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ARTICLE

Examining the Main Areas of Environmental Awareness, Sustainability and Clean Energy

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ABSTRACT | Objective: This study investigates the level of environmental awareness, sustainability practices, and the use of renewable energy sources among the population of the Gyöngyös micro-region in Northern Hungary. **Method:** The research employed a stratified random sampling technique, conducting surveys across 25 settlements in the Gyöngyös micro-region. The data collection focused on understanding local knowledge of renewable energy, the use of such energy sources, and financial investments made by households in renewable technologies. **Results:** The findings reveal that a significant portion of the population is aware of solar, wind, and hydro energy, while knowledge of biofuels, geothermal energy, and biomass is limited. The majority of residents (90.9%) do not use renewable energy, and those who do primarily invest in solar panels. Investments are largely financed by personal resources (58.5%), with modest monthly savings from renewable energy use, typically below HUF 25,000 (EUR 70). **Conclusions:** The research highlights the need for greater promotion of renewable energy sources and environmental sustainability in Northern Hungary. Although awareness of certain renewable energy types is relatively high, actual usage remains low, indicating a potential area for policy intervention and education efforts.

Keywords | Renewable Energy, Environmental Awareness, Sustainability, Solar Energy, Hungary

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INTRODUCTION

What is happening in the world shows how renewable energy, environmentally conscious lifestyle and sustainability are playing an increasing role in our lives. Not only the renewable energy usability itself but the topic of sustainability development has become one of the most important issues in environmental policy. Both European Union and national requirements are becoming more and more demanding in terms of future targets. When we focus on sustainability, we need to think in long term and keep attention to the basic conditions.

It follows from the above that sustainable development can only be achieved by reconciling a wide range of economic, social and scientific considerations and objectives. However, this

raises the question of whether sustainability can be measured, and if so, by what indicators and how precisely. There are several methods and indicators for the general measurement of sustainability and for the measurement of the use of natural resource and the ecological impact of a product. Some of these are related to the traditional measurement systems of economic and social development. On the other hand, others are based on their rejection and exceeding.

The most common indicators used to measure full or partial sustainability can be:

1) traditional indicators of economic and social development: GDP, HDI, GNI, GINI;
2) sustainability indicators on environmental pressure: ecological and thematic footprints;
3) alternative indicators of development and well-being: ISEW, GPI, GNH, HPI[1].

One of the above mentioned condition is the world population growth, which is the biggest trend-making factor. In practice this means 65 to 80 million more people annually (Max et al., 2017), exceeding 8 billion by 2024, and 9 billion by 2037[2]. Even if there are several countries that have decreasing populations (e.g. Ukraine, Romania, Hungary, Portugal, Bulgaria, Serbia, Croatia, Georgia), carefully paying attention to the circumstances, this kind of rapid growth raises a number of issues, related to globalisation, urbanisation, environmental sustainability and demand for food products including animal feed which arises from increasing meat consumption (Philip, 2017). This moving production to the most competitive regions causes the food trade to become more liberalized and concentrated (Magda, 2012).

However, we also face other problems affecting human life on a daily basis, such as extreme poverty, increasing pollution of clean water and fresh air, malnutrition and starvation (Klaus von Grebmer et al., 2018). As an example, one of the development goals – which were adopted by the 55th General Assembly of the United Nations (FAO) on 6th September, 2000 – was to reduce poverty by 50% by 2015. The targets set could not be met, as more than 1 billion people still live in extreme poverty (20% of the world's population lives on less than 1 dollar a day); 700 million people are malnourished; 120 million children have no chance of getting an education and more than 20% of the world's population does not have access to clean drinking water (Fróna, 2020). Even greater problem can be that these mentioned issues will be increasing further in the future. From Table 1 we can see that the biggest problem occurs in the case of less and the least developed countries, where this increase is higher than the avarage cases (Magda et al., 2015).

1 Traditional indicators of economic and social development and their critique are discussed in the book of Baranyai & Csernus (2018): Sustainable development and the role of the state.
2 http://nepesseg.population.city/world/ – Downloaded: 24th May 2021

Table 1. World population change between 1950 and 2050

	1950	2000	2003	2050
Total (million)	2519	6071	6301	8919
Developed countries	813	1194	1203	1220
Less developed countries	1706	4877	5098	7639
Least developed countries	200	668	718	1675

Source: Magda, R. – Bozsik, N. – Erdélyi, T. (2015): Sustainable green innovation, pp. 8-9.
Note: 1) Less developed countries: each African, Asian country exclusive of Japan, Latin-America and Caribbean region. 2) Developed countries: each European countries, North-America, Australia, New-Zealand and Japan.

In the case of some estimates and predictions, around 80% chance of a food shock that reduces global food production by about 10% and about 10% chance of total food production loss, which can happen within this century (Bailey et al., 2015, Denkenberger et al., 2017). In fact, looking further into the issue, it becomes apparent that these are combined with a number of serious environmental changes including the declining soil fertility, desertification, forest depletion, unsustainable rates of water usage, air pollution, the disappearance of animal habitats, the meltic of Artic ice and many more mentionable case.

Therefore, it is clear that existing sustainability challenges, such as the ever-increasing demand for energy and the ecosystem changes associated with climate change, also influence peoples' behaviour and attitudes towards environmental awareness and sustainability (Tatjana et al, 2020). Therefore, the question rightly arises, how can we contribute to taking these challenges in a positive direction?

The 2030 Climate and Energy Framework of the European Union

Answering the question is not a simple task because as mentioned above, sustainability factors are a very complex issue. First of all, a good starting point if we take into account the energy framework of EU. But before we examine the EU's climate and energy framework for 2030, it is also worth mentioning the main key objectives of the 2020 package.

The 2020 package was a set of laws passed to ensure the EU meets its climate and energy targets for the year 2020. The package were set the following key targets: 20% cut in greenhouse gas emissions (from 1990 levels), the 20% of EU energy should be from renewable energy sources and 20% improvement in energy efficiency. These targets were set by EU leaders in 2007 and enacted in legislation in 2009. The EU was taking action in several areas to meet the targets[3]. It is clear, therefore, that the 2020 package already included significant expectations for the regulation of environmental sustainability and the development of environmental aspects.

Further developing the previous 2020 package, the 2030 climate and energy framework includes EU-wide targets and policy objectives for the period from 2021 to 2030. As part of the European Green Deal[4], 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. It looked at the actions required across all sectors, including increased energy efficiency and renewable energy, and started the process of making detailed legislative proposals by July 2021 to implement and achieve the increased ambition. This will enable the EU to move towards a climate-neutral economy and implement its commitments under the Paris Agreement by updating its Nationally Determined

3 European Union (2020): 2020 climate and energy package, https://ec.europa.eu/clima/policies/strategies/2020_en – Downloaded: 25th May 2021
4 The *'European Grean Deal'* provides an action plan to boost the efficient use of resources by moving to a clean, circular economy; restore biodiversity and cut pollution. The plan outlines investments needed and financing tools available. It explains how to ensure a just and inclusive transition, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en – Downloaded: 25th May 2021.

Contribution. Key targets for 2030 are the following: at least 40% cut in greenhouse gas emissions (from 1990 levels); at least 32% share for renewable energy; and at least 32.5% improvement in energy efficiency. All three pieces of climate legislation will now be updated with a view to implement the proposed at least 55% net greenhouse gas emissions reduction target. The Commission will come forward with the proposals by July 2021[5].

The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions. This objective is at the heart of the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement. The transition to a climate- neutral society is both an urgent challenge and an opportunity to build a better future for all. All parts of society and economic sectors will play a role – from the power sector to industry, mobility, buildings, agriculture and forestry. The EU can lead the way by investing into realistic technological solutions, empowering citizens and aligning action in key areas such as industrial policy, finance and research, while ensuring social fairness for a just transition. The Commission set out its vision for a climate-neutral EU in November 2018, covering nearly all EU policies and is in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C as possible[6].

Sustainable Development Goals of the European Union

It may now become more visible that the future goal of the EU is clear on these challenges. The political and economic influence of the EU, which includes twenty-seven Member States, is indisputably decisive for the international developments of the 21st century. This calls for a clear, practical and, above all, effective response from the EU to the challenges of the complex issue of sustainability, including the recently declared *'EU climate action policy – Responding to the global emergency'*[7]. Sustainability encompasses the environmental, social and economic subsystems, and is essentially about achieving a balance between economic development, environmental protection and social and human factors, while taking responsibility for future generations (Baranyai & Csernus, 2018). Sustainable development issues have already been addressed in previous years in various strategy documents, in action programmes at EU and national level, and in EU environmental and other policy legislation. While the EU has never been unconcerned about the challenges of sustainability - as evidenced, for example, by its report on the *'Environmental health risks of air pollution'*[8] - it is clear that not all Community initiatives have been success stories, and that the environment as a complex phenomenon is a very broad regulatory area with a thousand links to the economy and social security (Horváth, 2020).

„The EU and the United Nations are natural partners in the efforts to shape a safer and better world for all. To that end, the EU supports effective multilateralism and a rules-based international order with the UN at its core. As a major negotiating success of the EU, the Sustainable Development Goals (SDGs) are a useful vehicle to project globally the EU's values and objectives, and provide a shared framework, useful for international partnerships" – says the European Comission in the 2030 Agenda for sustainable development. Worth mentioning that this Agenda is a plan of action for people, planet and prosperity, which also seeks to strengthen universal peace in larger freedom. In addition one of the most interest of the EU's is to play a leading role in the implementation of the 2030 Agenda globally through its external action[9]. In September 2015, at the United Nations General Assembly,

5 European Comission (2021): Climate action - 2030 climate and energy framework, https://ec.europa.eu/clima/policies/strategies/2030_en – Downloaded: 25th May 2021.
6 European Comission (2021): 2050 long-term strategy of European Union, (https://ec.europa.eu/clima/policies/strategies/2050_en - Downloaded: 25th May 2021.
7 European Parliament (2021): European Union climate action policy, https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_STU(2021)689378 – Downloaded: 25th May 2021
8 European Court of Auditors (2021): Air pollution – Our health still insufficiently protected, https://op.europa.eu/webpub/eca/special-reports/air-quality-23-2018/en/ – Downloaded: 25th May 2021
9 European Comission: Sustainable Development Goals (2021), https://ec.europa.eu/info/strategy/international-strategies/sustainable-development-goals/eu-and-united-nations-common-goals-sustainable-future_en – Downloaded: 25th May 2021

countries around the world signed up to the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (Figure 1). The 2030 Agenda, together with the Paris Agreement on Climate Change, are the solution to a better world and the global framework for international cooperation on sustainable development and its economic, social, environmental and governance dimensions. The importance of consistently progressing towards the SDGs and engaging with partner countries and civil society as well as the Union's representation at high-level international forum, including the United Nations on Sustainable Development, which is crucial to advance the EU's commitment to sustainable development[10].

Figure 1. The 17 main elements of Sustainable Development Goals, 2021

Source: https://sdgs.un.org/goals - Downloaded: 25th May 2021

The 17 Sustainable Development Goals and 169 targets demonstrate the scale and ambition of this new universal Agenda. They seek to build on the Millennium Development Goals and complete what those could not achieve. They seek to realise the human rights of all, achieve gender equality and the empowerment of all women. They are integrated, indivisible and balancing the three dimensions of sustainable development: more specifically the economic, social and environmental dimensions[11].

The Goal 7 of SDGs focuses on to ensure access to affordable, reliable, sustainable and modern energy for all. Briefly highlighting the most important parts, the Agenda aims to achieve the following points: by 2030, ensure universal access to affordable, reliable and modern energy services; increase substantially the share of renewable energy in the global energy mix; double the global rate of improvement in energy efficiency; enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy sources, energy efficiency, advanced and cleaner fossil-fuel technology, investment promotion in energy infrastructure and clean energy technology; and the last one is to develop infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land- locked developing countries, in accordance with their respective programmes of support (Nurunnabi et al., 2020).

10 United Nations (2021): Transforming our world – The 2030 Agenda for Sustainable Development, https://sdgs.un.org/2030agenda – Downloaded: 24th May 2021
11 United Nations (2021): Transforming our world, the 2030 Agenda for Sustainable Development, https://sdgs.un.org/2030agenda - Downloaded: 24th May 2021

By now, a significant amount of international and national research is dealing with the rates of renewable energy use, as well as the opinion of the population in the case of environmental protection, environmental awareness and sustainability.

In relation to the ambitions set out by the EU, the problem I have raised is also that polluting and irresponsible energy-wasting behaviour will lead to the depletion of natural resources in the long term. For this reason, alternative energy sources must increasingly be the focus of attention, rather than fossil energy sources.

The methods, sapling technique, main circumstances, location and the hypotheses of the research are described in the Material and Method chapter.

MATERIAL AND METHOD

During my research, my main initial goal was to assess and examine the potential of green and renewable energy use and application in the Northern Hungary region, such as electricity generation, fuel use (biodiesel, bioethanol), geothermal heat (thermal water), passive and active solar energy (solar collector systems), hydropower (hydroelectric power plants, water turbines), and wind energy (wind power, wind turbines).

I have combined this with the topics of environmental protection, attitudes to environmental lifestyles and environmental sustainability. After starting the research - thanks to the results obtained - I narrowed down the research area to the latter topic, and geographically to Heves County and then to the micro-region of Gyöngyös, because this gave me the opportunity to conduct representative primary research.

The micro-region of Gyöngyös, with an area of 751 km^2, is located in the Heves County area of the North-Hungary region (Figure 2). Out of the 25 settlements in the micro-region, the nearest is about 76 km far from Budapest.

Two towns, Gyöngyös and Gyöngyöspata, are located in the micro-region of Gyöngyös, while the other 23 settlements are registered as villages. According to 2018 data, the population of the micro-region is 69,833 which decreased by an average of 600 persons annually from 2011 to 2016, and then reduced by 135 persons annually by 2018, but the population of the micro- region continues to fall.

In 2005, the population was 77,249 but mainly due to the capital's labour drain, this number has decreased to about 69,833 in 2018 (TeIR, 2020). By the end of 2016, there was a positive change, as new factory buildings were built and other major companies (e.g. Apollo Tyres, Procter & Gamble) started their activities.

Since 2005, one of the biggest unresolved problems of the micro-region is its inability to compete with the wages of similar jobs in the capital and its agglomeration. As a result, a significant proportion of the active workers in the micro-region spend up to 2-3 or more hours a day commuting (100-160 km) rather than strengthening the labour market at micro-region level (Kassai and Ritter, 2011).

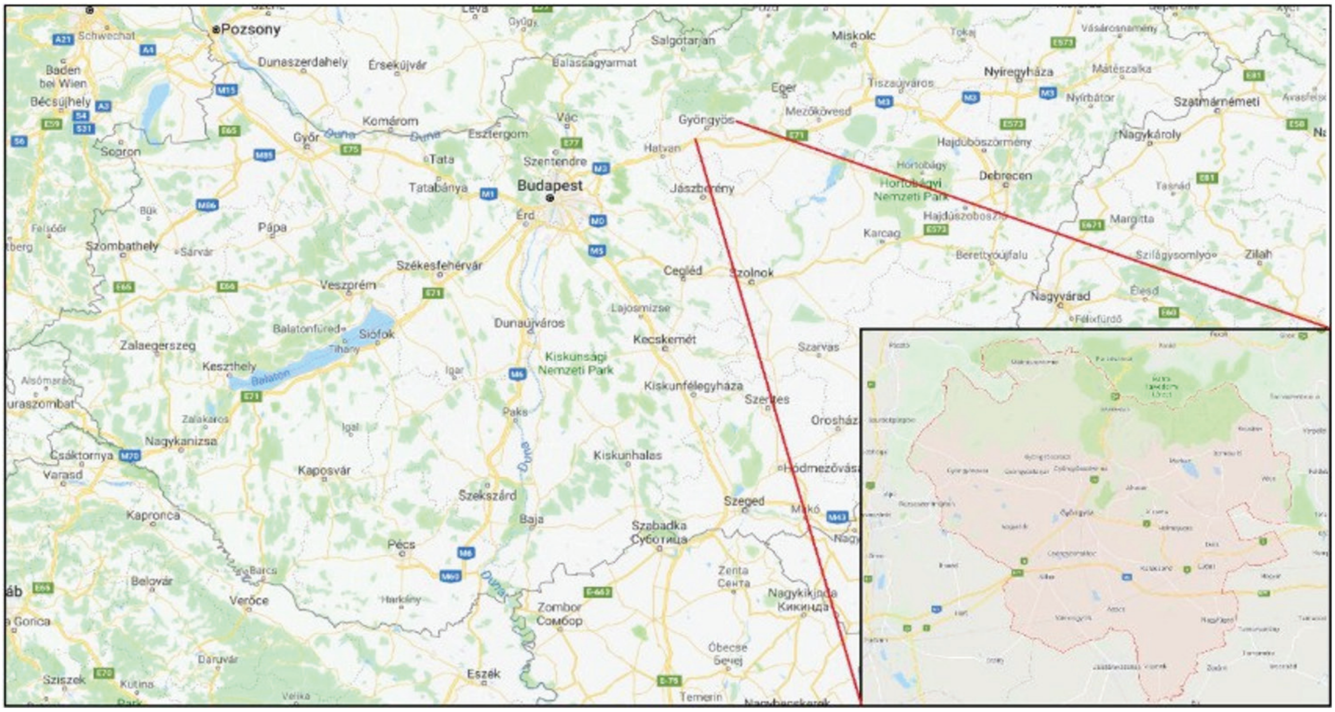

Figure 2. Location of the micro-region of Gyöngyös

Source: Own editing based on Google Maps, 2020

In the questionnaire I used a stratified random sampling technique, based on gender and age. I examined the distribution of gender and age proportions at the level of settlements and then carried out the sampling on the basis of these distributions.

I surveyed local inhabitants in all 25 settlements in the micro-region of Gyöngyös, in relation to their share in the total population of the region, using a questionnaire designed for them from late 2019 to early 2020, with the focus on the following topics:

- their general knowledge of renewable energy, their residential use, their investments, and the amount of energy saved per month;
- the amounts invested in renewable energies, the payback period and the purpose of the investments;
- methods to reduce efficient energy consumption and environmental impact.

Since my whole research consists of three major parts (1. primary, secondary and university students in the micro-region; 2. local governments, and 3. local population), in this article I will only focus on the main results of the population survey.

On the basis of my own practical experience and preliminary research, I seek to confirm/reject the following hypotheses:

> *H1: The knowledge of the population living in the examined area about renewable energy and the use of renewable energy sources is low.*
>
> *H2: Within the examined population, the investments of renewable energy users are mostly accomplished by their own financial resources.*

H3: The average monthly savings from renewable energy investments of the examined local population is less than HUF 25,000 (EUR 70).

The main results related to the hypotheses and GOAL 7 are presented in the Results and Discussion chapter.

RESULTS AND DISCUSSION

In order to be representative, I surveyed the population of the 25 settlements in proportion to the total population of the micro-region. The population questionnaire was completed by 468 respondents, of which 10 could not be evaluated due to incorrect completion or lack of interest, resulting in a final response rate of 458[12] respondents, of which 51% were female and 49% male.

As first question, I used an open but simple question, asking what renewable energy means to the respondents. According to the answers given by the survey residents, the term of 'renewable source' means the following to them:

- natural resources, renewable energy (non-fossil energy) such as solar, hydro, wind and geothermal energy, i.e. all resources that do not run out;
- it also means to them as key terms which are related to environmental protection, environmental policy, environmentally conscious living that constantly present in their lives;
- in concrete terms, they also understand it to mean energy resources that are available in unlimited quantities in nature, that are continuously available through natural processes, that do not pollute/ destroy the environment and that are renewable;
- and finally, it also means energy saving and improvement in life quality to them.

I was also curious about which types of renewable energy are known, especially to the meaning of renewable resources. The option of tidal energy also included in addition to the six response options, which was defined afterwards because 7.8% of respondents identified it as a category of 'other' (Figure 3).

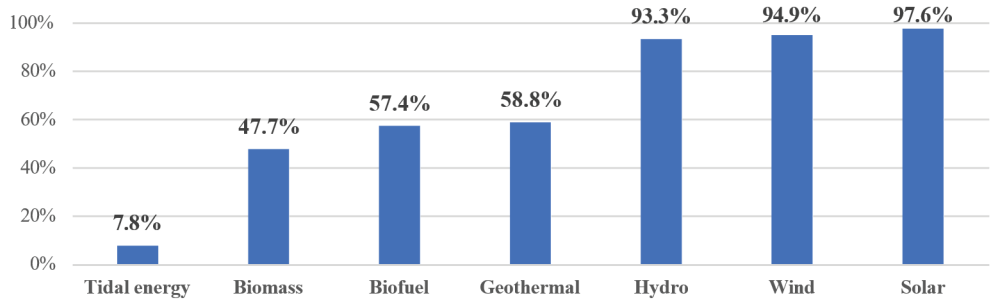

Figure 3. Distribution of the surveyed population by the renewable energy sources they know (%)

Source: Own research and editing, 2020 Note: More than one answer could be marked!

The results clearly show that overall knowledge of biomass (47.7%), biofuels (57.4%) and geothermal energy (58.8%) is significantly lower than for hydro energy (93.3%), wind energy (94.9%) and solar energy (97.6%). In the questionnaire survey, residents of Abasár, Detk, Gyöngyös, Gyöngyössolymos, Nagyréde, Pálosvörösmart and

12 Where the range of respondents is incomplete (e.g. whether they have made an investment in renewable energy), the item number is shown separately in the results.

Visonta had a more comprehensive knowledge of renewable energy, while in the other settlements they had much less general knowledge.

The third question in the residential questionnaire was about personal use of renewable energy, which restuls can be seen on Figure 4.

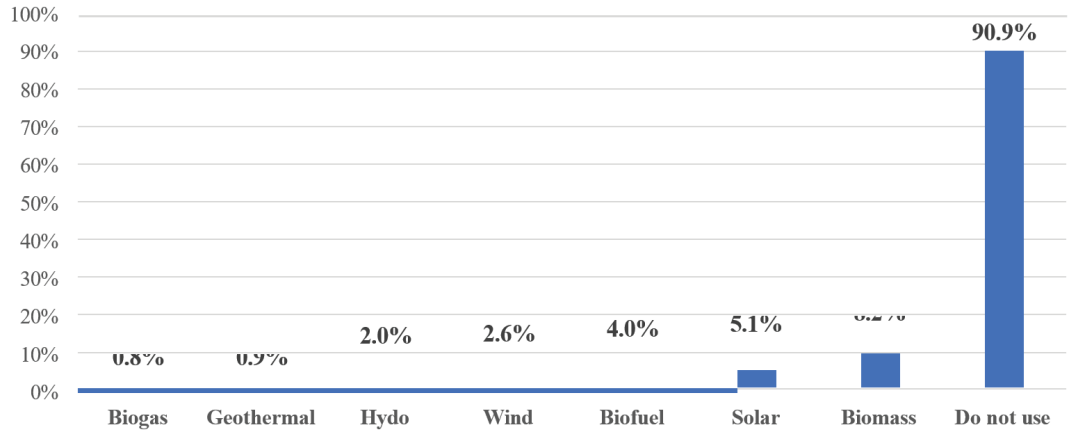

Figure 4. Distribution of the surveyed population by renewable energy use (%)

Source: Own research and editing, 2020 Note: More than one answer could be marked!

The results show that a very small proportion of the population uses only some form of renewable energy. Only 5.1% use some form of solar energy (typically solar panels), the most well-known energy source. The 2.6% use of wind energy is less surprising, as wind energy (e.g. wind turbines) is not used in Hungary as a whole due to less favourable weather conditions. As the vast majority (90.9%) do not use any form of renewable energy, for the following questions I will present the answers of those who do use some form of renewable energy.

For residents who use renewable energy sources, I used an open question to investigate the sources of the investments. Based on the responses received, I identified four different sources of applications (Figure 5), with a total distribution of 100%, as each respondent had typically participated in only one application or had made one renewable energy investment by the time the research was conducted.

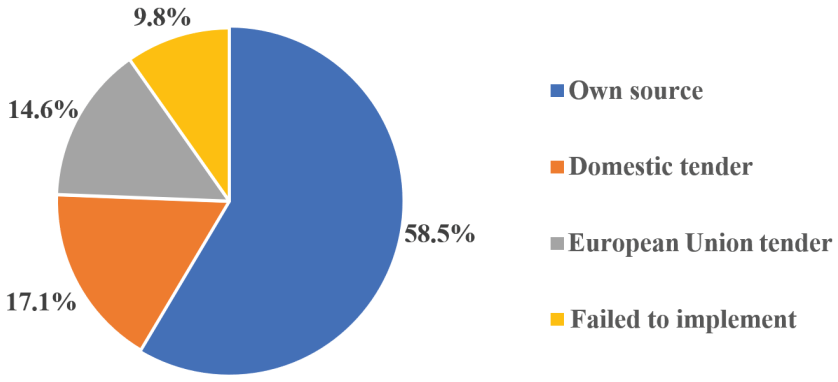

Figure 5. Distribution of the investments of the examined population in renewable energy sources, in terms of financing (%)

Source: Own research and editing, 2020, n=41

Most of them - around 58.5% - made investments in renewable energy from their own resources. In addition, 17.1% of the respondents had successfully applied for and won a national (domestic) tender (TÁMOP[13], KEHOP[14]) and 14.6% had implemented a European Union tender[15]. In terms of results, 9.8% had applied for a renewable energy investment but failed to implement the application due to rejection or failure to meet the conditions set out in the application.

It is understood that the results are also influenced by factors such as the energy source, the amount of energy used and the technology used, but I was not able to go into the details of this in this research, but it is an objective of my future research.

Figure 6 shows the monthly average energy savings achieved by the investments compared to the previous consumption expenses of the population under study.

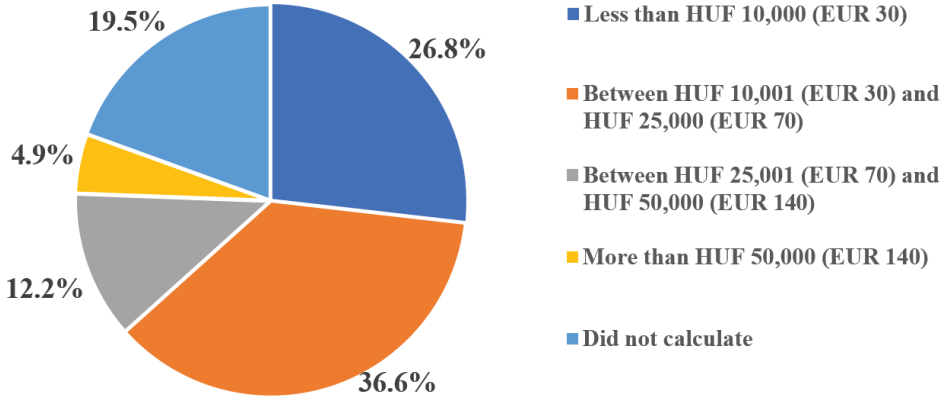

Figure 6. Distribution of average monthly savings (in HUF) from renewable energy investments in the responding households (%)

Source: Own research and editing, 2020, n=41

About 26.8% of the average monthly savings are less than HUF 10,000 (less than EUR 30[16]). For most of the respondents (36.6%), the savings are between HUF 10,001 and HUF 25,000 (between EUR 30 and EUR 70). Savings higher than this were much less common. 12.2% of respondents have savings of between HUF 25,001 and HUF 50,000 (between EUR 70 and EUR 140) and far fewer (4.9%) have average monthly savings of more than HUF 50,000 (more than EUR 140). 19.5% of those who did not deal with the difference in savings or did not calculate it.

CONCLUSIONS

Increasing the promotion of sustainability and the use of renewable and clean energies are among the visionary goals. The article highlighted that although sustainability is measurable and has a number of indicators, it is still a very meaningful and complex issue.

Solving this area is also one of the EU's objectives, one phase of which was the implementation of the key targets of the 2020 package, and will pursued further in the 2030 climate and energy framework. It is visible that

13 The 'Társadalmi Megújulás Operatív Program' abbreviation is 'TÁMOP', which can be translated to Social Renewal Operational Programme.
14 The 'Környezeti és Energiahatékonysági Operatív Program" abbreviation is 'KEHOP', which can be translated to Environment and Energy Efficiency Operational Programme.
15 In the case of the European Union Programmes, the following can be mentioned from a research perspective: Customs Control Equipment Instrument (CCEI), Creative Europe (CREA), Customs Programme (CUST), Programme for the Environment and Climate Action (LIFE), Promotion of Agricultural Products (AGRIP).
16 Based on EUR / HUF exchange rate as of 25th May 2021.

the future goal of the EU is clear on these challenges, therefore the Sustainable Development Goals are a useful vehicle to project globally the EU's values and objectives, and provide a shared framework. Goal 7 focuses on the importance of affordable and clean energy topic. For me, this is important because my own research and related findings seek to find answers to the questions that arise in this area.

Only a part of my representative research is presented in this article, but these results answer the three hypotheses I have formulated. After summarising the research results and comparing the hypotheses, the following conclusions can be drawn.

The H1 – The knowledge of the population living in the examined area about renewable energy and the use of renewable energy sources is low – is linked to the first and second questions of the questionnaire, the results of which show that the local residents interviewed are mostly only aware of solar, wind and hydro energy as renewable energy sources. Only about half of the respondents have knowledge about biomass, geothermal energy, biofuels, and less than 8% know the meaning of tidal energy. The results show that this hypothesis has been confirmed.

The results of Figure 5 are the most relevant to test the H2 – Within the examined population, the investments of renewable energy users are mostly accomplished by their own financial resources. The results show that 58.5% of the local residents surveyed are indeed using their own financial resources for their renewable energy investments. Only 31.7% of them have implemented renewable energy projects with domestic or EU funding (mostly KEHOP, TÁMOP, CREA, LIFE or AGRIP). Therefore, based on the results, I consider this hypothesis to be confirmed as well.

The results in Figure 6 help to test H3 – The average monthly savings from renewable energy investments of the examined local population is less than HUF 25,000 (EUR 70). The results of the survey question show that 26.8% of the respondents save less than HUF 10,000 (EUR 30) per month and 36.6% save between HUF 10,001 and HUF 25,000 (between EUR 30 and EUR 70) per month. Adding these two categories together, a total of 63.4% of respondents can actually save less than HUF 25,000 (EUR 70) per month, confirming this hypothesis.

The results of the research are certainly relevant, as they represent a general picture not only of the local population's attitude towards renewable, affordable and clean energy sources, but also of whether they plan to develop or invest in them in the future. Therefore, it is clear that further research in this direction is strongly recommended.

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