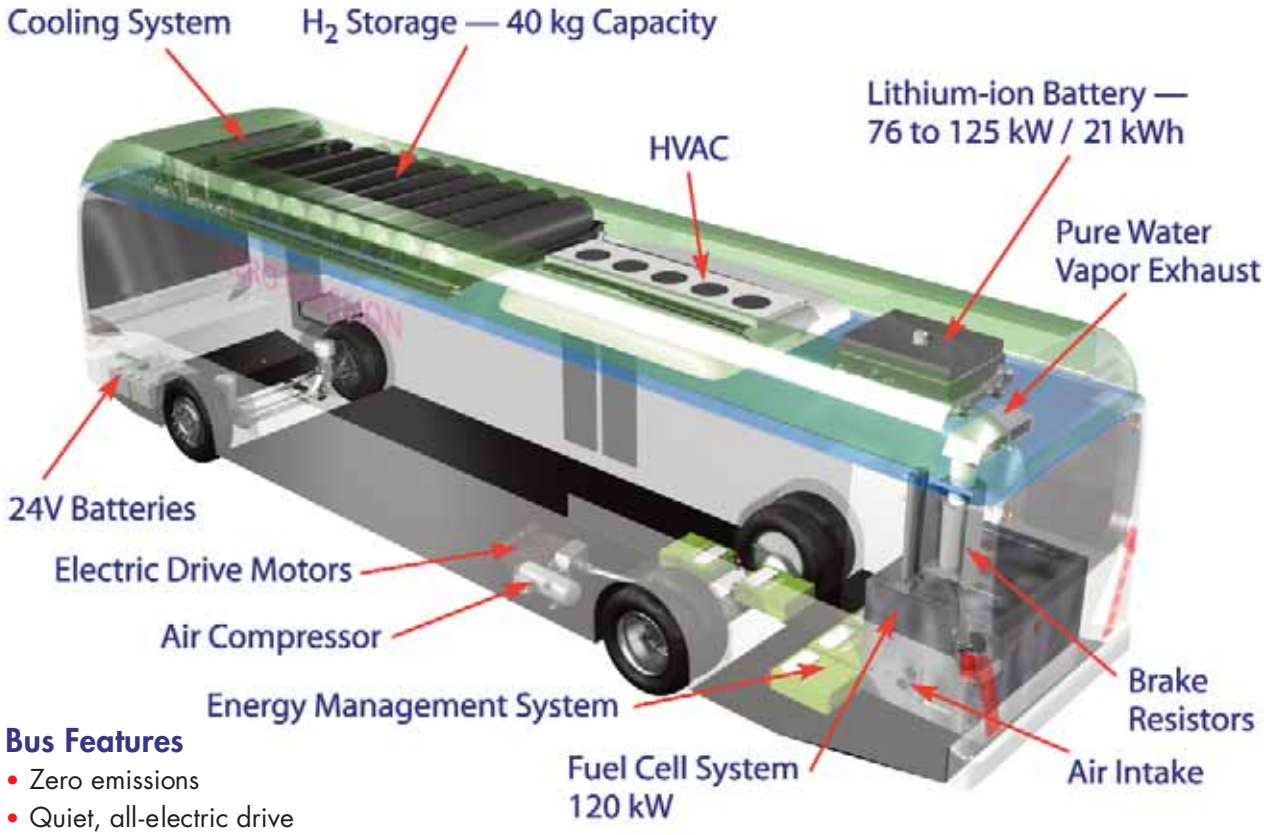
Taking the HyRoad

...With Zero-Emission Technology

Driven by a desire to protect the health and the environment of the communities we serve, AC Transit has spent over a decade developing and implementing advanced, zero-emission transportation technology.

Zero-Emission Vehicles

AC Transit operates twelve 40' hybrid-electric fuel cell buses, each powered by a 120 kW UTC fuel cell system. The buses use lithium-ion batteries and hybrid-electric technology to store regenerative braking energy and provide up to 125 kW of booster power. Fuel cells do not burn the fuel they use. Instead, they combine hydrogen with oxygen from the air electrochemically to produce electricity and emit only water vapor.



Bus Features

- Zero emissions
- Quiet, all-electric drive
- Regenerative braking
- Twice the energy efficiency of diesel
- Low floor for easy entrance and exit

System Specifications

Length/Width/Height:	40 feet/102 in./136 in.
Curb Weight:	31,400 pounds
Gross Vehicle Weight:	40,000 pounds
Capacity:	29 seated, plus 2 wheelchairs; 33 seated without wheelchairs; 25 standees
Wheel Base:	22 ft. 5.29 in.
Fuel Cell Power:	120 kW
Drive System:	Series Hybrid Electric
Battery Energy/ Capacity:	21 kWh / 29 Ah
Vehicle Control:	VDO KIBES 32 Multiplex System via SAE CAN J1929
Operating Range:	220-240 miles

Components

Bus Chassis:	Van Hool A300L Fuel Cell
Model Year:	2010
System Integration:	Van Hool
Electric Propulsion:	Siemens ELFA Drive System; two 85 kW AC traction motors
Power Plant:	UTC Power PureMotion® 120
Fuel Storage:	8 Dynetek Type 3 tanks (aluminum core with carbon fiber-wrapped exterior; 40 kg Gaseous Hydrogen Stored at 5000 psi/350 bar
Traction Battery Pack:	EnerDel Lithium Ion Batteries 76 kW to 125 kW Charge and Discharge Power 21 kWh energy storage
Heating/ Air Conditioning:	Carrier-Sutrak AC 136 AE
Brakes:	4 wheel Knorr Disc Brakes, Air Actuated
Emissions Equipment:	Zero Emission Vehicle – none required

AC Transit's Stationary Fuel Cell System

- Provide electric power at an average efficiency of 52%, compared to the mid to high 30s of standard grid power
- Will reduce greenhouse gas emissions by more than 1,500 tons/year
- Save over $3 million in energy costs over 10 years

Overall, the Oakland fueling station, funded with grants from the California Energy Commission and the California Air Resources Board, will have the capacity to produce and dispense 360 kilograms of hydrogen per day, with the capability of doubling capacity by adding additional compressors and storage.

Advanced Compression Technology

Max Fueler 90: Primarily for passenger car fueling, Linde's oil-free piston compressor, Max Fueler 90, allows for the quick, safe, and efficient fueling of hydrogen vehicles to 350 or 700 bar. Equipped with dual compressors for high reliability, it is capable of fueling four or more vehicles per hour, depending upon vehicle service pressure, state of charge and size of vehicle tanks.

Ionic Compressor 50: Primarily for bus fueling, Linde's ionic compression technology replaces a conventional metal piston with a specially designed, nearly incompressible ionic liquid. Benefits include low energy consumption, low noise level, and no contamination of the hydrogen gas.

About Landfill Gas: As organic materials decompose in landfills, they emit methane, an even more potent greenhouse gas than carbon dioxide. Capturing that methane before it goes into the atmosphere prevents some amount of global warming. Using that methane as a source of hydrogen for fuel cell vehicles prevents even more climate change.

About Solar Electrolysis: Using clean, renewable, solar electricity (produced onsite) to separate water into hydrogen and oxygen demonstrates the completely renewable potential of fuel cell technology. In fuel cells, the hydrogen and oxygen are recombined, producing electricity for vehicles, and the same amount of water that went into the system in the first place. Beyond powering a fleet of buses, this technology shows one way to store solar or wind-generated electricity for later use.

Energy Stations

AC Transit's on-site energy stations demonstrate the capability for using "renewable" hydrogen—hydrogen produced from biogas or using solar-powered electrolysis. The stations also feature the latest advancements in compression and dispensing technology, enabling buses to be refueled at rates up to 5 kilograms/minute—a time comparable to refueling diesel buses.

Emeryville Station—Demonstrating Solar Electrolysis

In Emeryville, we dispense hydrogen made both from natural gas, and from water and solar electricity. Thanks to a major grant from the California Air Resources Board, one dispenser is accessible to the public for fueling passenger cars. Overall, this station has the capacity to rapidly fuel 12 buses consecutively with more than 30 kilograms of hydrogen each, and 20 or more cars per day. While Linde's car fueling system has a daily capacity of 240 kilograms, local permitting restricts fueling to no more than 20 cars per day.

Oakland Station—Demonstrating Biogas-fed Stationary Fuel Cells

In Oakland, we are taking an innovative approach to producing hydrogen, as well as providing on-site electrical power to AC Transit's largest operating division. With a $6 million grant from the Federal Transit Administration, in 2013 we will be installing a 420 kW stationary fuel cell system. Directed Biogas—collected from landfills—will feed the fuel cells, which will in turn supply clean electricity to the entire facility. Electricity from the stationary fuel cells will also power an electrolyzer to produce 65 kilograms of hydrogen per day for the zero-emission bus fleet.

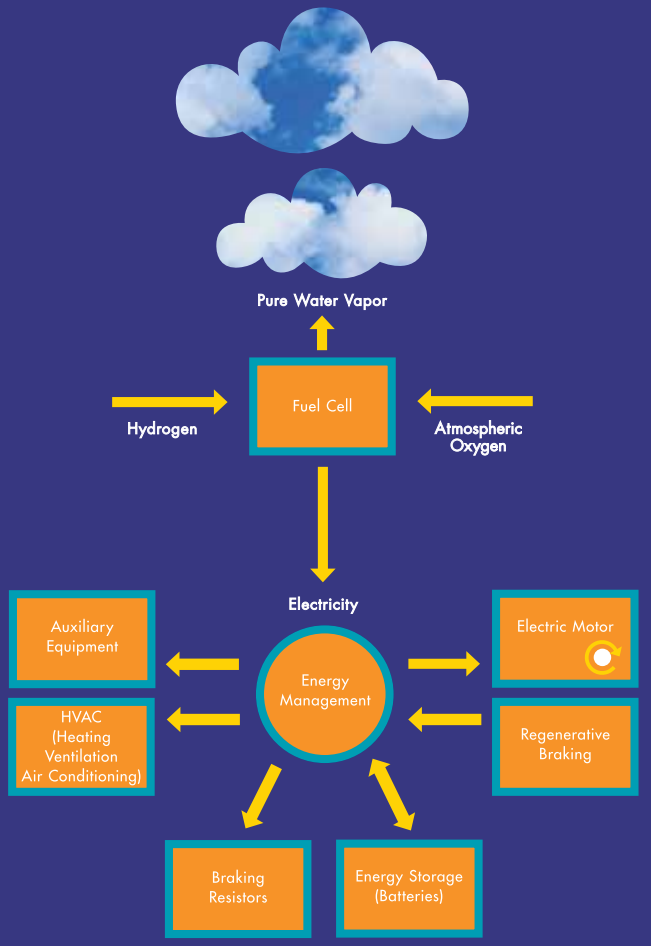
Emeryville Station Key Components

Solar Electricity:	21 kW on site; 1.324 MW at other AC Transit properties; approximately 1,720 MWh of electricity per year; will reduce greenhouse gas emissions by more than 900 tons/year
Electrolyzer:	Proton PEM Electrolyzer; 65 kg/day
Compression:	Linde IC50 Ionic Compressor and MF90 Mechanical Dry-Running Compression with advantages in through-put and efficiency
Liquid Storage:	9,000 gallons (2,400 kilograms*)
Gaseous Storage:	360 kg @ 7,000 PSI for bus fueling; 28 kg @ 13,000 PSI for light-duty fueling
Dispensers:	Linde Bus-Fueling and Car-Fueling Integrate dispensers with controls and authorization and point-of-sale system for public fueling. Cars can be fueled in 3-5 minutes, buses in 6 minutes.

Equipment in Illustration at Left

- A H_2 Storage for Buses
- B ICE 50 Bus Compressor
- C 9,000 Gallon Liquid Storage Tank
- D Vaporizer
- E Solar Panel
- F MF90 Car Compressor & Storage
- G Electrolyzer

**One kilogram is equivalent in energy content to one gallon of gasoline.*



Hybrid-Drive Propulsion System

An energy management system controls electric power from three different energy sources: the fuel cell, the battery, and regenerative braking energy produced by the electric-drive motors as the bus slows or goes downhill. The system distributes power to the traction motors and the electric drive accessories on the bus (doors, lights, air compressor, power steering, heating and air conditioning, and other equipment). Managing the power in and the power out requires a very complicated package of software to meet demand while maximizing fuel economy.

For more information about
AC Transit's environmental initiatives,
please visit **www.actransit.org/environment**
or follow our daily updates on
twitter **@act_environment**

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