ENVIRONMENTAL PROTECTION

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WIND POWER GENERATION IN THE CONTEXT OF ENVIRONMENTAL SAFETY

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The review of environmental aspects of development of industrial windpowerstations in Ukraine on the example of project of concrete object is offered. For the account of requirements EIA of procedures, are considered in prospects of development of wind energy generation.

Розглянуто екологічні аспекти розвитку індустріальної вітроенергетики в Україні на прикладі проекту конкретного об'єкта. Запропоновано підходи до оцінки впливу вітроенергетики на навколишнє середовище. Наведено перспективи розвитку вітроенергетики.

Рассмотрены экологические аспекты развития индустриальной ветроэнергетики на Украине на примере проекта конкретного объекта. Предложены подходы к оценке влияния ветроэнергетики на окружающую среду. Приведены перспективы развития ветроэнергетики.

Statement of purpose

In search of alternative energy sources in many countries, considerable attention is paid to wind power. Using wind energy is becoming increasingly urgent for Ukraine, which depends on supplies of fossil fuels. Practice shows that in countries that do not have their own reserves of energy resources, energy independence is based on accelerated development of renewable energy, including wind power - one of the most promising.

Wind power – energy that specializes in using wind energy – kinetic energy of air masses in the atmosphere. Wind energy refers to renewable energy.

Wind power station – setting that allows converting wind energy into electrical energy and operates in two versions.

Autonomous is designed to automatic power provision of individual consumers as well as navigational, meteorological, microwave and other posts in the field conditions.

Network designed for parallel operation with the industrial network single-phase 220V/50 Hz. In conditions of excess electricity produced allows giving it to the network, and in the absence of wind energy electricity using. Switching between modes is automatic.

The aim of the article is a preliminary review of the environmental aspects of industrial wind park creation in Ukraine on example of project of specific WPP and defining priorities of development of wind power as renewable type of energy in the context of environmental safety.

Wind energy potential of Ukraine

In environmental terms wind energy development in Ukraine creates the real prospect of reducing fossil fuel use, reducing emissions and pollution, and so contributes to effective implementation of ratified several international treaties such as the Convention on transboundary air pollution over long distances (especially in the provisions of the Protocol on reducing emissions of sulfur by 30% and the Protocol on limiting emissions of nitrogen or its cross-border flow), and requirements of UN Framework Convention on Climate Change, and it is critical both in the context of transition to sustainable environmental principles and issues of environmental safety.

The point is that emissions of thermal power stations in Ukraine in the atmosphere reach 76% of sulfur oxides, nitrogen oxides by 53% and 26% solids in relation to overall stationary emissions. 1000 MW of electrical power of nuclear power plants (NPP) emits into the environment at least 2000 MW of thermal capacity unused.

Unrecoverable water losses in the operation of nuclear power plant unit are 30 million cubic meters per year.

According to the Interdisciplinary Science and Technology Center for Wind Energy of National Academy of Sciences of Ukraine, the area of the country has significant wind energy potential. Total specialists distinguish seven regions, where the use of wind is feasible - a Carpathian, Preasov, Donbas, Western Crimea, the Crimean Mountain-and Kerch, and area of Kharkiv and Poltava regions.

Among the key factors promoting development of wind power in Ukraine are:

– prices for traditional energy resources;

– increasing requirements of environmental standards;

– improve the opportunities of joining the European community;

– the need to replace worn out assets of energy industry;

– introduction of “green tariff”.

Wind Energy industry, compared with other sources of energy supply has significant advantages, which include:

– no costs for mining and transportation of fuel;

– low specific labor spending to build wind power plants (WT) - these costs are lower than for thermal and nuclear power plants;

– wide technological range of direct energy use (including autonomy and working in centralized networks, compatibility with other energy sources);

– short term of power commissioning;

– minimal impact of wind turbines on the environmental state (in this respect only helium power station outstrips wind installations).

Cabinet of Ministers of Ukraine defined the main directions of Ukraine's electricity production.

Decree of the President of Ukraine from 02.03.1996 № 159/96 identified further priority development of wind energy. Under the Decree, in 1996 in Ukraine was developed and implemented a comprehensive national program of building wind power plants (WPP) for the period to 2010. One emphasis of this program is investment opportunities for wind energy development in Ukraine.

Later Parliament approved the Law of Ukraine № 1220 - VI as of 01.04 in 2009 on amendments to the Law of Ukraine “On Electricity” [1] to encourage the use of alternative energy sources. It gave a new momentum in investment of WPP building projects in Ukraine.

Wind paver plant as objects of environmental impact

Location of wind energy installations is performed according to regulations, the findings of the research and recommendations of the manufacturers WT.

The choice of territory (area of WPP) primarily affected by the following factors:

– wind energy resources of each area;

– the absence of migratory paths of birds;

– taking into account the limitations of archaeological, environmental, sanitary-epidemiological and navigation services;

– potential land use in agriculture;

– the possibility to lease area;

– the ability to transport electricity in a given direction with minimum cost;

– no reservations about radio and television interference (shading);

– location of roads and entrances and using existing.

Each WT is equipped by devices of definition and regulation of work depending on wind flow characteristics and it works in the following modes depending on the prevailing wind speed:

– in under-synchronous range (the range of partial load) generator stator provides 100% of electricity supply network;

– in over-synchronous range (the range of nominal load) generator stator provides supply of electricity directly into the network by 83% without going through the converter, remaining 17% of power are given into the network from the rotor through a converter.

Electronic wind direction sensor with corresponding software controls the inclusion of time and direction of rotation of electric motors.

According to "Appendix E" of WPP is not included in the list of activities and objects of high environmental hazard [2].

It is imperative when selecting a potential supplier of WT that the manufacturer of a certain WT type has "Type Certificate" of the WT type conformity with safety requirements of international standard harmonized in Ukraine [3].

Presence of "Type Certificate" confirms that the type passed certification tests in International Certification Center of WT on compliance with the applicable safety requirements (as in the integrity of WT design in various meteorological conditions and in the field of noise and electromagnetic interference, electromagnetic compatibility, etc.).

By Ukrsepro system and applicable standards in Ukraine wind turbines are not subjected to mandatory certification (on safety). Oblenergos conduct voluntary certification of wind turbines.

While in the world (eg EU), any construction of wind turbine is certified (according to international standard) [4].

The decision to build wind farms and protect the public from possible adverse effects of hazardous events – is a responsibility of the developer / owner of the project. For some types of extreme wind events is used meteorological data / expertise to quantify the probability of the wind puffs over limit values for wind turbine [5].

Considering the global practice of limiting the risk of danger on WPP, it is recommended to comply with safety measures during the location and operation of turbines to mitigate the negative impacts of extreme wind speeds.

Aspects of environmental impact

Materials of the project consider impacts of planned activities for all components of the environment- natural, social and man-made, revealing the acceptability of these impacts according to environmental, sanitary, social and technical conditions, but also imply costs for environmental measures. Design solutions to prevent or limit dangerous effects of planned activities on the environment divided into resource preserving, protection, recovery, compensation, safety, planning, organization, etc.

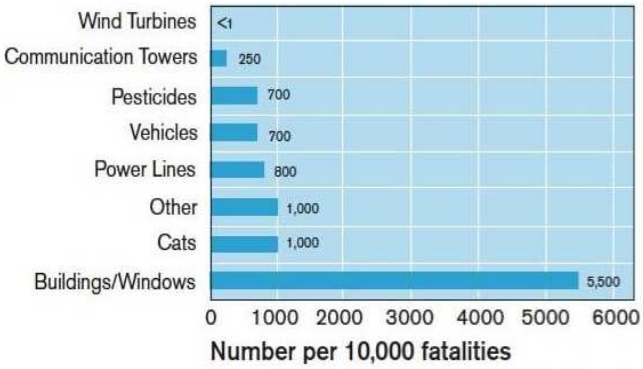
Complex of potentially possible environmental measures is determined by the principle of ecological and economic efficiency [2].

Climate and microclimate. Biogeocenosis

Materials include characteristics of the climate zone of allocation of objects of planned activities and data of current and long-term climate observations. Also should be noted that the replacement of natural soil, trees and bushes and grass by concrete structures, access roads etc. during the project may have an impact on local conditions and microclimate of biogeocenotic cover. In particular, there may be a damage of vegetation, fragmentation and change the usual appearance of the landscape (during the construction of WT foundations,

transformer substations, communications), modified ecotopes, bird deaths from the WT rotor (while WT installing of 100–150 m height and the work of WT due to collision with WT).

Important elements of the EIA are the consideration of the situation concerning the objects of natural reserve fund, and species of red and green book and cenosis, availability of land for biodiversity, land, promising to form econet. On consideration of zoological components of biogeocenosis cover types except Red book species, crucial is the presence of bird migration routes (see figure).



Causes of bird fatalities

In order to maintain ecobalance of the territory it is necessary to restore natural ecosystems on free areas, and take measures to protect surrounding areas with natural vegetation.

Air environment

There is a need for assessment of air environment due to compliance requirement of the object's projected impacts to urban sanitation and environmental rules and norms. Initial requirements for potential impacts levels on the air are defined by the Law of Ukraine "On protection of atmospheric air" [6].

According to Article 24 of "Design, construction and reconstruction of enterprises and other objects which affect or may affect the status of air", improving existing and introducing new processes and equipment must be carried out with observance of environmental safety standards, public health requirements and rules for construction of planned facilities, and also with consideration of the accumulation and transformation of pollution in the atmosphere, its cross-border transfer, the climate conditions unfavorable for the dispersion of pollutants.

Sources of emissions, noise impact on the population, electromagnetic and ionizing radiation are subjected to investigation and consideration of the impact and actions on their prevention or reduction are justified.

In the WPP, you can expect the following impacts of surface layer of the atmosphere: acoustic effects (noise, vibration), electromagnetic interference fields of high-voltage power transmission lines, and emissions from construction machinery during the construction, repair, welding and other types work and, during operation - from vehicles.

While preparation for foundation pits of WT, construction of access roads etc. there is an air pollution resulting from emissions from work of construction arrangements, road engineering, road transport resupplying building materials, mobile power and so on. The emission may include CO, NO_x (in recalculation to NO_2), SO_2, CnHm, soot.

The presence of harmful substances in exhaust gases is caused by the fuel type, oils and additives, combustion conditions, mode of engine, its technical condition, traffic conditions etc.

For a comprehensive assessment of noise from wind farms in general it is necessary to determine the contribution of each wind turbine in the total acoustic field WPP. For this purpose, is used the principle of energy sum L_Σ sound levels L_i [2], that are generated from each turbine at the point of control, using the formula:

$$L_\Sigma = 10 \lg\left(\sum_i 10^{0,1L_{ii}}\right).$$

Hygienic assessment of environment in settlements according to the results of laboratory studies of noise in the individual elements of the environment, and calculation materials for design and planning documentation is based on hygienic standards, approved in the established order – for noise are used maximum permissible level [7].

The main sources of noise created by wind turbine are aerodynamic and mechanical, and radiation occurs in the sonic and infrasonic frequencies. International Standard IEC 61400-11 [8] of definition of noise levels of wind turbine distributes only the audio frequency range. Measurement of noise radiation orientation, infrasound (<20 Hz), low frequency noise (in the frequency range 20-100 Hz) and impulse noise parameters are optional. The standard requires the measurement of sound in a wide band of frequencies, sound levels in third-octave bands and tunes. These measurements are used to determine turbine sound power level [9].

During the work wind generator creates an electromagnetic field (EMF), like any household appliance. In the industrial wind turbine (capacity over 1 MW) electromagnetic field is strong enough, but this type never set in the vicinity of residential buildings. EMF measurement results can vary depending on equipment location, such as turbines, substations and internal electrical cables. Most of the electric equipment of wind installation is mounted close to the wind turbine, at the base of the tower or is located at an altitude of 80-100 m above the surface. Protection by screens and distance and reduces the impact of electromagnetic fields from sources of radiation.

Highest values EMF are fixed near substations. A typical strategy to reduce the influence of electromagnetic fields is increasing distance from the source of EME.

Geological environment

Available general description of the main geological, structural and tectonic elements of the area, geomorphological and landscape features, analysis of existing and predicted negative endogenous and exogenous processes and phenomena of natural and anthropogenic origin (tectonic, seismic, geodynamic, landslide, mud, karst, rock properties of arrays, deformation of the earth's surface, etc.), considering the impacts of planned activity. The biggest development of hazardous geological processes is due to water encroachment area, static pressure and hydrodynamic effects.

Methods of study of the geological environment sufficiently known and need no further explanation. Research of soil strength, its bearing capacity should be made under each unit in addition during working design for the foundations calculations for wind installations.

Water environment

The subject to analysis are violations of hydrological and hydrogeological parameters of water bodies and territories in areas of impact of planned activity, impacts on surface and ground water pollutants entering the water environment when sewage filtration and man-made source.

Surface water, impacts on which should be considered include all kinds of natural waters and water bodies in all their states, permanently or temporarily located on the ground. The study subject is the whole stack that gets to them within the study catchment area.

Materials that characterize the groundwater include general information about the basin of underground water, power of zone of active water exchange, development of groundwater levels, of data their economic use, list and descriptions of geological observations.

Groundwater in the construction practice usually includes waters of aeration and saturation zones. During construction development of the territory and its further operation to impact of technogenic factors are mainly exposed water aeration zone and groundwater, and aquifers that lie below if they have no natural protection. Natural protection of groundwater (ground water relationship) is determined by the presence of hydrogeological windows, which are places of absence or erosion of waterproof layers of rock, through which aquifers combined and represent the only hydraulically connected water-bearing complex. Areas of distribution of hydrogeological windows are naturally vulnerable areas of groundwater. Such impacts on groundwater are possible: pollution from corrosion of foundation supports of wind farms, utilities, emergency oil spills, etc., increase or decrease the level of groundwater.

Assessment of groundwater pollution is given on the base of four main indicators: power of aeration zone, structure and lithological characteristics of the zone of aeration, power of poorly permeable sediments in section of aeration zone, filtration of aeration zone.

Soils

Impacts of projected activities on soil are analyzed with taking into account land-use patterns, availability of areas of agricultural land, pollution of harmful substances, vibration and other factors.

During estimation of soils state are taken into account genetic types of soil, characteristics of humus composition, mechanical and water-physical properties, landscape-geochemical barriers (migration and accumulation of substances), fertility, degree of soil degradation processes and so on.

Materials of project documents include legal, organizational, economic and other factors.

Legal – compliance with regulations and laws and normative acts of Ukraine on land protection.

Organizational – development of measures for rational use of lands, territories ecosafe territory organization, respect for the target land use, special land use of environmental, health, recreational, historical and cultural significance, restoration and improvement of soil fertility, protection from adverse human impact.

Context of resource and energy saving and wind paver plant case

Resource and energy efficiency at the present stage are priorities during reconstruction and operation of engineering buildings and economic installations. According to European expert organizations in the field of energy saving application of retrenching measures can increase the economic efficiency of production on 12-25% depending on the type of activity. Savings technologies are important for integrated environmental protection and should be taken into account in the design stage. Resource saving measures at design work that can have environmental effects include:

– saving of water resources;

– exclusion of machinery under no load;

– minimization of work in the dark part of day;

– heat saving measures for mechanisms and domestic premises a during construction works in the cold season.

Organization of construction works on wind farms are planned on the basis of common technologies, with using appropriate technological schemes and maps. In areas of building new facilities, work supposed to be performed by streaming method, linear specialized subdivision by work types.

During preparation of building in designated areas it is expected to perform complex operations that include:

– conducting geodesic work;

– cleaning of withdrawal strips;

– fixing boundaries of land allocation under WPP elements;

– installation of communications and surface water drainage;

– installation of temporary roads;

– of works of demolition or transfer of buildings and structures;

– removal of fertile soil.

In the basic period of construction it's expected to perform building of wind farms. In accordance with current legislation, in carrying out work related to soil breaching, fertile soil should be removed and saved to use it for biological reclamation of land and increasing fertility of unproductive soil. Fertile soil removed from the area, limited by external circuits WPP territory. Herewith should be taken measures to protect it from contamination, mixing with mineral soil, debris, erosion.

Piles of fertile soil are located on dry places outside zone of smoothing embankment slopes (notches) separately, in a form acceptable for the next load and transport. The height of stacks should not exceed 10 m. The stacks surface of fertile soil layer and potentially fertile soils are fixed by seeding perennial grasses. To keep soil from washing out stacks, arranged drain ditches. Influence on soil will be performed mainly in the construction of WPP aggregates. For protection of soils during construction are ensured:

– prohibition of movement of heavy construction equipment outside access roads;

– use of construction machinery, which have the lowest possible undercarriage pressure on underlying soils;

– removal and storage of vegetable soil in accordance with [10] for designated sites with followed use the of it during restoration;

– use of waste reduction measures during construction;

– prohibition of storage of construction waste outside places designated for temporary storage and its further removal from the territory of the site;

– ensuring prophylactic repair of machinery which is to prevent soil contamination of fuel and lubricants;

– building and engineering sites and working passages taught by ferroconcrete slabs with surface sloping of at least 2% to exclude flow of surface water in watercourses,

– machines and devices that run on internal combustion engines, mounted on metal trays to collect oil, condensate and diesel fuel;

– filling up machines and mechanisms outside the construction site;

– removed vegetable soil should be neatly stowed and preserved for future use in the work of reclamation.

Possible measures to minimize negative impacts of wind farms

General measures to reduce negative environmental impact, related to:

– prevention of landslides and erosion action, action of water;

– reduction of emissions into air (proper control on compliance of work technology);

– measures to reduce exposure to noise (prohibition or regulation of works in the housing areas at night);

– protection of soil (vegetation removal and storage of soil on the designated areas and its further use for improvement of fertility);

– reducing the impact on flora and fauna (prohibition of felling trees outside the areas designated for the construction of wind farms, avoid filling necks and trunks of trees growing near the construction of provide animal migration, etc.);

– waste management (the regular transportation of building materials during construction without storing large quantities of construction sites, temporary storage of building waste in construction sites in specially designated areas, the availability of mobile waste containers for metal, oiled rags, oil, etc., obligatory removal and subsequent disposal of construction waste that comes from construction sites);

– avoid negative changes of the hydrological environment (prevention of contamination of the aquatic environment through soil contamination, etc.).

Since the construction of wind farms affect the environment, should be ensured all the necessary measures that will provide a repair of biocenosis cover and / or minimize negative consequences. WT impacts on air, soil, water are local in nature.

Thus, the impact of the WPP is local; during the construction it is temporary, and during operation is constant. Direct impact during WPP construction will be caused by temporary withdrawal of land for construction, air and soil pollution, noise. Impact may also appear in the depletion of ecosystems adjacent to WPP.

In order to minimize the level of impact on avifauna of WPP areas recommended special measures:

– not directly illuminate wind units;

– if necessary, to make lighting area its boundary and this would avoid migratory birds targeting on it;

– conduct biotechnological active measures to prevent bird feeding movement through sowing fields located outside the zone by the most attractive crop for birds.

Preliminary results of examination

Main impacts of wind energy in the environment are:

1) at the construction stage:

– damage to vegetation and landscape fragmentation, threats to the fauna (WT building foundations, communications);

– loss of agricultural lands (WT foundation construction, telecommunications);

– change of usual appearance of the landscape (WT installation height of 100–150 m, construction, telecommunications);

– slight soil contamination (due to building WT foundations and communications);

– air pollution by emissions from construction equipments;

2) at WPP operation:

– increased noise level (due to movement of blades and generators);

– electromagnetic radiation of WT (due to movement of blades of WT and generators);

– death from bird from WT rotor (from a collision with wind turbines).

Conclusion

Using wind energy is becoming increasingly urgent for Ukraine, which largely depends on supplies of fossil fuels.

Possible impacts:

– biocenotic and natural soil covering (wood-bushes and herbaceous vegetation, faunal complex migration routes of birds);

– on local microclimate conditions;

– on surface layer of the atmosphere - acoustic (noise, vibration) and electromagnetic;

– on the underground water - contamination from corrosion of WPP support fundaments, utilities, increase or reduction of groundwater;

– change the usual appearance of the landscape (WT installation height of 100-150 m);

– threats to the avifauna;

– obstacles to radio and television communications.

Wind Farm Impacts on air, soil, water in scale are small and have local character. Among these measures - avoidance of bird migration routes and places of high biodiversity, technological innovation, high culture of design, construction and operation of wind farms.

Wind Energy industry, compared with other sources of energy supply has significant advantages, which include:

– no costs for mining and transportation fuel;

– low specific labor costs to build wind power plants – these costs are lower than for thermal and nuclear power plants;

– wide technological range of direct WT energy use (including autonomy and working in centralized networks, compatibility with other energy sources);

– short term commissioning of powers;

– minimal impact of wind plants on the environment.

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