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## ANALYSIS OF THE EFFECTS OF RENEWABLE ENERGY SOURCES WITHIN TOURIST DESTINATIONS

**Abstract:** *The purpose of the article is to analyze the possible effects of renewable energy sources (RES) on the territory of tourist destinations and to develop a program for monitoring such impact. The study used the following methods: statistical, observation and analysis, comparison. Main objects of the effects of renewable energy sources (solar, wind and small hydro power) activity were determined. The system of assessment of the sensitivity of such objects impact was proposed. The possible effects of existing RES on the environment and tourism development within tourist destinations were determined. The system of monitoring of the RES effect on the tourist environment was developed. A program for monitoring the effects of RES in tourist destinations was proposed.*

**Keywords:** *renewable energy sources, monitoring program, environmental impact, tourist destination*

### Introduction

The monitoring system should take into account the fact that the effects of renewable energy sources (RES) on tourist destinations can appear in different directions and consequences.

Ecological impact in its positive effects means improvement of the state of the environment, which can lead to a number of progressive changes in the development of tourist destinations. Negative consequences can lead to the degradation of certain objects of influence which may affect the functioning of landscape units.

Social impact in its positive effects allows to increase the energy supply of buildings, improve employment, use renewable energy sources in energy tours and green tourism. Local residents' dissatisfaction may be a negative consequence.

The economic impact in its positive effects will appear from the sale of produced electricity; satisfying 100% energy demand; choice of production capacity can be from domestic to industrial use; production or current operation can be done both by local and foreign organizations; electricity can be used immediately or stored in accumulators and used when needed; silent electricity production; no emissions; possibility of use in places with unstable or limited power supply; financially effective compared to the use of mobile diesel power stations. Negative consequence is a relatively long payback period – 7-10 years.

The desire of people to communicate with nature prevails among the motives of tourists' trips. Scenic landscapes, clean air, unpolluted water, spacious beaches, biodiversity of forests belong to tourist resources that make this area attractive to tourists. Thus, according to the world scientific researches 84% of European tourists named ecological safety of tourist destination as the main criterion for choosing the territory for holiday. But we should not forget about the positive socio-economic situation in the area, satisfied local residents, absence of dangerous ecological situations such as

landslides, floods, etc. Last criteria should also be taken into account when assessing the effects of RES as they have an indirect effect on the development of tourist destinations in some regions.

Problems of environmental impact assessment among Ukrainian researchers were studied by Y.O. Adamenko, L.M. Arkhypova, T.A. Safranov, H.I. Rudko, E.V. Khlobystov and others. Problems of renewable energy sources were considered by P.P. Borschevskyi, S.I. Dorohuntsov, B.M. Danylyshyn, V.S. Mishchenko, A.M. Palamarchuk, Y.S. Vasiliev, N.M. Moskalchuk and others. However, these works outline general directions for the use of renewable energy sources, and the issue of their use and their negative impact within tourist destinations remains almost not studied.

In the world scientific community studies on the use of renewable energy sources were carried out in the context of sustainable tourism development, in particular by such scholars as M. Evanthie, B. Blazevic, M. Beer. The issue of negative impact of such energy sources were outlined in the studies of F.C. Prinsloo, E. Marunda, E.A. Bergmann.

The purpose of the study is to analyze the possible effects of renewable energy sources on the territory of tourist destinations and to develop a program for monitoring such impact. To achieve the goal the following tasks were set:

- to analyze and determine the possible directions of the RES impact on the territory of tourist destinations;
- to identify main objects of influence from the activity of renewable energy sources;
- to develop an assessment system of sensitivity from the influence of such objects;
- to justify and determine main stages of developing a system for monitoring the RES effect on tourist destination;
- to develop a program for monitoring the effects of RES in tourist destinations.

## **Methods and materials of research**

The article used the statistical method (analysis of statistical indicators of tourist destinations development), method of observation and analysis (determination of the main objects of influence from the activity of RES), comparing method (comparison of the influence of certain types of renewable energy sources on the components of the natural environment within tourist destinations).

After preparatory studies we outlined possible positive and negative effects of existing RES on the environment and tourist destinations [2, 3] (tab. 1).

Therefore, the objects of RES activities effects will be the following:

- climate (air quality, smell);
- surface and ground waters (their resources, flood regimes, water quality);
- geology and soils (valuable soils, contaminated lands, landslide zones);
- landscapes and biodiversity (aquatic ecosystems, protected landscapes, biodiversity protection zones, left natural ecosystem without protection status, adapted ecosystems without protection status);
- population and socio-economic situation (demography, health of population, employment, population income, branches of the economy, infrastructure, tourist and environmental benefits);
- cultural heritage (UNESCO world heritage sites, registered cultural heritage sites, unidentified and unregistered cultural heritage sites, intangible cultural heritage sites).

**TABLE 1.** Analysis of RES effects on environmental components and tourism development in tourist destinations

	Effects			
	Positive	Explanation	Negative	Explanation
For all RES	Climate	Reduction of GHG emission (in case of RES replacing traditional forms)	Landscapes and biodiversity	Loss of protected or preserved natural habitats and related species as a result of land acquisition
	Socio-economic situation	Additional employment opportunities and increased reliability of energy supply	Population and socio-economic situation	As a result of displacement of communities or households resulting from the construction of objects, roads or transmission lines
	Socio-economic situation	Development and promotion of ecotourism, geological tourism	Population and socio-economic situation	Effect of electromagnetic fields in case of close location of houses to transmission lines
			Geology and soil	Loss of the possibility of land use for other economic purposes, including land along the transmission lines
			Objects of cultural heritage	Loss and/or damage to cultural heritage resources due to physical location of objects and buildings, including objects of auxiliary infrastructure in the form of transmission lines
			Objects of cultural heritage	Changes in the context of the physical presence of historical heritage objects due to the presence of renewable energy development facilities and related infrastructure
Wind power plants (WPP)	Socio-economic situation	Possibility of simultaneous use of land for agriculture and power generation	Landscapes and biodiversity	Risk of bird death from collision with turbine blades
			Landscapes and biodiversity	Effects of large turbines on the territories attractiveness
			Population	Effect on ethnic minorities in places of their considerable presence
			Population	Work-related accidents (involving workers who work at a height)
Small hydro power plants (HPP)			Geology and soil	Increased risk of landslide processes activation within landslide territories
			Surface waters	Effect on the amount and quality of river flow in the lower sections, as well as changes in flood regimes in adjacent areas of river basins
			Surface waters	Effects on the condition of migratory representatives of aquatic fauna and aquatic ecosystems

	Effects			
	Positive	Explanation	Negative	Explanation
Solar photo-voltaic power plants			Geology and soil	Need for large land plots will reduce the area of available land with valuable soils, which may lead to a decrease in agricultural productivity
			Population and socio-economic situation	Effects on ethnic minorities in places of their considerable presence

The number of tourists, historical and cultural, and natural objects, accommodation and food facilities, recreational load and recreational capacity in Ukraine and tourist Carpathian region in particular are important for the basic indicators of tourist destinations. Thus, according to the data of the State Statistics Service of Ukraine 283452 tourists visited the Carpathian region in 2017 [5], and, taking into account the number of excursionists, this indicator increases several times. As for the indicator of recreational potential of the Carpathian region the total number of protected natural and historical and cultural objects here is 1509. Lviv region is the leader. As for the indicator of tourism development the total number of accommodation and food facilities is 3930, and Ivano-Frankivsk region has the best indicator of tourist infrastructure. The conducted calculations showed that the recreational capacity of the territory of the Carpathian region in the summer period is 20660,3 ths. pers., and in winter it is about 13018,8 ths. pers. Ivano-Frankivsk region, and especially its popular Verkhovyna and Yaremche districts, has the highest recreational capacity (fig. 1) [4].

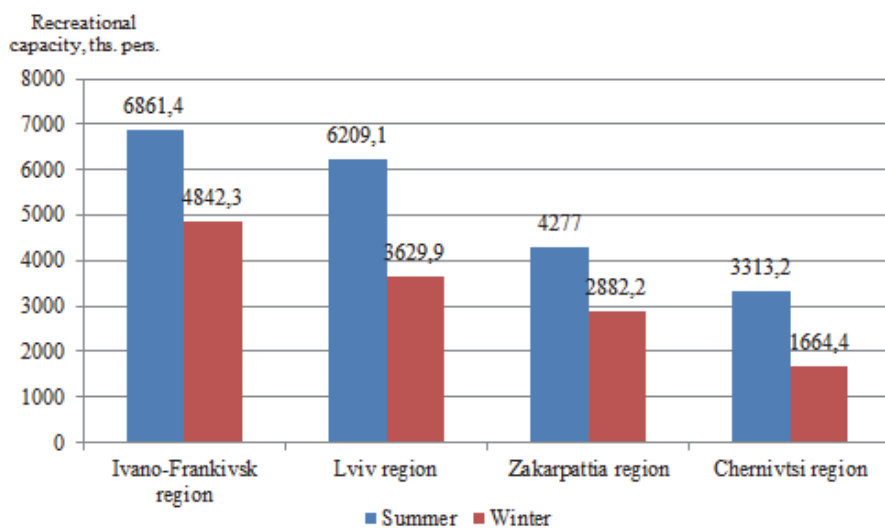


FIGURE 1. Recreational capacity of the Carpathian region

Any results should be justified by the additional detailed analysis of the activities of different types of RES. The criteria for determining the impact on the tourist environment relate to the nature of the impacts associated with each scenario of renewable energy development. In the process of determining the nature of these effects the following factors should be taken into account:

- probability, duration, frequency and reversibility of the effects;
- possibility of cumulative effects taking into account future basic conditions and other projects;
- possibility of transboundary effects;
- risks to public health and environment (e.g., accidents);
- strength and spatial coverage of impacts (geographic area, number of population that can be affected);

- value and vulnerability of an area that may be affected by the following causes: particular natural conditions or objects of cultural heritage, exceeding over the quality standards of the environment or regulatory levels of their impact, intensive land use, impacts on areas or landscapes that have a protection status established at the national or international level.

## Results and discussion

For the observation system certain existing environmental conditions and future ones without considering RES, comparison with the conditions during construction and operation will be important for determining the tendencies of possible changes [1]. The stages of developing a system for monitoring the effect of RES on the tourist environment will be the following:

1. Determination of existing and future basic conditions of an area that can be affected. To forecast possible effects in these conditions in the absence of the proposed activity.
2. Determination of the value, vulnerability and sensitivity of the objects of influence.

The value of the object of influence (high or low) is determined taking into account its geographical size, rarity, significance from the point of view of biodiversity, social or economic considerations, and the regime of legal protection. Vulnerability of the object of influence (high, medium, low or zero/absent) is determined on the basis of the probability of this object being affected, and also taking into account the endurance and stability of the object in relation to a certain type of influence. The sensitivity of the object of influence is defined as high, medium, low or zero/absent taking into account the value and sensitivity of the object of influence.

Taking into account the value and vulnerability of the objects of influence and considering their use in tourism we can determine their sensitivity to the impact of RES. It will be different for each scenario (tab. 2). Let us use the following scale for assessing the sensitivity of objects: low – 1 point, average – 2 points, high – 3 points.

TABLE 2. Assessment of the sensitivity of objects influenced by RES

Objects of influence	Wind PS	Small HPP	Solar PVPP
<b>Climate</b>			
– Air quality	2	2	2
Surface and ground water			
– Resource of surface water	2	3	2
– Quality of surface water	2	2	2
– Flood regimes	2	3	2
– Resource of ground water	2	2	2
– Quality of ground water	2	2	2
Geology and soil			
– Landslide areas	1	2	1
– Valuable soils	2	2	2
Landscapes and biodiversity			
– Protected landscapes	3	3	3
– Biodiversity protection zones	3	3	3
– Aquatic ecosystems	2	3	2
– Left natural ecosystems without protection status	3	3	3
– Adapted ecosystems without protection status	1	1	1
Population and socio-economic system			
– Health of the population	2	2	2
– Infrastructure	2	2	2
– Tourist and ecological benefits	1	2	1
Cultural heritage			
– Objects from UNESCO World Heritage List and objects from the previous list	3	3	3
<b>Total score</b>	<b>35</b>	<b>40</b>	<b>35</b>

3. Determination of the types of effects that the object will be exposed to in each alternative. Also a program for monitoring the impact of RES in tourist zones (tab. 3).

**TABLE 3.** Tentative program for monitoring the effects of RES in tourist areas

Objects of observation	Type of RES	Indicators	Criteria	Score	Observation system
Climate	all	<ul style="list-style-type: none"> <li>- air quality</li> <li>- smell</li> </ul>	<ul style="list-style-type: none"> <li>- improvement of the general indicators</li> <li>- without changes</li> <li>- deterioration of general indicators</li> </ul>	<p style="text-align: center;">-1 0 +1</p>	twice a year (April, October)
Surface and ground water	Small HPP	<ul style="list-style-type: none"> <li>- resource (water supply)</li> <li>- quality</li> <li>- flood regime</li> </ul>	<ul style="list-style-type: none"> <li>- improvement of the general indicators</li> <li>- without changes</li> <li>- deterioration of general indicators</li> </ul>	<p style="text-align: center;">-1 0 +1</p>	twice a year (April, October)
Geology and soils	all	<ul style="list-style-type: none"> <li>- presence of landslide zones (area)</li> <li>- condition of valuable soils</li> <li>- presence of contaminated lands (area)</li> </ul>	<ul style="list-style-type: none"> <li>- improvement of the general indicators</li> <li>- without changes</li> <li>- deterioration of general indicators</li> </ul>	<p style="text-align: center;">-1 0 +1</p>	twice a year (April, October)
Landscapes and biodiversity	all	<ul style="list-style-type: none"> <li>- condition of protected landscapes</li> <li>- biodiversity protection zones</li> <li>- aquatic ecosystems</li> <li>- left natural ecosystems without protection status</li> <li>- adapted ecosystems without protection status</li> </ul>	<ul style="list-style-type: none"> <li>- improvement of the general indicators</li> <li>- without changes</li> <li>- deterioration of general indicators</li> </ul>	<p style="text-align: center;">-1 0 +1</p>	twice a year (April, October)
Population and socio-economic situation	all	<ul style="list-style-type: none"> <li>- demography (age composition of the population)</li> <li>- health of the population</li> <li>- employment of the population</li> <li>- population income</li> <li>- branches of the economy</li> <li>- infrastructure</li> <li>- tourist and ecological benefits</li> </ul>	<ul style="list-style-type: none"> <li>- improvement of the general indicators</li> <li>- without changes</li> <li>- deterioration of general indicators</li> </ul>	<p style="text-align: center;">-1 0 +1</p>	once a year (January - data for the previous year)
Cultural heritage	all	<ul style="list-style-type: none"> <li>- objects from UNESCO World Heritage List and objects from the previous list</li> <li>- registered objects of cultural heritage</li> <li>- unknown and unregistered objects of cultural heritage</li> <li>- objects of intangible cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>- improvement of the general indicators</li> <li>- without changes</li> <li>- deterioration of general indicators</li> </ul>	<p style="text-align: center;">-1 0 +1</p>	once a year (January - data for the previous year)

The total impact is determined by summing the points according to the criteria for all indicators.

4. Determining whether each of the effects is direct or indirect, far-reaching, cumulative or caused by further development.

5. Determination of the probability of effect occurrence (high – more than 90%, average – 50-90%, low – 10-50%, very low – less than 10%).
6. Determination of the stage of effect occurrence (construction, operation or decommissioning), effect duration (long – more than 10 years of the period of operation and decommissioning; medium – 3-10 years at the operation period; short – 1-3 years at the construction period; very short – less than 1 year at the construction period) and frequency of effect.
7. Determination of irreversibility/reversibility and/or temporality/permanence of effect.
8. Determination of the intensity of effect.

The intensity of the effect is defined as the percentage of the object of influence, which is subject to effect exposure, and is classified as high, medium, low or very low. In case when no impact was forecasted considering some resource scenario, this situation was defined as “no changes”. Principles of determining the degrees of the effect intensity are the following:

- high – more than 90% of the objects of influence is affected;
- average – more than 50-90% of the objects of influence is affected;
- low – more than 10-50% of the objects of influence is affected;
- very low – less than 10% of the objects of influence is affected or absent).

9. Determination of the spatial coverage of the effect and whether it is a cross-border one.

The following categories can be used to characterize the territorial scale of effect: local (focuses within a radius of <1 km from the source of effect), regional, national and international.

10. Determining whether the effect is positive or negative.

11. Formulation of assumptions, limitations and uncertainty factors associated with the assessment. They can be the following:

- heterogeneity of spatial coverage, influence and quality of available data;
- information on certain types and habitats of flora and fauna;
- possibility of data inconsistencies.

12. Use of all of the above information for the RES effects monitoring system.

Also, in the process of developing strategic principles for tourist zones management, concrete conditions should be taken into account for each component of the recreational environment within the limits of RES functioning. They must be achieved.

So, neglect of the problems of ecological safety of tourist territories can lead to deterioration of its attractiveness for tourists and complicate the environmental problems of the territories of tourism development.

## Conclusions

Thus, on the basis of analysis of scientific works main objects of influence of renewable energy sources activity were identified. They are climate, surface and underground waters, geology and soils, landscapes and biodiversity, population and socio-economic situation, cultural heritage. The system of assessment of the sensitivity of such objects impact was proposed. The effect possibilities of existing RES (solar, wind and small hydro power) on the environment and tourism development within tourist destinations were determined. The system of monitoring the RES effect on the tourist environment was developed. A program for monitoring the effects of RES in tourist destinations was proposed.

## References

- [1] *Alternative Energy Financing Program in Ukraine*. Strategic Ecological Analysis. Environmental Report, September 2012.
- [2] Mandryk, O., Arkhypova, L., Pobigun, O., Latsyk, N., 2018, *The Establishment of Local Energy Source as the Element of Tourist Infrastructure in Certain Carpathian Regions*. Journal of New Technologies in

Environmental Science. Kielce University of Technology, No. 2, Vol. 2, pp. 98-106. [www.jntes.tu.kielce.pl](http://www.jntes.tu.kielce.pl). ISSN 2544-7017.

- [3] Mandryk, O.M., Arkhypova, L.M., Prykhodko, M.M., Adamenko, Ya.O., Pobigun, O.V., Moskalchuk, N.M., Kachala S.V., 2018, *Methodology of ecologically safe use of renewable energy sources in the sustainable tourist and recreational development of the Carpathian region*, a collective monograph (in Ukrainian). Ivano-Frankivsk: IFNTUOG, 298 p.
- [4] Murava, Iu.I., 2015, *Tourism development and recreational capacity of the Carpathian region* (in Ukrainian). Ecological safety and sustainable resource use. Ivano-Frankivsk. Vol. 2 (12), pp. 117-122.
- [5] State Statistics Service of Ukraine. [www.ukrstat.gov.ua](http://www.ukrstat.gov.ua) (viewed on 28.01.2019).