

## Hydrogen and Sustainable Aviation

Until recently, fossil-based liquid fuel has been the primary energy source and carrier for powering flight. Aviation is transitioning to renewable energy sources to reduce life cycle CO<sub>2</sub> emissions. Hydrogen produced with renewable energy sources can greatly improve production of drop-in sustainable aviation fuels and has the potential to be a low carbon impact fuel for use in fuel cell or combustion aircraft propulsion systems. Boeing is researching the potential performance of hydrogen-powered aircraft as well as consideration of the fuel supply chain, including fuel production, transportation and use at the airport.

## BOEING'S HYDROGEN DEMONSTRATION PROJECTS

Boeing has conducted numerous demonstration projects and has extensive experience using hydrogen as a fuel for launch vehicle and space applications. We continue to study and test the potential of this energy source.



Boeing's Fuel Cell Demonstrator, a two-seat Dimona, flew three flights in Spain-representing the first piloted airplane in history to use power generated solely by hydrogen fuel cells.



Boeing's Phantom Eye high-altitude and longendurance uncrewed aircraft flew several flights in California powered by liquid hydrogen



Insitu completed the first flight of its ScanEagle3 unmanned aerial vehicle powered by an all-electric, hydrogen-fueled, proton exchange membrane (PEM) fuel cell.



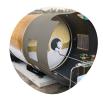
Aurora Flight Sciences, a Boeing company, is developing a hydrogen fuel cell-powered small uncrewed aircraft system (sUAS), the SKIRON-XLE, for long-range reconnaissance.



Our ecoDemonstrator program tested similar regenerative fuel cell technology for onboard auxiliary power applications on a Next-Generation 737-800.



A second project in Spain completed over 100 hydrogen flights on an uncrewed flight demonstrator



A new type of composite cryogenic fuel tank was designed and manufactured by Boeing, signifying this lightweight storage technology is mature, ready and safe for use in aerospace vehicles.



Producing green hydrogen for sustainable aviation fuels requires abundant renewable energy to ensure emissions reductions from flying are not negated during the production portion of the fuel's life cycle.

The larger fuel volume and very cold temperatures required for storage of liquid hydrogen present significant innovation opportunities in aircraft design and systems integration.

All-new distribution, storage and fueling infrastructure for airports around the world must be established for use of hydrogenfueled airplanes.



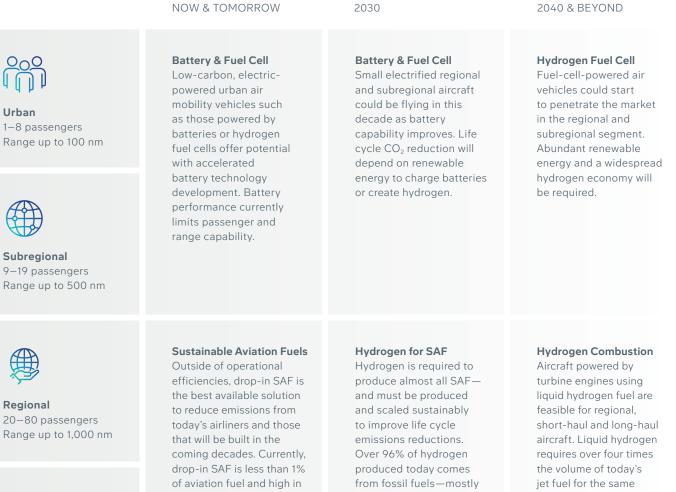
Given the urgent need for emissions reductions, our near-term emphasis is on implementation of drop-in sustainable aviation fuels (SAF). Our current and future investments in green hydrogen for aviation will enable the next generation of future flight and propulsion concepts that reduce total climate impact.



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Green hydrogen is produced using renewable energy and can reduce life cycle carbon emissions. Its use in aircraft propulsion requires new designs, safe certification approaches and platform developments coupled with new system-wide ground and network infrastructure. Based on the level of innovation and infrastructure investment required, hydrogen's role in aircraft propulsion could begin to make an impact in the longer term.

## RENEWABLE ENERGY SOLUTIONS EVOLUTION



Short & Long Hau Over 80 passengers Range over 1,000 nm

cost. Innovation, supportive policies and public-private partnerships are crucial to help catalyze commercialscale production and use.

natural gas.

given energy and must be cooled to minus 253 degrees Celsius.