HyWREAP Concept
NASA's call for early-stage highly innovative ideas to meet national aeronautics needs elicited the novel Hybrid Wave-Rotor Electric Aero-Propulsion (HyWREAP) concept that combines electric battery and motor drive with a highly fuel-efficient and compact combustion turbine engine. Conventional turbine engines operate efficiently during cruise, but often burn fuel inefficiently during taxing and idling at congested airports. To maximize fuel efficiency for medium-range aircraft, the benefits of electric propulsion would be combined with an innovative wave-rotor turbine engine.

The HyWREAP engine merges the functions of a compressor, combustor, and turbine found on today's aircraft engines into a single rotating component, and offers significantly lower-fuel consumption and greenhouse gas emissions. The underlying wave rotor combustor (WRC) technology has been investigated at IUPUI for several years, and demonstrated in the laboratory.

Boeing SUGAR Study
In 2011-2012, an industry-university team led by Boeing completed a study for NASA on 'Subsonic Ultra Green Aircraft Research' (SUGAR). The study explored many options for reducing fuel use and greenhouse gas emissions of medium-range passenger aircraft (similar to the Boeing 737) in the 2030-2040 timeframe. Some concepts for a hybrid-electric propulsion system showed much promise, with the expectation that light-weight chemical batteries will be developed that use atmospheric oxygen and materials like Lithium. Fuel use could be reduced by 60-70% relative to current airplanes.

Typically, a hybrid propulsion airplane could cruise and taxi using electric power alone, and would be boosted by a combustion engine for take-off, climb, and acceleration. The combustion engine can also extend the range of the airplane as needed. Battery packs would be recharged at airports, and possibly in flight with solar power. Additional synergy can come from the use of cryogenic fuels, such as liquid natural gas (LNG), by enabling superconducting motors.

HyWREAP Design
The wave rotor combustor turbine offers substantial improvement in fuel efficiency as well as a unique low-speed drive for the propelling fan. The wave turbine enables internal wave compression and pressure-gain combustion, together with shaft-output power at relatively low rpm.

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