

# Creating a better



## At Boeing, technology leads to environmentally progressive products, services and operations

By JAY SPENSER

**F**rom their development of solar cells and fuel cells to advanced aerodynamics, lightweight materials and alternative fuels, Boeing people are tackling environmental challenges with unprecedented energy and enthusiasm.

Over the past four decades, Boeing has made its jetliners about 70 percent more fuel efficient with an approximately 90 percent smaller noise footprint. The 787 Dreamliner and 747-8 Intercontinental will continue this progress with a further reduction in fuel consumption, emissions and noise.

But that's only part of the environmental technology story at Boeing, which is committed to leading the aerospace industry in developing clean, green products for the future. Boeing experts also are pursuing alternative energy developments, reimagining the world's aviation systems to make them more efficient, and implementing process improvements to operate greener. The result is tangible technology that delivers solid environmental benefits today—and will be transformative tomorrow.

"As a technology leader, our greatest contribution will be innovation, as we find ways to make our products, services and operations ever more environmentally progressive," said Jim McNerney, Boeing chair-

man, president and CEO. "This issue is critical for our business success. Reducing the greenhouse-gas emissions (which lie at the heart of climate-change concerns) is one of the greatest challenges—and opportunities—that Boeing has encountered."

Taking the lead in helping coordinate Boeing's environmental activities is the company's Environment, Health and Safety (EHS) organization. Formed in 2007, EHS has the charter to integrate and expand the focus of previously separate environmental groups and initiatives across the enterprise. EHS now is spearheading a companywide environmental strategy that embraces Boeing products, processes and facilities even as it reaches out to customers, suppliers and communities.

"Our employees have tremendous talent and passion, and we are working on environmentally progressive technologies across every part of this company," said Mary Armstrong, EHS vice president. "Our job is to help provide pathways and connections for that passion to create truly innovative environmental solutions for our customers."

Also in 2007, Boeing unveiled a new enterprise technology strategy that seeks to ensure the right technologies are developed, now and in the future. To implement this competitiveness-enhancing strategy, Boeing this year created eight technology domains covering the different areas of company research and development (R&D). One of these domains is devoted to environmental technologies.

"As an aerospace leader, enhancing our environmental capabilities and performance is the right thing to do," said Environment Technology Domain Leader Vanessa Gemmill. "But it's more than that—it's also the key to our future growth and success as an aerospace company. At Boeing, we plan to be ready with a balanced portfolio of environmental

# future



Boeing is active in myriad activities that support environmental improvements. They include (from left) flying a manned airplane powered by clean, quiet hydrogen fuel cells; continually improving the environmental performance of its factories, such as its satellite plant in El Segundo, Calif.; creating products that use less fuel and have smaller noise footprints, such as the 747-8 Intercontinental airplane (shown here is the airplane's interior); spurring the development of aviation biofuels by leveraging research like that of the Hawaii Agriculture Research Center on *Jatropha curcas*; and creating solar cells, through its Spectrolab subsidiary, that turn the sun's energy into electricity.

FROM LEFT: BOEING PHOTO; BOB FERGUSON PHOTO; BOEING PHOTO; ALLEN BIRNBACH PHOTO; BOB FERGUSON PHOTO

**“As a technology leader, our greatest contribution will be innovation, as we find ways to make our products, services and operations ever more environmentally progressive,”**

— Jim McNerney, Boeing chairman, president and CEO

technologies when our customers, the world and we ourselves need them.”

## INNOVATING FOR THE ECOSYSTEM

Boeing is one of the world's leading manufacturers of solar cells, a fact that might surprise some people. Solar cells made by wholly-owned Boeing subsidiary Spectrolab, a part of Integrated Defense Systems, power everything from satellites and interplanetary missions to renewable energy plants in California, Arizona and Australia.

Tim Vinopal, IDS chief engineer for the environment, noted that Spectrolab's concentrator cells currently hold the world's record with 40.7 percent efficiency in converting sunlight to electricity. “Great as this is, we're expecting further improvements thanks to new technologies now being pioneered by Boeing,” he said. (For more about Spectrolab, see Page 30 of the November 2007 *Boeing Frontiers*).

In addition, Boeing is investigating biofuels as another alternative energy source that can reduce carbon-dioxide emissions from aerospace products.

“We and our partners from other industries are working on advanced-generation aviation biofuels derived from sources that will not take arable land out of production,” said Darrin Morgan, who's responsible for business analysis and biofuels strategy at Commercial Airplanes. “Feasibility has been established over the past two years, and commercial production will soon begin.”

Morgan added that a number of biofuel feedstock candidates are being investigated. Particularly promising are algae that thrive in brackish water and strong sunlight, making harsh desert environments ideal for their production. These fast-growing algae produce high-energy-density fats that can be modified to create a biofuel similar to kerosene but without its environmental drawbacks.

To highlight the technical feasibility of sustainable biofuels for jetliners, Boeing conducted the first commercial aviation flight using a different biofuel mixed with regular jet fuel in February with Virgin Atlantic and GE Aviation. In addition to doing engine ground testing with Pratt & Whitney, Boeing will conduct joint biofuel demonstration flights later this year with Air New Zealand and Rolls-Royce, and in 2009 with

Continental Airlines and GE Aviation.

Fuel cells are yet another alternative energy technology being pursued by Boeing. These devices directly convert hydrogen into electricity without combustion, reducing noise, emissions and the need for conventional fuels. When running on hydrogen, they emit only heat and water vapor. When equipped with a reformer allowing conventional hydrocarbon fuels to be used, they produce far fewer emissions than do combustion engines.

Boeing is collaborating with industry to explore fuel-cell applications in jetliner electrical power systems. Capping a learning effort earlier this year, an engineering team at Boeing Research & Technology Europe in Madrid, Spain—part of the company's Phantom Works advanced R&D unit—successfully flew a manned airplane powered solely by a hydrogen fuel cell (see Page 44 of the May 2008 *Boeing Frontiers*).

Boeing technologists also are working to improve air traffic management, the global successor to traditional air traffic control. In addition to letting more airplanes safely share the world's airspace, ATM offers a critical near-term opportunity to improve aviation's global environmental performance. In fact, the International Air Transport Association estimates that ATM solutions could improve fuel efficiency by up to 12 percent with a corresponding reduction in carbon dioxide emissions.

ATM will reduce fuel use by using airspace more efficiently, minimizing delays and hold-

ing patterns over airports and using precision navigation and other airplane capabilities not now exploited. One example is the Boeing tailored arrival concept, in which jetliners descend continuously to the runway instead of descending to low altitude and then maneuvering in the airport vicinity before landing. Trials have shown that this advanced arrival technique can save up to 500 gallons (1,893 liters) of fuel per flight.

Boeing environmental R&D also is helping the company's military customers meet their sustainability challenges. Biofuels hold out strategic as well as environmental benefits for military operators such as the U.S. Air Force, which in terms of fuel use would rank as the world's second largest airline. In addition, IDS environmental R&D is making available new technologies that reduce emissions and hazardous waste creation as Boeing military aircraft are maintained and operated in service.

### SMALLER FOOTPRINTS

Even as Boeing helps its customers reduce their carbon footprints, the company continues to reduce its own. According to Jeff Nunn, conservation initiative leader for Shared Services Group, on a revenue-adjusted basis since 2002, the company has cut energy consumption and carbon dioxide emissions by 24 percent, water consumption by 28 percent, and hazardous waste by 30 percent.

"More reductions are now under way thanks to the challenging five-year targets

the company committed to last year," said Nunn. "Our current goal is 25 percent further improvements in solid waste recycling rates, energy efficiency and greenhouse gas emissions intensity by 2012 at the company's major manufacturing facilities."

Boeing has a similarly ambitious goal for hazardous waste reduction—an area in which Boeing has made great strides over the decades, Nunn added.

### ENVIRONMENTAL LEADERSHIP

Global challenges require global collaboration for meaningful solutions, of course. As an aerospace leader, Boeing is pressing for broad industry alignment to effectively address environmental-improvement opportunities.

In April, for example, Boeing helped gather many of its customers, partners and competitors in Geneva, where these entities committed to a pathway toward carbon-neutral growth and the aspiration of a carbon-free future.

Further demonstrating its commitment to the environment, Boeing this year joined the U.S. Environmental Protection Agency's Climate Leaders program, which requires action on carbon dioxide reductions. Boeing also is a member of the World Business Council for Sustainable Development and the Pew Center on Global Climate Change, two important forums for learning and spreading the word. ■

*jay.p.spenser@boeing.com*

In February, Boeing partnered with GE, Imperium Renewables and Virgin Atlantic Airways to conduct the first commercial flight using sustainable biofuels. Shown here is the Virgin Atlantic 747-400 that flew the historic flight from London to Amsterdam.

BOEING PHOTO



## New report details Boeing's environmental focus

Boeing last month issued a report that details its performance, strategy and actions to reduce its environmental footprint and lead the aerospace industry with environmentally progressive products and services.

According to the 2008 Environment Report, Boeing's manufacturing operations have achieved significant improvements between 2002 and 2007. On a revenue-adjusted basis, Boeing has reduced energy use and carbon dioxide emissions at its major facilities by 24 percent and hazardous waste by 30 percent. On an absolute basis, the reductions are 5 percent for energy use, 4.8 percent for carbon dioxide emissions and 12 percent for hazardous waste.

The report also states that Boeing is now targeting a further 25-percent revenue-adjusted reduction of energy use and greenhouse gas emissions by 2012, with similar goals for recycling and hazardous waste.

To see the report, visit [www.boeing.com/aboutus/environment](http://www.boeing.com/aboutus/environment) on the World Wide Web.

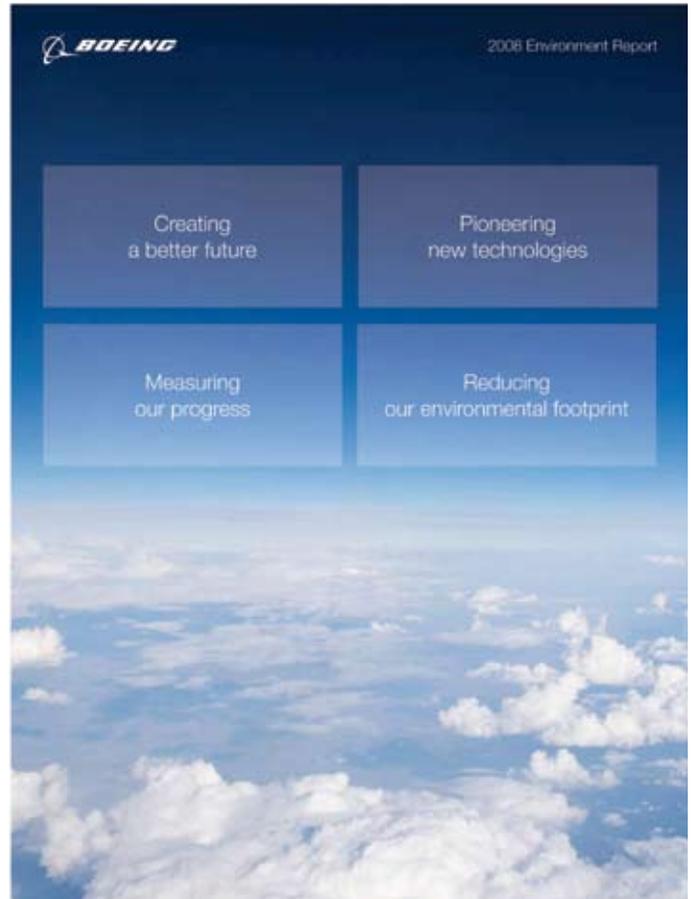
"Climate change and pollution are serious global concerns," said Jim McNerney, Boeing chairman, president and CEO. "Recognizing that, Boeing has set a clear strategy to help protect our eco-system. Our greatest contributions will continue to come from innovation—delivering improved environmental performance for customers while relentlessly reducing our own footprint."

Boeing has a record of integrating environmental performance improvements through technology advancements. Over the last 40 years, airplane emissions of carbon dioxide have been reduced by around 70 percent, and the noise footprints have been reduced by approximately 90 percent. Boeing targets improving fuel efficiency of each new generation of commercial airplane by 15 percent compared to the airplanes they replace.

"It's a good record, but it's clear we need to accelerate our efforts," said McNerney. "Because of the tremendous benefits aerospace brings to the world, our industry—and our company with it—is growing, and we are focused on achieving carbon-neutral growth and then continued reductions."

Highlights of Boeing's work with environmentally progressive technologies in 2008 include:

- The world's first flight of a commercial airplane powered in part by biofuels, in collaboration with Virgin Atlantic Airways and GE Aviation. Boeing is focused on research for advanced generations of sustainable biofuels using biomass that do not compete with food crops or water resources.
- The world's first straight-and-level flight of a manned airplane powered only by a fuel-cell. The research may benefit secondary aircraft system power use. ■



**“Boeing has set a clear strategy to help protect our eco-system. Our greatest contributions will continue to come from innovation—delivering improved environmental performance for customers while relentlessly reducing our own footprint.”**

— Jim McNerney, Boeing chairman, president and CEO