National Aeronautics and
Space Administration

Automotive Stirling Technology

Supplying electrical and mechanical power with high-fuel efficiency and low emissions

TECHNOLOGY OPPORTUNITY

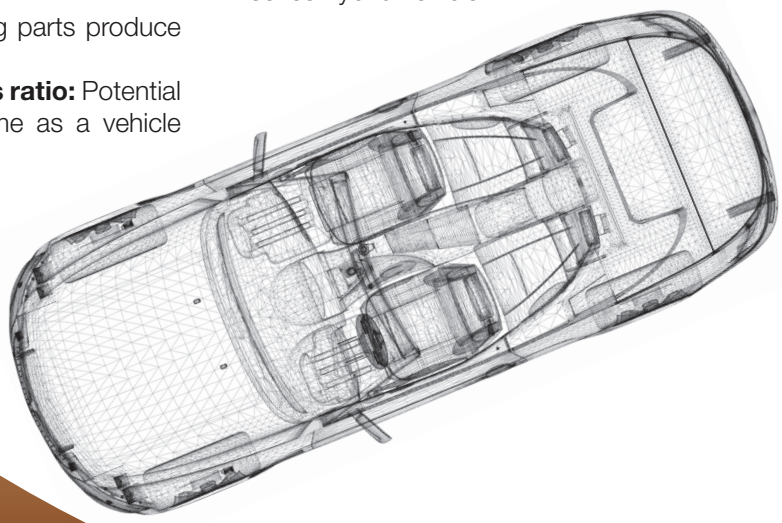
NASA's Glenn Research Center invites companies to establish partnerships to develop its automotive Stirling engine. This external combustion heat engine can provide either electrical or mechanical power output. Developed under the space power program, the free-piston design features high fuel efficiency and ultralow emissions and offers reliability and improved performance over internal combustion engines (ICEs).

BENEFITS

- **Ultraefficient:** Offers up to 40 percent thermal-to-electric conversion efficiency, compared to 18 to 20 percent for ICEs
- **Multifuel capability:** Can use any heat source (solar, air, hot water, and even liquid sodium) depending on the application
- **Clean, green technology:** Ultralow CO_2 emissions as the technology uses steady combustion rather than quick bursts
- **Free-piston design:** Enables operation at design resonant frequency where piston motion is converted to electricity via linear alternator; displacement can be adjusted to modulate power output
- **Friction-free properties:** No contact and no wear mechanisms increase system reliability and product life
- **Long-life operation:** Design eliminates loss mechanisms such as seals and lubrication pumps
- **Quiet:** Noncontacting moving parts produce fewer vibrations
- **Unmatched power-to-mass ratio:** Potential for low mass and low volume as a vehicle auxiliary power unit (APU)

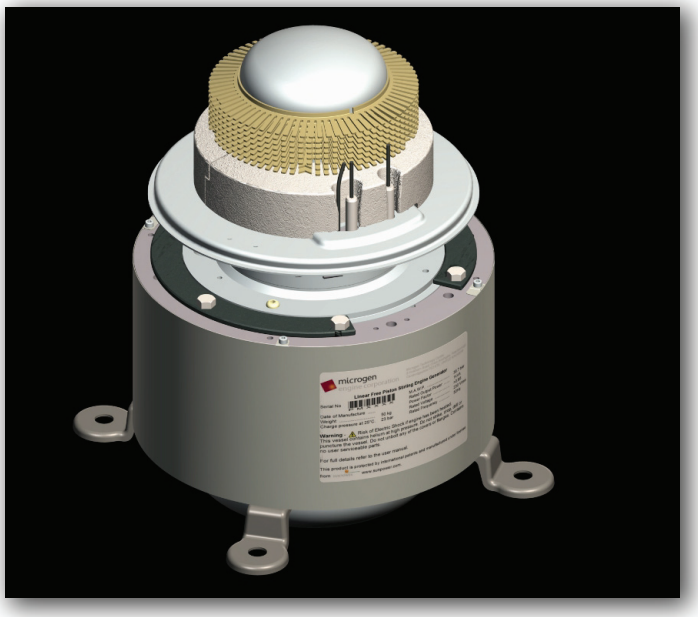
APPLICATIONS

- Primary power source alternative to the ICE
- APU that could operate via ICE's waste heat
- Fuel-fired generator supplying electricity for battery charging and electric drive motor in series hybrid vehicle



TECHNOLOGY DETAILS

Stirling technology is a critical component of the Advanced Stirling Radioisotope Generator (ASRG), a high-efficiency candidate power source for future NASA space science missions. Glenn's unique facilities have allowed for more than 400,000 hr of reliability testing and operation on experimental models and flight prototypes.

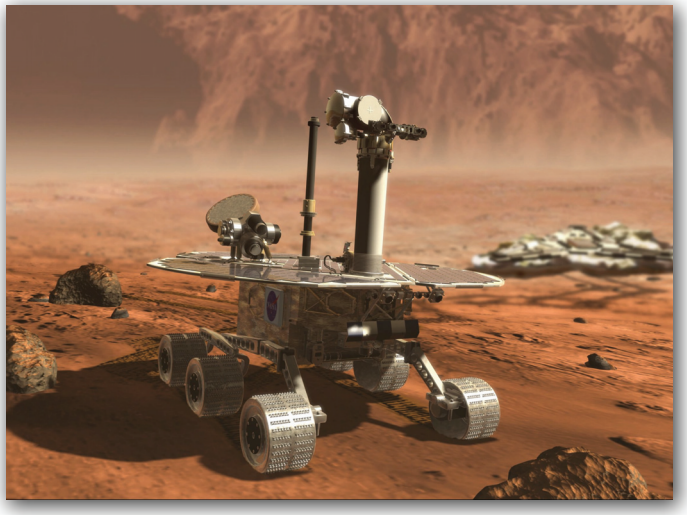


HOW IT WORKS

A displacer shuttles gas between hot and cold zones to raise and lower gas pressure. The resulting pressure wave moves the piston, which has no contact with the cylinder wall. The piston motion is converted to electricity via a linear alternator. There are no linkages or crankshafts in the free-piston design, as the motion of the displacer is excited by the pressure wave that it creates. All moving parts are suspended by gas bearings or planar springs.

WHY IT IS BETTER

Motion of the displacer and piston is tuned via the spring/mass/damping resonant dynamics, eliminating the need for complex mechanisms. The noncontacting operation between the moving components eliminates inherent friction and the resulting wear on mechanisms and ensures long-life operation. The Stirling engine's high conversion efficiency, capability for long-life operation, and high specific power make it a candidate for automotive power systems.



LICENSING AND PARTNERING OPPORTUNITIES

Glenn's Office of Technology Partnerships and Planning seeks to transfer technology to and from NASA to benefit the space program and U.S. industry. NASA invites companies to consider partnering with Glenn to further develop this automotive Stirling technology.

FOR MORE INFORMATION

For more information about this and other technology licensing opportunities, please contact

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