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PROSPECTS FOR THE INTEGRATION OF AIRFIELD MOBILE POWER UNITS WITH RENEWABLE ENERGY SOURCES

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Abstract
This article examines promising directions for integrating airfield mobile power units (AMPUs) with renewable energy sources (RES). An analysis of current trends in the development of ground aviation electrical equipment based on the use of solar and wind energy, as well as energy storage systems, is presented. Particular attention is paid to the modernization potential of APA-150 airfield mobile power units through the implementation of hybrid energy systems. The study demonstrates that the use of renewable energy sources can reduce conventional fuel consumption, lower operating costs, and improve the environmental sustainability of airports.

Keywords: Airfield mobile power unit, APA-150, renewable energy sources, solar energy, energy storage systems, aviation, environmental sustainability, aircraft ground handling.

Introduction

The modern aviation industry faces the challenge of reducing greenhouse gas emissions and improving the energy efficiency of airport infrastructure. A significant portion of energy consumption is associated with ground support equipment, including airfield mobile power units (AMPUs), which provide electrical power to aircraft during parking and maintenance operations. Traditional AMPUs are powered by diesel internal combustion engines, resulting in fuel consumption, pollutant emissions, and high noise levels.

In recent years, the global aviation industry has increasingly adopted electric and battery-powered ground power units that operate without local emissions. Modern battery-powered Ground Power Units (GPUs) are already being used in airports across Europe and North America as an environmentally friendly alternative to conventional diesel-powered equipment.

In this context, the integration of airfield mobile power units with renewable energy sources has become a particularly promising area of development.

Current State of Technology and Prospects for Integrating AMPUs with Renewable Energy Sources

One of the most important components of the aircraft ground support system is the airfield mobile power unit (AMPU), designed to supply electrical power to aircraft while onboard generators and the Auxiliary Power Unit (APU) are switched off. The use of external power sources significantly reduces aviation fuel consumption, minimizes wear on onboard

equipment, and improves overall aircraft operational efficiency. Furthermore, AMPUs contribute to lower noise levels at airports and reduce harmful emissions into the environment. Traditionally, airfield mobile power units are equipped with diesel engines that drive alternating-current or direct-current generators. Despite their high reliability, such systems involve considerable operating expenses, require regular maintenance, and have a negative environmental impact. Due to increasingly stringent international environmental regulations and rising energy costs, the aviation sector is steadily transitioning toward more environmentally friendly and energy-efficient technologies.

In recent years, a clear trend has emerged toward replacing conventional diesel-powered units with battery-powered and hybrid power supply systems. Modern battery-operated airfield power units are equipped with high-capacity lithium-ion batteries that enable extended autonomous operation without starting an internal combustion engine. Such systems operate almost silently, produce no direct carbon dioxide emissions, and offer high energy efficiency. Advances in battery technology and power management systems have created favorable conditions for the further integration of airfield power units with renewable energy sources.

Among all renewable energy technologies, solar energy is considered the most promising for aviation infrastructure. Most airports possess large unused areas that can be utilized for photovoltaic installations without compromising flight safety or operational activities. Solar panels may be installed on the roofs of terminals, hangars, technical facilities, parking structures, and other airport infrastructure elements.

Practical experience shows that many international airports already use solar energy to cover part of their electricity demand. In some cases, solar power plants provide a substantial share of the airport's energy requirements, reducing dependence on external power grids. This experience demonstrates the effectiveness of solar generation and opens opportunities for charging airfield mobile power units using renewable electricity.

The integration of solar power systems with AMPUs can be implemented in several ways. The simplest approach involves charging the batteries of power units from stationary solar power plants located within airport premises. In this case, electricity generated during daylight hours is stored in batteries and later used to power aircraft. Another option is the use of mobile solar modules that can operate in remote areas of the airfield or at temporary aviation deployment sites. Additional opportunities arise from the creation of local airport microgrids that combine solar panels, energy storage systems, and electrical consumers into a single intelligent energy network. Such solutions are particularly relevant for remote airfields and aviation facilities located far from centralized electrical grids.

A key element in integrating renewable energy sources with airfield power units is energy storage technology. One of the primary challenges of solar energy generation is its dependence on weather conditions and daylight availability. To ensure reliable aircraft power supply, excess energy generated during peak production periods must be stored and used when solar generation decreases.

Lithium iron phosphate (LiFePO4) batteries are currently regarded as one of the most promising energy storage solutions. These batteries offer high energy density, long service life, excellent cycle durability, and enhanced operational safety. Due to these characteristics,

LiFePO4 batteries are increasingly used in aviation ground support equipment and are capable of providing reliable performance over many years of operation.

A promising energy supply architecture may consist of a solar power plant, an energy storage system, an airfield mobile power unit, and an aircraft. In such a system, solar energy is converted into electricity and stored in batteries. The AMPU then supplies the required voltage and frequency to the aircraft's onboard systems. This architecture enables uninterrupted power supply regardless of weather conditions or time of day while maximizing the use of environmentally friendly energy sources.

Further technological development is associated with the creation of next-generation hybrid airfield power units. Such systems may include a highly efficient diesel generator for backup purposes, a large-capacity battery pack, an intelligent energy management system, communication and remote monitoring equipment, and the capability to connect to airport solar power facilities. Under normal operating conditions, aircraft power supply would be provided by electricity stored in batteries charged from renewable energy sources. The diesel engine would operate only during emergencies or when battery charge levels become critically low.

The application of hybrid technologies offers numerous advantages. First, diesel fuel consumption can be reduced significantly, with experts estimating savings of 50–80 percent compared with conventional units. Operating expenses associated with fuel procurement and engine maintenance are also substantially decreased. Additional benefits include reductions in carbon dioxide emissions, nitrogen oxides, and other pollutants, thereby improving environmental conditions around airports. The transition to electric power also lowers noise levels, which is especially important for airports located near residential areas. Moreover, renewable energy integration enhances airport energy independence and supports compliance with international sustainable aviation objectives.

It should be noted that the use of modern AMPUs positively affects not only ground infrastructure but also aircraft operation. When an aircraft is connected to an external power source, there is no need for prolonged operation of the Auxiliary Power Unit, resulting in lower fuel consumption, reduced equipment wear, and decreased pollutant emissions.

Despite these advantages, the implementation of renewable energy technologies within airport power systems faces several challenges. These include the high cost of advanced battery systems, the need to modernize existing airport infrastructure, the dependence of solar generation on weather conditions, and the requirement for sophisticated energy management systems. Nevertheless, continuous advances in energy storage technology, declining photovoltaic panel costs, and increasing battery efficiency are making such solutions increasingly affordable and economically viable.

Therefore, the integration of airfield mobile power units with renewable energy sources represents one of the most promising directions in the development of aviation ground support equipment. The use of solar energy, advanced energy storage technologies, and intelligent control systems will enable the creation of environmentally friendly, cost-effective, and highly reliable power systems for aircraft servicing. In the future, such technologies may become a

fundamental component of the "green airport" concept, supporting the sustainable development of the aviation industry while reducing its environmental impact.

Conclusion

The integration of airfield mobile power units with renewable energy sources is one of the most promising directions for the development of aviation ground support technology. The use of solar energy, battery energy storage systems, and intelligent energy management solutions can significantly improve airport energy efficiency, reduce operating costs, and minimize environmental impacts.

In the future, the modernization of APA-150 power units through the implementation of hybrid energy technologies may become an important step toward the realization of the green airport concept, meeting the modern requirements of sustainable aviation development.

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