ISSN 2616-6771
eISSN 2617-9962

Л.Н. Гумилев атындағы Еуразия ұлттық университетінің

ХАБАРШЫСЫ

BULLETIN
of L.N. Gumilyov Eurasian
National University

ВЕСТНИК
Евразийского национального
университета имени Л.Н. Гумилева

ХИМИЯ. ГЕОГРАФИЯ. ЭКОЛОГИЯ сериясы

CHEMISTRY. GEOGRAPHY. ECOLOGY Series

Серия **ХИМИЯ. ГЕОГРАФИЯ. ЭКОЛОГИЯ**

№1(130)/2020

1995 жылдан бастап шығады

Founded in 1995

Издается с 1995 года

Жылына 4 рет шығады
Published 4 times a year
Выходит 4 раза в год

Нұр-Сұлтан, 2020
Nur-Sultan, 2020
Нур-Султан, 2020

Редакцияның мекенжайы: 010008, Қазақстан, Нұр-Сұлтан,қ., Сәтбаев к-сі, 2,
Л.Н. Гумилев атындағы Еуразия ұлттық университеті, 402 б.
Тел: +7 (7172) 709-500 (ішкі 31-428). E-mail: vest_chem@enu.kz

Жауапты хатшы, компьютерде беттеген А. Нұрболат

Л.Н.Гумилев атындағы Еуразия ұлттық университетінің Хабаршысы. Химия. География. Экология сериясы
Меншіктенуші: ҚР БҒМ "Л.Н. Гумилев атындағы Еуразия ұлттық университеті" ШЖҚ РМК
Мерзімділігі: жылына 4 рет.
Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінде 27.03.2018ж.
№16997-ж тіркеу куәлігімен тіркелген. Тиражы: 25 дана
Типографияның мекенжайы: 010008, Қазақстан, Нұр-Сұлтан, қ., Қажымұқан к-сі, 12/1,
Л.Н. Гумилев атындағы Еуразия ұлттық университеті
Тел: +7 (7172)709-500 (ішкі 31-428). Сайт: *http://bulchmed.enu.kz*

Editorial address: 2, Satpayev str., of. 402, L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan, 010008

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Responsible secretary, computer layout: A. Nurbolat

Bulletin of the L.N. Gumilyov Eurasian National University. Chemistry. Geography. Ecology Series

Owner: Republican State Enterprise in the capacity of economic conduct "L.N. Gumilyov Eurasian National University" Ministry of Education and Science of the Republic of Kazakhstan

Periodicity: 4 times a year

Registered by the Ministry of Information and Communication of the Republic of Kazakhstan. Registration certificate №16997-ж from 27.03.2018. Circulation: 25 copies

Address of Printing Office: 13/1 Kazhimukan str., L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan 010008

Tel: +7 (7172) 709-500 (ext.31-428). Website: http://bulchmed.enu.kz

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Ответственный секретарь, компьютерная верстка: А. Нурболат

Вестник Евразийского национального университета имени Л.Н. Гумилева. Серия: Химия. География. Экология.

Собственник: РГП на ПХВ "Евразийский национальный университет имени Л.Н. Гумилева" МОН РК

Периодичность: 4 раза в год. Зарегистрирован Министерством информации и коммуникаций Республики Казахстан.

Регистрационное свидетельство №16997-ж от 27.03.2018г. Тираж: 25 экземпляров

Адрес типографии: 010008, Казахстан, г. Нур-Султан, ул. Кажимукана, 13/1.

Евразийский национальный университет имени Л.Н. Гумилева. Тел.: +7(7172)709-500 (вн.31-428). Сайт: *http://bulchmed.enu.kz*

BULLETIN OF L.N. GUMILYOV EURASIAN NATIONAL UNIVERSITY. CHEMISTRY. GEOGRAPHY. ECOLOGY SERIES

№1(130)/2020

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MRNTI 27.25.19.

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Transformation of the renewable energy structure in Hungary

Abstract: According to the Eurostat database, the percentage of renewable energy sources in the energy mix of the EU is increasing year after year (www.europa.eu/eurostat). In 2018, the values reached 73% in neighboring Austria (48% in Croatia, 42% in Romania, 32% in Slovenia and 21% in Slovakia), Hungary now stands at 8%. Wind energy is the leader in the renewable energy structure of the EU countries (35, 8% in 2018), since the construction of wind farms is prohibited in our country, one of the main objectives of research is to examine our energy structure. Our last position in renewable energy in 2020 prompted the government to develop a new climate strategy (mekh.hu/nemzetienergiastrategia2030). According to the new strategy, Hungary is estimated to be climate and carbon neutral by the end of the decade. Among the alternative sources of energy, solar energy is becoming the favorite, and our article points out why other forms of energy are being overshadowed. Analyzing the changes in the country's future energy mix, it can be said that it will be based essentially on nuclear power and electricity from Russia's electricity grid. However, due to the drastic drop in the cost of solar panels in the energy mix of households, solar energy has become a favorite of renewable energy sources. In the climate strategy, the government plans to create 8,000 MW of solar energy by 2050, which will be mainly used in households, municipal buildings, and tourism.

Keywords : renewable energy, solar energy, solar panel, households, capacity

DOI: https://doi.org/10.32523/2616-6771-2020-130-1-103-112

Introduction. With the continuous development of technology, Hungarian households are increasingly in need of energy. The ecological footprint of Hungarian households is close to the European average and we expect further growth. The projects of the Szechenyi 2020 program promoting the development of the green economy provide significant subsidies for the use of renewable energy for households and small- medium sized enterprises. In our country, tenders prefer the utilisation of geothermal and solar energy among all the alternative energy sources. With the advancements of technology, the Hungarian households have a higher need for energy. The ecological footprints of the households is near the European Union's average and is expected to grow. Two Operational Programs, GINOP's and VEKOP's contracts offer non-refundable sponsorship for small and medium sized businesses to use renewable energy. For households interest subsidies are offered in the form of credits with 0% interest rate. In 2019 the credit's duration could only be 20 years maximum, with an own contribution of 10% for the contracts. In 2020 the non-refundable sponsorships may be consumed as part of the housing assistances, because we could only accomplish a small percentage of our obligations towards the European Union's plans.

In energy generating the alternative energy sources made up 7.2% of the electricity production. Consumers of the alternative energy sources prioritized biomass, geothermal- and solar energy. Hungary's gross energy consumption in 2017 was 3000 ktoe, consisting of 80% biomass usage [1]. It would ne obvious for households to use our enormous 60PJ/year geo-thermic potential for their heat demands, but only a small portion is used [2]. The capacity of coal energy could be raised from 330 megawatts to 1200 Mws, but due to the lack of authorisation there were no such power plants built since 2010. As of 2017 more than 20 000 solar power systems were working in our country, generating a total of 28.5 ktoe energy [3].

Table 1. Comparing renewable energy sources, self made [4]

	Consumption			Domestic facilities	Availability	Investment	Payback time	Barriers to use
	Electricity	Heat production	Fuel					
Biomass / Biogas	X	X	X	Favourable agricultural conditions, few energy forest	It depends on agricultural production and is therefore seasonal	Processing plant, operating units	Very soon	It can be detrimental to food production
Wind energy	X			Northwest Hungary is favourable,	Weather dependent	Construction & Network Integration, Land Use	7-8 years	Integration into a centralized electricity grid is problematic
Geothermic energy	X	X		Excellent conditions, especially in the Danube-Tisza Intermediary	Anytime	Installation, relatively high cost	Electricity: 5-8 years, heat generation: 2 years	Relatively high capital requirements
Solar energy	X	X		Favourable conditions: number of sunny hours per year: 1900-2300 hours / year	Weather dependent	Installation, relatively high cost	Photovoltaic application: 12-17 years, solar thermal energy: 6 years	Costly installation, long-term return on investment
Hydropower	X			Adverse hydrographic situation	Area and hydrographic dependent	Power plant construction, network integration (very high capital requirements)	8-15 years	Nature conservation problems, unfavourable conditions

Continuation of table 1

Hydro power	X			Adverse hydro-graphic situation	Area and hydro-graphic depen-dent	Power plant con-struc-tion, network inte-gration (very high capital require-ments)	8-15 years	Nature conser-vation prob-lems, un-favourable condi-tions

As seen in Table 1 from the return rates, the households prioritize geothermic - and solar energy among the alternative energy sources. Next we can see an examination of a household's long term benefits.

On the one hand, the research aimed to analyze the correctness of the results announced by the new climate strategy and, on the other hand, we are contemplating why solar energy is becoming the favorite renewable energy source.

1. Development of Solar energy and heat units in Hungary. While this article was being written, we conducted primary and secondary analyses and applied research methods in regional science. We started from the basic thesis that the results of the announced climate strategy will be sustainable. During the in-depth interviews, Lбszly Magyar, head of the Energy Club, said that the introduction of six thousand megawatts of solar power in the system is not exaggerated or even underestimated. According to our calculations from the Central Statistical Office, domestic solar capacity has almost tripled over the past three years and is now close to 1,200 MW. This rapid expansion has seen the greatest increase in the number of residential units, now reaching 1/3 of its capacity, with the remaining two-thirds being owned by municipal buildings and the tourism industry. Tamбs Zarбndy, (former head of the Szбzadvйg Economic Research Energy Division), decarbonization of electricity generation, which integrates 8000 MW of solar capacity into the system by 2050, costs $ 4200 billion, and costs $ 500 billion a year in network development and system balance - the latter could bring about an average 50% increase in the price of electricity, according to the document. However, this would also mean that transport would be converted into electric drive, which would require the installation of 250,000 charging points at a cost of 3,000 billion US dollars [5].

Return calculations have been made on household energy use, which shows that even larger investments will generate profits for families within 10 years. Municipalities benefiting from EU subsidies and tourism sites can expect even better payback times [6].

From a tourist point of view, solar energy is used to reduce the energy bill for accommodations and attractions, and the government provides significant support to improve the use of solar energy in rural accommodations [7].

More than 1000 people have been consulted on their views concerning energy sources.

During the cluster analysis, we asked different questions about the energy structure of the country for each age group. There are great differences between age groups because younger generations see solar and wind energy as the energy source of the future, meanwhile middle-aged people are considering nuclear power and older people traditional hydrocarbon-based technology to be a reliable source of energy.

The Q method can be useful for exploring individual opinions and differences of opinion, as well as for describing different opinion groups [8]. The advantage of a focus group is that we get to know each other's opinions independently, so we do not have to worry that the opinions of lower-level executives in the organizational hierarchy are not as pronounced when they are different from those of higher-level executives. The Q method uses correlations and so-called inverse factor analysis. In this method, factor formation is not done through statements, as is customary in social statistical procedures, but through individual Q-orders (filled-in Q-tables for each respondent) to create groups of individuals. Thus, I also determine the correlations between persons' Q-orderings in pairs. A factor, that is to say, an opinion group that will be based on that person who filled out the above table in a similar way and can, therefore, be considered as an opinion group.

Since the start of the 20th century there are usual observations of the rays and to register the hours of sunshine. In Hungary the global rate, at midday, with average sunshine in the winter seasons, meaning from October to March is 250-600 W/mI. In the summer, from April to September this rate is between 600-1000 W/mI [9]. The proportion of the sprinkled light can reach 40-50%, so keeping in mind the domestic conditions flat solar panels are more useful since they can absorb both direct and sprinkled light.

In theory our solar energy potential goes beyond our current energy consumption and even a 1999 government decision planed 20 000 solar panels installed by 2020. As of now, we can see our neighbour Austria operating a 4.5 million m2 solar panel system, while this rate (in the sunnier) Hungary has stopped at 300 000 m2 [10] Solar energy is a costly energy source, however in the past decade the price of an average Solar panel has been reduced to less than a third of it's original price, so it is becoming more and more beneficial to use one (Figure 1).

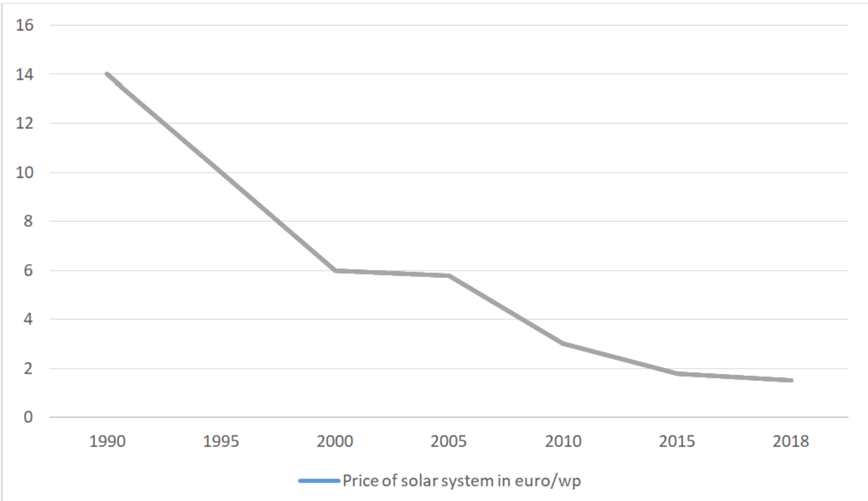

FIGURE 1 – Price of solar panel systems [10].

It is hard to get an assessment of the exact number of solar panels in use and the size of the Hungarian solar panel market because the Central Statistics Office does not provide data. The statistics seen now are based on the data from the Hungarian Technical Building Union.

The next figure shows the yearly achievements of the new solar panel system in Hungary between 2008 and 2018. It can be seen that in the given time frame, a constant growth occurred on the solar panel market. The currently used household sized (under 50kW) solar panels' capacity is around 200 000 m2 in Hungary (Figure 2).

The domestic solar panel market shows a rather unstable performance, as seen in the previous display. It can be explained by comparing the market data and the individuals' and detached house owners' state aid, the gaps align with the changes of the aid's quality.

The energy consumption of an average Hungarian household is estimated to around 2000kWh. To estimate the performance of a solar panel system needed to generate energy, we need to calculate it by dividing the yearly electricity consumption, given in kWh by 1100 (because 1100kWh can be generated with a 1 kW system) which, in the case of consuming 2000 kWh, equals to 1.82kWh. The mostly used polycrystalline solar panels generate 0.12-0.18 kWh per m2. So for a normal household, at least 10 m^2 of solar panels with a 1.8 kW performance is needed to cover the whole electricity bill. According to annuity costs it is built up of multiple factors. We have to take into consideration, the investment cost at the beginning of the examined period, the yearly maintenance fees, the energy consumption fees that come with operating the machines and other expenses such as the payment

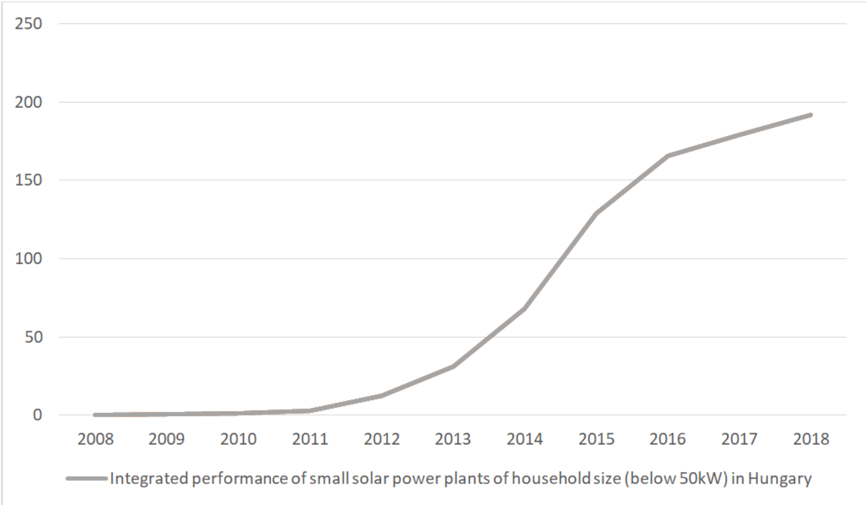

FIGURE 2 – Household size (under 50kW) solar panel generator‘s performance in Hungary [11]

of the workers and insurances. The one year value is obtained by correcting with annuity factors that take inflation, changes in interest rates and other price increase effects into consideration. Then we compare the annuity costs to the income that was also calculated with with annuity factors. The income is interpreted as the savings coming from using renewable energy instead of traditional energy. We calculate the values to 4-5 people, take 3 flat-panels as base, since that can be seen as the usual phenomena. In the case of domestic hot water, the floor area of the house in m2 is not needed, only the number of inhabitants, since they will be the water users.

1.1 Exact data of the solar panel system

-solar panel‘s full usable surface (FKOLL): 5,4 m2,
-capacity of the hot water tank: 300 litre,
-systems gross investment cost (A0): 1.000.000 Ft,
-system‘s estimated energy production (QFKOLL): 600 kWh/(m2.year),
-system‘s yearly energy generating (QKOLL): 5,4 m2*600 kWh/m2= 3240 kWh,
-system‘s maintenance cost factor (fS): 0,5%.

To calculate, estimate data is used from macroeconomic and technical literature. The current central bank interest rate is 6.25%, but for the sake of simplicity I will count with 6%, general inflation of 4%, regarding energy sources I estimate a higher rise in cost, equal to 5% in electricity and 7% in pipeline gas.

The economic data in the example:
- central bank interest rate (p): 0,9%,
- interest rate factor that equals the central bank interest rate: (q=1+ (p/100): 1,009,
- price change factor of electricity (rF): 1,05 (5%-os annual growth),
- price changing factor of pipeline gas (rB): 1,07 (7%-os annual growth),
- maintenance costs are a price change factor (rS): 1,04 (4%-os annual growth),
- price of electricity in the first year (Eelec): 45Ft/kWh,
- price of pipeline gas in the first year (Egas): 18Ft/kWh,
-length of examined life – cycle (T): 25 years,
-solar panel system‘s residual value at the end of the 25 year cycle (RW): 0Ft.

1.2 Cost of capital of the examined system

The highest cost is almost always the investment cost of the equipment. The annuity of it (AN,C) can be calculated as the series of the gross investment cost (A0-RW) divided by the residual value and the examined period‘s (T) annuity factor (a). To keep it simple I will not count the residual value, meaning I will take it as the system‘s inability to provide values after the 25 years period

The annuity factor that shows one Forint‘s present value with the „q” annuity factor is this:

So the interest rate calculated with it is:

AN,C = (A0 – RW) x a = (1.000.000 – 0) x 0,0782 = <u>78.227 Ft</u>

$$a = \frac{q^T \cdot (q-1)}{q^T - 1} = \frac{1{,}06^{25} \cdot (1{,}06-1)}{1{,}06^{25} - 1} = 0{,}0782$$

1.3 Maintenance cost

The yearly regular maintenance cost is proportional to the investment cost, it's value can be calculated with the maintenance cost factor (fs) and the annuity factors (a, baS).

In case of solar panel systems, the maintenance cost is the 0.5% of the investment. If the inflation of the maintenance cost's yearly rise is too high, the price-dynamic annuity factor (bas) should also be counted by the annuity of the maintenance cost capital value's factor (bs).

$$b_S = \frac{1-\left(\frac{r_S}{q}\right)^T}{q - r_S} = \frac{1-\left(\frac{1{,}04}{1{,}06}\right)^{25}}{1{,}06-1{,}04} = 18{,}94$$

ba $_S$ = b $_S$ x a = 18,94 x 0,0782 = 1,48

So the maintenance cost calculated with annuity:

A $_{N,S}$ = A $_0$ x (f $_S$ / 100) x ba $_S$ = 1.000.000 x (0,5/100) x 1,48 = 7.409 Ft

1.4 Operating costs

The solar panel system's operating cost means the cost of the energy used to operate it. In this case it's the electricity used for regulations and pumps [12]. The regulator's energy consumption can be overlooked and the pump's energy consumption can be estimated like this:

- average operating hours of the solar system ~ 2500 hour/year,
- average electric performance of the pump: 30W,
- yearly energy consumption of the pump: Qpump = 2500 x 30 = 75000 Wh = 75 kWh,

This is the (75/3240) × 100=2.3% of the solar panel system's useful heat quantity.

Solar panel system's electricity cost in the first year:

A $_{F1}$ = Q $_{pump}$ × Eelec = 75 kWh x 45 Ft/kWh = 3.375 Ft

Taking into consideration, the 5% rise in electricity cost, the energy cost capital value factor is:

$$b_F = \frac{1-\left(\frac{r_F}{q}\right)^T}{q - r_F} = \frac{1-\left(\frac{1{,}05}{1{,}06}\right)^{25}}{1{,}06-1{,}05} = 21{,}10$$

The energy cost's price-dynamic annuity factor can be calculated as seen here:

ba $_F$ = b $_F$ × a = 21,10 × 0,0782 = 1,65

Based on this the energy cost value calculated with annuity is:

A $_{N,F}$ = A $_{F1}$ × ba $_F$ = 3.375 × 1,65 = 5.569 Ft

With bigger renewable energy producing equipment, further costs can appear, for example the worker's fee, or the insurance of the equipment, however these are not likely, therefore I will not include them in my calculations.

The full cost of the solar panel system calculated with annuity:

A $_{N,TOT}$ = A $_{N,C}$ + A $_{N,S}$ + A $_{N,F}$ = 78.227 +7.409 + 5.569 = 91.205 Ft

With the knowledge of the full cost, the price of the heat energy generated, also known as solar heat can be calculated like this:

K $_{KOLL}$ = A $_{N,TOT}$ / Q $_{KOLL}$ = 91.205.-Ft / 3240 kWh = 28,15 Ft/kWh

This means that the solar panel system in my example, during the 25 years, produces us energy at that price, which is not a bad price, considering that 18 Ft/kWh is the current price of gas, which would result in an only 1.8% rise yearly. However we can also compare it to the current price of electricity, which is much higher, standing at 45 Ft/kWh.

1.5 Calculating Incomes

The solar panel system's income (AN,B) is the traditional energy (natural gas) consumption cost that was replaced by using the equipment.

Natural gas savings in the first year:

$A_{B1} = Q_{KOLL} \times E_{GAS}$ = 3240 kWh x 18 Ft/kWh = 58.320 Ft

Considering the yearly 7% increase of natural gas price, the income capital value rate is:

$$b_B = \frac{1-\left(\frac{r_B}{q}\right)^T}{q-r_B} = \frac{1-\left(\frac{1,07}{1,06}\right)^{25}}{1,06-1,07} = 26,46$$

Income's price-dynamic annuity factor is calculated this way:

$ba_B = b_B$ x a = 26,46 x 0,0782 = 2,07

So the income calculated with annuity:

$A_{N,B} = A_{B1}$ x ba_B = 58.320 x 2,07 = 120.722 Ft

Equation of annuity: income – all costs:

$A_N = A_{NB} - A_{N,TOT}$ = 120.722 – 91.205 = 29.517 Ft

2. Survey about the energy consumption of the households

We made a survey to find out about people's thoughts about their energy consumption and how that fits with the challenges of the present days. During the survey, we chose 1035 people with the help of the internet. Answering was entirely voluntary and anonymous for every person. The research took place between 2018 December 2nd and 2019 January 12th. The composition of the respondents satisfied the socio-demographic view of Hungary's population, however it isn't a representative research. The survey proved that people have significant general knowledge of renewable energy sources. They recognize the importance of it and know the equipments, with which households can help protect nature. The survey also proved that the majority of the respondents (60%) does not or can not use renewable energy sources. The following questions focused on daily equipment of households and how much attention is given to energy efficient lifestyle. 80% of respondents stated, they use energy saving light-bulbs, in contrast to 20% who use normal light-bulbs. Electronic devices are hidden energy consumers, and 62% of respondent said they let the devices consume freely. It would be highly beneficial to unplug or turn off these devices [13].

Regarding heating, 40% thought their heating system is outdated, to which they gave „old, it needs to be repaired" as a reason.10% said that there are better heating systems than theirs, or it is not fitting since it does not use renewable energy. 80% of respondents expressed their interest in using renewable, alternate energy for their heating. Those who answered with no, thought that they are too old to start a proper conversion process to renewable energy, or that their current accommodation makes it impossible to do so. About the energy consumption 76% picked solar energy as the one they would like to switch when it comes to heating. This falls in line with the fact that most technological advancements were made in this field and solar panel systems are available to everyone now [14]. 51% of the respondents said yes when I asked if they know the term „half-passive house" , so more than half of the people have encountered it before. Overall it seems like a better ratio than what we expected, however when we asked what that is, most respondents selected „energy saving building". The respondents gathered 82% of their information from the internet, their knowledge on the other hand often appeared to be completely different regarding the renewable energy sources.

In conclusion, it can be stated that instead of alternative energy sources, gas- and district heating is still considered the best heating system.

Summary. Summarizing the research hypotheses, the government's carbon-neutral targets will be maintained by 2030 [15]. The Paks Nuclear Power Plant, electricity coming from Russia and 8,000 MW of solar energy will be enough to supply the country. Cheap Chinese solar panels will make solar energy a favorite for households and the tourism industry, but they may also raise a ton of problems in the near future. Because they are cheap, but will fail soon, solar panels will contain relatively large amounts of environmentally hazardous material [16], so large quantities of units that are already inoperable will need to be stored. There are currently no calculations on how much the storage of large amounts of solar panels will cost, according to our current calculations, we paint a very positive picture for investing in energy.

From our calculations we can determine, that with the assumed economic and technical data, a normal sized household's solar panel system, that generates 60-70% of the house's hot water needs, is economical, since with 25 years of usage, we can save around 29,500 Ft per year, which would be around 737,500 Ft for the 25 years. On the contrary, if we look at the outcomes of the costs and profits, (as seen in Figure 3.) it is concluded, that the system‘s payback period, meaning the time when the income is higher than the costs, is rather long, taking 19 years.

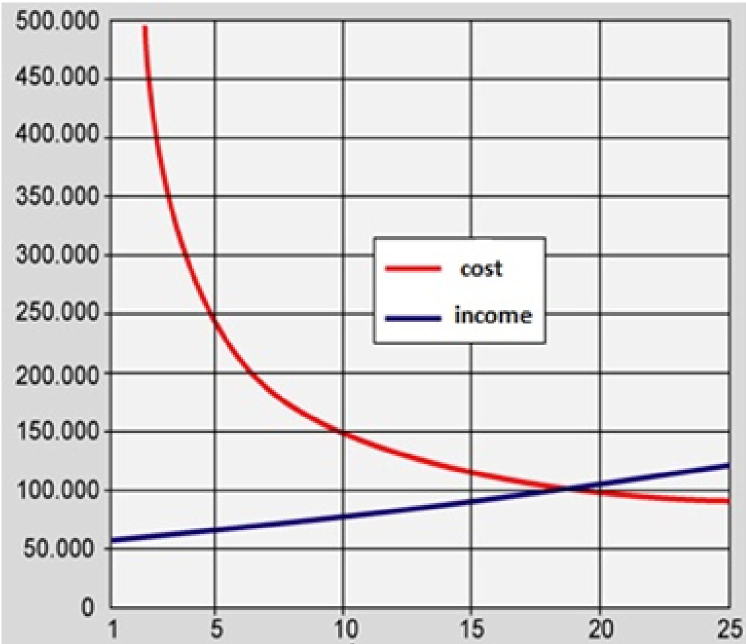

Figure 3 – Cost and Income calculated with Annuity, self-made (Source: made with the data from the example).

It is important to note, that the chosen energy source in our example was natural gas, which is the cheapest energy source now. If we use the significantly more expensive electricity for example an electric water-heater with the solar panels instead of gas, the payback period is reduced to 8 years. Aside from this, it will bring further improvements if we are granted State Aid. The percentage of this according to the Green Investment System‘s population tendering procedure is 30-60%. The base 30% could reduce payback period to 14 years with natural gas and 6 years with electricity [17].

The mainly complex investments allow for a „climate bonus" with a further 10-30% aid, which will reduce even natural gas‘s payback period to a single digit.

We believe that it is important to state, that after the examination shown above from a financial perspective, in case of a renewable energy using investment, it is not only the quantifiable profit that should be considered. The prevention of carbon dioxide and other harmful emission with the substituting of fossil fuels, the independent, local energy generation‘s benefits, the optimisation of the economics of scale with such systems, also the workplaces created for planning, implementing and maintenance, all count towards the benefits of the investments.

It is seen from our survey, that the households are interested in the new possibilities, but due to their own comfort, it is hard to make steps to reduce their own carbon footprints. Regarding modern heating systems 80% of the respondents thought district- and gas heating is the safest, cheapest solution. For the future of the households, it can be stated that including their energy structure, renewable energy source usage will also play a bigger role. Flat-panels gained popularity in Europe and energy storing litium-ion accumulators are the ones they see opportunities in. However new technologies have appeared, such as solar cooling, solar process heating, and solar disrick heating systems. If the energy storing conditions improve, the State Aids will also experience growth (according to our measurements, these two factors play a big role in our decisions), and then solar energy and bioenergy [14, 17] is going to gain bigger exposure in households compared to other energy sources.

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Структурная трансформация возобновляемой энергии в Венгрии

Аннотация. Согласно статистической базы данных Евросоюза, доля возобновляемых источников энергии в структуре энергопотребления ЕС растет из года в года. В 2018 году значения возобновляемой энергии достигли 73% в соседней Австрии, 48% в Хорватии, 42% в Румынии, 32% в Словении и 21% в Словакии, но в Венгрии в настоящее время оно составляет всего 8%. Ветровая энергетика является лидером в структуре возобновляемых источников энергии в странах ЕС (35,8% в 2018 году). Поскольку строительство ветровых электростанций в нашей стране запрещено, одной из основных целей исследований является изучение Венгерской энергетической структуры. Наша последняя позиция в области политики возобновляемых источников энергии на 2020 год, побудила правительство разработать новую климатическую стратегию. Согласно новой стратегии, к концу десятилетия Венгрия будет считаться климатически нейтральной к углеродному сырью, как источнику энергообеспечения. Среди альтернативных источников энергии солнечная энергия становится фаворитом. В данной статье отражается, почему другие виды энергии затмеваются. В работе проанализированы изменения в будущем энергетическом балансе Венгрии, что отражает использование в будущем главным образом атомной энергии и электроэнергии из российской электросети. Тем не менее, из-за резкого снижения стоимости солнечных батарей в энергобалансе домашних хозяйств солнечная энергия стала фаворитом возобновляемых источников энергии. По климатической стратегии правительство планирует к 2050 году создать 8 000 МВт солнечной энергии, которая будет в основном использоваться в быту, муниципальных зданиях и туризме.

Ключевые слова: возобновляемая энергия, солнечная энергия, солнечная батарея, домашние хозяйства, мощность

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Венгрияда жаңғырмалы энергияның құрылымдық трансформациясы

Аңдатпа. Еуроодақтың статистикалық деректер базасына сәйкес ЕО энергия тұтыну құрылымындағы жаңғырмалы энергия көздерінің үлесі жылдан -жылға артып келеді. 2018 жылы жаңғырмалы энергияның мәні көрші Австрияда 73% - ға, Хорватияда 48% - ға, Румынияда 42% - ға, Словенияда 32% - ға және Словакияда 21% - ға жетті, бірақ Венгрияда қазіргі уақытта ол тек 8%-ды құрайды. Жел энергетикасы ЕО елдерінде жаңғырмалы энергия көздері құрылымында көшбасшы болып табылады (2018 жылы 35,8%). Біздің елімізде жел электр станцияларын салуға тыйым салынғандықтан, зерттеудің негізгі мақсаттарының бірі болып Венгрияның энергетикалық құрылымын зерделеу болып табылады. Біздің 2020 жылға арналған жаңғырмалы энергия көздері саясаты саласындағы соңғы ұстанымымыз, үкіметті жаңа климаттық стратегияны әзірлеуге түрткі болады. (mekh.hu/nemzetienergiastrategia 2030). Жаңа стратегияға сәйкес, онжылдықтың соңына қарай Венгрия энергиямен қамтамасыз ету көзі ретінде климаттық тұрғыдан көміртек шикізатына бейтарап болып саналатын болады. Баламалы энергия көздерінің арасында күн энергиясы әспетті болып табылады. Бұл мақалада энергияның басқа түрлерінің неге өшетіндігі көрсетілген. Жұмыста Венгрияның болашақтағы энергетикалық теңгеріміндегі өзгерістер талданды, яғни бұл болашақта негізінен ресейлік электр желісінен электр энергиясы мен атом энергиясын пайдалануды көрсетеді. Дегенмен, үй шаруашылықтарының энергия теңгеріміндегі күн батареялары құнының күрт төмендеуіне сәйкес, күн энергиясы жаңғырмалы энергия көздерінің әспеттісіне айналды. Климат стратегиясы бойынша Үкімет 2050 жылға қарай 8000 МВт күн энергиясын құруды жоспарлап отыр, ол негізінен тұрмыста, муниципалдық ғимараттарда және туризмде пайдаланылатын болады.

Түйін сөздер: жаңғырмалы энергия, күн энергиясы, күн батареялары, үй шаруашылықтары, қуаттылық.

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Received 10.03.2020