24. Turner, L. W., & Witt, S. F. (2001). Factors influencing demand for international tourism: tourism demand analysis using structural equation modeling, revisited. *Tourism Economics, 7,* 21-38.

25. Wong, K. K. F., Song, H., & Chon, K. S. (2006). Bayesian models for tourism demand forecasting. *Tourism Management, 27,* 773-780.

26. Yang, Y., Liu, Z. H., & Qi, Q. (2014). Domestic tourism demand of urban and rural residents in China: Does relative income matter? *Tourism Management, 40*, 193-202.

ECONOMIC EFFECTS OF THE WIND-TURBINE AND SOLAR PANELS APPLICATION IN VEGETABLES' PRODUCTION AT THE FAMILY FARMS[16]

Marko Jeločnik[17], Jonel Subić[18]

Abstract: in order to support the promotion of the efficient energy use, as well as larger use of renewable energy sources and green technologies in agriculture and rural areas, the Institute of Agricultural Economics from Belgrade, in cooperation with the Institute "Mihajlo Pupin" (Centre for Robotics) from Belgrade, was conducted the field research at the experimental farm of the secondary agro-chemical school in Obrenovac (Belgrade). Consequently, in paper was accented the assessment of economic justification of the energetic hybrid system use (wind turbine and solar panels) for the irrigation of vegetables produced in green house.

The economic analysis involved the use of analytical calculations based on variable costs (contribution margin) in four production lines (production of tomatoes, red pepper, lettuce, and white onion) conducted in greenhouse. In order to present the improvement in economic efficiency of irrigation use, each calculation considers the substitution of conventional energy sources (gasoline, diesel or electric power) with free "green" energy generated from the installed energetic hybrid system, what induces the production costs reduction. Based on gained contribution margins, it can be concluded that the substitution of fossil fuels and electric power used for the irrigation of vegetables with the energy derived from the energetic potential of the sun and wind is economically justified and above all ecologically sustainable. As the consequence of mentioned substitution, in line to observed crops, the obtained contribution margins in the veggies'

[16] Research was supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (MESTD RS) and agreed in decision no. 451-03-9/2021-14.

[17] Marko Jeločnik, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 69 72 852, E-mail: marko_j@iep.bg.ac.rs.

[18] Jonel Subić, Ph.D., Principal Research Fellow, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 69 72 863, E-mail: jonel_s@iep.bg.ac.rs.

production are increasing from 1.5 % to 3 %. Besides in veggie production, applied energetic hybrid system could be useful support in many farm activities (livestock production, food processing, rural tourism, etc.) boosting its overall sustainability.

Key words: renewable energy sources, irrigation, vegetables, green house, economic effects.

Introduction

Renewable energy directly corresponds to terms sustainability and sustainable development. In early times sustainability was mainly linked to ecology and environmental issues. As a concept, sustainable development was formulated in line to globally growing awareness that mankind is rapidly approaching to ecological deadlock. So in last few decades it has been becoming one of the key driving forces of world society (Du Pisani, 2006).

In its core definition, sustainable development is described as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (Brundtland, 1990). Nowadays, there is imposed the need for strict monitoring of the state of available natural resources and level of environmental degradation, as present World population is morally responsible to leave the future generations the same developmental possibilities we have today (Glavič, Lukman, 2007).

Although it usually refers only to economic implications, basically, the concept of sustainability is based on three-pillar satisfaction, while full sustainability could be faced only if social, economic and environmental requirements are jointly and completely fulfilled. Concept fits to any sphere of human activity and living (Purvis et al., 2019).

From the stand point of agriculture, sustainability comprises to the system of integrated activities (such are selection of crops, optimal use of mechanisation, agro-chemicals, energy, or water, adequate land management, proper storing, transport and distribution of agro-food products, etc.) intensely monitored by pre-defined procedures applied in crop and livestock production, and processing. Meeting the sustainability criteria in agriculture at certain territory should: provide the food security to local population, adequately maintain the natural environment and efficiently use available natural resources, increase the competitiveness of production capacities, as well as stabilize producers incomes and upgrade living standard of local rural community (Jeločnik, Subić, 2020).

Coming to farm level, reaching the sustainability usually guarantees the farm survival, as it could enter the market and try to compete with other food producers. Depending on available natural resources and production capacities, farmers’ knowledge, skills and production orientation, farmer could choose among applicable sustainability strategies adapting them to its primary needs (Suess Reyes, Fuetsch, 2016). Whether it decides to approach the certain market niche, to implement advanced technology, launch the innovative product, diverse farms portfolio or fully adjust to the consumers' requirements, farmer market recognition and possible success and rise in profitability lies in his awareness and later adoption of required procedures that boost farm overall sustainability (Hamlin et al., 2016).

For agriculture, nature and available natural resources (water, land and landscape, climate, energy, flora and fauna, etc.) represent the key production factor. Individually they have priceless value for sustaining production continuity or managing production intensity (Bignal, McCracken, 2000; Benayas et al., 2007).

It is not wrong to claim that energy, primarily fossil fuels are in group of nature elements with the most pronounced impact on environment and climate change (Jaccard, 2006). Accordingly, indispensability of energy in agriculture and high dependency on fossil fuels (as well as expecting shortage in their availability) impose the much larger exploitation of renewable energy in agro complex (Omer, 2008). The most widely used definition for renewable energy describes it as energy produced by natural resources, as are the power of sunlight, wind, biomass, water flow, waves and tides, or geothermal water. They are characterized by natural renewal in quite a short period (Lund, 2010).

Facing the growing trend in energy consumption and finite quantity of conventional energy sources, global energy policies are turned to increase in production of energy gained from renewable sources, e.g. renewable energy has almost 25 % share in overall energy production in EU (Pacesila et al., 2016), while around 19 % worldwide (Bhattacharya et al., 2016). Despite the unevenly distributed hydropower potential worldwide, it represents the dominant resource of electricity produced from renewable energy, around 90 %, or it has a share of around 15 % in totally produced electricity (Sipahutar et al., 2013). On the other hand, according the availability and easiness of transfer to, before all electricity, types of renewable energy that could easily fulfil the global energy deficit are before all hydropower, wind and solar energy (Barbosa et al., 2017). According to some scenarios the share of electricity derived from renewables will increase to almost 40 % by 2050. Except the role in eliminating pollution, globally renewables have significant function in CO2 decreasing, i.e. slowing down the rise of long-term means temperature to around 2°C (Bhattacharya et al., 2016).

Besides the fact that in line to technological progress needed energy for gaining pre-defined volume of certain agro-food product in most cases decline in last few decades (agriculture has become more energy efficient), growing population and global requirement for production of additional food increase the consumption of energy in agriculture (Bonny, 1993).

Previously, "green revolution" with introduction of agrochemicals, mechanisation and fossil fuel utilisation rapidly boosts crops and animal products yields, while in recent times "clean" revolution with intensification of renewable energy use contributes to better energy availability (Kalair et al., 2021). Agriculture and agro-complex represents the great consumer of energy, mostly in form of fossil fuels or electricity from public power grids. Energy is usually used for work with mechanisation and equipment, facility heating, cooling, lighting or pond aeration, animal feeding, food processing, irrigation, partly is contained in fertilisers, etc. In same time, conventional agriculture and food industry are great polluters of environment, affecting the contamination of ground and surface water, land complex, and not so rare even jeopardizing the food safety.

So, there are many arguments for the presence of clean energy in agriculture (rise in energy consumption, food safety and environmental pollution issues, impact to climate change, etc.). Relieving fact is that in certain form it is present all around us. Only question is what could be the price of its transformation into the suitable form of energy useful in farm activities. Meanwhile, does the turning from the road of ecological self-destruction has some price for humanity?

The main goal of the paper is to assess the economic effects of the energetic hybrid system (EHS) implementation at the farm, i.e. system that joins the wind turbine and solar panels, in the process of irrigation of vegetables produced in green house.

Methodology and Data Sources

With main goal to support the promotion of “greening” the agriculture at national level, i.e. fostering the farmers’ initiatives in implementation of farming practices that are fully adjusted to global environmental and climate goals, Institute of Agricultural Economics – Belgrade has joint field research with the Centre for Robotics of the Institute "Mihajlo Pupin" – Belgrade. Project was carried out at the experimental farm of the secondary agro-chemical school in Obrenovac (Belgrade – Serbia), during the 2020.

The main project task was implementation of renewable energy, i.e. substitution of conventional with renewable energy sources used in irrigation at small farms (using of drip irrigation in veggie production in greenhouse). That was done by installation of autonomous and easily collapsible energetic hybrid system (EHS) based on wind turbine and solar panels, used for starting the irrigation system pump.

Accordingly, in paper was assessed economic effects gained after changing the previously used energy sources (fossil fuels and electricity taken from public power grid) with clean energy. Assessment was done by the application of analytical calculations based on variable costs (contribution margin). Assessment involves four lines of veggie production in protected area (tomatoes, red pepper, lettuce, and white onion). Each calculation considers costs reduction of used conventional energy after its change with free and “green” energy used for veggie irrigation. So, it was assumed fixed character of incomes, while on costs side were assessed savings derived from implementation of renewables that initiate the rise in contribution margin value.

In order to perceive better significance of incurred savings, analytical calculations involves several categories of variable costs, such are the costs of seedlings, fertilizers, pesticides, energy, mechanization, packaging, labour, etc. Enabling the additional comparison with similar researches, all calculations were made for the greenhouse surface of 1 are and 1 hectare. All values are expressed in EUR. Derived results are presented by tables. Several scientific and professional sources were consulted during the paper writing. The most of gained data corresponds to production year of 2020, while some data derives as expert judgement or scientifically validated standard in veggie production.

Methodology follows the logic that farmers can hardly influence the selling price of agro-food product, but they could largely control production costs, eliminating the unnecessary costs. Of course, use of renewables benefits the farmer not only in economic sense, while they also strengthen the component of farms' environmental sustainability.

Results and Discussion

Linking the renewables and agriculture potentially creates the wining situation for entire mankind. Renewable energy of wind and sun, or thermal energy and biomass could be continually used for always, securing the farmers with durable and almost free energy sources (Subić et al., 2017). Joining the available renewable energy systems into the one hybrid system, potentially improve initial performances end economic efficiency of each system when it works individually. As good solution is marked combination of solar and wind systems as they jointly lead to decrease in transmission costs, based on all day complementarity in peak output that reduces the grid congestion, allowing the shorter and smaller transmission lines (Kantenbacher, Shirley, 2018).

Serbia tends to advance the structure of used energy sources, trying to increase the presence of renewables towards the rise in production requirements for electricity. Wind and solar energy are among the most powerful renewables in Serbia. The strongest wind potentials came from the Carpathians' area, while the windiest territories are in eastern and south-eastern Serbia, or Banat region and valley of the lower Danube. On the other side, southern and south-eastern parts of Serbia are perfect locations for solar energy utilization (Gburčik et al., 2013; Doljak et al., 2021).

There are promising possibilities for the wind turbines and solar panels applying within the Serbian agriculture, as they do not require special conditions, they are easy to maintain, long-lasting and friendly using. The suitability of wind turbines and solar panels for outdoor or indoor use, e.g. for irrigation is linked to year-round presence of certain level of air flow or insolation, so their pairing into the energetic hybrid system could provide constant use in some capacity.

Constructed and tested EHS consists of small wind turbine (around 6 m high) with the power of up to 0.5 KW (during the optimal wind speed of around 5 m/s), and four solar panels with maximal power of 275 W each (Picture 1.).

Picture 1. Implemented energetic hybrid system

Source: IMP, IAE, 2020.

Installed energy plant has battery bank for accumulation of generated energy that should provide power supply of irrigation system in period without required wind or insolation. In average EHS enables annual electric energy production of around 2,150 KWh. Besides, in occurrence of specific situation, e.g. short-term deficiency in renewables, system is additionally connected to public power grid that will allow continuity in irrigation process. Installed system has limited power ideal for different activities at small farms, such are irrigation, electrification or heating of greenhouses, organic food production, animal feeding, fish ponds aeration, rural tourism, etc. Established EHS was linked to energy consumers used in irrigation of veggies in greenhouse of 5 are (starting of electric submersible pump with the power of up to 1.5 KW and compressor of 0.1KW). The EHS working autonomy is from 2.5 hours (with batteries discharging to 50 %) to 4 hours (with batteries discharging up to 80 %). Tested EHS could be functionally used up to 30 years. Established EHS could be scalable, i.e. its power could be enlarged in line to required energy consumption mostly with additional solar panels (IMP, IAE, 2020).

As was previously mentioned, assessment of economic effects of implemented EHS use was done for four production lines (tomatoes, red pepper, lettuce, and white onion). According irrigation requirements widely applied in veggie production in small green houses (up to 5 are), for this purposes it was assumed the use of diesel engine with the power of 3.3 KW, petrol engine with the power of 2.2 KW, or electric pump with the power of 1.5 KW. Determining of economic effects supposes just elimination of energy costs made for irrigation (their value depend on used pump engine), while other production variable costs are considered fixed.

In next tables (Table 1.-4.) are presented analytical calculations (based on contribution margin) showing economic effects of conventional energy sources substitution with "green" alternatives used for irrigation in veggie production in protected area. Calculations assume one production cycle, or for tomato and red pepper 5 months, while for lettuce and white onion 45 days.

Table 1. Contribution margin in tomato production

Element	Quantity	UM	Price per UM	Total EUR/100 m^2	Total EUR/ha
I – Incomes					
Tomato	1,290	kg	-	-	-
I class (90%)	1,161	kg	0.52	610.02	61,002.00
II class (10%)	129	kg	0.27	34.98	3,498.00
Total I				**645.00**	**64,500.00**
II – Variable costs					
Seedlings	250	pcs	0.18	45.97	4,597.00
Fertilizers	-	-	-	84.11	8,411.00
Manure	0.75	t	11.87	8.90	890.00
Pesticides	-	-	-	8.43	843.00
Raffia - hank	0.75	pcs	1.87	1.40	140.00
Mulch foil	65	m	0.12	7.71	771.00
Packaging – wooden boxes	120	pcs	0.11	13.61	1,361.00
Drip tapes	65	m	0.07	4.35	435.00
Manure dispersion (manual)	6	hour	2.00	11.95	1,195.00
Planting (manual)	3	hour	2.00	5.97	597.00
Binding (manual)	4	hour	2.00	7.97	797.00
Sprout tearing	3	hour	2.00	5.97	597.00
Pesticide spraying (manual)	4	hour	2.00	7.97	797.00
Picking, sorting and packaging	36	hour	2.00	71.69	7,169.00
Transport	-	-	-	50.85	5,085.00
Green market fee	-	-	-	10.59	1,059.00
Mechanisation	-	-	-	30.34	3,034.00
Other costs	-	-	-	4.97	497.00
Shading net	-	-	-	6.38	638.00
I – Irrigation (petrol engine 2.2 KW) – variant I	6	l	1.19	7.12	712.00
II – Irrigation (diesel engine 3.3 KW) – variant II	7.2	l	1.23	8.85	885.00
III – Irrigation (electric pump 1.5 KW) – variant III	90	KWh	0.07	6.48	648.00
IV – Irrigation (renewables) – variant IV	-	-	-	0.00	0.00
Total II – variant I				**396.27**	**39,627.00**
Total II – variant II				**398.00**	**39,800.00**
Total II – variant III				**395.63**	**39,563.00**
Total II – variant IV				**389.15**	**38,915.00**
III – Contribution margin (I-II) – variant I				**248.73**	**24,873.00**
III – Contribution margin (I-II) – variant II				**247.00**	**24,700.00**
III – Contribution margin (I-II) – variant III				**249.37**	**24,937.00**
III – Contribution margin (I-II) – variant IV				**255.85**	**25,585.00**

Source: IMP, IAE, 2020.

Table 2. Contribution margin in red pepper production

Element	Quantity	UM	Price per UM	Total EUR/100 m^2	Total EUR/ha
I – Incomes					
Red pepper	750	kg	-	-	-
I class (75%)	563	kg	0.85	477.10	47,710.00
II class (23%)	172	kg	0.63	109.30	10,930.00
Spoilage (2%)	15	kg	-	-	-
Total I				**586.40**	**58,640.00**
II – Variable costs					
Seedlings	850	pcs	0.10	86.40	8,640.00
Fertilizers	-	-	-	65.00	6,500.00
Pesticides	-	-	-	11.50	1,150.00
Packaging – cardboard boxes	50	pcs	0.30	14.80	1,480.00
Fertilizers dispersion (manual)	1	hour	2.00	2.00	200.00
Planting (manual)	4	hour	2.00	8.00	800.00
Binding (manual)	5	hour	2.00	10.00	1,000.00
Picking, sorting and packaging	20	hour	2.00	39.80	3,980.00
Sprout tearing	5	hour	2.00	10.00	1,000.00
Raffia – hank	0.75	pcs	1.87	1.40	140.00
Mulch foil	-	-	-	25.00	250.00
Foil (double, anti – UV/dripping/insect)	¼	set	212.00	53.00	5,300.00
Pesticide spraying (manual)	6	hour	2.00	11.90	1,190.00
Rototilling	0.5	hour	4.60	2.30	230.00
Transport	-	-	-	10.60	1,060.00
Other costs	-	-	-	5.30	530.00
I – Irrigation (petrol engine 2.2 KW) – variant I	7	l	1.19	8.30	830.00
II – Irrigation (diesel engine 3.3 KW) – variant II	9	l	1.23	11.10	1,110.00
III – Irrigation (electric pump 1.5 KW) – variant III	100	KWh	0.07	7.20	720.00
IV – Irrigation (renewables) – variant IV	-	-	-	0.00	0.00
Total II – variant I				**368.20**	**36,820.00**
Total II – variant II				**370.90**	**37,090.00**
Total II – variant III				**367.10**	**36,710.00**
Total II – variant IV				**359.90**	**35,990.00**
III – Contribution margin (I-II) – variant I				**218.20**	**21,820.00**
III – Contribution margin (I-II) – variant II				**215.50**	**21,550.00**
III – Contribution margin (I-II) – variant III				**219.40**	**21,940.00**
III – Contribution margin (I-II) – variant IV				**226.60**	**22,660.00**

Source: IMP, IAE, 2020.

Table 3. Contribution margin in lettuce production

Element	Quantity	UM	Price per UM	Total EUR/100 m^2	Total EUR/ha
I – Incomes					
Lettuce	2,000	pcs	-	-	-
I class (85%)	1,700	pcs	0.22	374.60	37,460.00
II class (12%)	240	pcs	0.20	46.80	4,680.00
Spoilage (3%)	60	pcs	-	-	-
Total I				**421.40**	**42,140.00**
II – Variable costs					
Seedlings	2,000	pcs	0.07	135.60	13,560.00
Fertilizers	-	-	-	5.70	570.00
Pesticides	-	-	-	12.10	1,210.00
Fertilizers dispersion (manual)	1	hour	2.00	2.00	200.00
Foil (double, anti – UV/dripping/insect)	¼	set	212.00	53.00	5,300.00
Packaging – cardboard boxes	100	pcs	0.25	25.40	2,540.00
Planting (manual)	15	hour	2.00	29.90	2,990.00
Pesticide spraying (manual)	4	hour	2.00	8.00	800.00
Rototilling	0.5	hour	4.60	2.30	230.00
Lettuce cutting and packaging	28	hour	2.0	55.80	5,580.00
Transport	-	-	-	14.80	1,480.00
Other costs	-	-	-	2.70	270.00
I – Irrigation (petrol engine 2.2 KW) – variant I	5	l	1.19	5.90	590.00
II – Irrigation (diesel engine 3.3 KW) – variant II	6	l	1.23	7.40	740.00
III – Irrigation (electric pump 1.5 KW) – variant III	75	KWh	0.07	5.40	540.00
IV – Irrigation (renewables) – variant IV	-	-	-	0.00	0.00
Total II – variant I				**353.20**	**35,320.00**
Total II – variant II				**354.70**	**35,470.00**
Total II – variant III				**352.70**	**35,270.00**
Total II – variant IV				**347.30**	**34,730.00**
III – Contribution margin (I-II) – variant I				**68.20**	**6,820.00**
III – Contribution margin (I-II) – variant II				**66.70**	**6,670.00**
III – Contribution margin (I-II) – variant III				**68.70**	**6,870.00**
III – Contribution margin (I-II) – variant IV				**74.10**	**7,410.00**

Source: IMP, IAE, 2020.

Table 4. Contribution margin in white onion production

Element	Quantity	UM	Price per UM	Total EUR/100 m^2	Total EUR/ha
I – Incomes					
White onion	500	pkg	0.25	127.12	12,712.00
Total I				127.12	12,712.00
II – Variable costs					
Planting material – bulbs	40	kg	0.85	33.90	3,390.00
Fertilizers				13.45	1,345.00
Pesticides				3.03	303.00
Planting, fertilizers dispersion and pesticides spraying (manual)	8	hour	2.00	15.93	1,593.00
Picking with packaging (manual)	20	hour	2.00	39.83	3,983.00
Packaging – foil				2.54	254.00
Rototilling	0.50	hour	4.66	2.33	233.00
I – Irrigation (petrol engine 2.2 KW) – variant I	2	l	1.19	2.37	237.00
II – Irrigation (diesel engine 3.3 KW) – variant II	2.5	L	1.23	3.07	307.00
III – Irrigation (electric pump 1.5 KW) – variant III	35	KWh	0.07	2.52	252.00
IV – Irrigation (renewables) – variant IV	-	-	-	0.00	0.00
Total II – variant I				**113.39**	**11,338.62**
Total II – variant II				**114.09**	**11,408.54**
Total II – variant III				**113.53**	**11,353.45**
Total II – variant IV				**111.01**	**11,101.33**
III – Contribution margin (I-II) – variant I				**13.73**	**1,373.24**
III – Contribution margin (I-II) – variant II				**13.03**	**1,303.33**
III – Contribution margin (I-II) – variant III				**13.58**	**1,358.41**
III – Contribution margin (I-II) – variant IV				**16.11**	**1,610.53**

Source: IMP, IAE, 2020.

Gained results in all lines and all variants of veggie production in greenhouse (Tables 1.-4.) indicate the positive contribution margin. Besides, it has the highest value if the renewables are used. Similar research results were gained during the testing of solar and wind energy use in veggie production on open fields (Subić, Jeločnik, 2017).

According to derived contribution margins, there are solid beliefs that the substitution of conventional energy (fossil fuels, or electric power) used in production of vegetables with the renewables could be economically justified. Besides, skipping to mentioned energy alternative will empower overall farm's sustainability.

In next table (Table 5.) is presented the share of costs of used energy in veggie irrigation in total variable costs that burdens the one production cycle of veggies.

Table 5. Share of energy costs used for irrigation in total variable costs in one cycle of veggie production (for 1 are, in EUR, in %)

Vegetable	Element	Costs of energy	Total variable costs	Share in variable costs
Tomato	Variant I – Petrol engine 2.2 KW	7.12	396.27	1.80
	Variant II – Diesel engine 3.3 KW	8.85	398.00	2.22
	Variant III – Electric pump 1.5 KW	6.48	395.63	1.64
	Variant IV – Renewables	0.00	389.15	0.00
Red pepper	Variant I – Petrol engine 2.2 KW	8.30	368.20	2.25
	Variant II – Diesel engine 3.3 KW	11.10	370.90	2.99
	Variant III – Electric pump 1.5 KW	7.20	367.10	1.96
	Variant IV – Renewables	0.00	359.90	0.00
Lettuce	Variant I – Petrol engine 2.2 KW	5.90	353.20	1.67
	Variant II – Diesel engine 3.3 KW	7.40	354.70	2.09
	Variant III – Electric pump 1.5 KW	5.40	352.70	1.53
	Variant IV – Renewables	0.00	347.30	0.00
White onion	Variant I – Petrol engine 2.2 KW	2.37	113.39	2.09
	Variant II – Diesel engine 3.3 KW	3.07	114.09	2.69
	Variant III – Electric pump 1.5 KW	2.52	113.53	2.22
	Variant IV – Renewables	0.00	111.01	0.00

Source: Authors calculation.

In line to data presented in Table 5, it could be seen that "greening" (changing the commonly used energy sources with renewables) of specific activity in veggie production could lead to increase in contribution margin and farm profitability in range of 1.53% to 2.99%.

Besides the fact that renewables have not generated the energy costs for the farmers, generally the highest costs (absolutely and relatively expressed) were obtained if diesel was applied, or the lowest costs were obtained if electricity form public power grid was used.

As irrigation campaign lasts just for several days within the one cycle of certain veggie production, mentioned EHS can be additionally used for some other activities at the farm that require energy. Specifically it is perfect solution for the farm activities that are characterized by pronounced ecological impact. There is a business opinion that cutting of production costs in couple percent caused by implementation of new, or after advancing the previously used technological solution, could lead to technological revolution. On the other side, in line to increasing negative impact of global environmental issues, it can be said that applying the production equipment or inputs which eliminate or decrease the previous environmental impact for couple percent could lead to ecological revolution. Implementation of tested EHS based on renewables generates the multiply wining situation, as for individual farmer as well as for entire society.

In additional assessing of the described EHS use profitability, it could be assumed that it generates at daily basis almost 6 KWh (based on supposed annual average production capacity of 2,150 KWh), what is more than enough for 4 hours of irrigation of 0.05 ha large greenhouse per day with the electric pump. Hypothetically, for the same treatment with the diesel engine (it requires slightly above 1 litter of diesel per working hour), annually farmer will be spent almost 1,500 l of diesel, or almost 1,850 EUR. If the price of EHS establishment is estimated at around 10 thousand EUR, payback period could be met at almost 5.5 years, or even shorter under the certain level of public subsidies.

Besides, it should be mentioned that the production and larger use of energy derived from renewables at farms in Serbia is mostly limited by higher price of equipment for renewable energy production, economically weak farms, insufficient level of public support for renewables use, lack of farmers' awareness related to overall farm sustainability or climate change, etc. According to that, possibilities of more significant use of renewables in national agriculture should be based on decreasing the prices of equipment used for energy production from renewables, or on more intense co-financing of investments within the area of renewable energy source utilization, both from national budget or international environmental funds.

Conclusion

Use of renewables has multiple benefits, as through the substitution of fossil fuels they provide environmental cleanness, mitigate the climate changes, maintain the human health, empower the overall sustainability, etc.

While using the fossil fuel engine in agricultural production, e.g. irrigation or animal feeding, there is spent large volume of fuels, whose combustion is emitting significant concentration of carbon dioxide, making the additional pressure on environment. On the other hand, use of renewables for starting the pumps utilized for irrigation directly contributes the carbon dioxide reduction. So, using the wind and solar energy for that purposes follows the global environmental requirements. Besides, use of renewable energy contributes to food safety, since there is no spillage of fossil fuels and later contamination of land, water and agricultural products. In other words renewables are welcomed in all types of ecologically oriented food production systems.

According to their complementarity, combining the solar and wind energy sources could derive good economic results in irrigation of veggies produced in greenhouse. By implementing the established energetic hybrid system (0.5 KW wind turbine joint with four solar panels) in order to change the previously used fossil fuel engines for pump starting, farm could achieve from 1.5 to 3 % higher contribution margin in one production cycle of certain vegetable (tomato, red peppers, lettuce or white onion). Considering that professional approach in greenhouse production of vegetables is based on crop rotation of minimum 2 crops during the year, farmer could cut energy costs cumulatively for over the 7 % if apply crop rotation of three crops. Likewise, by the diversification of energetic hybrid system use (it is characterized by high mobility and ease handling) in other farm activities, overall contribution margin at farm level could be theoretically increased in line to savings in energy for tens of times.

References:

1. Barbosa, L., Bogdanov, D., Vainikka, P., Breyer, C. (2017). Hydro, wind and solar power as a base for a 100% renewable energy supply for South and Central America. *PloS one*, 12(3):1-28.
2. Benayas, J. R., Martins, A., Nicolau, J. M., Schulz, J. J. (2007). Abandonment of agricultural land: An overview of drivers and consequences. *CAB reviews: Perspectives in agriculture, veterinary science, nutrition and natural resources*, 2(57):1-14.
3. Bhattacharya, M., Paramati, S. R., Ozturk, I., Bhattacharya, S. (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. *Applied Energy*, 162:733-741.
4. Bignal, E. M., McCracken, D. I. (2000). The nature conservation value of European traditional farming systems. *Environmental reviews*, 8(3):149-171.
5. Bonny, S. (1993). Is agriculture using more and more energy? A French case study. *Agricultural systems*, 43(1):51-66.
6. Brundtland, G. H. (1990). *Our common future*. In: Tolba, M. K., Biswas, A. K. (eds.) Earth and Us: Population – Resources – Environment – Development, Butterworth-Heinemann Ltd., Oxford, UK, pp. 29-31.
7. Doljak, D., Stanojević, G., Miljanović, D. (2021). A GIS-MCDA based assessment for siting wind farms and estimation of the technical generation potential for wind power in Serbia. *International Journal of Green Energy*, 18(4): 363-380.
8. Du Pisani, J. A. (2006). Sustainable development: Historical roots of the concept. *Environmental Sciences*, 3(2):83-96.
9. Gburčik, V., Mastilović, S., Vučinić, Ž. (2013). Assessment of solar and wind energy resources in Serbia. *Journal of Renewable and Sustainable Energy*, 5(4):041822.
10. Glavič, P., Lukman, R. (2007). Review of sustainability terms and their definitions. *Journal of Cleaner Production*, 15(18):1875-1885.

11. Hamlin, R., Knight, J., Cuthbert, R. (2016). Niche marketing and farm diversification processes: Insights from New Zealand and Canada. *Renewable Agriculture and Food Systems*, 31(1):86-98.

12. IMP, IAE (2020). *Tehno i agroekonomska analiza primene energije vetra i sunca za potrebe navodnjavanja u poljoprivrednom sektoru Srbije*. Unpublished study – internal documentation, Institut Mihajlo Pupin and Institute of Agricultural Economics, Belgrade, Serbia, retrieved from: www.iep.bg.ac.rs/images/2020/Prirodni%20resursi%20vetra/Studija_vetroturbina_IEP_IMP_28_09.pdf, 31st March 2021.

13. Jaccard, M. (2006). *Sustainable fossil fuels: The unusual suspect in the quest for clean and enduring energy*. Cambridge University Press, Cambridge, UK.

14. Jeločnik, M., Subić, J. (2020) *Evaluation of economic efficiency of investments in organic production at the family farms*. In: Platania, M., Jeločnik, M., Neta Gostin, I. (eds.) Course for trainers: Organic farming, eco-market and their capitalization through the entrepreneurial initiative, Alexandru Ioan Cuza University, Iasi, Romania, pp. 261-300.

15. Kalair, A., Abas, N., Saleem, M. S., Kalair, A. R., Khan, N. (2021). Role of energy storage systems in energy transition from fossil fuels to renewables. *Energy Storage*, 3(1):1-27.

16. Kantenbacher, J., Shirley, R. (2018). *Renewable Energy: Scaling Deployment in the United States and in Developing Economies*. In: Woodrow, C. (edt.) Sustainable Cities and Communities Design Handbook: Green Engineering, Architecture, and Technology, Butterworth-Heinemann Ltd., Oxford, UK, pp. 89-109.

17. Lund, H. (2010). *Renewable Energy Systems: The Choice and Modeling of 100% Renewable Solutions*. Academic Press, Cambridge, USA.

18. Omer, A. M. (2008). Energy, environment and sustainable development. *Renewable and sustainable energy reviews*, 12(9):2265-2300.

19. Pacesila, M., Burcea, S. G., Colesca, S. E. (2016). Analysis of renewable energies in European Union. *Renewable and Sustainable Energy Reviews*, 56:156-170.

20. Purvis, B., Mao, Y., Robinson, D. (2019). Three pillars of sustainability: In search of conceptual origins. *Sustainability Science*, 14(3):681-695.

21. Sipahutar, R. D., Bernas, S. M., Imanuddin, M. S. (2013). Renewable energy and hydropower utilization tendency worldwide. *Renewable and Sustainable Energy Reviews*, 17:213-215.

22. Subić, J., Jeločnik, M. (2017). *Economic Effects of the Solar and Wind Energy Use in Irrigation of Vegetable Cultures*. In: Subić, J., Kuzman, B., Andrei, J. V. (Eds.) Sustainable Agriculture and Rural Development in Terms of the Republic of Serbia Strategic Goals Realization Within the Danube Region: Development and Application of Clean Technologies in Agriculture, Institute of Agricultural Economics, Belgrade, pp. 37-55.

23. Subić, J., Kljajić, N., Jeločnik, M. (2017). Renewable energy use in raspberry production. *Economics of Agriculture*, 64(2):821-843.

24. Suess Reyes, J., Fuetsch, E. (2016). The future of family farming: A literature review on innovative, sustainable and succession-oriented strategies. *Journal of rural studies*, 47:117-140.

DIGITAL-РЕКЛАМА КАК МЕТОД ПРОДВИЖЕНИЯ ТУРИСТСКОГО ПРОДУКТА

Масалова А.,
магистрант, Ставропольский государственный аграрный университет
Иволга А. Г.,
к.э.н., доцент, Ставропольский государственный аграрный университет
Трухачев А. В.,
д. э. н., доцент, Ставропольский государственный аграрный университет

Аннотация: в статье рассмотрен материал, раскрывающий сущность цифровых технологий, их преимущества. Описаны основные направления развития цифровизации в мире, а также уделено внимание лидеру по применению цифровых технологий – Китаю.

Ключевые слова: туризм, агротуризм, сельский туризм, законодательство о туризме, Всемирная Туристическая Организация

DIGITAL-ADVERTISING AS A METHOD OF PROMOTING A TOURIST PRODUCT

Masalova A.,
Master student, Stavropol State Agrarian University
Ivolga A.G.,
Candidate of Economic Sciences, Associate Professor,
Stavropol State Agrarian University
Trukhachev A.V.,
Doctor of Economic Sciences, Associate Professor,
Stavropol State Agrarian University

Abstract: the article discusses the material that reveals the essence of digital technologies, their advantages. The main directions of the development of