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Abstract

The Challenges and Opportunities for the Development of Industry 4.0 and Agri-Food Supply Chain in the Context of Energy Infrastructure Restoration in Ukraine †

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The war in Ukraine is one of the most catastrophic events of the 21st century, and it has been accompanied by significant civilian casualties and the destruction of buildings, structures, and infrastructure. The Ukrainian economy has experienced a loss of 50–60% of its "unproduced" gross domestic product. Revenue to the state budget has decreased by 70% from customs authorities and by 30% from tax authorities. The reconstruction of Ukraine's national economy will require active development of the energy sector and the involvement of foreign companies to restore the social and economic infrastructure. The issue of energy development is closely linked to the formation of food chains, as the harvest and price of agricultural products depend on the cost and availability of energy resources.

Ukraine faces the challenge of centralizing and unifying large-scale power-generation facilities, such as nuclear power plants, thermal power plants, hydroelectric power plants, etc. The deployment of Russian military aggression against Ukraine and constant missile attacks on energy infrastructure objects pose significant challenges to the functioning of the power supply system. For instance, as of 10 February 2023, nearly twenty thermal power plant units remain damaged due to constant Russian attacks. Considering the occupation of certain energy facilities, Ukraine has temporarily lost 44% of its nuclear generation capacity, 75% of its thermal power plants, and 33% of its block heating power plants. Energy infrastructure in conflict-affected areas has been almost completely destroyed and requires restoration based on modern and innovative foundations. The development of alternative energy and energy generation methods in liberated communities could serve as a solution. Given Ukraine's energy dependence on supplies and the constant increase in energy prices, changing its energy strategy by implementing effective energy conservation programs and developing alternative energy sources, including in the agricultural sector, is of strategic importance and requires urgent attention. Ukraine's Energy Strategy until 2030 recognizes the exploration of alternative energy sources as a crucial factor in increasing energy security, particularly in light of Ukraine's European integration aspirations.

However, little attention has been given to the technology involved in energy generation through the use of solar energy, as well as the storage and accumulation of hydrogen gas. These technologies are mainstream aspects of Industry 4.0. Similar facilities are already being used in Australia and some European countries, primarily in the private sector, enabling households to meet their energy needs and redirect surplus energy for sale. Currently, a significant portion of Ukraine's population resides in private homes in rural

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areas (over 40%). The same situation applies to the currently occupied territories. Additionally, nearly all internally displaced people have lost their jobs and income. Therefore, establishing energy generation systems in private households in de-occupied rural areas would provide the opportunity to achieve the following goals: meet the basic needs of the population, ensure stable incomes for households, strengthen community autonomy and Ukraine's energy independence, foster the development of modern ecological technologies in energy and transportation, and prevent agri-food production from decreasing.

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