among variables should be below 0.7 and specify a tolerable level of discriminant validity [61]. Furthermore, the lower values of the correlation coefficient compared with the square root of the AVE index also endorse the discriminant validity [60].

## 4. Results

### 4.1. Descriptive and measurement model analysis

In Lithuania from all the mechanisms studied (financial, social and informational) financial mechanisms were the most important

**Table 2**
The items of the survey, means, standard deviations and results of CFA analysis (reliability, and validity).

| | M | SD | Factor Loading | Cronbach's Alpha | CR | AVE |
|---|---|---|---|---|---|---|
| *Financial tools:* | 3.45 | | | 0.82 | 0.9 | 0.69 |
| The government support could promote to use renewable energy; | 3.37 | 1.12 | 0.84 | | | |
| The financial abilities could promote to use of renewable energy; | 3.53 | 1.15 | 0.82 | | | |
| *Social tools* | 2.64 | | | 0.87 | 0.91 | 0.71 |
| My friends could promote me to use renewable energy; | 2.53 | 0.95 | 0.89 | | | |
| My family could promote me to use renewable energy; | 2.88 | 1.05 | 0.76 | | | |
| My colleagues could promote me to use renewable energy. | 2.51 | 0.97 | 0.87 | | | |
| *Informational tools:* | 3.06 | | | 0.89 | 0.92 | 0.74 |
| Environmental education could promote to use renewable energy; | 3.12 | 1.03 | 0.90 | | | |
| The provision of environmental information could promote to use renewable energy; | 3.19 | 1.04 | 0.89 | | | |
| The advertisement about renewable energy could promote to use renewable energy | 2.87 | 1.05 | 0.79 | | | |
| *Knowledge about bioenergy:* | 3.29 | | | 0.88 | 0.91 | 0.73 |
| Do you agree that biomass is renewable energy source; | 3.29 | 0.91 | 0.80 | | | |
| Do you agree that biofuel is renewable energy source; | 3.27 | 0.95 | 0.88 | | | |
| Do you agree that biogas is renewable energy source; | 3.33 | 0.93 | 0.87 | | | |
| *Knowledge about bioenergy benefit on environment:* | 3.44 | | | 0.7 | 0.7 | 0.52 |
| Biogas power plants used on livestock farms reduce the environmental impact; | 3.31 | 0.81 | 0.72 | | | |
| The use of biofuels in transport reduces air pollution | 3.57 | 0.81 | 0.73 | | | |
| *Willingness to use bioenergy:* | 3.33 | | | 0.92 | 0.95 | 0.79 |
| If it is possible, I would like to use biomass; | 3.22 | 1.02 | 0.85 | | | |
| If it is possible, I would like to use biofuel; | 3.40 | 1.04 | 0.9 | | | |
| If it is possible, I would like to use biogas. | 3.39 | 1.03 | 0.92 | | | |

CR - composite reliability, AVE - average variances extracted.

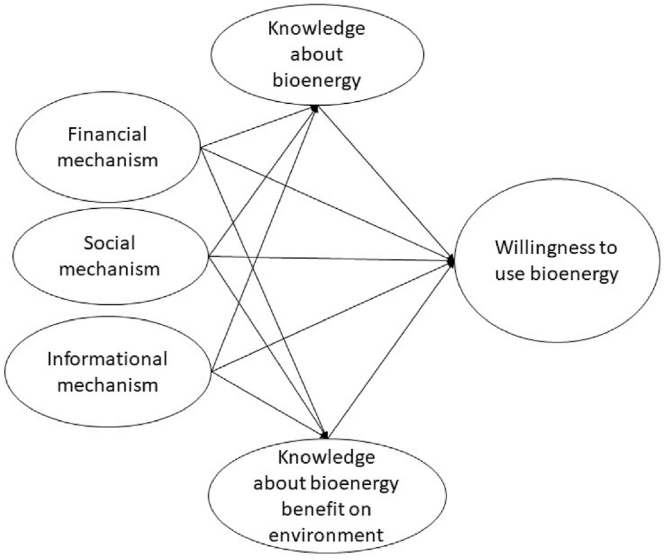


**Fig. 1.** Proposed model.

to respondents. The largest share of citizens declared that government support and financial abilities should promote the usage of renewable energy. Informational mechanisms are also important for Lithuanian individuals, particularly the information provision about renewable energy. However, advertisement related to renewable energy is not very highly suggested by respondents. Meanwhile social mechanisms are the least recommended (Table 2). Therefore, as it was expected that in Lithuania as an individualistic country, social aspects are not very important for the promotion of renewable energy.

Taking into account their knowledge level, Lithuanian people know more about the benefit of bioenergy on the environment, particularly that biofuels reduce air pollution in the transport sector. However, not all respondents were aware that biomass, biofuel and biogas are renewable sources. People also moderately agree that if it possible, they would like to use bioenergy. Biofuels and biogas are the bioenergy sources which people willingness to use the most, meanwhile, people the least willing to use biomass.

Considering the CFA analysis, it reveals a good fit to the data: $\lambda^2 = 510$, df = 95: $p < 0.001$. The value of CFI was 0.96, RMSEA was 0.066. Thus, these indicators show that the model is an adequate fit [56,57]. The reliability of constructs and internal consistency also was suitable. Cronbach's alpha and CR values for all constructs exceeded the value of 0.7. Furthermore, the results showed that the assumption of convergent validity was satisfied as well. Standardized loading items revealed that the threshold values exceeded 0.6, the values of AVE for all constructs were higher than 0.5 (Table 2).

Considering the discriminant validity, all the correlations among all constructs were below 0.7 and exceed the level of square root of the factors AVE (Table 3). Furthermore, the results showed that informational, financial and social mechanisms were the most related variables. Therefore, people who stated that informational mechanisms are important also declared that financial and social mechanisms are necessary. Meanwhile, the relationships between social mechanisms, knowledge about bioenergy and its benefits on the environment were the weakest (Table 3). Therefore, people who declared that the social aspect is important in order to promote renewable energy is not related to the knowledge level about bioenergy. Furthermore, the correlation matrix revealed that all factors were rather dissimilar. Thus, the multicollinearity was absent in this study.

### 4.2. Structural model analysis

The SEM analysis was carried out in order to evaluate the proposed model presented in Fig. 1.

The SEM model fit indicators provided evidence of a good model suitability: $\lambda 2/df = 5.36$, $p < 0.001$; CFI = 0.96, RMSEA = 0.066. Analyzing the impact of separate mechanisms on the knowledge about bioenergy and benefit on environment, results revealed that only financial mechanism was significantly related to these knowledges (respectively $\beta = 0.14$, $p < 0.01$, $\beta = 0.175$, $p < 0.01$). Meanwhile social and informational mechanisms insignificantly influenced this knowledge ($\beta = 0.026$, $p = 0.504$, $\beta = 0.039$, $p = 0.305$, $\beta = 0.046$, $p = 0.44$, $\beta = 0.035$, $p = 0.543$) (Table 4). Therefore, these mechanisms are not related to both knowledge level. Thus, people who declared that social and informational

**Table 3**
Constructs' correlations.

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1.Financial mechanism | **0.83** | | | | | |
| 2.Social mechanism | 0.42 | **0.84** | | | | |
| 3.Informational mechanism | 0.70 | 0.64 | **0.86** | | | |
| 4.Knowledge about bioenergy | 0.23 | 0.14 | 0.20 | **0.85** | | |
| 5.Knowledge about bioenergy benefit on environment | 0.32 | 0.20 | 0.28 | 0.34 | **0.72** | |
| 6.Willingness to use bioenergy | 0.49 | 0.32 | 0.46 | 0.35 | 0.43 | **0.88** |

Diagonal elements in bold show the square root of AVE.

**Table 4**
Path coefficients for SEM analysis.

| Paths | Estimate | SE | CR | P |
|---|---|---|---|---|
| Financial mechanism → knowledge about bioenergy | 0.14 | 0.043 | 3.254 | 0.001 |
| Financial mechanism→ knowledge about benefit on environment | 0.175 | 0.043 | 4.102 | <0.001 |
| Social mechanism → knowledge about bioenergy | 0.026 | 0.039 | 0.667 | 0.504 |
| Social mechanism → knowledge about benefit on environment | 0.039 | 0.038 | 1.026 | 0.305 |
| Informational mechanism → knowledge about bioenergy | 0.046 | 0.06 | 0.766 | 0.444 |
| Informational mechanism → knowledge about benefit on environment | 0.035 | 0.058 | 0.609 | 0.543 |
| Financial mechanism → willingness to use bioenergy | 0.229 | 0.046 | 4.939 | <0.001 |
| Social mechanism →willingness to use bioenergy | 0.049 | 0.04 | 1.225 | 0.22 |
| Informational mechanism → willingness to use bioenergy | 0.155 | 0.061 | 2.533 | 0.011 |
| Knowledge about bioenergy → willingness to use bioenergy | 0.226 | 0.037 | 6.063 | <0.001 |
| Knowledge about benefit on environment → willingness to use bioenergy | 0.314 | 0.056 | 5.634 | <0.001 |

mechanisms are important don't have enough knowledge about bioenergy and its benefits on the environment.

Looking at which of the analyzed mechanisms are the most important, the results showed that only financial and informational mechanisms significantly and positively influenced willingness to use bioenergy. The impact of financial mechanism was the highest. The knowledge about bioenergy and its benefit on the environment also significantly and positively influenced willingness to used bioenergy (Table 4). Therefore, these results emphasize that information and knowledge level is very important promoting bioenergy consumption. Meanwhile, social mechanism insignificantly influenced willingness to use bioenergy. Thus, social mechanism has no effect both on knowledge level and intention to use bioenergy.

## 5. Discussion and policy implication

Bioenergy in Lithuania has become very developed over the last decade. Bioenergy resources are transformed into other types of energy in Lithuania (heat and fuels) or are used as end-use energy products. Growth trends were observed in the use of for transforming energy: consumption of biogas increased 15 times; scopes of the transformation of biomass to heat and electricity increased 4 times. This fast bioenergy development, particularly in heating sector, was related to Lithuanian commitments of climate change policy and seeking energy independence. The production of energy from municipal waste, a part whereof is materials of biological origin, was started only in 2013 [62]. However, the main issue remains how to promote bioenergy consumption in Lithuania. The liberalization of electricity suppliers enables consumer to choose green or bioenergy. Therefore, it is very important to analyze the factors and mechanisms which could motivate people to choose and consume bioenergy.

Our results revealed that people are not very willing to use bioenergy, particularly biomass. However, the largest share of energy for central heating in Lithuania comes from biomass. Referring to the Eurostat database, biomass for energy is the main source of renewable energy in the EU, accounting for up to 60% of all renewable energy sources. In Lithuania biomass is also the main renewable source (nearly 81%) mainly used for heating (more than 60%) [63]. Therefore, it could be assumed that respondents in terms of bioenergy mostly considered transport sector, but heating sector there is also very important.

Considering mechanisms which encompasses financial, social and informational aspects, results showed that financial mechanisms are the mostly important. Furthermore, people who think that this mechanism is very important also have higher level of knowledge about bioenergy. It reveals that citizens in Lithuania understand why the support of government is so important. Furthermore, the subsidies and financial abilities could very motivate respondents to use bioenergy. The European Commission emphasized the necessity to foster and improve renewable energy and facilitate investments. Regarding this recommendation and for this purpose policymakers are fostering to apply the financial measures to enhance bioenergy consumption. In Lithuania, government plans to apply financial measures that promote the usage of bioenergy in transport sector by maintaining the biofuels from raw materials of the first generation and the production and consumption of biofuels. Furthermore, referring to Lithuanian National Energy Independence Strategy financial incentives have been launched, such as support for low-power biofuel production and the Future Economy DNA program also provides financial resources for the development of bioenergy. However, for policymakers it is important to not only to finance the development of bioenergy, but to subside this resource in order that the price would be not so high compare with no-renewable energy sources.

Despite that informational mechanism effect on the willingness to use bioenergy was the least among other analyzed factors, the knowledge level about bioenergy and benefit on environment influenced the most intention to use bioenergy. Furthermore, people who declared that informational mechanism is very important it insignificantly was related to level of knowledge about bioenergy. Thus, people who stated that informational mechanism is very important have not the higher-level knowledge about bioenergy. Therefore, these results reveal that environmental education and information provision about this energy source could enhance the level of knowledge and contribute to the willingness to use bioenergy. Only the advertisement about bioenergy is not very

recommended by respondents and it could be related to the fact that people are getting too many advertisements and it doesn't influence them. Therefore, policymakers should promote the education and information provision related to bioenergy. Particularly, referring that bioenergy contributes to the climate change mitigation the most this knowledge also should be related to this mitigation and climate-friendly behavior. However, the government strategies for education and information provision related to bioenergy is still in the initial phase. Considering that bioenergy resource is vulnerable for climate conditions, the most attention now is paid to the enhancement of the production of bioenergy implementing circular economy principles.

Social mechanism is the least recommended by respondents, and this mechanism doesn't affect knowledge about bioenergy and benefit on environment nor the willingness to use bioenergy. It could be related that Lithuania is individualistic country and social mechanism is not very important for citizens. Furthermore, people could choose bioenergy not due to the family's and friends' recommendation but due to financial and informational aspects. The performance of this intention is rather individualistic and social pressure is the least important. Zailani et al. [34] also found that social values insignificantly influenced the willingness to pay for biofuels.

The program of the Government of the Republic of Lithuania envisages increasing the volume of bioenergy. Lithuania has more opportunities and resources to promote economic growth and increase competitiveness by exploiting the potential of biomass value chains, i.e. the production of wood, textile, and chemical products made from raw materials of biological origin, using bio-waste for the production of value-added products, including biogas and biofuels.

The Lithuanian Ministry of Agriculture encourages the population to use renewable energy resources. A financing mechanism for the construction of bio-power plants and the production of bioenergy on farmers' farms is currently being prepared. The results of the study can be used to develop a strategic plan for the development of biopower plants.

## 6. Conclusions and future directions

Implementing bioeconomy strategy, climate change mitigation and Energy Independence Strategy it is very important to promote bioenergy consumption for heating, electricity and fuel. Reducing the energy system's dependence on fossil fuel is crucial for the successful implementation of change in 2030–2050. The continued development of European energy infrastructure, regulatory frameworks, market design, and research and innovation are equally necessary to foster and improve renewable energy and facilitate the necessary investment. However, it is also important to focus on a bottom-up approach how to enhance the usage of bioenergy in household level. In Lithuania the liberalization of energy supplier choice enables consumers to enhance the consumption of renewable energy sources via their choice. Therefore, the aim of this paper was to evaluate the impact of financial, social and informational mechanisms, knowledge about bioeconomy and about benefit on environment on willingness of use bioenergy.

The results reveal that Lithuanian citizens were not very willing to use bioenergy, particularly biomass. The financial mechanism and knowledge about bioenergy and its benefit on the environment most influenced willingness to use bioenergy. Information mechanism also influenced this intention. Meanwhile, social mechanism had no effect on knowledge level nor on the willingness to use bioenergy. Therefore, this study revealed that financial support and information provision related to bioenergy is particularly important seeking promote the bioenergy usage referring to a bottom-up approach.

In the future, it would be important to analyze the difference of these mechanisms among people with different environmental awareness levels or age groups. It could enrich this topic and provide more specific and detailed recommendations for policymakers to promote the willingness to use bioenergy. Moreover, in this paper, the Lithuanian case was analyzed. Thus, future researchers could perform a comparative analysis of mechanisms in different countries. The impact of war in Ukraine, scarcity of non-renewable energy sources and increasing prices for non-renewable energy could also be essential for future analysis of the willingness to use bioenergy in Lithuania.

## CRediT authorship contribution statement

**Genovaitė Liobikienė:** All authors contributed equally in preparing this paper. **Astrida Miceikienė:** All authors contributed equally in preparing this paper.

## Declaration of Competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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