



## Green Aviation: Safeguarding Our Future on Earth

An ever increasing global demand for moving people and cargo through the air shows no signs of slowing down. During 2014 alone, more than 760 million passengers and freight worth more than \$1.6 trillion travelled on U.S. air carriers – numbers that were up from the previous year. The International Air Transport Association forecasts nearly a billion more passengers will demand air travel worldwide during the next five years.

Building and flying more airplanes to meet that demand will place additional burdens on an

environment already facing challenges from limited resources and global climate change. As a result, NASA's aeronautical innovators are working on new airplane designs that use dramatically less fuel, generate less pollution and will reduce noise to levels far below where they were just a decade or two ago. They are doing this by embracing emerging technology in areas not usually associated with aviation, while also pioneering new approaches to air travel based on a research heritage that is a century old.



Images (clockwise from upper left)

**Alternative Fuel Research:** NASA and partners are documenting how using biofuels affects aircraft emissions. **New Materials:** A 30-foot aircraft component built from nonmetallic material that can reduce or eliminate the need for drag-causing rivets or bolts is stress tested. **Bug-phobic Wing Coatings:** Coatings applied to the leading edges of wings were tested for ability to prevent buildup of bug residue that creates drag. **Future Aircraft:** Engineers in a NASA wind tunnel test a scale model “double bubble” D8 aircraft concept that can reduce drag and fuel consumption.

More specifically, for airplanes that could be flying in the 2020-2025 timeframe should industry choose to build them, NASA is researching technologies that cut fuel use in half, reduce emissions up to 75 percent during takeoff and landing, and reduce aircraft noise 42 decibels below current standards. These goals were recently proven achievable thanks to eight technology demonstrations completed as part of a NASA project focused on more Earth-friendly aviation. For airplanes that will enter service even farther into the future, NASA's goals are even more ambitious (see "NASA's Reduction Goals" chart below).

In addition to reducing fuel burn, noise and emissions by designing new aircraft, achieving those same environmental goals can be helped by moving airplanes more efficiently through the National Airspace System. NASA is working with the Federal Aviation Administration to provide air traffic controllers with new tools for safely managing the expected growth in air traffic across the nation.

NASA's green aviation research takes place at all four of the agency's aeronautical field centers, including the Ames Research Center at Moffett Field, Calif., Neil A. Armstrong Flight Research Center at Edwards Air Force Base, Calif., Glenn Research Center in Cleveland, and Langley Research Center in Hampton, Va. The work is managed by the Aeronautics Research Mission Directorate at NASA Headquarters in Washington, DC.

### Some of the things we're working on to help meet our goals:

Shape-changing wing flaps that reduce drag and fuel use

Technologies that could make electric propelled aircraft possible

Flight tests of alternative renewable jet fuels developed by others to ensure they are viable

Software to help air traffic controllers and pilots select more fuel- and time-efficient routes

Non-traditional aircraft wing and body shapes

More widespread use of composite materials in building lighter weight aircraft

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Areas to Improve	NASA's Reduction Goals		
	Aircraft Entering Service in 2020-2025	Aircraft Entering Service in 2025-2030	Aircraft Entering Service in 2030-2035
Noise (Cumulative margin relative to ICAO* 8.4.2/ FAA Stage 4 noise limit)	-32 dB	-42 dB	-52 dB
Landing/Takeoff Cycle NO <sub>x</sub> ** Emissions (Relative to ICAO CAEP/6 standard)	-60%	-75%	-80%
Cruise NO <sub>x</sub> Emissions (Relative to 2005 best in class)	-55%	-70%	-80%
Aircraft Fuel/Energy Consumption‡ (Relative to 2005 best in class)	-33%	-50%	-60%

\* ICAO = International Civil Aviation Organization

\*\* NO<sub>x</sub> = Nitric oxide and nitrogen oxide, which contribute to ozone creation.

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