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THE PECULIARITIES OF CLIMATIC ZONING OF UKRAINE AREA IN TERMS OF THE BEST LOCATION FOR ENERGY-ACTIVE BUILDINGS

The article analyzes the possibilities of using renewable energy sources (solar and wind power plants) in energy-active buildings throughout the whole territory of Ukraine. The conducted analysis identifies the most efficient areas of Ukraine for the placement of such buildings.

Keywords: energy-active buildings, renewable energy, climate zones, solar energy, wind energy sources

INTRODUCTION

One of the most important challenges for architectural and construction industry in Ukraine lies in taking into consideration the climate pattern of specific areas of Ukraine, while designing new energy-generating buildings. The aim of the research is to develop an integrated climate chart of Ukrainian cities in terms of the best location for power-generating buildings, which use solar and wind power plants.

1. RENEWABLE ENERGY SOURCES IN ENERGY-GENERATING BUILDINGS

A distinctive feature of energy-generating buildings is the usage of renewable energy sources for their operation: solar, wind, hydrothermal, biothermal energy, etc. Therefore, it is important to choose the best type of power equipment for such buildings in different areas of Ukraine with different climate. It is equally important to analyze database of energy indicators of renewable energy sources and the distribution of their power potential on Ukraine territory for the main areas of operation: solar energy resources, wind power resources [1].

1.1. Solar energy resources of Ukraine

The annual average of total solar radiation entering the surface of 1 m^2 on the territory of Ukraine varies from 1070 kWh/m^2 in northern Ukraine to 1400 kWh/m^2 and higher in the Crimea (Tab. 1). The period of efficient solar power plant equipment operation in the southern regions of Ukraine is 7 months (from April to October);

while in the northern regions it lasts 5 months (from May to September). The photovoltaic equipment, especially the flat solar collectors, can be efficiently utilized throughout the whole year. At the same time the concentrating solar collectors are efficient only in the southern regions of Ukraine [2, 3].

Table 1. **Annual total expedient and economic potential of solar energy in Ukraine**

PP	Areas of Ukraine	Expedient and economic potential of solar energy [MWh/year]	PP	Areas of Ukraine	Expedient and economic potential of solar energy [MWh/year]
1	Odessa	3.4	14	Vinnitsa	2.3
2	Kherson	2.9	15	Kirovohrad	2.2
3	Dnepropetrovsk	2.8	16	Sumy	2.0
4	The Crimea	2.7	17	Lviv	1.9
5	Kharkiv	2.7	18	Khmelnytsky	1.8
6	Chernihiv	2.6	19	Cherkassy	1.8
7	Zaporizhia	2.6	20	Volyn	1.6
8	Lugansk	2.5	21	Rivne	1.6
9	Donetsk	2.5	22	Transcarpathia	1.2
10	Zhytomyr	2.4	23	Ivano-Frankivsk	1.2
11	Kyiv	2.4	24	Ternopil	1.2
12	Mykolaiv	2.4	25	Chernivtsi	0.7
13	Poltava	2.4		Total	53.8

Figure 1 shows the pattern of total solar radiation distribution in summer and throughout the year. According to the measurements and researches, the conclusion can be made that the installation of photovoltaic equipment in energy-active buildings will be efficient and reasonable almost throughout the whole territory of Ukraine, except for Chernivtsi, Ternopil and Ivano-Frankivsk regions.

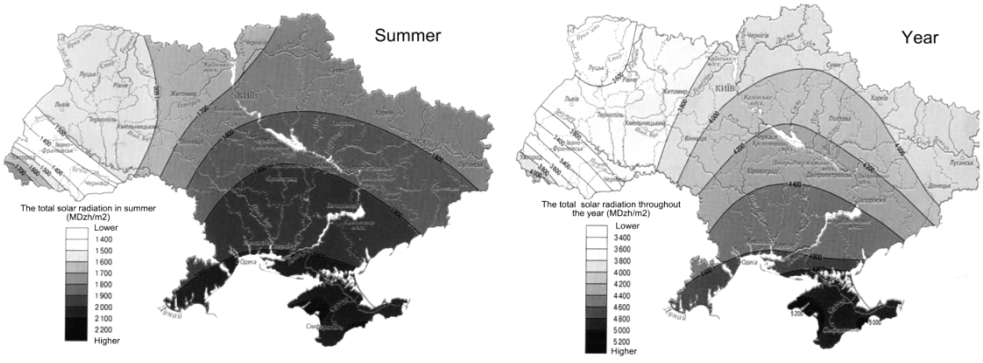

Fig. 1. The total solar radiation (summer and year), MDzh/m^2 [4]

1.2. Wind energy resources of Ukraine

The conditions in Ukraine allow the usage of 15÷19% of the annual volume of wind energy by the means of wind generators. The expected volume of power production from 1 m^2 of windwheel cross-section in promising regions are 800÷1000 kWh/m^2 per year (Tab. 2) [3, 5].

Table 2. **Energy potential of wind power in Ukraine [4]**

The average wind speed [m/s]	Height [m]	Natural potential of wind power [kWh/m^2] per year	Technical potential of wind power [kWh/m^2] per year
Less than 4.25	15	1120	200
	30	1510	280
	60	2030	375
	100	2530	460
4.5	15	2010	390
	30	2710	520
	60	3640	700
	100	4540	850
5.0	15	2810	520
	30	3790	690
	60	5100	860
	100	6350	975
5.5	15	3200	620
	30	4320	830
	60	5810	1020
	100	7230	1150

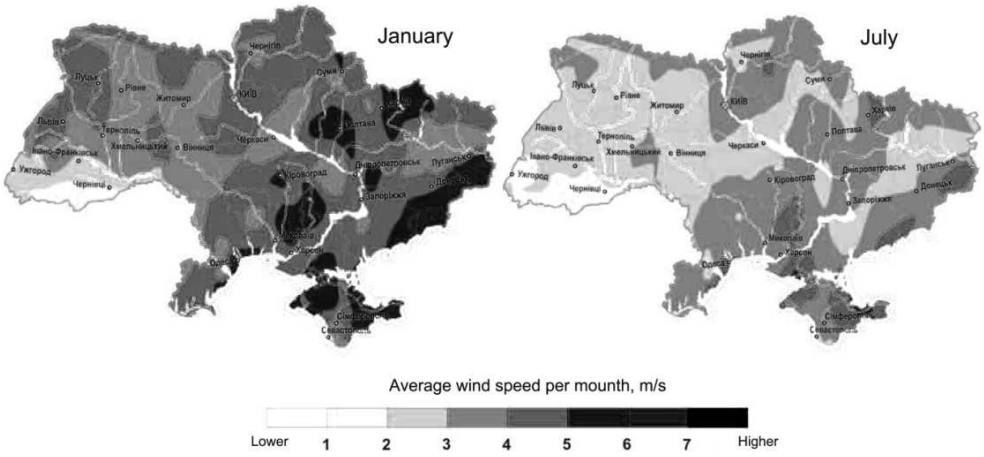

Fig. 2. Map of the distribution of wind energy resources of Ukraine during the year (January, July) [5]

The most effective course of action is to install the wind generators for power production in the regions of Ukraine, where the average annual wind speed is higher than 4.0 m/s: the Azov-Black Sea coast, Odessa, Kherson, Zaporozhia, Donetsk, Luhansk, Mykolaiv, the Crimea and Carpathians regions (Fig. 2).

2. TOTAL SOLAR AND WIND ENERGY POTENTIAL OF UKRAINE

The integrated maps of solar-wind loads in Ukraine regions were made according to the weather observations (Fig. 3). Based on these data, the following regions of Ukraine, where the installation of solar and wind energy facilities is the most appropriate (Fig. 4) can be outlined, although their efficiency varies. The amount of energy produced by these plants directly depends on the basic characteristics of the natural resources they use, on the one hand, and the selection of technical means, on the other.

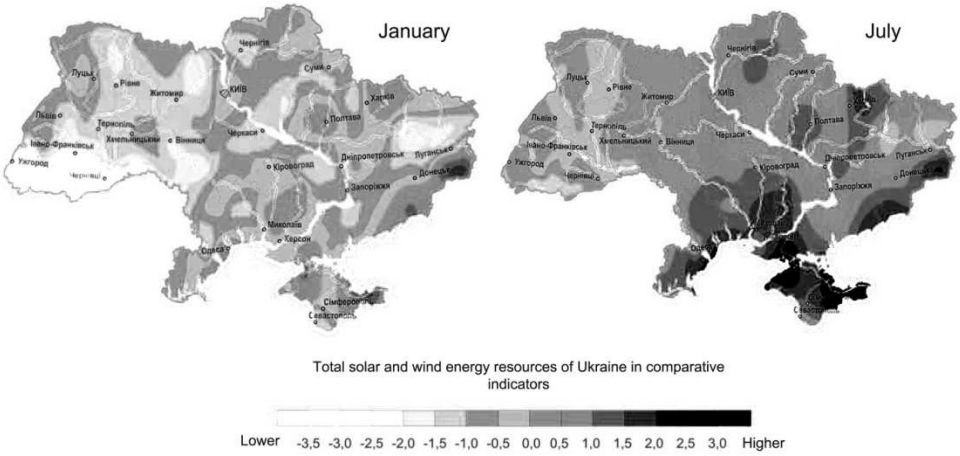

Fig. 3. Solar and wind energy resources in Ukraine during the year (January, July) [5]

№	Cities of Ukraine	Mounth of the year: January	April	July	October	The average per year (in comparative indicators)	№	Cities of Ukraine	Mounth of the year: January	April	July	October	The average per year (in comparative indicators)
1	Uzhgorod					- 1,25	14	Cherkassy					- 0,5
2	Chernivtsi					- 1,5	15	Kirovograd					0,375
3	Ivano-Frankivsk					- 1	16	Poltava					1,125
4	Lviv					-0,25	17	Kharkiv					1,25
5	Ternopil					- 0,625	18	Dnepropetrovsk					0,375
6	Khmelnytsky					- 0,125	19	Lugansk					- 0,25
7	Lutsk					- 0,125	20	Donetsk					0,375
8	Rivne					- 0,625	21	Zaporizhia					-0,25
9	Zhytomyr					- 0,25	22	Mykolaiv					0,875
10	Vinnitsa					- 0,5	23	Kherson					0,75
11	Kyiv					0,375	24	Odessa					1,625
12	Chernihiv					-0,25	25	Simferopol					0,75
13	Sumy					0,125	26	Sevastopol					- 0,125

Map legend:

-2,5	-0,5	1,5
-2,0	0,0	2,0
-1,5	0,5	2,5
-1,0	1,0	

Fig. 4. Total solar and wind energy potential of cities in Ukraine during the year

Upon analyzing the maps, we can come to the conclusion that the usage of solar and wind generators will be most efficient in the following regional centers (Fig. 4): Kyiv, Sumy, Kirovograd, Poltava, Kharkiv, Dnepropetrovsk, Donetsk, Mykolaiv, Kherson, Odessa and Simferopol.

CONCLUSION

In today's world, more and more often economically developed countries pay attention to the usage of renewable energy in the construction of housing. The energy-active buildings are actively designed and implemented in many countries. The usage of renewable energy sources in these facilities is both reasonable and mandatory. This paper examined the usage of appropriate features of solar and wind generators throughout the whole territory of Ukraine. The conclusion can be made that, for the most part, the territory of Ukraine is suitable for the installation of such systems, and hence the construction of power architecture is a promising direction of development of the construction sector in Ukraine.

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KLIMATYCZNE UWARUNKOWANIA OBSZARU UKRAINY DLA NAJLEPSZEJ LOKALIZACJI BUDYNKÓW ENERGOAKTYWNYCH

Artykuł analizuje możliwości wykorzystania odnawialnych źródeł energii (elektrownie słoneczne i wiatrowe) w budynkach energoaktywnych na całym terytorium Ukrainy. Przeprowadzona analiza wskazuje najbardziej odpowiednie obszary Ukrainy do lokalizacji tego typu budynków.

Słowa kluczowe: budynki energoaktywne, energia odnawialna, strefy klimatyczne, energia słoneczna, źródła energii wiatrowej