



# Build Something Cleaner

The Boeing Company  
2015 Environment Report



# About The Boeing Company

At Boeing, we aspire to be the strongest, best and best-integrated aerospace-based company in the world — for today and tomorrow.

Cover photo: In 2014, the Boeing ecoDemonstrator 787 assessed more than 25 technologies designed to reduce aviation's fuel use, carbon emissions and noise. ecoDemonstrator technologies included

a Ceramic Matrix Composite engine nozzle that may enable engines to operate at a higher temperature, improving fuel efficiency while decreasing emissions and noise. (Boeing photo)

- ▲ Total revenue in 2014: \$90.8 billion.
- ▲ Employs more than 165,000 people across the United States and in more than 65 other countries.
- ▲ For the fifth straight year, Boeing was named the No. 1 innovator among aerospace and defense companies.
- ▲ Boeing has been awarded 15,573 patents around the world.
- ▲ More than 21,000 suppliers and partners around the world.
- ▲ Boeing is the No. 1 exporter in the United States — a position the company has held for the last decade.
- ▲ Boeing has customers in more than 150 countries.
- ▲ Established 11 research and development centers, 16 consortia and 22 joint global research centers.



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Energy-efficient chillers and other improvements at the Douglas Center office complex have helped Boeing's Long Beach site substantially reduce its energy use and boost energy efficiency. (Boeing photo)

# Our Approach



**Boeing has a clear strategy and commitment to take action to address concerns about climate change and the environment.**

This is good for our business, customers, employees and Boeing communities around the world.

Aerospace is an essential part of modern life. It helps drive economic growth and prosperity, and it brings the people of the world closer together. Because of the tremendous benefits aerospace provides, our industry continues to grow, and our company with it.

As a company, we understand that taking care of the environment is crucial to our aerospace and technology leadership. Boeing employees are actively working on many fronts to improve the environmental performance of our products and services as well as our operations. In sum, Boeing is committed to building a better planet.

A community garden with pollinator habitat replaced a former chemical processing facility in Olathe, Kansas, as part of a remediation strategy that is setting new standards for environmental stewardship. (Boeing photo)

## Leadership Message

Like our founder Bill Boeing and our predecessors who succeeded in making this a great company in its first century, today's generation of Boeing employees has built a stronger company for launching our second century. >



**Jim McNerney**  
Chairman and Chief Executive Officer,  
The Boeing Company  
**Ursula English**  
Vice President,  
Environment, Health & Safety

## LEADERSHIP MESSAGE

As we approach the start of our 100th year in business, we continue to focus not only on building a bigger, better Boeing but also on further improving the environmental performance of our company and industry — through both our operations and our products.

The people of Boeing drove significant progress in these areas over the past year.

At Boeing Commercial Airplanes, we continued to design, build and deliver the world's most fuel-efficient airplanes, such as the 787 Dreamliner and future products like the 737 MAX and 777X. We are working with our customers and global partners to meet aggressive, industry-wide targets to improve fleet fuel efficiency while reducing carbon emissions and noise. And we remain focused on leading the aerospace industry in working with global partners to develop sustainable aviation biofuel around the world.

Boeing Defense, Space & Security also made great strides with high-technology products that harness the power of alternative energy sources. Our unmanned Phantom Eye airborne system — which is powered by liquid hydrogen and produces only water as a byproduct — made additional test flights last year. Boeing launched the first two all-electric-propulsion satellites, which use only clean electric power and nonhazardous gas for propulsion. And Spectrolab (part of Boeing Defense, Space & Security) is the world's leading supplier of high-efficiency, multijunction solar cells for concentrated photovoltaic and spacecraft power systems and airborne searchlights.

In facilities worldwide, the people of Boeing are working toward a target of zero growth by 2017 in greenhouse gas emissions, water intake, hazardous waste generation (normalized to revenue) and solid waste sent to landfills. This is a significant goal — and one we are on target to achieve even as we increase commercial airplane production rates

by 50 percent. We are succeeding by addressing all areas of stewardship, from enhanced recycling in our facilities to designing buildings that meet LEED standards.

At our 4.3-million-square-foot (400,000-square-meter) 737 factory in Renton, Washington, 100 percent of the electricity comes from renewable sources, just like at our facility in North Charleston, South Carolina. Our site in Huntington Beach, California, is saving millions of gallons of potable water each year.

It's clear that the passion with which Bill Boeing founded our company 99 years ago continues to this day. We see it in our people. Everyone at Boeing is committed to further innovation to improve the environmental performance of our products, our services and our industry.

As we prepare for our second century of innovation and leadership, we do so with a clear view of our planet, our responsibility to future generations and the ways in which our teams are changing the world.

Jim McNERNEY  
Chairman and  
Chief Executive Officer  
The Boeing Company

Ursula English  
Vice President  
Environment, Health & Safety

Boeing has increased commercial aircraft production by **more than 50%** while continuing to **reduce** our facilities' environmental footprint.





The 787 Dreamliner sets new standards for environmental performance and is the most efficient commercial airplane in its class. (Boeing photo)

## ENVIRONMENTAL POLICY AND STRATEGY

In 2015, commercial aircraft will carry an estimated 9 million passengers and 162,000 tons (147,000 metric tons) of cargo every day, according to the International Air Transport Association. And governments around the world will make thousands of defense aircraft flights throughout the year. To meet this sustained growth, Boeing's goal is to deliver more value to our customers for less cost — while also being the most environmentally progressive aerospace company.

To accomplish this goal, we are pursuing an environmental leadership strategy made up of three tenets:

- ▲ Design-in Environmental Performance
- ▲ Innovate for Sustainable Operations
- ▲ Inspire Global Collaboration

In addition to providing the most advanced and fuel-efficient family of airplanes and services to our customers, Boeing is committed to:

- ▲ Conducting operations in compliance with applicable environmental laws, regulations and Boeing policies and procedures.
- ▲ Preventing pollution by conserving energy and resources, recycling, reducing waste and pursuing other source-reduction strategies.
- ▲ Continually improving our environmental management system.
- ▲ Working together with our stakeholders on appropriate policies and activities that promote environmental protection and stewardship.

Through our strategy, Boeing employees continually research new and innovative technologies to reduce our company's environmental footprint.

To support the commercial and defense markets, this includes improving operational efficiency for our customers with digital tools; using advanced, lightweight materials and improved aerodynamics to reduce our products' fuel consumption; developing and commercializing new sustainable fuel sources; and researching hybrid, solar and electric-powered aircraft. It also means further developing new alternative energy systems, such as high-efficiency multijunction solar cells for concentrated photovoltaic and spacecraft power systems.

We are also focused on accelerating the environmental efficiency of our production facilities and working with institutions, governments and stakeholders to build better communities worldwide.

### Boeing Environmental Leadership Strategy:

- Design-in Environmental Performance
- Innovate for Sustainable Operations
- Inspire Global Collaboration



## GOVERNANCE

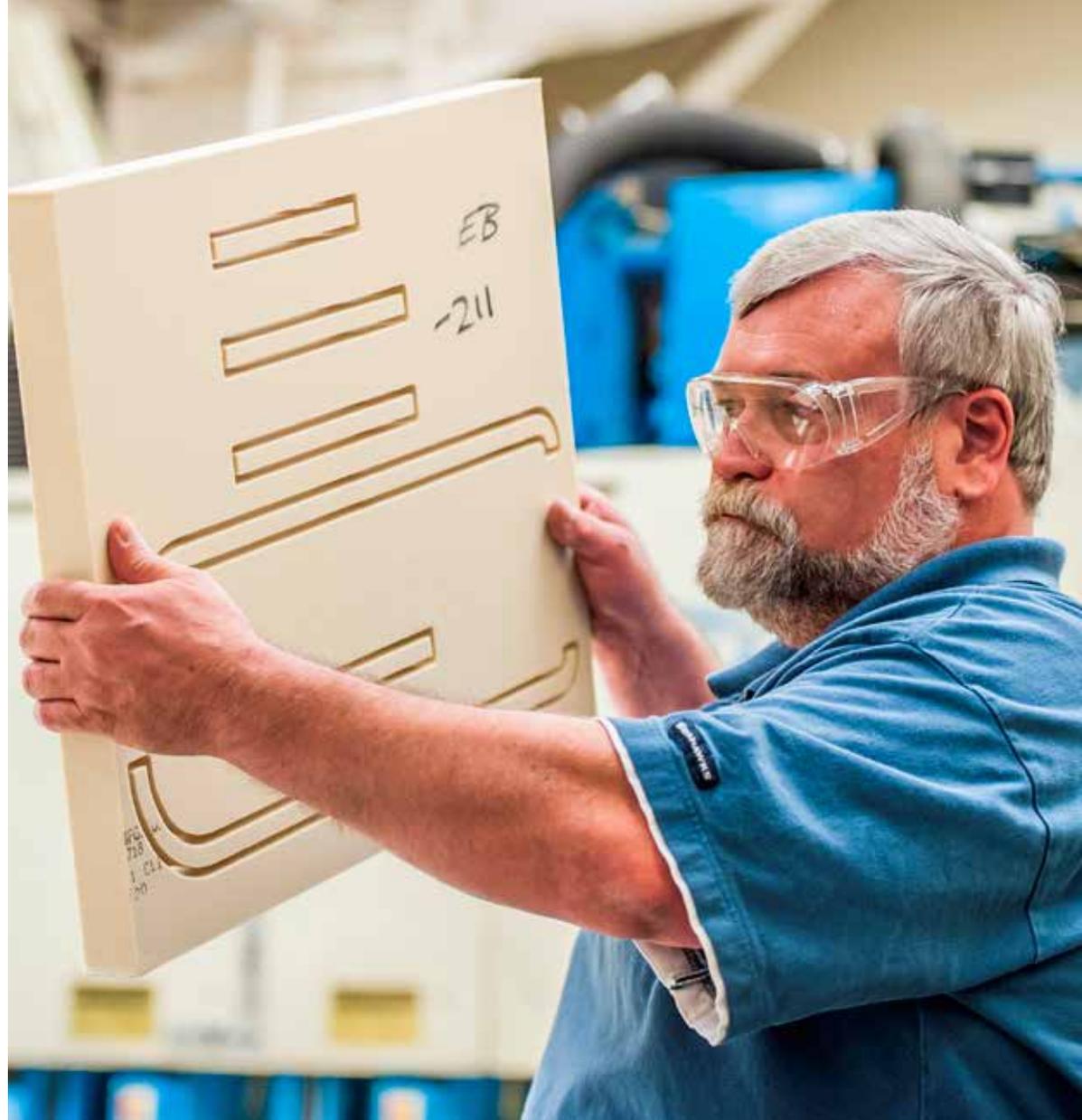
Our company's environmental strategy and policies are guided by the Environment, Health & Safety (EHS) Policy Council, which is composed of Boeing's Executive Council and led by the CEO/chairman of the board.

The Policy Council ensures that strategy and performance targets are set and monitored. A team of 20 cross-functional executives meets twice monthly to advance our strategy and plan.

Reviews by the EHS Policy Council and a functional review with the CEO/chairman of the board are conducted twice a year. Progress and status are reported through each of these venues, in addition to other internal executive reviews across the company. One Policy Council meeting each year is focused on setting targets that are aligned with corporate long-range business planning; the other meeting each year is focused on detailed planning and reviewing our performance.

Environmental initiatives are embedded into every organization and function within Boeing. The EHS organization contains functions focused on workplace safety and health, environmental performance and regulatory compliance. The team also works with our business unit and operational leaders to drive an integrated, enterprise-wide strategy that includes our products, services, processes and operations.

This highly integrated and coordinated approach has driven continuous improvement in the environmental performance of our products and operations around the world.



Manufacturing employees in Everett and South Carolina reduce waste by ensuring a precise amount of material is ordered to manufacture a part. (Boeing photo)

## ABOUT THIS REPORT

This is Boeing's eighth annual report focusing on the company's environmental activities and progress toward our targets. The report and its data reflect most of our operations, unless otherwise noted.

This report is intended to highlight our performance objectives, results and business relevancy. Whenever possible, we provide relevant environmental information for the corresponding time period for our operations.

The data presented in our Performance section undergo an Internal Audit review to verify data collection and authentication processes. Additionally, the data representing our greenhouse gas (GHG) emissions have received a limited assurance by an external third-party verifier. This external verification ensures that our reported GHG emissions are a fair representation for the stated period and boundaries. Our verified GHG emissions include data provided by our air travel and car rental preferred suppliers for business travel as well as Scope 1 and Scope 2 emissions for additional locations beyond those reported in the Performance section.

### Forward-Looking Statements

This report contains "forward-looking statements" within the meaning of the Private Securities Litigation Reform Act of 1995. Words such as "may," "should," "expects," "intends," "projects," "plans," "believes," "estimates," "targets," "anticipates" and similar expressions are used to identify these forward-looking statements. Examples of forward-looking statements include statements relating to our future financial condition and operating results, as well as any other statement that does not directly relate to any historical or current fact. Forward-looking statements are based on our current expectations and assumptions, which may not prove to be accurate. These statements are not guarantees and are subject to risks, uncertainties and changes in circumstances that are difficult to predict. Many factors could cause actual results to differ materially and adversely from these forward-looking statements.

Additional information concerning these and other factors can be found in our filings with the Securities and Exchange Commission, including our most recent Annual Report on Form 10-K, Quarterly Reports on Form 10-Q and Current Reports on Form 8-K. Any forward-looking statement speaks only as of the date on which it is made, and we assume no obligation to update or revise any forward-looking statement, whether as a result of new information, future events or otherwise, except as required by law.

Since 2012, Boeing's reduction in greenhouse gas emissions at the majority of facilities is equal to **taking 990 cars off the road for one year.**



# Design

**Boeing employees build and deliver the world's most modern and fuel-efficient fleet of commercial airplanes and continue to innovate in our defense and space products.**

We work with our commercial and defense customers to incorporate efficiencies that reduce their fuel use and costs, and reduce greenhouse gas emissions.

As a technology and innovation leader, we are developing and testing new technologies that will bring fuel efficiency and environmentally progressive innovations to our customers and our communities around the world.

An employee at Boeing subsidiary Spectrolab in Sylmar, California, examines solar cell wafers during the final step of the manufacturing process. (Boeing photo)

## DESIGN

### Cleaner Products

#### Boeing Commercial Airplanes

Commercial aviation is poised for continued growth, as technology and economic growth are making air travel more accessible to people around the world. Boeing has forecast that, to meet passenger demand for air travel that is projected to grow 5 percent annually, the global commercial fleet will grow by nearly 37,000 commercial airplanes over the next 20 years, more than doubling the number of airplanes currently in service.

Yet Boeing understands that commercial aviation also needs to grow sustainably. The aviation industry, which the United Nations estimates is responsible for about 2 percent of global manmade carbon emissions, has set aggressive goals for carbon-neutral growth from 2020 and a 50 percent reduction in CO<sub>2</sub> emissions in 2050 compared to 2005 levels.

This is why, to meet the business and environmental goals of our industry, Boeing is providing market-leading fuel-efficient airplanes and services.

In aviation, fuel costs, efficiency and profitability are tightly linked since jet fuel can account for up to 40 percent of airline operating budgets. This is why the aviation industry has long been focused on reducing fuel consumption, which also reduces carbon emissions. Since the dawn of the Jet Age, airplanes have increased fuel efficiency by 70 percent and reduced the noise footprint by 90 percent.



**Birds Do It: Saving Energy in Flight** Saving energy is not an easy task; how do the Boeing engineers do it? The answer is flying above you. [Click here to watch the video.](#)



The 787-10 Dreamliner will offer unprecedented fuel efficiency: 25 to 30 percent more than the airplanes it replaces. (Boeing photo)

## DESIGN

The trend toward greater efficiency will continue as Boeing delivers its new generation of airplanes:

- ▲ The Dreamliner family is 20 to 30 percent more fuel-efficient and reduces CO<sub>2</sub> emissions by 20 to 30 percent compared to the airplanes it replaces.
- ▲ The 747-8 is 16 percent more fuel-efficient and 30 percent quieter than airplanes it replaces. It is also 29 percent more fuel-efficient per trip than its competitor.
- ▲ The 737 MAX will be 14 percent more fuel-efficient than today's Next-Generation 737s and 20 percent more efficient than the original Next-Generation 737s.
- ▲ The 777X will be the largest and most fuel-efficient twin-engine jet in the world. The 777X will be 12 percent more fuel-efficient than its competitor due to key innovations such as a new composite wing and all-new GE9X engines.

In addition to designing and delivering the world's most fuel-efficient airplane family, Boeing provides services that improve gate-to-gate efficiency. Boeing works closely with airlines to analyze opportunities for fuel reduction and to develop and implement plans for adjusting operational practices to drive optimum efficiency. As examples, Boeing and its subsidiary Jeppesen offer a suite of fuel efficiency management solutions and services, including:

- ▲ Fuel Dashboard—analyzes fuel efficiency performance and identifies and prioritizes opportunities for improving fuel efficiency.
- ▲ Emissions Reporter—collects and files required European Union emission reports.
- ▲ Wind Updates & Direct Routes—uses real-time environmental conditions to optimize flight performance.



Start of final assembly of the new, fuel-efficient 737 MAX is planned for 2015, with first delivery in 2017.  
(Boeing photo)

## DESIGN

### Boeing Defense, Space & Security

Boeing's Defense, Space & Security business is a vibrant center of innovation, and within the walls of our factories and offices, we are accelerating improvements in environmental performance.

Boeing's all-electric-propulsion satellites, completed in December 2014, use only clean electric power and xenon (an inert, nonhazardous gas) for propulsion.

Boeing is testing and using proposed solutions such as hexavalent chrome-free primers for its AH-64 Apache helicopter and the V-22 Osprey. The new coatings will need to meet strict engineering requirements for the aircraft while reducing the use of hazardous chemicals in the manufacturing process.

The aptly named and Navy-led "Green Hornet" team took home its third Secretary of the Navy Award for Environmental Excellence in the "Weapon System Acquisition, Large Program, Individual or Team" category in 2014. The team's efforts and continued progress with biofuel development, noise reduction, hazardous materials management and lower emissions inspired Donald Schregardus, deputy assistant secretary of the Navy for the environment, to say, "In a nutshell, the Green Hornet team knows what it means to be 'green' in the best connotation of the term."

### Electric-Propulsion Satellites

Boeing is building the world's first all-electric-propulsion satellites. The all-electric-propulsion design of the 702SP (small platform) satellites gives customers new flexibility and capability while reducing weight, which saves on launch costs. Boeing's newest 702 satellite model couples proven technology from Boeing's previous designs with next-generation technology and processes, resulting in an affordable, lightweight alternative design to meet customer needs.



Left: Last year, the V-22 Osprey celebrated 25 years since its first flight. It is just one example of the success Boeing teams are having in finding new ways to make Boeing products safer and cleaner to build, fly and maintain. (Boeing photo)

Above: The 702SP, designed by Boeing Network & Space Systems satellite businesses and Phantom Works, features an all-electric-propulsion system and a joint configuration for a dual-manifest launch. (Boeing photo)

## DESIGN

The 702SP relies exclusively on xenon for its propulsion system and builds on the success of the 702HP (high power) spacecraft hybrid propulsion technology, which uses a combination of nonhazardous chemical bipropellant and xenon-ion propulsion.

Production on the first 702SP satellites began in 2013. The first two 702SP satellites were completed in December 2014 and successfully launched as a pair in a Boeing-patented stacked payload configuration on March 1, 2015.

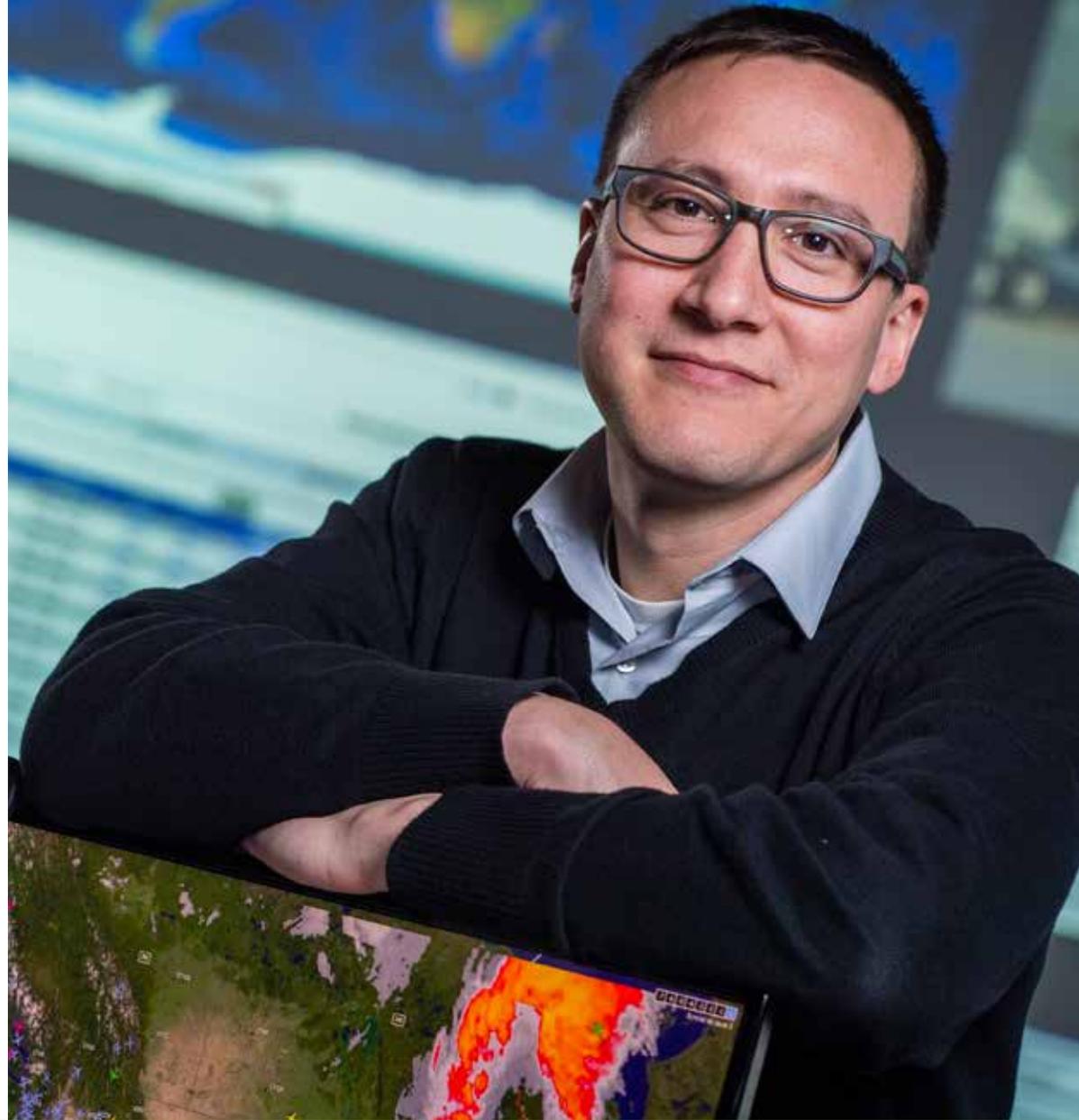
### Bill Peterson, 777X

When the pilot of a Boeing aircraft changes course to avoid bad weather, or adjusts an airport approach to save fuel, the airplane may be following a flight strategy designed by engineer Bill Peterson and his team in Commercial Airplanes Environmental Performance.

“Our focus is on operational efficiency. When an aircraft enters into service with a Boeing customer, we want to make sure it operates at peak efficiency on every flight, from takeoff to landing,” Peterson said.

A primary focus now is on implementing technology that will enable operational efficiencies on the new 777X.

Peterson and his team are developing 777X environmental performance targets for reductions in emissions and community noise for each phase of flight from departure through arrival. Typical targets are defined in a range, such as saving



777X will be the largest,  
**most fuel-  
efficient** twin-  
engine jet in the world.



Bill Peterson and his team in Commercial Airplanes Environmental Performance develop strategies to improve the efficiency and reduce the fuel consumption and community noise of Boeing aircraft. (Boeing photo)

## DESIGN

400 pounds (181 kilograms) to 600 pounds (272 kilograms) of CO<sub>2</sub> and reducing community noise by 1 to 3 decibels during departure and arrival.

A variety of innovative technologies, services and strategies are available or in development to assist the 777X and its operators achieve environmental performance targets, Peterson said. Steps to improve operational efficiency and reduce noise and emissions include:

- ▲ Taxiing from the runway to the gate on one engine.
- ▲ Receiving continually updated information to fly at the most efficient altitude.
- ▲ Changing course to avoid bad weather.
- ▲ Landing the aircraft in a continuous descent instead of frequently leveling off in a series of steps toward the airport.
- ▲ Using GPS-based navigation and landing systems during arrival to enable the use of a higher, more precise approach angle in all weather.

In developing the environmental performance targets, Peterson said his team works closely with Boeing engineers, customers and other partners. “We want to know what the airlines and airports are looking for in operational efficiency and ensure we meet their needs,” he said.

Boeing customers understand the potential impact of improving their fleets’ operational efficiency. “We know from experience small improvements in operational efficiency can bring measurable benefits,” said a spokesman for Norwegian Air Shuttle.

“A strategy that can help us reduce miles flown, fuel use and emissions is good for our business, the industry and the environment.”

The efficiency improvements expected with the 777X and other Boeing aircraft are integral to helping the industry meet its larger environmental performance targets, Peterson said.



The 777X is Boeing’s newest family of twin-aisle airplanes, designed to be 12 percent more fuel-efficient than its competitor.  
(Boeing photo)

## DESIGN

“The industry’s commitment is carbon-neutral growth for aviation after 2020. Every gain in flight efficiency is an important step toward that goal.”

### Sharon Sofian, F/A-18 “Green Hornet”

The “Green Hornet” team is living up to its name.

Sharon Sofian and representatives from several Boeing partners, including the U.S. Navy, began collaborating more than 20 years ago on ways to improve the environmental performance of Boeing’s F/A-18 Super Hornet fighter aircraft.

“The ‘Green’ in our team name means we wanted to do everything possible to manage the aircraft’s environmental impacts,” said Sofian, materials engineer at Boeing’s St. Louis site, home of the F/A-18.

“We knew the aircraft was going to be in service for decades into the future; we wanted it to be as clean, efficient and safe as we could make it.”

The team accomplished its mission, and then some. Last year the F/A-18 won its seventh consecutive environmental excellence award from the Chief of Naval Operations and its third award from the Secretary of the Navy.

The improvements that make the F/A-18 Super Hornet cleaner, quieter and more energy efficient include:

- ▲ A fire suppression system that eliminates Halon, an ozone depleter.
- ▲ Paint primers used in several applications eliminate hexavalent chromium, and other coatings eliminate cadmium.
- ▲ Approving the use of sustainable biofuel in a 50/50 blend with jet fuel.
- ▲ New engine technology that reduces community noise.

Sofian said the “Green Hornet” team has remained effective because its attitude is “continuous improvement.” “We’ve never rested after getting an award and said, ‘Oh, we’re done now.’ We’re always seeking to make things better.”



Sharon Sofian and the “Green Hornet” team have won numerous awards from the U.S. Navy for their successful efforts to improve the environmental performance of Boeing’s F/A-18 Super Hornet fighter aircraft. (Boeing photo)

## DESIGN

### Customer Engagement

Boeing is actively partnering with customers around the world to support their environmental goals.

For example, Alaska Airlines—the sixth-largest carrier in the United States—uses more than a million gallons (3.8 million liters) of jet fuel every day to operate its all-737 fleet. As part of its commitment to sustainability, Alaska Airlines is investing in more fuel-efficient airplanes. Since 2012, Alaska Airlines has ordered 37 737 MAX airplanes, which will be 14 percent more efficient than today's Next-Generation 737s and 20 percent more efficient than the first Next-Generation 737s delivered.

The airline also works closely with Boeing to improve its operational efficiency and reduce fuel consumption.

“Boeing has been very supportive of its airline customers and has helped with policy issues and driving initiatives like biofuel,” said Jacqueline Drumheller, sustainability manager for Alaska Airlines. In 2014, Drumheller talked with Boeing employees about how the SeaTac, Washington–based airline is focusing on environmental sustainability.

“When it comes to things like reducing emissions and conserving fuel, we rely on Boeing to help us and collaborate. We couldn't do it by ourselves,” she said.

### Cleaner Paint

At Boeing's Vertical Lift factory in Philadelphia, Pennsylvania, efforts are continuing in 2015 to expand the use of chrome-free anti-corrosion primer paint on H-47 Chinooks. These new alternative “aerospace primers” have performed successfully thus far in the field since the first Chinook fuselage was painted with them in June 2013.

Boeing is also planning to expand the use of the new primers to international customers with similar configurations as the first Chinook previously mentioned.

The same paints are being considered for wider use on the Bell Boeing V-22 Ospreys beyond the current configuration, which now uses the new chrome-free primers in select areas.



The 737 MAX will be **14% more fuel-efficient** than today's Next-Generation 737 and **20% more efficient** than the first Next-Generation 737s delivered.



Alaska Airlines is investing in more fuel-efficient Boeing airplanes and works closely with Boeing to improve operational efficiency. (Photo courtesy of Alaska Airlines)

## DESIGN

### More Efficient Flight Operations

#### Air Traffic Management Efficiency

Boeing is a leader in developing the technology to improve the efficiency of the air traffic system and airplane flight operations. With improved air traffic management, pilots are able to make changes in speed or route that will reduce fuel consumption, carbon emissions and community noise on each flight.

These operational efficiencies will enable airlines to take advantage of new and future airplane capabilities.

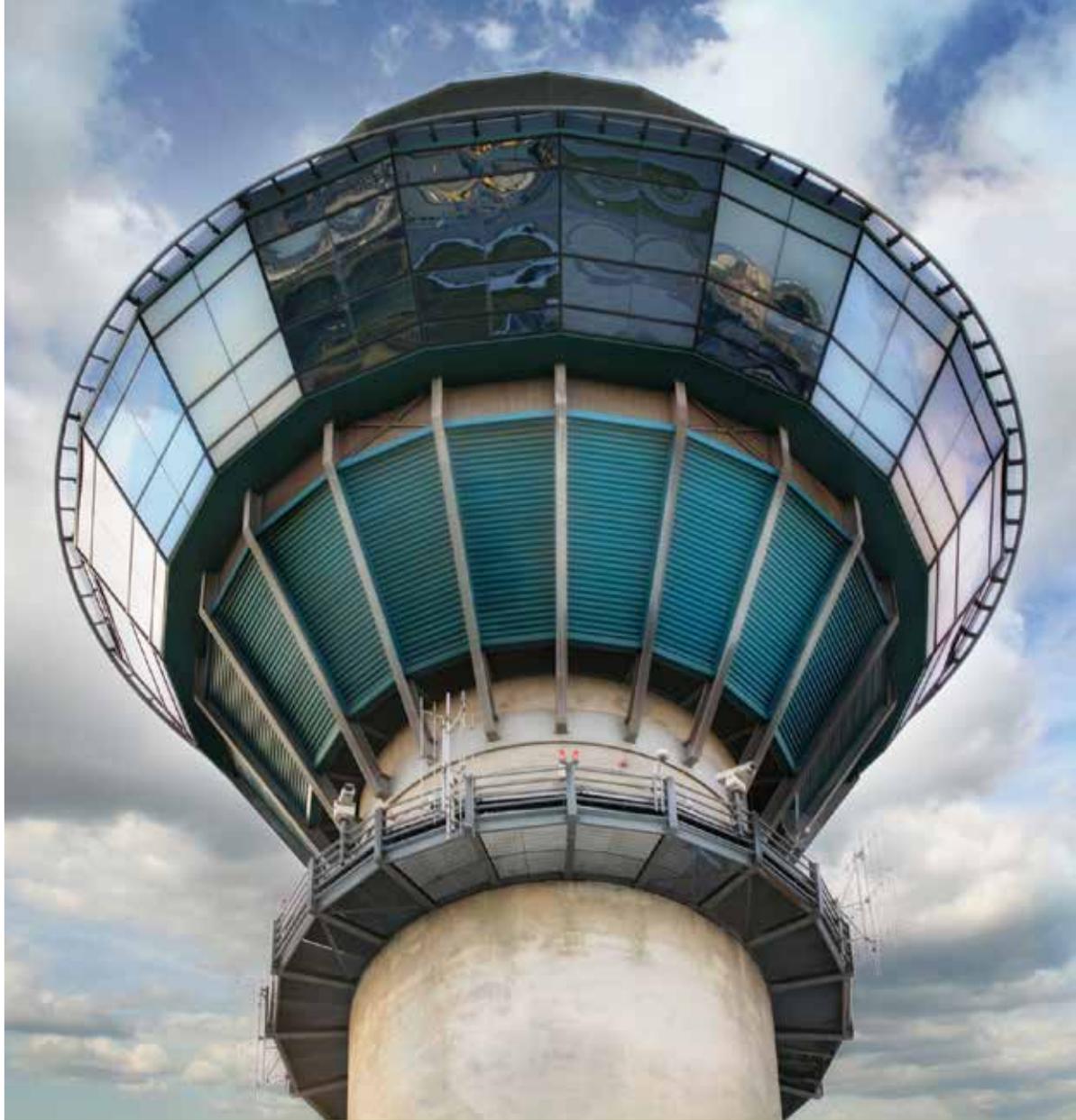
Boeing has helped train airlines and assisted Air Navigation Service Providers to certify new operational procedures collectively known as Precision Based Navigation, which allows an airplane to fly an extremely precise path. As an example, Boeing has worked with numerous airports to certify Required Navigation Procedures, enabling shorter paths to a landing and savings of between 100 pounds (45.3 kilograms) and 400 pounds (181 kilograms) of fuel for every arrival.

In 2014, Boeing also conducted flight trials with a customer to incorporate satellite precision systems into airport operations to increase the variety of approaches and departures that can be flown. Particularly at airports with multiple runways, some procedures will allow aircraft to fly at different glideslopes, reducing CO<sub>2</sub> emissions and noise in communities near airports.

In addition, Boeing is working to enable greater sharing of operational data between airplanes and ground-based systems. This would allow airlines to better communicate with ground control while the airplanes are flying. Increasing the flow of information benefits trip planning, helps minimize delays and reduces fuel consumption.

#### Boeing Acquires ETS Aviation

In 2014 Boeing acquired ETS Aviation, a United Kingdom-based provider of fuel efficiency management and analytics software. When it was acquired, the company's fuel efficiency solutions supported more than 600 commercial aircraft across nearly 900,000 flights annually.



With improved air traffic management, pilots are able to make changes that will reduce fuel consumption, carbon emissions and community noise. Pictured here, an air traffic control tower in Toronto, Canada. (Dreamtimes photo)

## DESIGN

ETS Aviation's fuel efficiency tools have become part of the integrated suite of aviation services marketed as the Boeing Edge. These include digital solutions that increase efficiency and profitability for aircraft operators by optimizing flight operations, maintenance, and crew planning and scheduling.

One market-leading product in this new portfolio is the Boeing Fuel Dashboard, which harnesses operational data to help airplane operators drive decisions to help reduce fuel use and emissions. Boeing is now providing airlines and corporate flight departments with these new tools to monitor fuel consumption, identify fuel savings opportunities, and track and report carbon emissions.

### Ian Britchford, Boeing Fuel Dashboard

Ian Britchford is giving commercial airlines a much clearer picture of how their airplanes use fuel in flight, as well as the steps they can take to cut fuel consumption and greenhouse gas emissions.

Britchford developed the Boeing Fuel Dashboard, a web-based application that collects and analyzes a wide variety of data on each flight and spots larger trends across an airline's entire fleet.

The Dashboard is combined in a handheld device with an application that can provide key fuel use statistics to the flight crew during preflight briefings.

"It's important to analyze both flight and fleet performance because improvements in fuel efficiency can be small per flight. But added together on all flights each day, the benefits are significant," said Britchford, director of fuel efficiency with the Boeing subsidiary Jeppesen, in Bristol, the United Kingdom.

The Fuel Dashboard monitors and analyzes a wide range of parameters in an airline's operations, including aircraft performance data such as speed, altitude, fuel weight and the amount of fuel consumed on the ground during takeoffs, taxiing and other airport operations. The software then compares performance data to the flight plan and expected performance.



Ian Britchford developed the Boeing Fuel Dashboard, a web-based application that is helping airlines better understand their fuel use and steps they can take to reduce consumption and carbon emissions. (Boeing photo)

## DESIGN

“The software looks at the big picture and operational trends. For example, are we getting the correct altitude to optimize fuel efficiency?” Britchford asked. “We want to develop the best flight plan and make sure the aircraft follows the plan.”

Based on the experience of airlines currently using the Fuel Dashboard, the software has identified improvements in fuel efficiency averaging 4 percent, which reduces emissions by the same percentage, Britchford said. Additional software solutions are in development that will further improve fuel efficiency and trim airlines’ operating costs.

“With such a direct link between fuel consumption and greenhouse gas emissions, relatively small gains in efficiency add up to important steps toward reducing local and global emissions,” Britchford said.

### New Technology

#### ecoDemonstrator Program

The Boeing ecoDemonstrator Program is the company’s multiyear effort to accelerate the testing, refinement and use of new technologies and methods that can improve commercial aviation’s efficiency and reduce noise.

In 2012, the company tested more than 15 technologies aboard an American Airlines 737-800. In 2014, Boeing used the ecoDemonstrator 787 to test more than 25 new technologies aimed at improving airlines’ gate-to-gate efficiency and reducing fuel consumption, emissions and noise through every phase of flight.

Last July, the ecoDemonstrator 787 completed flight tests for an acoustic ceramic matrix composite nozzle designed by Boeing to reduce weight and noise. These tests were part of the FAA Continuous Lower Energy, Emissions, and Noise (CLEEN) program, a competitively bid five-year program with costs shared by participants.



The Dreamliner family **reduces** fuel use and CO<sub>2</sub> emissions by **20-30%** compared to the airplanes it replaces.



In 2014, the ecoDemonstrator 787 tested more than 25 technologies to improve aviation’s environmental performance. (Boeing photo)

## DESIGN

Later in 2014, the ecoDemonstrator 787 evaluated several software and connectivity technologies related to operational efficiency, remote sensors to reduce wiring, and icephobic wing coatings to reduce ice accumulation, among other technologies.

Also, in December, the ecoDemonstrator 787 made the world's first flights using a 15 percent blend of "green diesel," a sustainable biofuel that is widely available and used in ground transportation. Boeing is providing data from these green diesel flights to support efforts to approve this fuel for commercial aviation and help meet our industry's environmental goals.

In 2015, the company has already begun flight tests with the third ecoDemonstrator flight-test airplane, a 757. In collaboration with NASA and TUI Group, Boeing is focused on improving aerodynamic efficiency through innovative technologies that are being tested on the tail and wings. With the exception of Boeing proprietary technology, NASA knowledge gained in collaboration with Boeing from eco-Demonstrator research will be publicly available to benefit the industry.

### Spectrolab

[Spectrolab](#), part of Boeing Defense, Space & Security, is the world's leading supplier of high-efficiency multijunction solar cells for airborne searchlights and concentrated photovoltaic and spacecraft power systems.



**Big Data for a Better Planet** Boeing's eco-Demonstrator 787 uses more than 140,000 data points to help make flying more efficient in real time. [Click here to watch the video.](#)



A technician at Spectrolab inspects a section of a solar panel that will eventually power a satellite. (Boeing photo)

## DESIGN

In 2013, Spectrolab set a new world record by producing a solar cell that converted 38.8 percent of solar energy into electricity, beating its previous own world record of 37 percent. The next year, Spectrolab set another record and became the first company to produce 4 million gallium arsenide-based solar cells for use in space.

To date, Spectrolab's solar cells have helped power more than 600 satellites and interplanetary missions since 1956, including the world's first all-electric-propulsion satellite, the Boeing 702SP. The 702SP, which is powered by a xenon-ion propulsion system, uses Spectrolab's solar cells in its solar arrays.

### Jill Seebergh, BR&T Technical Fellow

Finding solutions to some of the toughest environmental issues facing the aerospace industry isn't easy or fast. But Dr. Jill Seebergh and a team of scientists in Boeing's Chemical Technology Group aren't daunted by the long lead times in research and development.

"Developing a new technology can take 10 years or longer. But if you don't take the first step and try, then at the end of 10 years you have nothing. It's worth the investment of time and resources," said Seebergh, a Technical Fellow in the company group that leads research and development.

The patience and persistence have paid off. Seebergh's group develops and tests paints, primers and other surface coatings, with a focus on nontoxic substances that can replace select chemicals — most notably hexavalent chromium, which is widely used to resist corrosion on commercial and military aircraft.

Seebergh said a good success story is the development of Boegel, a nontoxic water-based surface treatment used to prepare metal surfaces for painting, bonding and sealing. It replaced some of the products that contain chromium, and is now used on all Boeing commercial jetliners and many military aircraft.



Dr. Jill Seebergh sits behind small metal samples used in the laboratory to test innovative aircraft coatings. Seebergh's team of engineers and scientists in Boeing's Chemical

Technology Group are developing paints, primers and other surface coatings with a focus on environmentally responsible materials. (Boeing photo)

## DESIGN

The development of Boegel was recognized by Boeing leadership with a 2014 Technical Replication Award, which underscores the value and importance of giving new technology the widest possible application, Seebergh said.

Boegel does not replace all chromium-containing coatings used on aircraft, and research continues throughout the industry to develop effective non-chromate corrosion inhibitors and coatings, particularly for interior applications, Seebergh added.

In other research, Boeing is collaborating with NASA and other partners for aviation's benefit to develop cutting-edge environmental technologies. For example, coatings that will reduce the buildup of bugs and ice on exterior surfaces can reduce drag, weight and energy consumption of an aircraft, which reduces fuel consumption and emissions.

"This is not your everyday paint you'd buy in a store. It takes collaboration across Boeing and with industry and university partners to develop materials that meet stringent aerospace requirements and can deliver the environmental benefits we want," Seebergh said.

Seebergh said she enjoys the opportunity at Boeing to see a new technology through the entire life cycle. "There are few companies where you can be involved from the very beginning of technology development to its ultimate implementation on a product. It's amazingly satisfying."



**Not Your Mother's  
Ceramics** In 2014, Boeing successfully flight-tested an innovative engine nozzle made of ceramic composites designed to reduce noise, weight and lower fuel use. [Click here to watch the video.](#)



Engineer Linda Thomas helps find ways to replace select chemicals on Boeing aircraft. (Boeing photo)

## DESIGN

### Jennifer Holder, ecoDemonstrator Program

Developing new technology to make Boeing aircraft cleaner, quieter and more efficient requires the kind of innovative thinking supported by programs like the ecoDemonstrator and engineer Jennifer Holder.

“The ecoDemonstrator helps make innovative ideas a reality by creating a unique environment where new technology can be tested and validated,” said Holder, ecoDemonstrator test platform manager. “We enable the innovation itself.”

The ecoDemonstrator Program tests technologies that can reduce emissions, reduce noise and improve the operational efficiency and fuel economy of Boeing products.

The program’s test platform in 2015 is a 757; in 2014 a 787 tested more than 25 promising technologies that could help improve the environmental performance of Boeing aircraft.

The ecoDemonstrator accelerates innovation by giving engineers access to flight tests sooner than would be possible in the development process. “Engineers can work for years refining and redesigning a new technology with software and simulators,” Holder said.

“Getting a chance to test an idea on a flying airplane enables someone to perform engineering tasks and other procedures you may not otherwise get the opportunity to do.”

Identifying new technologies to test on an ecoDemonstrator airplane usually isn’t a problem, Holder said. “Once we announce a new platform is available, we get a lot of phone calls.”

Holder sees a close alignment between the ecoDemonstrator and Boeing’s core product development strategy. “Our strategy is to learn by doing and inspire innovative thinking; this is what brought me to the ecoDemonstrator,” she said.



Engineer Jennifer Holder is test platform manager for the ecoDemonstrator, which accelerates innovation by evaluating new technologies that

will reduce emissions and noise and improve the efficiency and fuel economy of Boeing products. (Boeing photo)

## DESIGN

“I am inspired by the people who come up with amazing ideas that benefit the company and the environment. It’s great to work with these people day in and day out and be able to help make their innovations happen.”

### Nieves Lapeña-Rey, Boeing Research & Technology–Europe

In researching innovative ways to increase the use of environmentally progressive materials on Boeing aircraft, Nieves Lapeña-Rey and her team have developed a unique sustainable solution inspired by nature.

“We wanted a sustainable material for the sidewall panels of the passenger cabin, which have lower mechanical requirements than other parts of the airplane,” said Lapeña-Rey, leader of the Materials and Fuel Cells team at Boeing Research & Technology–Europe in Madrid, Spain.

“We start with the fibers of the flax plant and a natural resin as part of a fire-resistant sustainable composite material. It’s a novel solution that can reduce the environmental impact of our products,” Lapeña-Rey said.

Despite the environmental advantage, the unique solution must still meet stringent requirements for fire resistance, thickness, weight, noise reduction and basic mechanical performance, Lapeña-Rey said.



**From Plants to Planes**  
Boeing is improving the environmental performance of airplane interiors through innovative use of plant-based materials. [Click here to watch the video.](#)



Nieves Lapeña-Rey holds an aircraft passenger cabin panel made in part from the fibers of the flax plant. Lapeña-Rey and her team in Madrid are developing sustainable materials inspired by nature for aircraft parts and applications. (Boeing photo)

## DESIGN

The finished product is as light as current sidewalls, and the flax-based material is easier to recycle than the current technology. Other cabin parts, such as floors and carpet, are also good candidates for sustainable materials made with natural fibers, Lapeña-Rey said. The new sidewall solution is being evaluated for use on Boeing commercial aircraft.

Lapeña-Rey's team also researches other strategies for reducing materials such as hexavalent chromium and cadmium, which are commonly used in paints and primers applied to aluminum alloys and high-strength steel alloys to resist corrosion.

Another major focus area is fuel cells, which use hydrogen and air to generate electricity through an electrochemical reaction. The center is exploring fuel cell technology to power small, electrical unmanned air vehicles for flights up to 10 hours long.

The hydrogen used in the fuel cells is generated by using the power from ground-based highly efficient solar panels to break down the water molecules in an electrolyzer. The process produces no emissions.

"We started this project many years ago and at the beginning it was like a dream," Lapeña-Rey said. "But now we have developed environmentally progressive technologies and prototypes that we may see in commercial products in the future."

### Future Flight

#### Phantom Eye

Boeing's high-altitude long-endurance unmanned aircraft, Phantom Eye, is designed to stay airborne longer than any other aircraft of its kind in production. Capable of maintaining altitude for several days, the propeller-driven, lightweight aircraft is fueled by liquid hydrogen, producing only water as a byproduct.

The nine test flights conducted since 2012 have proved the capacities of the demonstrator aircraft, including the exceptional fuel economy of the unique liquid-hydrogen-propulsion

system. Phantom Eye has flown at altitudes above 53,000 feet (16,154 meters) — much higher than a typical aircraft's 35,000 foot (10,668 meter) average — and has achieved more than 34 hours of total flight time to date.

In January 2014, Phantom Eye received experimental status from the U.S. Air Force 412th Operations Group, allowing for expanded testing opportunities to bring this capability to market.



Boeing's Phantom Eye unmanned aircraft completes an autonomous flight at NASA's Armstrong Flight Research Center at Edwards Air Force Base, California. (Boeing photo)

# Innovate



## **Even as Boeing's business is growing, we are meeting environmental performance targets for our facilities.**

In order to sustain that balance, we need to take advantage of the innovative talents of our employees across the company. Increasingly, Boeing and its employees are applying energy conservation technologies and sustainable materials into new building designs to reduce the amount of water intake and waste generated by our facilities.

In addition, Boeing's remediation program is focused on using innovative approaches in cleanup efforts to ensure the protection of human health and the environment, coupled with the use of invaluable input from community members and environmental groups. This, combined with the guidance of leading environmental scientists and federal and state regulatory agencies, has led to great progress in cleaning up remediation sites. Boeing also often collaborates with wildlife and conservation organizations to restore habitat for the benefit of wildlife and the community.

Boeing worked with federal and state agencies and local tribes to restore Duwamish Waterway shoreline and create habitat at the historic Plant 2 site in Seattle. Native plants and woody debris provide refuge and food sources for fish and wildlife. (Boeing photo)

## INNOVATE

### Cleaner Operations

#### Renton Site

Boeing's 737 production facility in Renton, Washington, now uses only renewable electricity, furthering the company's significant use of renewable energy for its facilities.

Working with Puget Sound Energy (PSE), the Pacific Northwest utility company, the 737 manufacturing site receives power through hydroelectricity coupled with renewable energy credits from wind energy, generated by PSE's Wild Horse Wind Farm in Eastern Washington. Boeing is the first company of its size to invest in the new PSE program, which helps the Renton site meet its priorities to use energy wisely, even as it further increases production rates and begins production of the 737 MAX.

"Boeing is proud to expand our investment in clean, renewable energy," said Beverly Wyse, then the 737 vice president and general manager, at the Renton site event in December 2014. (Wyse currently leads Boeing South Carolina.) "Investing in local wind energy through Puget Sound Energy demonstrates our commitment to our local community and the environment and mirrors the environmental performance of our new fuel-efficient 737 MAX aircraft."

The investment in clean energy shrinks the carbon footprint at the Renton site and mirrors the investment that Boeing has made in the fuel-efficient 737 MAX.



#### Renewable Energy

Boeing's Renton facility's electricity originates from 100 percent renewable energy sources. [Click here to watch the video.](#)



**Top:** The 737 manufacturing line in Renton, Washington, where renewable energy powers the facility. (Boeing photo)

**Bottom:** The Wild Horse Wind Facility near Ellensburg, Washington. (Boeing photo)

## INNOVATE

### Enhanced Recycling

Boeing's extensive employee recycling program has been expanded to include composting, the process of recycling decomposed organic materials, such as food waste, into rich soil. The new program is being deployed at major U.S. sites in company cafeterias, offices and manufacturing areas. It's supported by cities and counties that are increasing the number of recycling and waste management suppliers and adding local composting processes.

Boeing's expanded program reinforces our environmental commitment by improving the personal connection employees make with recycling in their work areas; it also diverts waste from landfills or incineration. In company cafeterias, employees can compost food waste ranging from apple cores to eggshells, along with compostable paper plates, napkins and cups. In office and manufacturing areas, employees' current individual waste containers are being replaced with small desktop containers for the little waste that is left for landfills. Employees will use centralized station containers for recycling and composting.

To encourage behavioral changes, the enhanced recycling program is using a common container color scheme and common signage from site to site. It will play a major role in helping Boeing to achieve its goal of zero growth in waste to landfills from the 2012 baseline by 2017.

### ENERGY STAR Partner of the Year

The U.S. Environmental Protection Agency (EPA) has recognized Boeing's leadership in energy conservation and efficiency with an ENERGY STAR Partner of the Year—Sustained Excellence award. This is the fifth consecutive year that Boeing has been honored by ENERGY STAR for its superior energy conservation programs. Boeing's key 2014 accomplishments around energy use include the following:

- ▲ Participating in the ENERGY STAR Community World Tour by developing and teaching an energy curriculum to 650 middle school students.



Composting waste, otherwise bound for landfills, can be used to enrich the quality of soils.  
(iStock photo)

## INNOVATE

- ▲ Making energy infrastructure investments to reduce energy use by 280,000 MMBtu, including the largest single lighting retrofit of more than 5,100 fixtures.
- ▲ Contributing funding to 13 community conservation projects around the world, such as training at-risk youth for energy conservation jobs.
- ▲ Using the company's Partner of the Year and EPA Climate Leadership Award recognition to share Boeing's energy conservation message at numerous conferences and with key industrial and governmental bodies.

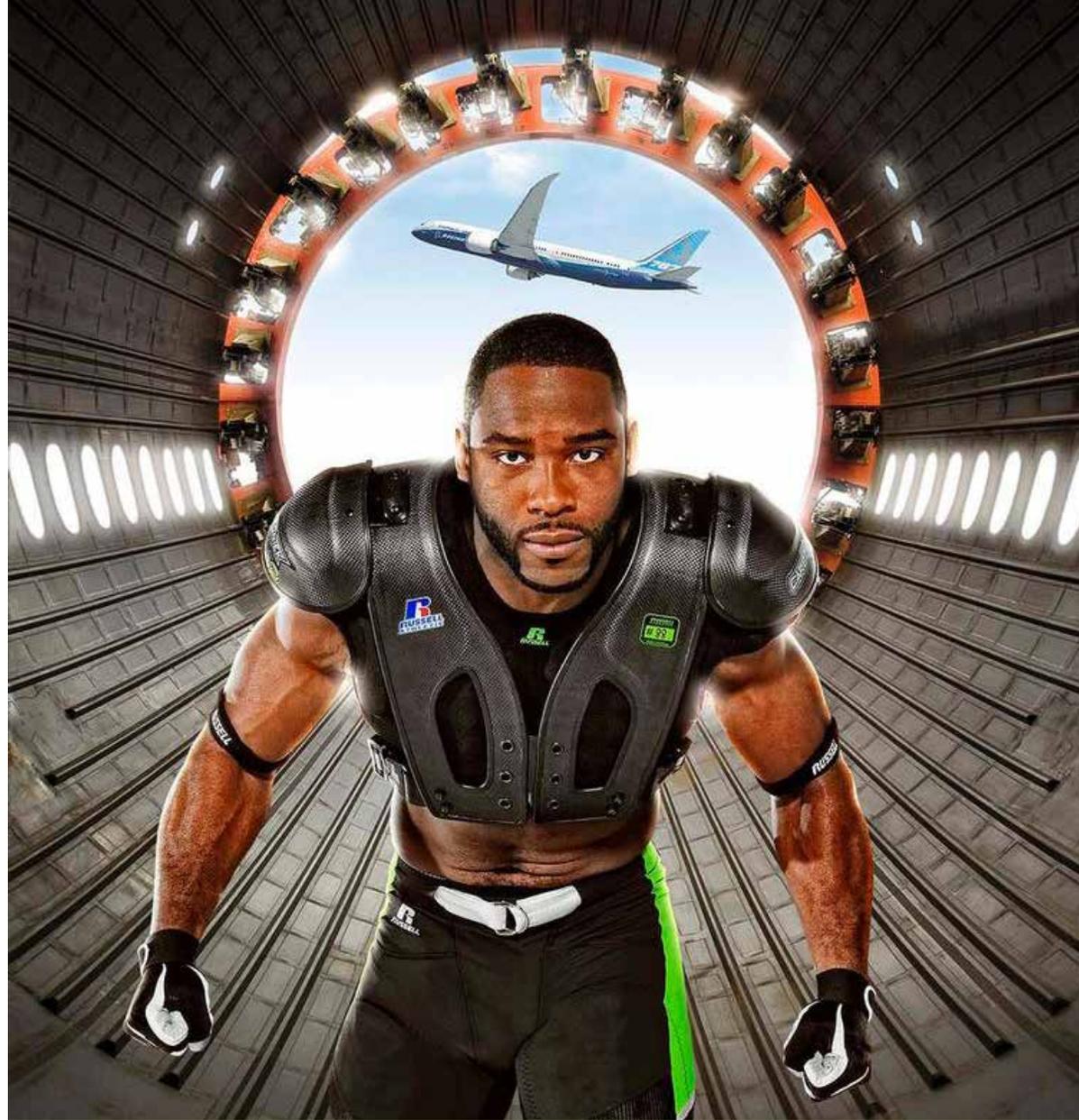
Through the company's sustained participation with ENERGY STAR, Boeing is reducing America's greenhouse gas emissions. Award winners were selected from the 757 industrial partners that participate in the ENERGY STAR program.

### 787 Carbon Fiber Recycling

As Boeing increases the use of carbon composite materials in its commercial airplanes, the company is finding new opportunities to repurpose carbon fiber from its factory production. This approach is in line with the company's long history of marketing surplus factory materials to meet the company's environmental and business goals.

Composite materials make up 50 percent of the primary structure of the 787 Dreamliner, including the fuselage and wing, helping to make the Dreamliner family 20 to 30 percent more fuel-efficient than the airplanes they replace. In addition, Boeing's new 777X will be the largest and most efficient twin-engine jet in the world due in part to the industry's largest composite wing.

As one example of efforts to repurpose carbon fiber, Boeing worked with Russell Athletic to incorporate excess carbon fiber from 787 production into a new CarbonTek football shoulder pad system. The carbon filaments in aerospace-grade fiber provide a higher strength-to-weight ratio and greater durability, enabling Russell to offer a shoulder pad system that it says is thinner, stronger and about 10 percent lighter than competing products.



Shown inside a 787 Dreamliner carbon composite fuselage, Pierre Garçon—a wide receiver with a National Football League team and a Russell Athletic brand

ambassador—wears the CarbonTek shoulder pad system containing an exoskeleton made of 787 carbon fiber. (Boeing image)

## INNOVATE

Boeing continues to talk with a range of companies about other high-value uses for its excess carbon fiber, helping to meet the company's objectives to reduce materials sent to landfills.

### Vince Villa, Energy Conservation, Everett

If you're going to be responsible for helping conserve energy and reduce waste in the world's largest building, it helps to have the mental outlook and stamina of a marathon runner.

"It's understanding the big picture and the incremental steps you need to take to reach your goal. It takes persistence," said Vince Villa, energy engineer and conservation representative at Boeing's largest manufacturing facility, in Everett, Washington.

"You know that every day there will be ups and downs and obstacles, but you keep pushing forward until you get to the finish. It also helps to work alongside teammates who share the same goal."

Villa, an experienced marathon runner, is pushing forward on the challenge of improving energy and resource efficiency at a site with over 15 million square feet (1.4 million square meters) of space, including the Everett factory, the world's largest building by volume.

Villa said the site made a commitment to energy efficiency in 2012 that includes a partnership with a local utility to help identify, measure and verify energy efficiency improvements.

The results have been substantial, including reducing "energy intensity" per assembled airplane by more than 20 percent, which means the site has been able to increase aircraft production while also cutting energy use.

Villa said conservation projects completed last year will save 3.5 million kilowatts of electricity annually, which is equal to taking 2,683 tons (2,434 metric tons) of CO<sub>2</sub> out of the air. Energy efficiency improvements include:



Vince Villa is on the design team that is ensuring that the latest in energy-efficient technology and resource conservation strategies are included in the construction of the new Composite Wing

Center at the Everett, Washington, site. Villa leads energy and resource conservation and waste reduction strategy at Boeing's largest manufacturing facility. (Boeing photo)

## INNOVATE

- ▲ A compressed-air controls and monitoring system that optimizes and automates compressed-air operation.
- ▲ LED lighting for office, manufacturing and utility areas and outdoor spaces across the site.
- ▲ The new Everett Delivery Center, which is built to LEED Gold standards and includes energy-efficient lighting and high-efficiency chillers and boilers.
- ▲ New, more energy-efficient chillers that will provide the site with chilled water.

The site's physical footprint is expanding by more than 1 million square feet (92,903 square meters) with the construction underway of the Composite Wing Center, which will build the wings for the new 777X, a larger version of the widebody aircraft that will enter service in 2020.

"A lot of our lessons learned in energy and resource efficiency are being designed into the new wing factory from the start," Villa said.

"It's rewarding to know that with the site's tremendous size, something as simple as changing the lights can have a huge impact."

### **Ashleigh Stewart, Conservation Leader, Philadelphia**

Moving from Boeing's newest factory—the Dreamliner assembly plant in North Charleston, South Carolina—to one with a much longer legacy in Ridley Township, Pennsylvania, just outside Philadelphia, Ashleigh Stewart sees very different challenges in conserving energy and reducing waste.

"It's a different world. In South Carolina we have solar panels and energy efficiency designed in to the new buildings. Here we have technology from an earlier era," said Stewart, utility and conservation leader at the Philadelphia site, which includes assembly facilities for the V-22 Osprey and H-47 Chinook helicopter programs.



Ashleigh Stewart is the utility and conservation leader at Boeing Philadelphia. She expands and builds on the environmental accomplishments of a site that features technology from an earlier era. (Boeing photo)

## INNOVATE

Stewart transferred to Philadelphia last September after several years of helping lead conservation projects at Boeing South Carolina.

One of her approaches is to build on the site's environmental and waste reduction accomplishments, Stewart said. For example, the Philadelphia site is one of six at Boeing that sends no solid waste to a landfill. Non-recyclable trash is sent to a facility that burns and converts waste into steam energy.

Stewart's team is evaluating a different facility and more efficient method of burning trash that generates more energy from the same amount of material. The site is also implementing "single-stream" recycling that enables employees to recycle a variety of materials in a single bin without first separating items.

The site replaced several 1920s- and 1970s-era boilers that ran on fuel oil with more energy-efficient natural gas-fired boilers. The switch reduced the site's CO<sub>2</sub> emissions by an estimated 14 percent and cut yearly energy bills by \$1 million.

Stewart's priorities for the coming year include continuing to improve overall energy efficiency by:

- ▲ Increasing the use of LED lighting.
- ▲ Replacing an annual inspection for leaks in compressed-air hoses with a continual monitoring system.
- ▲ Installing meters to measure and document electricity use throughout the site to help target conservation efforts.

Stewart also wants to replicate the strategy that worked well in South Carolina of working closely with teams in the company's Employee Involvement program. "Our employees are a tremendous resource in generating new ideas, and I can be a resource to them in supporting projects," Stewart said.

"Working closely with people who have a passion for the environment inspires all of us to want to do the right thing."



Daylight fills the renovated H-47 factory in Philadelphia. Using more natural light and installing more efficient boilers have helped the site substantially reduce energy use. (Boeing photo)

## INNOVATE

### Matt Mercer, Conservation Leader, Oklahoma City

Matt Mercer and his team don't let their successes in reducing waste and conserving resources stop them from always looking ahead at what they can do better.

"It's a mindset of continuous improvement. When we put our recycling program in place, we thought, 'Why stop there? Let's see how we can eliminate all of the waste we send to landfills,'" said Mercer, environment and safety leader at Boeing Oklahoma City.

The site provides services and support to most of the military's large aircraft programs, including Air Force One, the nation's bombers and legacy tankers. The Boeing Oklahoma workforce is growing rapidly and expects to expand even more over the next two years, Mercer said.

A big part of improving the site's waste management has been stepping up its recycling program for plastic, aluminum, cardboard, electronic waste and other material. Solid waste that can't be recycled is sent to a local facility that burns trash to generate clean electricity.

Mercer's team also is exploring opportunities for saving energy, such as converting older fluorescent lighting to more efficient LED technology. The site is evaluating a major retrofit that would either replace or remove 20,000 light bulbs in 6,000 fixtures. The retrofit's cost would be recovered with the help of an incentive program from the local utility.

Mercer is proud of what the site's environmental accomplishments can mean for the local community. "I think the community has embraced us and Boeing has embraced Oklahoma. Improving the site's environmental performance will help strengthen that relationship."



For Matt Mercer and his team at Boeing Oklahoma City, an attitude of continuous improvement drives ongoing successes in reducing waste and conserving resources. (Boeing photo)

## INNOVATE

### Matt McCalley, Conservation Leader, Boeing South Carolina

At a site that features several of Boeing's larger and more visible environmental achievements, Matt McCalley looks for the smaller, individual actions that will continue driving environmental innovation and progress.

"Employees who do the work every day can spot opportunities to reduce waste or improve a process that might get missed if we only focused on the big projects," said McCalley, environmental scientist at Boeing South Carolina.

"Small actions can add up to substantial improvements across the entire site."

Environmental thinking helped guide the design and construction of the South Carolina site, which manufactures the 787 Dreamliner, and has been a driver in ongoing operations since the facility opened in 2011. Innovations include 10 acres (4 hectares) of solar panels on the roof of the final assembly building that help supply the site's power, solid waste being recycled or reused and not sent to a landfill, and stormwater being captured and reused.

McCalley helps develop the tools and information that employees and teams can use in their work areas to conserve water and electricity, reduce hazardous waste, and expand the recycling and reuse of trash and other material. "They do the work; my job is to help them see the opportunities and take action," McCalley said.

To help employees learn how to spot waste and improve efficiency in their work processes, environmental training and "waste hunts" are required for the site's 300 Employee Involvement teams. The focus on continually improving the facility's environmental performance is a natural fit with the aircraft rolling off the production line, McCalley said.

"The site that builds the world's most environmentally progressive jetliner should be an environmental leader, too; that's our mindset."



Environmental scientist Matt McCalley helps develop the tools and information that employees at Boeing South Carolina can use in their work areas to reduce waste and conserve water and electricity. (Boeing photo)

## INNOVATE

### Remediation and Restoration

#### Lower Duwamish Waterway

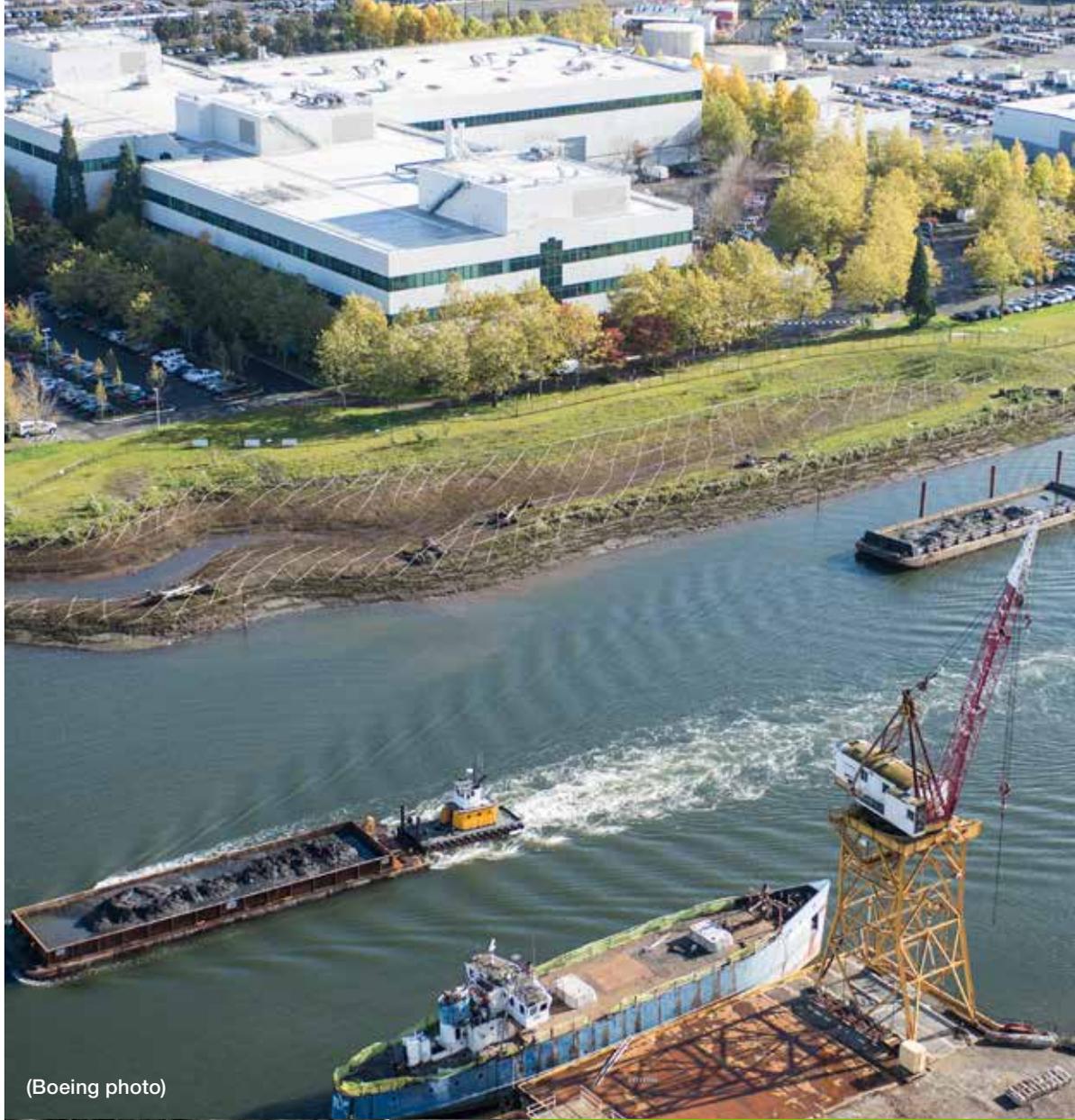
Since 2000, the Lower Duwamish Waterway Group, which is made up of Boeing, the City of Seattle, King County and the Port of Seattle, has been leading the cleanup and restoration of this five-mile (eight-kilometer) stretch of industrial waterway south of downtown Seattle, Washington. The collective “early action” efforts of the Lower Duwamish Waterway Group have reduced polychlorinated biphenyl (PCB) risks in the waterway sediment by about 50 percent—halfway toward the PCB sediment cleanup goal set by the U.S. EPA.

Boeing completed the largest of these early cleanups, addressing contamination alongside its Plant 2 location that spans one mile (1.6 kilometers) of the Lower Duwamish Waterway. Boeing restored the waterway bed with clean sand after removing approximately 265,000 cubic yards (202,607 cubic meters) of sediment, which is enough to fill approximately 4,000 railcars. Excavated sediment was transported by barge to a waterway facility, where it was packaged and loaded onto railcars and transported to an EPA-approved landfill. This work was carefully coordinated over the course of three years during “construction windows” when juvenile salmon were not migrating.

The EPA released its final decision on the Lower Duwamish Waterway Superfund cleanup in December 2014. Boeing is working with its Lower Duwamish Waterway Group partners on studies to support the design of a remedy.

Many efforts are underway to prevent contamination sources from entering the waterway before and after the sediment cleanup. Boeing installed state-of-the-art storm-water treatment systems at its facilities near the waterway as part of this source control strategy.

[Learn more at www.boeing.com/duwamish.](http://www.boeing.com/duwamish)



(Boeing photo)



#### Digging Deep

The sediment around Boeing's Plant 2 site in Seattle has a century's worth of stories to tell. The story it tells now is one of restoration. Click here to watch the video.



## INNOVATE

### Santa Susana

A former federal government rocket engine test and energy research facility located northwest of Los Angeles, California, the Santa Susana Field Laboratory has a rich history of contributions to the U.S. space program. Since acquiring its portion of the 2,850-acre (1,150-hectare) site in 1996, Boeing has made progress with extensive investigation, cleanup and restoration efforts to address soil and groundwater contamination and improve stormwater quality.

The transformation from field laboratory to open space is underway, with native plants and animals reclaiming most of the previously developed areas of the property. The San Fernando Valley Audubon Society, which performs year-round bird-banding and owl surveys on the site, has identified 124 bird species on the site. The Southwestern Herpetologist Society studies reptiles and amphibians, and Pollinator Partnership scientists assess the abundance and diversity of pollinators.

Boeing partners with area schools to support on-site student studies, including Oak Park High School, USC, UCLA, Moorpark College, Pomona College and Woodbury University. In 2014, Boeing also hosted remediation update meetings as well as bus and walking tours for more than 2,000 community members, elected officials and nonprofit organizations.

[Learn more at www.boeing.com/santasusana.](http://www.boeing.com/santasusana)



**Left:** A team installs groundwater monitoring wells as part of Boeing's seeps and springs investigation. Boeing has a network of more than 450 wells to monitor legacy contamination in the groundwater below the Santa Susana property. (Boeing photo)

**Above:** Each year, thousands of people visit Santa Susana to learn more about the site's important place in history and experience firsthand its beauty and biodiversity. (Boeing photo)

## INNOVATE

### Duwamish Habitat

Nearly 100 people gathered to celebrate the largest habitat restoration on the Lower Duwamish Waterway in June 2014. Boeing transformed one mile (1.6 kilometers) of former industrial waterfront into a wetland resource that improves Puget Sound salmon runs and supports local wildlife. This project would not have been possible without the guidance and support of the Natural Resource Trustees, including the National Oceanic and Atmospheric Administration and the Muckleshoot Indian Tribe.



(Boeing photo)

### Business for Bees

In 2014, Boeing signed on as a founding member of the Pollinator Partnership's Business for Bees network. This group of American businesses supports engagement and drives action to benefit pollinators, which fertilize most flowering plants and crops, and are now threatened from a variety of environmental factors. Boeing also works with the Pollinator Partnership on various restoration projects to ensure that selected plants support bees, birds and butterflies.



(Boeing photo)

## INNOVATE

### Santa Susana Habitat

Santa Susana lies in the heart of a habitat linkage in Southern California, a biological life link connecting the inland Sierra Madre Mountains to the coastal Santa Monica Mountains. The site is home to a diverse range of animals, including mountain lions and bobcat, and Boeing's cleanup will help protect this unique ecosystem. Boeing has restored 900 acres (364 hectares) with native plants to support the health of the watershed and wildlife habitat.

### LA Conservation Corps

Boeing collaborates with the Los Angeles Conservation Corps, which provides job skills training and education for inner-city youth and young adults. Together, they have created natural biofiltration systems featuring native plants at Santa Susana. In 2014, a Corps team added nearly 3,000 plants to a new bioswale that helps improve storm-water quality while also benefiting pollinators.

### Wildlife Habitat Council

The Pollinator Prairie in Olathe, Kansas, and Santa Susana in Simi Valley, California, are certified by the Wildlife Habitat Council under the Corporate Lands for Learning program. The Pollinator Prairie was an urban habitat restoration project resulting from a collaborative effort between Boeing, community groups and wildlife organizations. In 2014, Boeing and Pollinator Prairie volunteers hosted community educational events at the 1.5-acre (0.6-hectare) site.



(Boeing photo)



(Boeing photo)



(Boeing photo)

## INNOVATE

### Debbie Taege, Environmental Engineer, Santa Susana

Debbie Taege can look across tranquil woodlands and sandstone bluffs at Boeing's Santa Susana site in Simi Valley, California, and know that nature is hard at work.

"One of the most innovative technologies we use to treat stormwater that flows from Santa Susana is a biofilter that harnesses the natural ability of soil and native plants to get rid of contaminants," said Taege, environmental engineer and stormwater project leader.

"It's a natural ecosystem that not only filters pollutants in the water but also creates critical habitat for pollinators and wildlife."

This biofilter is one of an array of solutions the company employs to improve stormwater quality. In Seattle, Washington, Boeing installed biofilters, bioswales and advanced treatment plants at its facilities along the Lower Duwamish Waterway to help prevent waterway recontamination.

"We pride ourselves in developing and replicating the best technical solutions and sharing what we've learned with other companies and organizations to help improve stormwater quality on a broader scale," Taege said.

Boeing's stormwater management strategy for Santa Susana combines state-of-the-art technology and natural systems. Two treatment plants make use of filters, activated carbon and chemicals that are similar to those used by cities to treat drinking water. But active systems aren't suitable for the entire site, Taege said.

"Some watersheds are too large or the terrain is steep and rocky. For those locations, passive technologies, including the biofilter, are more effective," she said.



Environmental engineer Debbie Taege is on the team managing the investigation and cleanup of Santa Susana. Taege leads Boeing's stormwater management strategy for the site,

which involves a hybrid approach that combines state-of-the-art and natural processes to meet challenging regulatory standards. (Boeing photo)

## INNOVATE

Boeing collaborated with the Los Angeles Conservation Corps, Pollinator Partnership and a panel of experts in the stormwater field to design a biofiltration system that is part stormwater treatment and part wildlife habitat.

Rainwater runoff collects in a cistern where debris settles out before the water is pumped to a basin planted with native vegetation. The basin allows soil particles to settle out before the water flows into the adjacent biofilter to be treated with a mix of sand, carbon and minerals.

Pollutants such as organic compounds and metals are filtered out, and clean water flows from the biofilter to natural drainage channels.

“It’s an amazing natural system. Native plants stabilize soil and attract bees and butterflies, while physical, chemical and biological processes underground remove pollutants,” Taege said.

Helping design more natural systems to treat the site’s stormwater has brought Taege a lot of personal satisfaction. “I want to be able to walk up here as a community member with my daughter one day and say, ‘Wow, your mom helped build that.’”



**Left:** At Plant 2 in Seattle, Washington, Boeing installed a biofiltration system to help improve the water quality of the neighboring Duwamish Waterway. The passive system treats an average

of 84 million gallons (318 million liters) of stormwater annually. (Boeing photo)

**Above:** At Santa Susana, Boeing designed and constructed advanced stormwater treatment systems that can treat up to 2.5 million gallons (9.46 million liters) during rain events.

Some of the stormwater runoff from throughout the 2,850-acre (1,150-hectare) site is transferred to a pond before it is treated at the neighboring system. (Boeing photo)

# Inspire

## **Boeing is leading local and global collaboration, finding solutions for complex environmental challenges.**

As an aerospace leader, we support industry-wide opportunities to align on ways to improve the environment. For example, to support long-term industry growth and reduce CO<sub>2</sub> emissions, we are working aggressively with many stakeholders to advance commercialization of sustainable aviation biofuel. We are making great progress on a long journey.

Tapping into employee ideas and enthusiasm is how Boeing makes improvements in any area of the business, and it's no different for the environment. Through strategic investments with nonprofits, employee engagement and purposeful advocacy efforts, Boeing is creating powerful change through programs that work toward environmental protection and preservation in communities around the world.

Also, Boeing works with organizations, institutions, customers and governments around the world to drive environmental improvements throughout our industry and across the globe.



Boeing works with international partners on six continents to develop and commercialize sustainable aviation biofuel, which reduces life cycle emissions by 50 to 80 percent. (Boeing photo)

### Global Projects

**Australia:** Boeing continues to work with stakeholders across industry, government and academia to develop the commercial viability of sustainable aviation biofuels and advanced manufacturing technologies that reduce energy and material consumption, while employees across Australia work together to increase energy efficiency and reduce environmental impact at our facilities. Boeing's support of the Great Barrier Reef Foundation and its Citizen Science project provides opportunities for people to contribute to the protection and preservation of the Reef.

**Brazil:** Working with various partners, Boeing is helping to promote the establishment of a sustainable aviation biofuel industry in Brazil and is conducting research on sustainable aviation bio-sourced materials, focusing on Brazilian biodiversity.

**China:** Boeing and Chinese partners, including the Commercial Aircraft Corp. of China, are researching technologies to enable sustainable aviation biofuel and air traffic management (ATM) efficiency. The Boeing Tianjin Composites facility holds ISO 14001 and LEED certifications.

**European Union:** The Boeing Research & Technology Center in Madrid supports EU environmentally progressive initiatives, including ATM technologies to support the development of air traffic operational efficiency and digital aviation services.

**Germany:** Boeing is a member of the Aviation Initiative for Renewable Energy in Germany (aireg), which promotes the production and use of sustainable aviation biofuel and other alternative aviation fuels. Boeing supports the Environmental Detectives project of the Berlin Community Foundation (Bürgerstiftung Berlin), which inspires children to learn about nature and environmental protection through observation and hands-on activities.

**Hong Kong:** Boeing delivered the first 747-8 with performance-improved GEnx-2B engines as part of the airplane's Performance Improvement Package to Cathay Pacific Airways.



The 747-8 is **16% more fuel-efficient** and **30% quieter** than the airplane it replaces, and **29% more fuel-efficient per trip than its competitor.**



Boeing leads global collaboration around complex environmental challenges.  
(Thinkstock photo)

## INSPIRE

**India:** Boeing and Indian partners are working to create high-performance coatings and associated process technologies to address requirements relating to environmental regulation, corrosion and wear.

**Indonesia:** The Nature Conservancy, Boeing and other partners are working together to protect and responsibly manage 3,088 square miles (800,000 hectares) of forestland on the island of Borneo, lowering Indonesia's carbon emissions, while also protecting biodiversity and improving the livelihoods of local communities.

**Italy:** The Boeing "Svitati per l'ambiente" ("Let's talk about sustainability") program fosters young people's interest in sustainable development to raise their awareness of the importance of environmental protection.

**Japan:** Boeing is working with major airline customers as well as Narita Airport and the University of Tokyo to develop a roadmap for sustainable aviation biofuel within Japan.

**Malaysia:** The Boeing and Hexcel joint venture, Aerospace Composites Malaysia Sdn. Bhd., won certification to ISO 14001, a recognized standard for environmental performance.

**Nordic Countries:** Boeing actively supports the Nordic Initiative for Sustainable Aviation, an initiative that brings together stakeholders throughout the supply chain to promote the development of sustainable aviation fuel.

**Russia:** Boeing is supporting airline customers in Russia and the Commonwealth of Independent States with solutions aimed at increasing airline efficiency and profitability.

**Saudi Arabia:** King Abdullah University of Science and Technology and Boeing collaborated on research countering the effects of sand and dust on solar energy performance in a harsh desert environment in support of the Kingdom of Saudi Arabia's goal of expanding solar energy production.

**Spain:** Boeing Research & Technology–Europe is developing environmentally progressive materials for aeronautics, including coatings to avoid corrosion of high-strength steel alloys, materials from natural sources for aircraft interior sidewalls, and next-generation structural composites for rapid manufacturing.

**The Netherlands:** Boeing and a consortium that includes KLM Royal Dutch Airlines are demonstrating sustainable aviation biofuel and researching technologies that improve air traffic efficiency and reduce carbon and noise emissions.

**Turkey:** Boeing and Istanbul Technical University are working together to research and develop an advanced air-filtration system to enhance air quality for passengers in commercial airplane cabins.

**United Arab Emirates:** Boeing, Etihad Airways and the Masdar Institute are developing an innovative system using saltwater to grow crops for sustainable aviation biofuel.

**United Kingdom:** Boeing supports the Earth Restoration Service in sending native tree saplings to be planted in or near more than 100 schools to help children learn about ecology and to help schools engage with their local communities. Boeing has been a member of the UK's panaviation industry group Sustainable Aviation since January 2013. Sustainable Aviation is a long-term strategy that sets out the collective approach of UK aviation to tackling the challenge of ensuring a sustainable future for our industry.

**United States:** Boeing partners with the FAA, customers and industry groups to improve operational efficiency and modernize air traffic management, collaborates to develop sustainable aviation biofuel, invests in renewable energy and looks for opportunities to advance carbon fiber recycling.

## Sustainable Aviation Biofuel

### Brazil

In 2014, Boeing Research & Technology–Brazil (BR&T–Brazil) opened a center in Sao José dos Campos, Brazil, furthering Boeing’s commitment to the South American nation and advancing the company’s international footprint.

At the center, Boeing works with local entities to develop technologies that will make a positive impact on the future of aerospace. An area of focus is sustainable aviation biofuel, given Brazil’s leadership in the field of renewable energy. Other aerospace technologies investigated at the center include advanced air traffic management, remote sensing, advanced metals and bio-materials, and support and services technologies.

The facility is Boeing’s sixth advanced research center outside the United States, joining centers in Europe, Australia, India, China and Russia.

Earlier this year, Boeing and Embraer opened a joint sustainable aviation biofuel research center in Sao José dos Campos, expanding a company-to-company relationship begun in 2012.

Led by BR&T–Brazil and the Brazilian airplane manufacturer, research coordinated through the center focuses on technologies that address gaps for the establishment of a sustainable aviation biofuel supply in Brazil. These include feedstock production, techno-economic analysis, economic viability studies and processing technologies.



Sustainable aviation biofuel  
**emits 50–80%**  
**less carbon**  
compared to fossil fuel  
through its life cycle.



**Top:** Boeing worked closely with California-based Amyris and French oil company Total to support the 2014 approval of farnesane, a new sustainable aviation biofuel made from plant sugar. Amyris and Total are currently producing

farnesane using Brazilian sugarcane. Shown here, a sugarcane farm in Brazil’s São Paulo state. (Photo credit: Tadeu Fessel, provided by UNICA [Brazilian Sugarcane Industry Association])

**Bottom:** Sustainably produced Brazilian sugarcane is being used to make a newly approved type of aviation biofuel. (Photo by Tadeu Fessel, provided by UNICA)

## INSPIRE

Boeing is focused on “drop-in” aviation biofuel, which can be blended directly with petroleum jet fuel and used without any change to airplanes, engines or fueling infrastructure. In 2014 Boeing supported the approval of farnesane, a sustainable aviation biofuel made from plant sugar—currently Brazilian sugarcane—by the California-based company Amyris and the French oil company Total.

BR&T—Brazil and entities have worked together for two years in a series of workshops that resulted in a landmark contribution to sustainable aviation biofuel, led by Boeing; Embraer; FAPESP, the research funding agency of the State of Sao Paulo; and Unicamp, the State University of Campinas.

### Customer Engagement

In August, Boeing and South African Airways (SAA) announced a collaboration with Netherlands-based SkyNRG and Sunchem SA to develop an aviation biofuel supply chain from a nicotine-free, energy-rich tobacco plant called Solaris. The initiative broadens cooperation between Boeing and SAA to develop renewable jet fuel in ways that support South Africa’s goals for public health as well as economic and rural development.

Test farming of the plants began last year in Limpopo, South Africa. Starting in December, large commercial farms and small community farms conducted their first harvest of about 120 acres (50 hectares) of Solaris plants, which are intended to be a marketable replacement crop for traditional tobacco.



**First Harvest In 2014,** Boeing and South African Airways announced plans to turn “energy tobacco” into sustainable aviation biofuel. [Click here to watch the video.](#)



**Top:** Tobacco farm workers in Marble Hall, South Africa, carry Solaris seedlings from a nursery to the field. Boeing and SAA made exciting progress in

2014 on a collaboration to make sustainable aviation biofuel in southern Africa from a new type of tobacco plant. (Sunchem SA photo)

**Bottom:** The energy-rich Solaris tobacco plant can be a marketable replacement crop for traditional tobacco in southern Africa. (Boeing photo)

## INSPIRE

This project also positions SAA to gain a long-term, viable domestic fuel supply and improve South Africa's national balance of payments.

Oil from the plant's seeds may be converted into biofuel as early as this year, with a test flight by SAA as soon as feasible, with future aviation biofuel production using the entire plant. If test farming in Limpopo is successful, the project will be expanded in South Africa and potentially to other countries.

Sustainable aviation biofuel made from Solaris plants can reduce life cycle carbon emissions by 50 percent to 75 percent, ensuring it meets the sustainability threshold set by the Roundtable on Sustainable Biomaterials.

### UAE Biofuel Collaboration

Boeing and its partners in the United Arab Emirates announced breakthroughs in sustainable aviation biofuel development in 2014, using halophytes, desert plants that can be irrigated with seawater. The Sustainable Bioenergy Research Consortium (SBRC), affiliated with the Masdar Institute of Science and Technology in Abu Dhabi, will soon build a demonstration project that could lead to similar biofuel activities in other countries with coastal deserts.

Funded by Boeing, Etihad Airways and Honeywell UOP, the SBRC is dedicated to the development and commercialization of sustainable aviation biofuel, which emits 50 percent to 80 percent less carbon through its life cycle compared to fossil fuel.

Halophyte seeds contain oil suitable for biofuel production. In addition, SBRC researchers found that the entire shrublike plant can be turned into biofuel more efficiently than many other feedstocks.

In 2015, SBRC scientists will create a test ecosystem by planting two crops of halophytes in Abu Dhabi's sandy soil. Waste seawater from a fish and shrimp farm will nourish halophytes that clean the water as they grow. The water



Boeing and research partners in the United Arab Emirates have made breakthroughs in sustainable aviation biofuel development, finding that desert plants fed by seawater will produce biofuel more efficiently than other well-known

feedstocks. Shown here, a halophyte plant that is showing great promise in sustainable aviation biofuel research at Masdar Institute of Science and Technology in Abu Dhabi. The plant name is salicornia. (Photo credit: SBRC)

## INSPIRE

will next flow into a field of mangroves before returning to the ocean. Scientists will use the SBRC research findings to convert both plants into aviation biofuel.

SBRC's research success, announced at the 2014 World Future Energy Summit, continues momentum for aviation's sustainable growth in the UAE, one of the world's fastest-growing air traffic markets.

### First "Green Diesel" Flight

In December 2014, Boeing completed the world's first flights using "green diesel," a sustainable biofuel that is used in ground transportation but had never been used in a jet airplane. The company powered its ecoDemonstrator 787 flight-test airplane with a blend of 15 percent green diesel and 85 percent petroleum jet fuel in the left engine for the first flight and in both engines for nine additional test flights.

Boeing provided data from the ecoDemonstrator flights to support industry efforts to approve green diesel for commercial aviation and make sustainable aviation biofuel more available and more affordable for customers. With production capacity of 1.2 billion gallons (4.5 billion liters) in the U.S., Europe and Asia, green diesel could rapidly supply as much as 1 percent (800 million gallons, or 3 billion liters, in 2014) of global jet fuel demand.

Sustainable green diesel can be made from vegetable oils, waste cooking oil and waste animal fats. Earlier in 2014, Boeing announced that its fuel experts discovered that green



The world's first "green diesel" test flights used **15% green diesel fuel** blended with 85% petroleum jet fuel.



**Top:** Boeing has completed the world's first flights using "green diesel," a sustainable biofuel that is widely available and used in ground transportation. The company powered its ecoDemonstrator 787 flight-test airplane with a

blend of 15 percent green diesel and 85 percent petroleum jet fuel. Shown here, the ecoDemonstrator 787 is fueled with a green diesel blend at Boeing Field in Seattle. (Boeing photo)

**Bottom:** The ecoDemonstrator 787 takes off from Boeing Field in Seattle using green diesel. (Boeing photo)

## INSPIRE

diesel is chemically similar to HEFA (hydro-processed esters and fatty acids) aviation biofuel that was approved in 2011.

With a cost that tracks with petroleum diesel, inclusive of U.S. government incentives, green diesel approaches price parity with petroleum jet fuel. On a life cycle basis, green diesel used on the ecoDemonstrator 787 will significantly reduce carbon emissions compared to fossil fuel, according to Finland-based Neste Oil, which supplied the fuel.

### Junlei Sun, China Biofuel Program

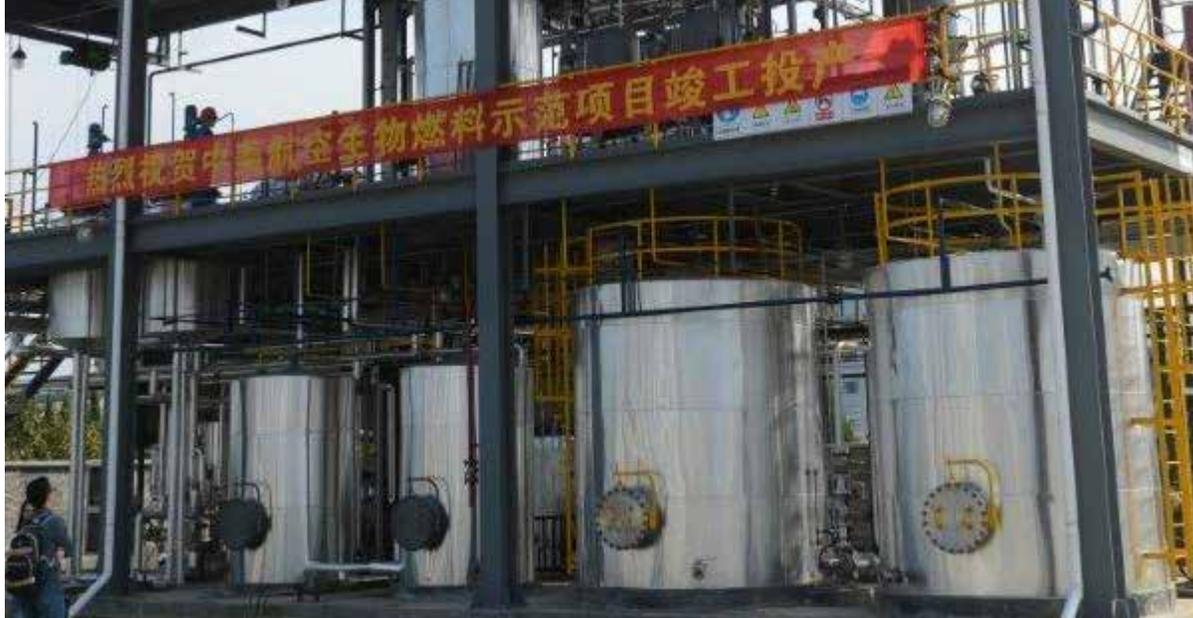
From his vantage point at Boeing Research & Technology–China, Junlei Sun can see the huge potential of the growing Chinese aerospace market and the equally expanding environmental challenges facing the industry and the country.

“China’s commercial airline fleet size is projected to triple in the next 20 years. Everyone from government to industry leaders is concerned about the environment,” said Sun, environment research leader in the China center. “There is a lot of interest in aviation biofuel as a key enabler to reducing carbon emissions and local pollution.”

Researching promising feedstocks and helping develop a sustainable Chinese aviation biofuel industry are key focus areas for the China center. Their approach is to develop goals and strategy and then collaborate with others such as universities and research institutes to carry out the research, Sun said.

They face several big challenges, especially in selecting possible biofuel feedstocks. “With such a large population to feed, the government has strict rules about land usage. For example, farmland and food crops cannot be cultivated for aviation biofuel,” Sun said.

A primary feedstock focus is on biomass, which includes agriculture or forest residuals such as corn stover and grasses, industrial waste from paper mills and municipal solid waste, Sun said. China also has a substantial research capability around biomass conversion but lacks experience with using biomass for aviation biofuel.



**Top:** Boeing and Commercial Aircraft Corp. of China opened a demonstration facility that will turn waste cooking oil, often called “gutter oil” in China, into sustainable aviation biofuel. Shown here, the

China-U.S. Aviation Biofuel Pilot Project in Hangzhou, China, will clean contaminants from gutter oil and convert it into sustainable aviation biofuel. (Boeing photo)

**Bottom:** At Boeing Research & Technology–China, Junlei Sun says there is a lot of interest in the potential of sustainable aviation biofuel to help address environmental challenges facing the country and the industry. (Boeing photo)

## INSPIRE

“This is where Boeing’s collaboration is so vital. With our deep understanding of aviation biofuel we can help guide the research,” Sun said.

Another promising feedstock is “gutter oil,” which is waste cooking oil from restaurants and catering facilities that needs to go through a cleaning process before conversion into biofuel. Boeing is collaborating with Commercial Aircraft Corp. of China (COMAC) on a demonstration facility that is assessing the technical and economic viability of processing gutter oil as a larger-scale feedstock for aviation biofuel.

Sun finds the collaboration on new technology very rewarding. “The process to figure out the challenges and overcome technical difficulties is amazing. What I do benefits the company, our stakeholders and the people of China. That is the most satisfying part for me.”

### Other Projects

#### Boeing South Carolina Wetlands

In South Carolina, Boeing is working a comprehensive wetlands mitigation plan to preserve and enhance about 4,000 acres (1,600 hectares) of land. The plan includes more than 2,000 acres (800 hectares) of wetlands on three separate tracts near the Francis Marion National Forest in the South Carolina Lowcountry.

Boeing worked with several federal, state and local agencies and conservation organizations to identify the tracts for preservation, which achieves conservation goals of regional and national significance. As a result of the plan’s approval, there will be a substantial increase in public land, public access and protection of land, water quality and several rare, threatened and endangered wildlife species.

The approved plan is part of the permitting process for the 468 acres (190 hectares) of land in North Charleston that Boeing announced in December 2013 it will lease from the state of South Carolina to protect it from potential future growth. Included in that leased property are 153 acres



Many rare, threatened or endangered species, such as the red-cockaded woodpecker, will benefit from the preservation of approximately 4,000 acres (1,600 hectares) near the

Francis Marion National Forest as part of Boeing South Carolina’s wetlands mitigation proposal approved July 10, 2014. (Lowcountry Open Land Trust photo)

## INSPIRE

(62 hectares) of wetlands that date to the property's use as a phosphate mine in the late 19th century.

Boeing funded the purchase of one tract by Lowcountry Open Land Trust. Lowcountry Open Land Trust will hold the property for up to five years and then transfer it to the South Carolina Department of Natural Resources for long-term ownership and management. Boeing also funded the purchase of the other two tracts by The Open Space Institute and The Nature Conservancy. The Open Space Institute and The Nature Conservancy will hold the property for up to five years and then transfer it to the U.S. Forest Service for long-term ownership and management as part of the Francis Marion National Forest.

### Michael Yamashita, Supplier Quality Team Leader

From his office in Nagoya, Japan, Michael Yamashita helps a global network of key Boeing partners work with the company's engineering and environmental experts to understand their role in building cleaner, more environmentally progressive aircraft.

"Major sections of Boeing products are built by our Japanese partners. They are critical in our strategy to innovate and improve the environmental performance of our products," said Yamashita, a Supplier Quality specialist who leads a team that works with Boeing partners throughout Japan.

More than 70 Japanese companies, including the nation's leading manufacturers, supply parts or build components for most Boeing aircraft models. Yamashita ensures the partners' special processes, such as those involving chemicals or hazardous materials, comply with Boeing standards.

Yamashita began a series of meetings and discussions with major partners several years ago to create a bridge between Boeing and its partners. They review new research and changing regulations covering the use of materials such as hexavalent chromium, used in most surface coatings such as paints and primers to prevent corrosion.

A growing number of countries have implemented or are considering restrictions or bans on chromium's continued use. Boeing and other aerospace companies are hard at work researching and developing environmentally responsible chromium replacements that meet the stringent aerospace requirements.

"We want our partners to understand how the use of new, cleaner materials may affect their production systems and processes," Yamashita said. "There is a lot of partner interest in new materials and processes that likely will be required on future generations of our airplanes."

Earlier this year, representatives from six Japanese partners visited the state-of-the-art surface treatment facility at Boeing in Portland, Oregon. Yamashita said the partners see the Portland site as a benchmark for their own new or expanding facilities.

The Japanese partners also are interested in other Boeing environmental and safety best practices around conserving energy, reducing emissions, managing solid waste and handling chemicals, Yamashita said.

"We are having open dialogues and discussion about improving the environmental performance of Boeing aircraft. It's promoting closer collaboration and strengthening the relationship with our partners, which is very gratifying."



Michael Yamashita helps Boeing partners in Japan, including several of the country's largest manufacturers, work with the company's engineering and environmental

experts to understand their role in building cleaner, more environmentally progressive aircraft. (Boeing photo)

## INSPIRE

### Sanjeet Dangi, Safety and Environment Leader, Hindan Air Force Base, India

Sanjeet Dangi can see firsthand how a commitment to protecting the environment can make a difference at a major construction project with one of Boeing's international partners.

"We have zero tolerance at our site for air pollution, which means we carefully manage the use of material like concrete," said Dangi, safety and environment leader at the C-17 Globemaster construction project at the Hindan Air Force Base near New Delhi.

"Air Force officials have told us they are very pleased with Boeing's management of the project."

Boeing is the prime contractor on the project to build the infrastructure that will support the Indian Air Force's fleet of 10 C-17 Globemaster III transport aircraft. Dangi said Boeing's environmental plan for the project includes steps to protect the quality of the air, water and land and to reduce noise.

"One of our first projects was to replace a number of trees that were cut down to clear the site," Dangi said. "Project officials and their families all came out and helped plant 200 saplings around the property."

Other steps to protect the environment include:

- ▲ Concrete is stored in silos for easier maintenance and dust control, including frequent monitoring of particulates and air quality.
- ▲ Water is frequently sprayed on the site's road to control dust.

- ▲ Water runoff is captured in holding tanks where sediment, such as cement particles, is separated out and hauled away by vendors for correct disposal.
- ▲ Drinking water is treated with reverse osmosis to filter out impurities.
- ▲ Non-potable wastewater is captured and reused in restrooms and in landscape watering.
- ▲ All equipment purchased or leased for the site meets government noise standards.
- ▲ Biomedical and other hazardous waste is collected by vendors for proper disposal.
- ▲ A "Go Green" initiative is looking for ways to reduce diesel fuel use in site vehicles.

The commitment to protect the environment is shared by employees throughout the project, Dangi said. "On World Environment Day, June 5, managers and employees take an oath and recommit ourselves to do everything possible to protect the environment for Boeing, our country and the planet," he said.

"I am very proud of our efforts here; small steps add up to a big contribution for future generations."



With the help of Sanjeet Dangi, Boeing is demonstrating its environmental stewardship by taking steps to protect the air, water and land at a major construction project at Hindan Air Force Base in India.  
(Boeing photo)

## Industry Collaboration

### Working Together for Global Solutions

Boeing works closely with industry groups and governments around the globe on steps to reduce greenhouse gas emissions.

The Greenhouse Gas (GHG) Reporting Guidance was released in 2014 by the International Aerospace Environmental Group, an international coalition of aircraft manufacturers and industry suppliers. Boeing is a founding member. New voluntary guidelines on measuring and reporting emissions are a good example of global collaboration on a complex environmental challenge.

The document outlines a consensus standard for aerospace industry companies on how to report their direct emissions as well as indirect emissions when linked to purchased energy and business travel. Once implemented, the standard will improve efficiency by eliminating the need for each company to develop its own system and promote consistency in GHG accounting across the industry.

Boeing also is working with industry stakeholders to support a global sectoral approach to reducing emissions that is being developed by the [International Civil Aviation Organization \(ICAO\)](#), a United Nations organization. ICAO's plan includes a CO<sub>2</sub> standard for aircraft, modernization of air traffic management systems to improve fuel efficiency for all airplanes flying, commercialization of sustainable alternative fuels, and a market-based measure mechanism to cut emissions.

The efforts aim to achieve carbon-neutral growth across commercial aviation from 2020 with continued efforts to reduce the industry's environmental footprint.

## Employee Engagement

### EI Teams/Energy Conservation

Employee Involvement (EI) teams in Everett, Washington, and St. Louis, Missouri, are leading efforts to light Boeing with rapidly evolving LED technology.

The Everett EI team is composed of carpenters, plumbers, electricians and heating, ventilation and air-conditioning technicians who maintain underground corridors that supply manufacturing buildings with utilities. The lights are kept on constantly, and before switching to LEDs, they frequently burned out. After quantifying the return on investment in kilowatt-hours per year and dollars, the lights were upgraded to LEDs in the tunnels beneath five buildings. In addition to improving employee safety and job efficiency, benefits include 280,000 kilowatt-hours per year in savings, improved light distribution and intensity, reduced maintenance cycles and improved ease of installation.

In St. Louis, the "Energy Stars" EI team replaced a parking lot's high-intensity discharge lamps with LEDs. The new lights improved parking lot visibility for employees who work late, so there are safety and security benefits in addition to a nearly 60 percent decrease in energy costs. Another St. Louis EI team, a group of electricians, installed LEDs in nearly inaccessible, high-maintenance settings such as the site's polysonic wind tunnel. Affected by the vibration of the wind-tunnel testing, the lights needed to be replaced frequently. Once LEDs were installed, the issues ceased.



Boeing volunteers are an important part of the success on many community projects for Earth Day and World Environment Day around the globe. (Boeing photo)

## INSPIRE

### Crystal Frost, Employee Environmental Engagement Program Leader

Crystal Frost knows that some of the best ideas for reducing waste and conserving resources come from the employees who work every day in Boeing's factories and offices. And she is making it easier to channel employee creativity and passion for the environment into workplace actions that can make a difference.

"I want to help break down the barriers that might prevent an employee from driving changes in the workplace," said Frost, employee environmental engagement program leader. "We develop programs and tools so all employees understand how they can take action to help Boeing improve its environmental performance."

The programs that Frost creates focus employee engagement on the company's environmental goals. For example, this year Boeing is expanding an enhanced recycling program that includes composting cafeteria waste.

"It's a specific behavior we can help address and a key one that employees identify with the environment. When we have strong fundamental projects like recycling, it builds confidence in our environmental strategy," Frost said.

The first step in developing tools and eliminating possible barriers to environmental engagement is listening to employees, Frost said. "People who work in our factories and offices see the challenges and possibilities every day; I need and value their input and ideas."

Frost works closely with teams in the company's Employee Involvement program and with Green Teams, which are made up of volunteers dedicated to environmental projects.

Resources to support environmental activities are available on a central website. They include training and tools that help employees understand the environmental impacts of their work, and how to make improvements.

Employees create and drive a variety of environmental activities, such as reducing the use of hazardous material and solid waste, conserving water and electricity, and improving efficiency and reducing waste in numerous work processes.

Major environmental events, such as Earth Day and World Environment Day, generate hundreds of projects supported by thousands of employees at Boeing sites around the globe.

"That's what I find so meaningful about my work," Frost said. "Engaging employees and encouraging sustainable behavior at a company the size of Boeing can have a significant impact around the world. It keeps me energized."



Crystal Frost is helping Boeing employees understand how they can get engaged and take action to help the company improve its environmental performance. (Boeing photo)

## INSPIRE

### Building Better Communities

#### Charitable Investments

As a committed, responsible environmental leader, we work with organizations, customers and communities to bring about fresh approaches toward environmental education, preservation and conservation. For three years, a Boeing-sponsored project known as “Seed Saving and Sustainable Energy Partnership in East Bali” has been increasing the capacity of farmers in Bali by providing the knowledge and tools necessary to organically grow and preserve plant seeds sustainably. Working with the IDEP Foundation in Indonesia, the farmers are also instructed in packaging, marketing and selling these seeds, enhancing their local economy.

In Germany, Boeing and the Berlin Community Foundation (Bürgerstiftung Berlin) aim to spark and nurture childhood curiosity about nature with the Environmental Detectives project, which allows children to experience nature directly and to learn about environmental protection through hands-on activities.

Boeing and the nonprofit Engineers Without Borders-USA (EWB-USA) have worked together since 2008 to support EWB-USA professional and university student chapters as they solve critical community problems—such as access to water—through low-cost, small-scale engineering projects that improve basic quality of life. In 2014 Boeing supported 55 projects in 24 countries, positively affecting the lives of 322,500 people.



In 2014, Boeing **contributed \$71 million in charitable donations** to support various causes, including the environment.



Since 2012, Boeing has supported a project known as “Saving Indigenous Plants—Seed Saving Partnership with Bangli Farmers” through the IDEP Selaras Alam

Foundation. The foundation works with local farmers to educate and train them in renewable farming techniques for long-term sustainability. (Boeing photo)

## INSPIRE

Beyond the contributions of our company, Boeing employees use their passion for the environment to improve the places where we live and work. Last year, Boeing contributed \$71 million in charitable donations to support various causes, including the environment. In South Carolina, the Employees Community Fund of Boeing is funding an environmental education program through the Friends of Coastal South Carolina for elementary and middle school students and their teachers. Through hands-on learning programs, students step out of the classroom and into nature, providing a real-world connection to subjects such as math, science and English. Additionally, teachers are provided materials that reinforce lessons and stewardship projects to instill a lifelong ethic of conservation and environmental stewardship.

To read other stories of how Boeing is building better communities worldwide, read our [Global Corporate Citizenship report](#).

### Earth Day and World Environment Day

While driving environmental performance doesn't end on Earth Day and World Environment Day, both annual events are an opportunity for Boeing employees to celebrate the company's ongoing commitment to the environment and to build a better planet.

Last June, in support of World Environment Day, Boeing sites around the world participated in activities that ranged from a tree planting in the United Kingdom to a beach cleanup and relocation of turtle eggs in Dubai, United Arab Emirates.

In Japan, a dozen students from Tokyo University and 20 more from other universities joined Boeing Japan employees for a discussion on aviation, the environment and the eco-Demonstrator Program.

Across the globe, employees participated in various Earth Day efforts. As part of Earth Day 2014, more than 300 Boeing volunteers at 10 sites along the Duwamish Waterway

in Washington state improved more than 95,000 square feet (8,800 square meters) of river banks, parks and urban forest-land. Volunteers also helped plant more than 875 native trees and shrubs.

At one of the locations along the Duwamish in Tukwila, Washington, a group of 25 Boeing volunteers pulled invasive weeds and placed mulch to reduce weed growth and help retain water for new plants. The cleanup and restoration gives native plants the chance to flourish in an area that was once overrun by blackberry bushes.

Volunteers from Boeing in the United Kingdom worked with Earth Restoration Service to plant tree saplings and help schoolchildren clear an overgrown conservation area.

In Heath, Ohio, employees collected eyeglasses and clothes for the community and cell phones for active-duty military members and veterans. During the drives, Boeing employees donated 87 pairs of eyeglasses, 438 articles of clothing, 25 pairs of shoes and 49 cell phones to be recycled for others to reuse.

Several Boeing sites participated in "E-Waste" programs, including Houston, Texas, where employees recycled more than 500 pounds (225 kilograms) of non-Boeing computer towers, printers, cords and computer monitors.

In 2014, Boeing **helped**  
**322,000 people**  
improve their lives through  
partnerships with Engineers  
Without Borders.



# Performance

**Boeing's strategy is to become the most environmentally progressive aerospace company.**

To get there requires the hard work and dedication of all our team members, along with the innovation and technology Boeing has brought to the aerospace industry since its inception.

We are committed to zero absolute growth from our 2012 baseline in greenhouse gas emissions, solid waste to landfill and water intake; and zero growth in hazardous waste generation (normalized to revenue) through 2017.



South Carolina employees recycle packaging material to support the Boeing commitment to zero absolute growth of waste to landfill. (Boeing photo)

## PERFORMANCE

In 2012, after successfully achieving our first set of environmental performance targets, Boeing established a set of targets that would hold the gains we had achieved in the first round during a period of substantial growth in production. This set of targets aim to keep our 2017 greenhouse gas emissions, solid waste to landfill and water intake at the same levels on an absolute basis to 2012. Additionally, hazardous waste generation, which is even more closely tied to production, would remain level with 2012 on a revenue-adjusted basis.

These are big goals that require continued, aggressive investment in our facilities, tools and processes combined with our teams' relentless focus on improved environmental performance.

The graphs and charts in this section are labeled with information rounded to the nearest decimal place and reflect the environmental performance of the majority of Boeing facilities, calculated from a baseline of 2012 values. However, some slight variation in the display of the data may occur in the appearance of some graphs, created for the purpose of visual presentations.

Additionally, each chart is represented by its own data set that is described in the accompanying footnotes.

### Summary of Environmental and Business Performance in 2014

	2012	2013	2014	% change*
<b>Revenue</b> (U.S. dollars in millions)	81,698	86,623	90,762	
<b>Deliveries</b>	745	812	902	
<b>Employment</b> (year-end)	174,429	168,421	165,529	
<b>GHG Emissions</b> (in millions of metric tons)	1.30	1.30	1.26	-3.2%
<b>Hazardous Waste</b> (in hundreds of U.S. pounds/\$Million)	2.09	2.12	1.92	-8.0%
<b>Water Intake</b> (in billions of U.S. gallons)	1.88	1.79	1.75	-6.8%
<b>Solid Waste to Landfill</b> (in millions of U.S. pounds)	45.59	45.58	45.52	-0.2%
<b>Environmental Fines</b> (U.S. dollars in thousands)	78.50	6.55	40.5	

\*Percent change since 2012 values is reported as absolute with the exception of Hazardous Waste, which is reported as revenue adjusted.

### 2014 Environmental Performance— Data Representative of the Majority of Boeing Facilities

(Percent Performance to 2012 Baseline)



Since 2012, Boeing has reduced:

■ GHG Emissions	3.2%	■ Solid Waste to Landfill	0.2%
■ Water Intake	6.8%	■ Hazardous Waste Generation†	8.0%

\*0% absolute growth—water intake, GHG emissions and solid waste to landfill;

0% revenue-adjusted growth—hazardous waste generation

†Normalized to revenue

[See Appendix for Performance Summary footnote.](#)

## PERFORMANCE

### Greenhouse Gas Emissions

Climate change is a serious environmental challenge that requires aggressive, credible action, and our new targets reflect that. An assessment of the environmental footprint across Boeing's value chain—including our greenhouse gas emissions profile—showed that the greatest sources of greenhouse gas emissions for our industry are our products in use, followed by the supply chain and our company operations. We are working to design and build more fuel-efficient products and improve airlines' operational efficiency to reduce emissions. We lead the industry on research and creation of sustainable aviation biofuel, and more than 75 percent of our commercial research and development funding supports greater efficiency and environmental performance of our products.

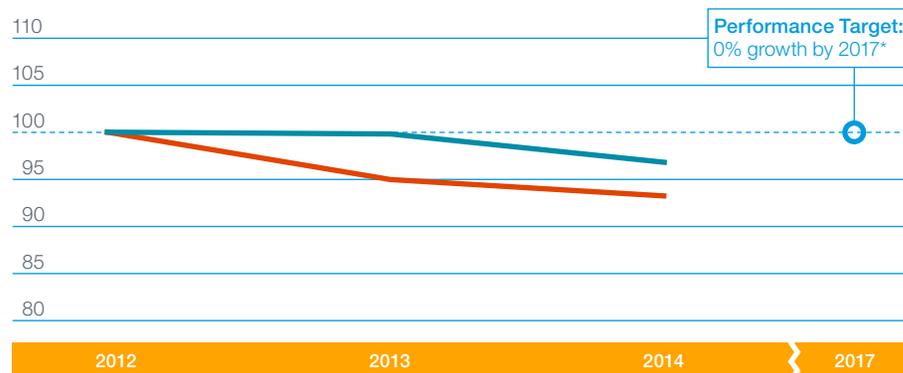
In 2013, we expanded our greenhouse gas target beyond CO<sub>2</sub> (carbon dioxide) to the internationally recognized CO<sub>2</sub>-e (carbon dioxide equivalence) standard by including methane and nitrogen dioxide. Our goal is to maintain our greenhouse gas emissions at or below 2012 levels, on an absolute basis, by 2017.

In 2014, Boeing's greenhouse gas emissions were 1.39 million tons (1.26 million metric tons), a reduction of 3.2 percent on an absolute basis from the 2012 baseline.

### Water

We continue to make progress with water-reduction efforts through alternative production methods, treatment technologies, water recycling solutions and employee awareness training on water management. As of 2014, we have cut our water intake by 6.8 percent from the 2012 baseline.

**2014 Environmental Performance:  
Greenhouse Gas Emissions and Water Intake—  
Data Representative of the Majority of Boeing Facilities**  
(Percent Performance to 2012 Baseline)



Since 2012, Boeing has reduced:

■ GHG Emissions	3.2%
■ Water Intake	6.8%

\*0% absolute growth—water intake, GHG emissions and solid waste to landfill;  
0% revenue-adjusted growth—hazardous waste generation

[See Appendix for GHG Emissions footnote.](#)

[See Appendix for Water Intake footnote.](#)

Since our baseline year of 2012, Boeing has saved enough water to fill **337 Olympic-size swimming pools.**



## PERFORMANCE

### Waste

#### Solid Waste

Boeing measures nonhazardous solid waste generated by our operations. In 2014, Boeing sent 45.52 million pounds (20.65 million kilograms) of solid waste to landfills, a 0.2 percent reduction from the baseline set in 2012. Waste is diverted from landfills through a combination of reducing, reusing, recycling, composting and energy recovery programs.

In 2014, Boeing had six zero-waste-to-landfill sites: El Segundo, California; Long Beach, California; Charleston, South Carolina; Huntsville, Alabama; Philadelphia, Pennsylvania; and Salt Lake City, Utah. Boeing defines “zero waste to landfill” to include, at a minimum, all solid waste generated by operations. It does not include hazardous waste, which is handled in accordance with applicable regulations.

#### Hazardous Waste

In 2014, we reduced the amount of hazardous waste Boeing generates (on a revenue-adjusted basis) by 8 percent from the baseline set in 2012. Building on this demonstrated performance, we are committed that our hazardous waste generation will not grow at a rate more than the rate at which our business is expanding, by the end of 2017.

To meet our commitment of zero revenue-adjusted growth by the end of 2017, we are implementing numerous projects throughout the company to reduce the amount of hazardous waste that we generate.

**2014 Environmental Performance:  
Solid Waste to Landfill and Hazardous Waste Generation—  
Data Representative of the Majority of Boeing Facilities**  
(Percent Performance to 2012 Baseline)



Since 2012, Boeing has reduced:

- Solid Waste to Landfill (Absolute) 0.2%
- Hazardous Waste Generation (Normalized)† 8.0%

\*0% absolute growth — water intake, GHG emissions and solid waste to landfill;

0% revenue-adjusted growth — hazardous waste generation

†Normalized to revenue

[See Appendix for Solid Waste to Landfill footnote.](#)

[See Appendix for Hazardous Waste Generation footnote.](#)



Recycling tons of bubble wrap collected each month is one way the St. Louis site is significantly reducing the amount of solid waste sent to landfills. (Boeing photo)

## PERFORMANCE

### Global Reporting

With corporate offices in Chicago, Boeing employs more than 168,000 people across the United States and in more than 65 countries. This represents one of the most diverse, talented and innovative workforces anywhere. Each year we submit environmental data to various regulatory agencies and voluntary disclosure organizations. A summary of our previous disclosures can be found in the 2014 Environment Report.

### Australia

Boeing Australia represents the company's largest operational footprint outside the United States. In 2014, Boeing Australia filed its sixth National Greenhouse and Energy Report, detailing its greenhouse gas emissions, energy consumption and energy production data. Boeing Australia's CO<sub>2</sub>-e emissions were calculated at 50,197 tons (45,500 metric tons) and energy use at 77,208,889 kilowatt-hours (277,000 gigajoules). Overall, Boeing Australia has achieved large reductions in CO<sub>2</sub>-e emissions since the first reporting period in 2008–2009, while simultaneously increasing production rates of high-end aerospace components.

[See Appendix for Global Reporting footnotes.](#)

### United Kingdom

Boeing participates in the Carbon Reduction Commitment Energy Efficiency Scheme (CRC Scheme), under the U.K. Department of Energy and Climate Change, a mandatory emissions trading scheme aimed at reducing CO<sub>2</sub> emissions in the United Kingdom. For the reporting period April 1, 2013, through March 31, 2014, CRC-regulated emissions were 5,399 tons (4,900 metric tons) of CO<sub>2</sub>. By December 2015, Boeing will comply with the Energy Savings Opportunity Scheme Regulations 2014.

### United States and Canada

Boeing reports to both the U.S. Toxic Release Inventory as well as Canada's National Pollutant Release Inventory, an inventory of pollutant releases, off-site disposal and treatment, on an annual basis. In 2013, Boeing had a total release of 440,000 pounds (199,580 kilograms) and total transfers of 3.40 million pounds (1.54 million kilograms). Total release and transfers for 2013 equaled 3.84 million pounds (1.74 million kilograms). Data for 2014 will be submitted to the U.S. and Canadian governments after the publication of this report, and will be included in next year's report. Data for 2007 through 2012 are available in the [2014 Environment Report](#).



Hydrogen + Oxygen = Sustainable Flight Fuel cell technologies being explored by Boeing use a fusion of hydrogen and oxygen to help power aircraft electricity, produce heat and provide clean water. [Click here to watch the video.](#)



## PERFORMANCE

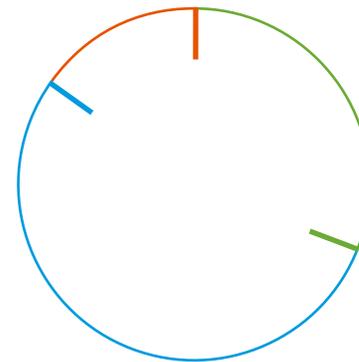
### Greenhouse Gas Corporate Inventory

Boeing reports our corporate greenhouse gas emissions to the CDP (Carbon Disclosure Project) annually. Emissions fall into three categories: Scope 1, Scope 2 and Scope 3 (business travel only), and go beyond our operational targets. Scope 2 emissions comprise the largest segment of our greenhouse gas emissions, followed by the direct emissions of our facilities and then our business travel.

Scope 1 emissions were 684,535 tons (621,000 metric tons) and cover our emissions from combustion of natural gas, fuel oil, the jet fuel used in our flight-test programs and the fugitive emissions from refrigerant leaks and chemical usage. Scope 2 emissions were 1,167,348 tons (1,059,000 metric tons) and focus on indirect emissions from our purchased electricity. For Scope 3 emissions, we track the emissions associated with our business travel, which were 330,693 tons (300,000 metric tons).

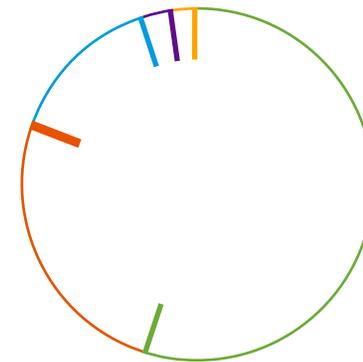
In 2014, Boeing was recognized by the CDP for its leadership in Climate Disclosure on CDP's Standard & Poor's 500 Climate Disclosure Leadership Index.

Greenhouse Gas Corporate Inventory



Scope 1 Emissions	31%
Scope 2 Emissions	54%
Scope 3 Emissions	15%

Greenhouse Gas Scope 1 Emission Sources



Natural Gas	55%
Jet Fuel	26%
Fugitive Emissions	14%
#2 Diesel	3%
Other Fossil Fuels	2%

[See Appendix for Greenhouse Gas Corporate Inventory footnotes.](#)

[See Appendix for Global Reporting site listings.](#)

**100% of the electricity**  
at our Washington 737  
and South Carolina 787  
factories comes from  
**renewable sources.**



## PERFORMANCE

### Awards

In 2014, Boeing's environmental leadership was recognized by several independent organizations.

Los Angeles County recognized Boeing's Space & Intelligence Systems in El Segundo, California, for moving toward more environmentally sound practices. The Natural Resources Conservation team at the satellite factory won top honors at the county's annual Green Leadership Awards, taking home the award for "outstanding and innovative environmental sustainability projects."

Air Transport World magazine named Boeing the "Eco-Company of the Year" at the trade publication's 41st annual Industry Achievement Awards in February 2015. The publication's editors credited Boeing for "ever-more fuel and emissions-efficient aircraft" such as the 787 Dreamliner, 737 MAX and the 777X, and the company's global effort to develop sustainable aviation biofuel and the Boeing ecoDemonstrator Program, which tests new technologies to improve fuel efficiency and reduce emissions and noise.

The U.S. EPA has recognized Boeing's leadership in energy conservation and efficiency with an ENERGY STAR Partner of the Year—Sustained Excellence award. This is the fifth consecutive year that Boeing has been recognized by ENERGY STAR for its superior energy conservation programs.



Installing energy-efficient LED lighting is part of Boeing's strategy to reduce its energy consumption and improve overall environmental performance. It's one of the actions that helped Boeing earn a 2015 ENERGY STAR Partner

of the Year—Sustained Excellence award from the U.S. EPA, the fifth consecutive year the ENERGY STAR program has recognized the company's superior energy conservation programs. (Boeing photo)

# Appendix



In this time-lapse photo, a Falcon 9 rocket carrying Boeing-built 702SP (small platform) all-electric-propulsion satellites for two customers leaves a trail through the night

sky after launch from Cape Canaveral, Florida, in March 2015. More information about the satellites is on page 12 of the Environment Report. (SpaceX Photo)

## APPENDIX

### Page 57 Footnote for Performance Summary Chart and Graph

- “Environmental Fines” represent total fines paid in 2012, 2013 and 2014, respectively.
- Data reported in this chart for the greenhouse gas emissions, hazardous waste, water intake and solid waste to landfill reflect environmental performance at the following sites from a baseline set on 2012 values. These sites (known as Core Metric Sites) represent the vast majority of Boeing’s operations and are identified by the city in which the Boeing operation resides. For each metric, additional facilities and office buildings have also been included where information is available.
  - Alabama: Huntsville
  - Arizona: Mesa
  - California: El Segundo, Torrance, Huntington Beach, Long Beach, Seal Beach, Palmdale
  - Illinois: Chicago
  - Indiana: Gary
  - Kansas: Wichita
  - Missouri: St. Charles, St. Louis
  - Ohio: Heath
  - Oregon: Gresham
  - Pennsylvania: Ridley Park
  - South Carolina: Charleston, Ladson
  - Texas: Houston, San Antonio
  - Utah: Salt Lake City
  - Washington: Auburn, Tukwila (Developmental Center, Duwamish Towers), Everett, Frederickson, Kent (Space Center), Seattle (North Boeing Field, Plant 2, Thompson, South Park), Renton (737 Assembly, Longacres), SeaTac (Spares Distribution Center), Bellevue
  - Canada: Winnipeg
  - Australia: Fishermans Bend
- **Site Changes:** Anaheim, California (closed in 2012): 2012 only data  
Bankstown, Australia (closed in 2013): 2012 and 2013 data only

[Return to Performance: Summary](#)

### Page 58 Footnote for Greenhouse Gas Emissions

- In addition to data from Boeing’s 39 Core Metric Sites, it also includes data from Portland, Oregon (PDX Paint Hangar), and the Phoenix, Arizona, Data Center.
- 1 metric ton = approximately 2,204.62 pounds.
- Carbon dioxide equivalent or CO<sub>2</sub>-e means the number of metric tons of CO<sub>2</sub> emissions with the same global warming potential as 1 metric ton of another greenhouse gas (in accordance with EPA 40 CFR 98).
- GHG emissions are calculated based on consumption of electricity, natural gas and fuel oil. (Our facility in Philadelphia is the only major U.S. site that uses fuel oil for heating.) Consumption of other fuels is not represented.
- For U.S. sites, Scope 1 emissions from natural gas, fuel oil and on-site-generated electricity are calculated using the emission factors provided in U.S. EPA GHG Mandatory Reporting Rule. Scope 2 emissions from purchased electricity are calculated using the year 2010 eGRID factors. For the Canada site, Scope 1 emissions are calculated using the emission factors provided in U.S. EPA GHG Mandatory Reporting Rule; Scope 2 emissions are calculated from the supplier data. For the Australia sites, Scope 1 and 2 emissions are calculated using the emission factors provided in the National Greenhouse and Energy Reporting (NGER) Scheme.
- In 2012, Boeing South Carolina (BSC) made arrangements to purchase Renewable Energy Credits (REC), and offset approximately 51,809 tons (47,000 metric tons) of GHG emissions. Portland also purchased RECs to offset approximately 3,307 tons (3,000 metric tons) of its GHG emissions. In 2013, BSC continued to make arrangements to purchase RECs, and offset approximately 57,320 tons (52,000 metric tons) of GHG emissions. In 2014, BSC and the Boeing 737 program made arrangements to purchase RECs, and have offset approximately 85,980 tons (78,000 metric tons) of GHG emissions.

[Return to Performance: Greenhouse Gas Emissions](#)

### Page 58 Footnote for Water Intake

- In addition to data from Boeing’s 39 Core Metric Sites, it includes data from Portland, Oregon (PDX Paint Hangar).
- 1 U.S. gallon = approximately 3.79 liters.

[Return to Performance: Water Intake](#)

## APPENDIX

### Page 59 Footnote for Solid Waste to Landfill (Absolute)

- Includes data from Boeing's 39 Core Metric Sites.
- 1 U.S. ton = 2,000 pounds.
- Solid waste numbers represent values determined from scale-weighed containers as well as calculated weights.

[Return to Performance: Waste](#)

### Page 59 Footnote for Hazardous Waste Generation

- In addition to data from Boeing's 39 Core Metric Sites, it includes data from Portland, Oregon (PDX Paint Hangar); Jacksonville, Florida (Cecil Field); El Paso, Texas; Macon, Georgia; and Sylmar, California.

[Return to Performance: Waste](#)

### Page 60 Footnote for Global Reporting

Australia National Greenhouse and Energy Report footnote: This comprehensive report must be completed by registered corporations that meet specified energy use and greenhouse gas emission thresholds. For the 2013–2014 reporting period, the Australian government's Clean Energy Regulator released data for companies emitting more than 55,000 tons (50,000 metric tons) of equivalent carbon dioxide (CO<sub>2</sub>-e).

United Kingdom Carbon Reduction Commitment footnote: Boeing operations in the U.K. consist of multiple units and subsidiaries. Boeing U.K. Training and Flight Services Ltd. operates flight simulators for training on Boeing aircraft at several locations throughout the U.K. Boeing Defence U.K. Ltd. has employees located at multiple locations throughout the U.K., supporting Ministry of Defence and U.S. military programs. Additionally, CO<sub>2</sub> emissions from Boeing subsidiary Jeppesen U.K. Ltd. are included in the Boeing U.K. CRC report.

Fifteen sites report TRI and NPRI releases and transfers: Auburn, Washington; Charleston, South Carolina; El Paso, Texas; El Segundo, California; Everett, Washington; Frederickson, Washington; Seattle, Washington (North Boeing Field, Plant 2); Gresham, Oregon (Portland Fabrication); Portland, Oregon (PDX Paint Hangar); Renton, Washington; St. Louis, Missouri; Sylmar, California; Wichita, Kansas; and Winnipeg, Canada.

2014 data will be submitted to the U.S. and Canadian governments after the publication of this report. Boeing will provide 2014 data in next year's report.

[Return to Performance: Global Reporting](#)

### Page 61 Footnote for Greenhouse Gas Corporate Inventory

- The greenhouse gas (GHG) emissions reported represent 1,742 buildings in 40 countries where Boeing has operational control. Refer to the Site listing footnote for Corporate GHG Inventory chart for a complete list.
- Scope 3 emissions only include emissions from business travel.
- Scope 1 "Other fossil fuels" include No. 6 fuel oil, gasoline, aviation gasoline, propane and LPG.
- 1 metric ton = approximately 2,204.62 pounds.
- Carbon dioxide equivalent or CO<sub>2</sub>-e means the number of metric tons of CO<sub>2</sub> emissions with the same global warming potential as 1 metric ton of another greenhouse gas (in accordance with EPA 40 CFR 98).
- Accounting protocol: This GHG inventory is prepared using the following protocols: The Greenhouse Gas Protocols and Methodologies: A Corporate Accounting and Reporting Standard (Revised Edition), GHG Reporting Guidance for the Aerospace Industry–IAEG, Australia's National Greenhouse and Energy Reporting Act, and the United Kingdom's CRC Energy Efficiency Scheme.
- Calculation factors: Data source of global warming potentials (GWP) is U.S. 40 CFR 98, subpart A, table A-1. For GHG inventory in North America, emission factors for combustion sources come from U.S. 40 CFR 98, subpart C, table C-1. U.S. Scope 2 emissions are calculated using year 2010 eGRID factors. Canada Scope 2 emissions are calculated from supplier data. For GHG inventory in the U.K., emission factors from the CRC Energy Efficiency Scheme are used. For GHG inventory in Australia, emission factors from the National Greenhouse and Energy Reporting Act are used. For GHG inventory in locations where energy data is not accessible, 2003 CBECS factors are used to estimate the energy consumption; and emission factors from the International Energy Agency's "CO<sub>2</sub> Emissions from Fuel Combustion Highlights 2013" and "2006 IPCC Guidelines for National Greenhouse Gas Inventories" are used to calculate the emissions.
- Renewable Energy Credits (REC) were applied to GHG calculation. In 2012, Boeing South Carolina (BSC) made arrangements to purchase RECs, and offset approximately 51,809 tons (47,000 metric tons) of GHG emissions. Portland also purchased RECs to offset approximately 3,307 tons (3,000 metric tons) of its GHG emissions. In 2013, BSC continued to make arrangements to purchase RECs, and offset approximately 57,320 tons (52,000 metric tons) of GHG emissions. In 2014, BSC and the Boeing 737 program made arrangements to purchase RECs, and offset approximately 85,980 tons (78,000 metric tons) of GHG emissions.

[Return to Performance: Greenhouse Gas Corporate Inventory](#)

## APPENDIX

### Page 61 Site listing footnote for Corporate GHG Inventory chart

Our greenhouse gas inventory reflects data gathered at the Boeing facilities in the following cities:

Country	State	City (site)
Australia	Australian Capital Territory	Canberra
	New South Wales	Bankstown
		Sydney
		Yerriyong
	Northern Territory	Gladesville
	Queensland	Alderley
		Archerfield
		Brisbane
		Cairns
	Victoria	Malvern
		Melbourne
		Mentone
		Tullamarine
Western Australia	Jandakot	
Belgium		Brussels
Brazil	Distrito Federal	Brasilia
	São Paulo	Sao José Dos Campos Sao Paulo
Canada	Alberta	Calgary
	British Columbia	Richmond
	Manitoba	Winnipeg
	Nova Scotia	Enfield
	Ontario	Mississauga
		Ottawa
Quebec	Boisbriand Montreal	
China		Beijing Hong Kong Shanghai
Denmark		Copenhagen
Egypt		Cairo
France		Blagnac
		Paris
Germany		Berlin
	Hesse	Neu-Isenberg
	North Rhine-Westphalia	Geilenkirchen
Greece		N. Smirni
Hungary		Papa
India	Andhra Pradesh	Hyderabad
	National Capital	New Delhi
	Karnataka	Bangalore
	Maharashtra	Navi Mumbai
	Tamil Nadu	Chennai
	West Bengal	Calcutta

Country	State	City (site)
Ireland	Leinster	Banbridge
		Dublin
Israel		Tel Aviv
Italy		Massa
		Rome
Japan		Chubu
		Kanto
		Nagoya
		Tokyo
		Yokohama
Kazakhstan		Almaty
Kenya		Nairobi
Korea		Seoul
Kuwait		Kuwait City
Malaysia		Kuala Lumpur
Mexico		Mexico City
Netherlands		Amsterdam
		Nieuw Vennepe
		Noord-Holland
		Schiphol-Oost
New Zealand		Auckland
Norway		Egersund
Oman		Muscat
Poland		Gdansk
		Warsaw
Qatar		Doha
Russia		Moscow
		Skolkovo
		St. Petersburg
		Tyumen
		V. Salda
Saudi Arabia		Riyadh
Singapore		Singapore
South Africa		Sandton
Spain		Madrid
		Villacarillo
Sweden		Goteborg
		Stockholm
Taiwan		Taipei
Turkey		Ankara
		Istanbul
Ukraine		Kiev
United Arab Emirates		Abu Dhabi
		Dubai

[Return to Performance: Greenhouse Gas Corporate Inventory](#)

## APPENDIX

### Page 61 Site listing footnote for Corporate GHG Inventory chart (cont.)

Country	State	City (site)
United Kingdom	England	Bristol
		Camberley
		Corsham
		Crawley
		Farnborough
		Feltham
		Gatwick
		Gosport
		Knaresborough
		London
		Milton Keynes
		Newbury
		Stockport
		Welwyn Garden City
Yeovil		
	Scotland	Perth
United States	Alabama	Daleville
		Huntsville
		Madison
	Alaska	Anchorage
	Arizona	MCAS Yuma
		Mesa
		Phoenix
	California	Alameda
		El Segundo
		Huntington Beach
		La Jolla
		Long Beach
		Mountain View
		Palmdale
Pleasanton		
Rancho Cucamonga		
Sacramento		
San Diego		
San Jose		
San Luis Obispo		
Santa Susana		
Seal Beach		
Sunnyvale		
Sylmar		
Taft		
Torrance		
Van Nuys		
Ventura		
Victorville		
Colorado	Aurora	

Country	State	City (site)	
United States	Colorado (cont.)	Centennial	
		Colorado Springs	
		Englewood	
		Connecticut	East Windsor
	Florida	Cape Canaveral	
		Fort Walton Beach	
		Ft. Lauderdale	
		Jacksonville	
		Kennedy Space Center	
		Miami	
		Orlando	
		Osprey	
		Shalimar	
Tampa			
Titusville			
Georgia	Atlanta		
	College Park		
	Macon		
	Warner Robins		
Hawaii	Honolulu		
	Kihei		
Illinois	Chicago		
	Fairview Heights		
	Lombard		
	Mascoutah		
	Rolling Meadows		
	Schaumburg		
	Scott AFB		
	St. Charles		
	Swansea		
	Indiana	Crown Point	
Gary			
Kansas	Kansas City		
	Wichita		
Louisiana	Bossier City		
	Lafayette		
Maine	Bangor		
	Waterford		
Maryland	Aberdeen Proving Ground		
	Annapolis Junction		
	California		
	Germantown		
	La Plata		
	Patuxent River		
Massachusetts	Lexington		
	Mashpee		

## APPENDIX

### Page 61 Site listing footnote for Corporate GHG Inventory chart (cont.)

Country	State	City (site)
United States	Minnesota	Eagan
	Missouri	Berkeley Earth City Florissant Hazelwood Maryland Heights Portage Des Sioux St. Charles St. Louis
	Montana	Glasgow Great Falls Helena
	Nebraska	Omaha
	Nevada	Las Vegas
	New Jersey	Berkeley Heights Millville Parsippany
	New Mexico	Albuquerque
	New York	New York
	North Carolina	Fayetteville Havelock Morrisville
	North Dakota	Minot
	Ohio	Brookpark Cincinnati Fairborn Heath
	Oklahoma	Oklahoma City
	Oregon	Arlington Boardman Gresham Hood River Portland Wilsonville
	Pennsylvania	Doylestown Eddystone Langhorne Lemont Furnace Pittsburgh Ridley Park Smithfield
	South Carolina	Charleston Ladson North Charleston
	Tennessee	Memphis

Country	State	City (site)	
United States	Texas	Austin Dallas Dyess AFB El Paso Houston Irving Richardson San Antonio Universal City	
		Utah	Layton Salt Lake City West Jordan
		Virginia	Arlington Chantilly Fairfax Herndon Leesburg Newington Newport News Reston Springfield Virginia Beach Yorktown
		Washington	Anacortes Auburn Bellevue Bingen Bothell Enumclaw Everett Issaquah Kent Moses Lake Mukilteo Olympia Puyallup Quincy Renton SeaTac Seattle Tukwila Vancouver White Salmon
		Wyoming	Cheyenne

# Engagement

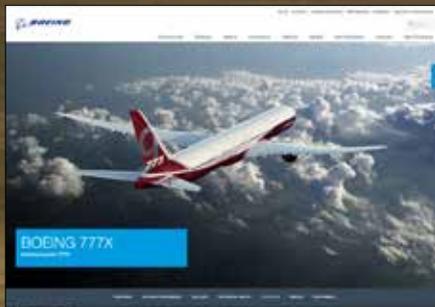


Visit us at [boeing.com/investorrelations](http://boeing.com/investorrelations) to view our annual reports and to find additional information about our financial performance and Boeing business practices.



Visit us at [boeing.com/community](http://boeing.com/community) to view our Corporate Citizenship Report and other information about how Boeing is working to improve communities worldwide.

Photo: Boeing's first KC-46 Tanker test aircraft, a 767-2C, takes off on its inaugural flight on Dec. 28, 2014. Boeing is building the U.S. Air Force's next-generation aerial refueling tanker aircraft.



Visit us at [boeing.com](http://boeing.com) to learn more about Boeing and how extraordinary innovations in our products and services are helping solve the world's toughest problems.



Visit us at [boeing.com/environment](http://boeing.com/environment) to view our current Environment Report and information on how the people of Boeing are developing ways to protect the planet and create a better tomorrow.



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