



Powered by renewable hydrogen
100% renewable energy
from NREL's wind and solar facilities



Learn More

- *Advanced vehicles and fuels basics:*
www.nrel.gov/learning/advanced_vehicles_fuels.html
- *NREL's advanced vehicles and fuels research:*
www.nrel.gov/vehiclesandfuels
- *NREL's hydrogen and fuel cell research:*
www.nrel.gov/hydrogen
- *Renewable electrolysis:*
www.nrel.gov/hydrogen/renew_electrolysis.html
- *Wind-to-hydrogen project:*
www.nrel.gov/hydrogen/proj_wind_hydrogen.html
- *DOE Fuel Cell Technologies Program:*
www.hydrogenandfuelcells.energy.gov

This vehicle is funded by:



U.S. DEPARTMENT OF ENERGY

National Renewable Energy Laboratory

1617 Cole Boulevard, Golden, Colorado 80401
303-275-3000 • www.nrel.gov

**NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC**

NREL/BR-560-48319 • August 2010

Photo credits: Front cover – Dennis Schroeder, NREL, PIX 17643; Page 1 – Dennis Schroeder, NREL, PIX 17645; Page 2 (clockwise from top left) – Keith Wipke, NREL, PIX 17134; Dennis Schroeder, NREL, PIX 17647; Dennis Schroeder, NREL, PIX 17648; Back page (from top) – Lee Fingersh, NREL, PIX 16389; Beck Energy, PIX 14726.

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.



*NREL's Hydrogen-Powered Bus
Serves as Showcase for
Advanced Vehicle
Technologies*



NREL's Hydrogen-Powered Bus Serves as Showcase for

Advanced Vehicle Technologies



Visitors to the National Renewable Energy

Laboratory (NREL)—the nation's primary laboratory for renewable energy and energy efficiency research and development—now have the opportunity to tour NREL in a hydrogen-powered shuttle bus. Produced by Ford Motor Company, the 12-passenger bus is used for special events and new employee orientation.

The U.S. Department of Energy funded the lease for NREL's hydrogen-powered internal combustion engine (H₂ICE) bus, along with 12 other buses at federal facilities across the country, to demonstrate market-ready advanced technology vehicles.

How do H₂ICE vehicles work?

Ford was one of the first automakers to develop commercially available H₂ICEs, which use the same basic technology as gasoline-powered engines but run on hydrogen fuel. The bus has a 6.8-liter supercharged Triton V-10 engine. Only modest design adjustments are needed to switch a basic gasoline-powered engine to a hydrogen-powered engine, such as using alternate materials for valve seats and other parts that may become brittle when exposed to hydrogen.

Using H₂ICEs offer many advantages. They are highly fuel efficient—up to 25% more efficient than gasoline-fueled ICEs. NREL's H₂ICE bus can run for about 175 miles per fill up. In addition, NREL has its own hydrogen fueling station, which dispenses some of the greenest hydrogen in the world made using wind and solar energy.

Filling up at NREL's Hydrogen Fueling Station

The hydrogen dispensed at the station is produced via water electrolysis as part of a wind-to-hydrogen demonstration project. A partnership between NREL and Xcel Energy, this project integrates wind turbines and photovoltaic arrays to power electrolyzer stacks that split water into hydrogen and oxygen. The hydrogen is then compressed and stored for later use.

NREL recently outfitted the station with cascading storage tanks, which decrease the time required for refueling. This is particularly beneficial for vehicles with large onboard storage systems like the H₂ICE bus, which can take up to 30 kg of hydrogen in a single fueling. The station has a 130 kg storage capacity at 413 bar (6,000 psi), so filling the bus takes about 20-30 minutes.



Renewable fuel from NREL's wind and solar facilities.

H₂ICE Advantages

- H₂ICE vehicles operate on hydrogen, which can be made from a wide variety of domestic, renewable resources such as solar, wind, and geothermal energy.
- When fueled by renewable hydrogen, H₂ICE vehicles have near-zero lifecycle greenhouse gas emissions.
- Compared to conventional gasoline vehicles, H₂ICE vehicles produce minimal tailpipe emissions.
- H₂ICEs are fuel efficient—up to 25% more efficient than conventional spark ignition engines.
- Only modest design modifications to standard ICE technology are necessary, so the engine technology is familiar to mechanics and fleet personnel.
- With very few cost and technical issues limiting commercialization and deployment, H₂ICE vehicles can help create the demand needed to support the development of a hydrogen infrastructure.

Fast Facts about Hydrogen

- Hydrogen is the simplest element on Earth.
- Hydrogen is rarely found in its pure form; instead, it's found in compounds such as water, methane, and biomass.
- Hydrogen is the lightest gas; it rises and disperses rapidly.
- Hydrogen is odorless, colorless, and nontoxic.
- When hydrogen burns in air, it doesn't produce smoke.
- 1 kg of hydrogen has the same energy content as 1 gallon (3.2 kg) of gasoline.