

FLEXI-FUEL HIGH-EFFICIENCY LINEAR PISTON ENGINE FOR FUTURE POWER GENERATORS

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Abstract

The FLEX-GEN project focuses on the development of advanced Free Piston Linear Generator (FPLG) technology as a sustainable and efficient solution for both stationary power generation and mobile applications. FPLGs combine several key advantages, including high net efficiency, low pollutant emissions, and the capability to operate with a wide range of sustainable fuels. These features make them highly suitable for future energy systems aiming to reduce environmental impact and fossil fuel dependence.

The core objective of FLEX-GEN is to develop advanced models, simulation tools, and prototypes of innovative combustion systems—such as ultra-lean pre-chamber configurations—to enhance the sustainability of FPLGs in both stationary and mobile applications. FLEX-GEN brings together leading research units with recognized expertise in thermal systems, combustion modelling, and experimental testing. The research includes the development of dedicated 0D/1D and 3D CFD simulation tools to analyse key processes such as air handling, combustion dynamics, and advanced fuel injection strategies, supporting the optimization of efficiency and emissions.

A new prototype FPLG is being developed and features a flexible combustion system capable of operating with both direct injection and pre-chamber ignition. This prototype allows for in-depth study of operational stability, including aspects such as knock and cycle-to-cycle variability. The experimental data generated will also be used to validate numerical models and support further optimization of the system. In addition to performance assessment, the project includes a comprehensive Life Cycle Analysis to evaluate the environmental benefits of the proposed technology compared to current state-of-the-art solutions. By combining modelling, experimentation, and sustainability assessment, FLEX-GEN aims to deliver technological innovations that will be valuable to both the scientific community and industry, contributing to the transition toward cleaner and more flexible energy systems.