

## NOISE IMPACT OF HYBRID-ELECTRIC AIRCRAFT: KEY FEATURES AND FUTURE OUTLOOK

Kazhan K.I., Makarenko V.M, Tokarev V.I.  
State University "Kyiv Aviation Institute", Kyiv, Ukraine

Hybrid-electric aircraft are emerging as a promising solution for reducing greenhouse gas emissions and significantly mitigating aircraft noise, a persistent issue for communities near airports. These aircraft combine traditional fuel-based engines with electric propulsion systems, enabling quieter operations, especially during takeoff and landing - the noisiest phases of flight. Electric motors can assist or partially replace thrust during these stages, so hybrid aircraft can substantially reduce overall sound levels. In particular, distributed propulsion systems, which utilize multiple smaller electric fans along the wings, help minimize per-unit noise and reduce tonal effects by lowering propeller tip speeds. This configuration also allows for better aerodynamic integration, contributing to noise reduction through smoother airflow. During descent and approach, the ability to maintain control with minimal engine power enables hybrid aircraft to fly steeper or slower approaches, reducing exposure over residential areas.

Modeling studies from initiatives such as Clean Sky 2 and NASA's N+3 program estimate that hybrid-electric aircraft could achieve reductions of 5–15 dB in comparison to today's regional jets. This may translate to a 50–80% decrease in the population exposed to harmful noise levels near airports. Sound Exposure Level (SEL) and maximum perceived noise levels ( $L_{Amax}$ ) for these aircraft could drop below 65 dB(A) at standard ground reference distances, potentially complying with stricter local noise regulations. However, several challenges remain. Battery mass and energy density still limit the duration of electric-only operation, particularly for larger aircraft, and integrating motors and gear systems must be done carefully to prevent the introduction of new mechanical noise sources. Moreover, existing certification frameworks must evolve to properly account for hybrid flight profiles and mixed-mode propulsion. Despite these uncertainties, early hybrid aircraft – especially 30–70 seat regional turboprops— are well suited for short-haul European routes where noise concerns are highest. As these aircraft begin replacing older, noisier models in the 2030s, they could transform the acoustic footprint of air travel.

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Катерина Іванівна Кажан, к. т. н.

Тел. 0632314076

E-mail: [kateryna.kazhan@npp.kai.edu.ua](mailto:kateryna.kazhan@npp.kai.edu.ua)

Державний університет «Київський авіаційний інститут»,

Віталій Миколайович Макаренко , к. т. н.

Тел. 0632314076

E-mail: [mak.vit.myk@gmail.com](mailto:mak.vit.myk@gmail.com)

Державний університет «Київський авіаційний інститут»,

Вадим Іванович Токарев , д. т. н. проф.

Тел. 0632314076

E-mail: [vadim.tok@gmail.com](mailto:vadim.tok@gmail.com)

Державний університет «Київський авіаційний інститут»,