Risk management of the alternative power engineering

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Abstract. The article summarizes the experience of risk neutralization arising due to the power generation from the alternative sources - solar, wind, hydraulic power engineering on the basis of ebbs and flows, the use of biomass power plants, etc. At the same time, the tool for blitz diagnostics of risks of the alternative power engineering is proposed in order to substantiate the economic feasibility of investments. The results of the risk assessment application of alternative power engineering reduce the level of information uncertainty relating to the transition to new energy sources or diversification of energy supply.

1 Introduction

High energy dependence of the modern material production, increasing human needs for energy, limited fuel mineral resources of the planet, uneven distribution of the fuel raw materials in the subsoil, asymmetrical location of fuel resources and the major energy consumers, the issue of the greenhouse effect [1] represent only part of the problems, the solution of which is implied by the means of alternative power engineering. At the same time, the alternative power engineering types are still considered as an additional source of electrical energy [2].

In this regard, a special role is given to the renewable energy sources [3, 4]: solar radiation, wind power, current strength of water objects, including the ebbs and flows, organic reactions based on the biomasses, atmospheric electricity, etc. Mankind is finally thinking about the fact that the traditional energy based on the hydrocarbon raw materials does not provide a long-term guarantee of economic stability, since the gas, oil and coal deposits are exhausted quickly enough, and their renewal lasts for about two million years.

2 Results

At the same time, there are a great many new options for the production and use of electricity that, however, does not exclude its limitation in the energy problems solution. Consequently, in the conditions of information uncertainty, it is important to reduce the level of risks and optimally substantiate the managerial decision in relation to the transition to alternative power engineering, for example, for the investment purposes [5, 6]. Having identified and summarized the main risks of alternative power engineering, it is important to make systematization in order to aggregate the cumulative risk assessment [7] of each option.

2.1 Risks of solar radiation use

The solar (helio) power engineering in the world energy system takes up a significant place due to a variety of reasons: the conditional inexhaustibility of the energy source, absence of the greenhouse effect during the power generation, the noiselessness and environmental friendliness of solar power plant elements, etc. At the same time, a number of significant shortcomings in the use of solar energy can be identified (Table 1) that, however, can be perceived as an initiating factor for problem neutralization and solution.

Thus, it is possible to conclude that the development of solar energy industry is not related to the critical risks, and the solar panels can be used in the areas with extensive open spaces to generate additional energy at an acceptable level of economic, social, technological, resource efficiency [9].

2.2 Risks of wind power use

The wind energy sector is considered in modern conditions as an active option for additional energy supply [10] for a number of reasons: renewability and conditional inexhaustibility of wind energy, wastelessness and ecological cleanliness of power generation, conditionally low costs for the station operation and maintenance, minor land allocation for the turbines, etc. The wind power plants do not confront other structures (production, infrastructure, residential ones, etc.), organically combining a unified land use.

The possibility of distributed placement of wind generators with various dimensions allows using the turbines of not only large industrial, but also small “home” options. It is also possible to mount the wind turbines on other structures, including movable ones. We will summarize the key risks of using wind energy (Table 2) in terms of reduction of the information
1. Instability of the power source  

The ability to offer the mobile designs, providing a response to the level of illumination at any given moment. It is also proposed to upgrade the battery to the sensitivity level (even in the low light conditions, for example, with the clouded sky, 50% of solar radiation still reaches the surface).

2. The need for land allocation for the heliostation  

In the conditions of limited valuable land areas, a “top floor” scheme is proposed for the heliostation structures. In this case, the separate land allocation is not required, since the photocells will be constructed above the existing facilities, for example, on the roofs of the large-scale industrial buildings.

3. Significant capital investments in the construction of the heliostation  

The economic practice proves that the increased production volume potentially leads to the lower costs. The active expansion of possibilities of the solar energy use can be perceived as a factor in reducing both variable and direct costs. In addition, we are talking about the relatively quick payback costs (for example, according to the German experience [8], the payback period of a medium power heliostation is about 2 years).

4. Climatic and natural risks for the solar panels  

The fragility of panel design is the points to ponder by the technologists. In addition, the negative impact of natural factors on epy solar panels can be minimized, ensuring their mobility not only to respond to the illumination level, but also to the direction of rain, hail shower, threatening to the structures. The design conception is also provided in relation to the protective coatings, including the mobile ones, for a period of negative impact.

2.3 Risks of tidal force use  

The hydraulic power engineering [12] on the basis of ebbs and flows is considered for limited use as an alternative power engineering typical for the areas with a marine and oceanic coastline.

The predictability and reliability of tidal energy is one of the key benefits of this renewable form of energy. Ecological cleanliness of the power generation,
The plant—implies a dam, the changes in specifications are not ken without tangible—s for comparable [14]. Therefore, they can be—gnificance, the higher—s quite possible to take such a risk,—al use of plants is possible. In this—rmation due to the lack of proper control—plications and reducing the disaster risks, influence of the human—p, etc. are the feasible arguments in favor of—l power engineering on the basis of ebbs and flows.

However, this type of energy is not hassle-free and have some potential risks (Table 3).

Thus, the specific nature of hydraulic power engineering on the basis of ebbs and flows is such that some of the risks have to be taken without tangible possibility of its neutralization.

### 2.4 Risks of biomass use in the energy industry

The biomass power plants [13] with the active release of methane are considered to be an unconventional type of energy. This energy source is considered in the context of renewability, continuity, stability of the station operation, the possibility of dispersing energy resources and reducing the disaster risks, influence of the human factor in the energy sector, etc.

The vulnerability of this energy will be considered in terms of exposure to the risks of biomass use in the power generation (Table 4).

Thus, the power generation based on the biomass can be available even to the households using the methane-operated generators while observing the safety rules for such biogas storage. However, methane is produced not only during the composting process, but it is also an associated gas during the exploitation of hydrocarbon deposits.

Consequently, the offer of technologies for the profitable methane collection as an associated gas is also aimed at the development of alternative power engineering based on the waste-free production principles.

### 3 Discussion

Having considered the various alternative power engineering options, it can be assumed that their key risks are comparable [14]. Therefore, they can be generalized and evaluated. In this regard, the tool for blitz diagnostics of alternative power engineering is proposed that makes it possible to justify the managerial decision to use one or another option (Table 5).

This example includes 5 types of risks that are typical for all considered alternative power engineering options to different extents. At the same time, the specific gravity of risks indicates their importance for the decision maker — the higher the significance, the higher

### Table 3. Risks of tidal force use in the energy industry and neutralization measures.

| Risks of tidal force use                                                                 | Risk neutralization measures (or reactions)                                                                 |
|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| 1. Significant capital investments in the hydroelectric power plant                      | Having considered the low operating costs, it is quite possible to take such a risk, focusing on the payback period of the station that is about 3 years. |
| 2. Negative impact on marine flora and fauna                                             | There are possible options for the buffer reas that limit the access of marine inhabitants to the turbine blades with the threat to their lives. |
| 3. Changes in the specifications of a water object in the case of the tidal station dam  | This risk is typical for the stations with dams that is not a prerequisite for operation. However, even if the construction implies a dam, the changes in specifications are not considered as a critical risk. The dam area is much less than the water area of the entire water object (sea, ocean) to make the impact significant. |
| 4. Local flood risk                                                                      | This potential threat is likely in the case of an erroneous station design and is impossible with the correct calculation of the tank filling level in the case of ebbs and flows in accordance with the sea level during such phases. |

### Table 4. Risks of the biomass power plant use in the energy industry and neutralization measures.

| Risks of biomass use in the energy industry                                               | Risk neutralization measures (or reactions)                                                                 |
|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| 1. Environmental risks                                                                    | When comparing to the hydrocarbon fuels, the biomass burning provides significantly less environmental pollution. However, it is impossible to completely avoid the negative impact due to the nitrogen oxides, carbon and dust. At the same time, special attention should be paid to the filtration and purification system during the biomass burning. The regulatory mechanisms are also required (for example, tax mechanisms) to stimulate measures to ensure the ecological cleanliness of power generation. |
| 2. The risk of uncontrolled fuel removal from the biomass (plants)                         | The conflict between the agricultural and technical use of plants is possible. In this regard, the regulatory mechanism for the use of biomaterials (for example, quota allocations, tax rules) is required. |
| 3. The risk of uncontrolled biogas production process                                      | The likelihood of the pathogenic bacteria formation due to the lack of proper control should be minimized by strengthening the control function of the environmental and tax authorities. |
| 4. Additional costs for the biomass transportation to the compost plants                   | This risk is neutralized by the optimal logistics and rational placement of the processing plants (compost plants), considering the long-term biomass reserves. |
Table 5. Example of the alternative power engineering option assessment.

| Risk                                           | Specific gravity | Solar energy | Wind energy | Tidal power plant | Biomass power plant |
|------------------------------------------------|------------------|--------------|-------------|------------------|--------------------|
| 1. Instability of the power source             | 25               | 1            | 1           | 0                | 0.25               |
| 2. The need for land allocation                | 10               | 1            | 0.75        | 0.25             | 0                  |
| 3. Significant capital investments in the structures | 20               | 1            | 1           | 0                | 1                  |
| 4. Climatic and natural risks (for the source) | 20               | 0.75         | 0.75        | 0.5              | 0                  |
| 5. Environmental risks (from the source)       | 25               | 0            | 0           | 0.75             | 0.75               |
| TOTAL                                         | 100              | 70           | 67.5        | 51.25            | 45                 |

The specific gravity. The assessment of options is performed on the basis of the following scale: 0 – impossible risk; 0.25 - low risk; 0.5 - medium risk; 0.75 - moderate risk; 1 - extreme risk.

The aggregated risk estimate [15] of each option is calculated as the product of the risk specific gravity by its probability estimate.

For example, the risk assessment of solar energy = 25*1 + 10*1 + 20*1 + 10*0.75 + 25*0 = 70.

This example certainly provides a general concept that requires additional data analysis. However, this approach may well be considered for the blitz risk assessment.

Thus, the substantiation of the managerial decision for selection or transition to the alternative power engineering is provided on the basis of the preliminary diagnostics results, considering the current shortage rate of the electric energy generation and transmission, territorial specifications, and financial capabilities of all participants in the energy market. It should be noted that the key decisions relating to the alternative power engineering supply will be made at the regional and national level. However, it is important to note another global risk of transition to the alternative power engineering that is the risk of opportunism [16]. While the main players in the traditional energy market (oil, gas, coal) do not reorient their business towards the alternative power engineering, the development of these areas will be artificially blocked.

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