E3S Web of Conferences **608**, 05002 (2025) https://doi.org/10.1051/e3sconf/202560805002
EENVIRO 2024

Social Acceptance of Green Infrastructure Adoption in Lithuania

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Abstract. Lithuania aims to have entirely renewable energy sector in the future, which will increase demand for sustainable infrastructure that integrates wind, solar, hydro, bio, geothermal, ocean, and hydrogen energy sources. This study uses demographic data to assess public acceptance of green infrastructure. While older, lower-income, rural, and less educated groups are more sceptical, younger, wealthy, urban, and highly educated people exhibit greater acceptance. These observations highlight the need of taking demography into account when trying to achieve broad acceptability and a successful transition to sustainability.

1 Introduction

Lithuania has ambitious plans and a strategic course towards a greener future which aims for a significant portion, and then ultimately, all of its energy needs to be met by renewable energy sources by 2050. This transition means that there is a need for the development and the implementation of a sustainable green infrastructure network.

The green infrastructure network should contain a combination of different types of infrastructure like onshore and offshore wind farms, solar parks, geothermal and hydropower, ocean and bio energy sources, the adaptation and use of hydrogen energy and CO_2 carriage and storage [1, 2, 3].

To further investigate, we have to define Lithuania's renewable energy sources and other means of adaptation into a plan for a greener future which relies on a mix of renewable energy sources:

- **Wind energy.** This includes both onshore and offshore wind farms. Wind is a significant contributor to Lithuania's renewable energy plan where currently it is estimated to improve the total wind energy capacity for offshore wind farms by 26 GW and for onshore wind farms by 18 GW [4].
- **Solar energy.** Solar parks will capture the sun's energy and while not the strongest renewable energy source in Lithuania, total solar capacity is estimated at 10 GW [4].
- **Hydro energy.** Energy generated from flowing water sources like dams. This is a mature technology for Lithuania.

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- **Bio energy.** This refers to burning organic matter like wood chips or agricultural waste. Currently, biomass is Lithuania's dominant renewable source, especially for generating heating energy during winter periods.
- **Geothermal energy.** In order to capture Earth's interior heat, geothermal power plants are used to generate heating and power. This is a potential renewable energy source that Lithuania is exploring [5].
- **Ocean energy.** The ability to capture energy from waves, tides, or currents. Currently there is very little development in this area as costs for this technology are high as well as Lithuania has only a small amount of shore-line with the Baltic Sea.
- **Hydrogen energy.** Hydrogen fuel can be produced from renewable sources and stored for later use. Lithuania sees potential in hydrogen storage and transportation where current aims are to develop a total of 10 GW synthetic fuel capacity [4, 6].
- **CO_2 carriage and storage.** An honourable mention is the capturing, transporting and storing of carbon dioxide emissions from power and other industrial sources which would also greatly help to mitigate climate change [7].

The success of this adaptation lies not only on technical and economic feasibility of green energy infrastructure but also on the social acceptance of the communities in Lithuania. Understanding how Lithuanian communities perceive and react to this evolving green infrastructure landscape is very important in order to have a balanced and successful transition towards a sustainable energy future.

When defining green infrastructure, we speak about a system of connected green ecosystems. These are hybrid systems, which are between ecology and technology. The essence of this type of infrastructure is to bring sustainable functions, with social, environmental and economic benefits.

The EU perspective on green infrastructure is that it is “a strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, while also enhancing biodiversity." [8], while the US Congress defined green infrastructure as “the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters.”. This definition emphasizes the multifunctional aspects of green infrastructure [9].

2 Social acceptance study

2.1.1 Methodology

The study is set-up as an online survey in which anyone can participate to express their level of acceptance.

The object of the study is the social assessment of the acceptability of green infrastructure.

The aim of the study is to assess at what level the general population of Lithuania accepts the idea and the perspective of new green energy infrastructure. Study evaluates how the Lithuanian population accepts green infrastructure with the intention to reach for a conclusion if an adoption of such green infrastructure is possible in the future.

The methods used in the study are the analysis, synthesis and comparison of statistical data received, generalization and conceptualization of infrastructures social acceptance. Experimental analysis includes documentation and categorization. The methods of statistical data analysis will be applied by processing the results of the questionnaire survey conducted in an experimental manner, and the statistical data in assessing the level of social acceptance. Mathematical modelling is applied in the analysis of the reasons for the acceptability of green infrastructure and the variables that determine the level of acceptability.

For the best scenario evaluation, a model of application of energy technology acceptability in Lithuania is used.

2.1.2 Study case

The study itself is based on a two-sided survey. Conducting a survey for social acceptance serves a valuable purpose of identifying the level of acceptance. The length of the survey carried was from 2023-10-01 to 2024-02-01, a total of 4 months.

The first part of the survey is demographical, requiring age, income level, location (geography) and education which are needed to determine a connection between the respondent and possible acceptance level.

The second part of the survey is purely sided with asking the respondent to rate a picture of infrastructure on the screen from 1 to 5, where 1 is not acceptable and 5 is completely acceptable. For the purpose of the study, 128 images were created by Author with Microsoft copilot artificial intelligence hardware that are depicting different types of regular and green infrastructure. Pictures were added to the survey in a random order where the respondent had to rate a total of 8 pictures in 8 turns. This means that respondent didn't know the pictures that will come up next on the screen and were not able to make a comparison between these pictures in one screen at the same time. The pictures show either a typically regular type of infrastructure that is not green or a type of infrastructure that is green. All of the questions, a total of 12 (4 demographic + 8 acceptance) were also mandatory to answer.

Below in Figures from 1 to 2 are some of the images, given in a random order, created and used in the social acceptance survey:

Fig. 1. An example of green infrastructure – a sustainable power plant with solar farms, wind turbines and hydrogen storage tanks

Fig. 2. An example of non-green infrastructure – an unsustainable power plant

All of the above images, depicted in Figures from 1 to 2, were created by Author using Microsoft copilot artificial intelligence hardware, based on “DALL-E 3” platform.

3 Results

A total of 5286 responses were received. Out of the total received responses, 5231 responses were unique and 4982 responses geolocation was from inside Lithuania territory therefore 4978 responses were further used in the study.

Table 1. Share of demographic responses

Age	**< 25**	**25 - 34**	**35 - 44**	**45 - 54**	**55 - 64**	**> 64**
	891	1187	1453	884	404	159
Income	**< 500**	**500 - 1000**	**1001 - 1500**	**1501 - 2500**	**2501 - 5000**	**> 5000**
	206	434	1353	1763	1109	113

Location	**Aukštaitija**	**Žemaitija**	**Suvalkija**	**Dzūkija**	**Mažoji Lietuva**
	1812	1257	954	781	174

Education	**Secondary education or lower**	**Professional, higher non-university**	**Higher university**
	770	1593	2615

Table 1 shows the share of responses between the demographic groups (age, income, location, education) that were set in the study.

Table 2. Green infrastructure acceptance level rating system (n=39824)

Rating	**Green infrastructure**	**Non-green infrastructure**
1	532	11898
2	162	1871
3	510	4187

Rating	Green infrastructure	Non-green infrastructure
4	8261	277
5	10447	1679
Total	19912	19912
	39824	

Table 2 shows green and non-green infrastructure acceptance level rating system, which consists of total 39824 ratings, equally shared between green and non-green infrastructure, as programmed in the study.

Further in the study, analysis of data is being done in order to identify any potential correlations between age groups and the acceptance level of green and non-green infrastructure. This is done by comparing the distribution of ratings across different groups.

Table 3. Connection between acceptance of green and non-green infrastructure, and demographic variables

Variable	Green infrastructure	Non-green infrastructure
Age	-0.31	0.26
Income	0.39	-0.37
Location	0.35	-0.22
Education	0.48	-0.41

Table 3 presents the correlations between acceptance of green and non-green infrastructure and demographic variables. A negative correlation coefficient indicates that as one variable increases, the other variable decreases. A positive correlation coefficient indicates that as one variable increases, the other variable also increases.

Younger individuals may exhibit a higher level of receptiveness towards green infrastructure due to their heightened environmental awareness and concerns for the future. Conversely, older individuals may display more scepticism towards it due to their preference for traditional infrastructure and resistance to change.

On the other hand, older individuals may be more accepting of non-green infrastructure due to their familiarity and trust in conventional systems. In contrast, younger demographics may show less acceptance due to their concerns about the environmental impact and the need for sustainability.

Individuals with higher incomes may be more inclined to support green infrastructure as they have the financial means to afford the initial investment costs and may place a higher value on the long-term environmental benefits it offers.

In contrast, individuals with lower incomes might prioritize immediate cost savings over long-term environmental benefits. As a result, they may favour non-green infrastructure options that are perceived as cheaper upfront.

Urban residents, who directly experience the advantages of green infrastructure such as improved air quality, reduced urban heat island effect, and increased green space, may be more accepting of it. Conversely, rural residents may exhibit less acceptance if they have limited exposure to the benefits of green infrastructure and perceive it as impractical or unnecessary in their surroundings.

https://doi.org/10.1051/e3sconf/202560805002

Higher levels of education could potentially correlate with a greater acceptance of green infrastructure. This is because individuals with more education may possess a better understanding of its benefits and environmental implications.

Conversely, lower levels of education may lead to less acceptance of green infrastructure. This is because individuals with limited exposure to environmental issues and a lesser understanding of the benefits of sustainable practices may be more influenced by traditional attitudes towards infrastructure.

4 Conclusions

Based on the connections between acceptance of green and non-green infrastructure and demographic variables, here are the final study conclusions:

1. Age plays a significant role in shaping attitudes towards green infrastructure. Younger individuals, who are often more environmentally aware and concerned about the future, tend to show greater acceptance of green infrastructure. On the other hand, older individuals may exhibit more scepticism towards green infrastructure, preferring traditional non-green options due to their familiarity and resistance to change.
2. Income also has a significant influence on preferences for green infrastructure. Higher-income individuals, who can afford the initial investment costs, are more likely to support green infrastructure. They prioritize the long-term environmental benefits that it offers. Conversely, lower-income individuals may prioritize immediate cost savings over sustainability, leading to a greater acceptance of non-green infrastructure.
3. Location is another factor that impacts attitudes towards green infrastructure. Urban residents, who have firsthand experience with the benefits of green infrastructure such as improved air quality and green spaces, are generally more accepting of it. On the other hand, rural residents may show less acceptance if they perceive green infrastructure as impractical or unnecessary in their surroundings.
4. Education also correlates with acceptance of green infrastructure. Higher levels of education are associated with greater acceptance, as individuals with more education have a better understanding of the benefits and environmental implications of green infrastructure. Conversely, lower levels of education may lead to less acceptance, as individuals may have limited exposure to environmental issues and a lesser understanding of sustainable practices.

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