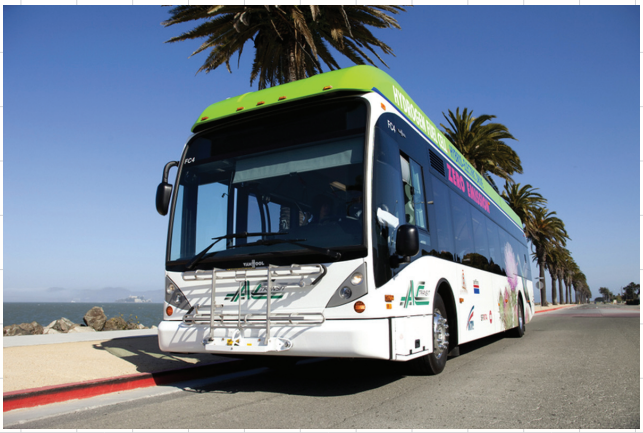
CASE STUDY

Location: Oakland, CA
Company: Alameda-Contra Costa Transit District (AC Transit)
Study: Hydrogen



Left, hydrogen fuel cell bus on highway; Right, bus leaving fueling station. Photos courtesy of AC Transit.

AC Transit believes that hydrogen is the fuel of the future. It is a clean-burning, high-performance fuel that provides numerous benefits to fleet managers and the community as a whole. AC Transit has been using demonstration hydrogen fuel cell buses since 1999, and has witnessed dramatic improvements in the technology over the past 10 years. In 2010, AC Transit made a firm commitment to the technology by purchasing 12 hydrogen fuel cell buses.

Decision Points

For some time AC Transit has operated under the belief that hydrogen is the fuel of the future. It is fuel efficient, which is a benefit to the agency, and it produces zero tailpipe emissions, which benefits the quality of life of the residents of the AC Transit service area. Because the AC Transit public transportation system includes high-traffic urban areas, the reduction in emissions caused by a switch to hydrogen fuel cell buses reduce the overall emissions in areas with the highest concentration of pollutants.

AC Transit first began working with hydrogen fuel cell buses in 1999 through a series of demonstration projects. The performance of the vehicles led to a larger demonstration project in 2006, and the purchase of three hydrogen fuel cell buses. It was at this point, after observing the decreased maintenance requirements, the increasing quality of life, and the overall satisfaction of the riders and drivers that AC Transit began seeking funds to purchase its own hydrogen fuel cell buses. AC Transit built its first hydrogen fuel station, in conjunction with Chevron, to fuel the three buses already in its fleet in 2006.

Hydrogen Case Study

In 2010, AC Transit purchased 12 hydrogen fuel cell buses. It also constructed a new hydrogen fuel station, this time in conjunction with Linde, and began plans to build a second station at the site of the previously decommissioned first station. The new buses were more durable than the previous ones utilized by AC Transit, which should reduce the maintenance costs associated with the buses.

Jaimie Levin, director of environmental technology and manager of the fuel cell program for AC Transit, acknowledges that there is still a significant cost gap between hydrogen fuel cell buses and conventional diesel buses. This is also true for the price of fuel. But AC Transit believes that an investment in the technology now will pay dividends in the future. The primary reason for the difference in cost is the lack of supply of the buses and the corresponding lack of demand for the fuel. AC Transit believes that by leading the way in purchasing hydrogen fuel cell buses, it is increasing the demand for hydrogen fuel, as well as demonstrating the efficacy of the technology for surrounding areas. Beginning in January 2012, AC Transit began loaning its buses to surrounding public transportation companies for additional demonstration programs. AC transit believes that by purchasing and sharing the technology, it will encourage the development of a region-wide hydrogen fuel cell program that will reap rewards for customers and the environment for the future.

QUICK FACTS

Fuel Type: Hydrogen fuel cell

Fuel Production: 66% Steam-methane reforming, 33% solar electrolysis

Number of Buses: 12

Operation: More than 11,000 hours

Driving Range: 220-240 miles

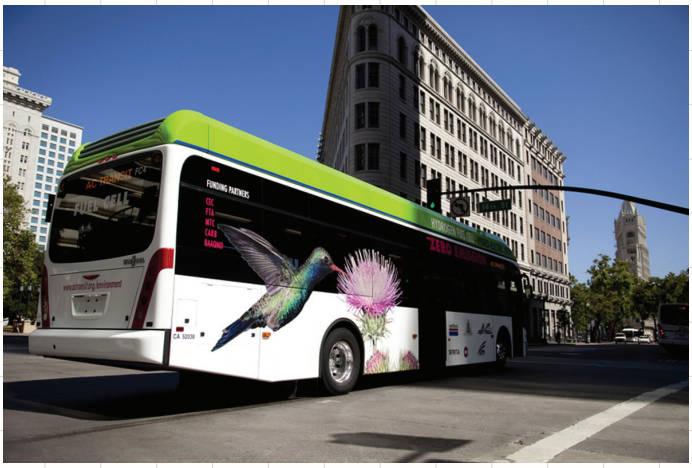
Fuel Cell Power: 120 kW

Fleet Facts

AC Transit owns and operates 12 third generation hydrogen fuel cell buses. These buses weigh 5,000 pounds less than the previous generation and are powered by a 120 kilowatt fuel cell system. The hydrogen fuel tanks are located in the roof and store enough fuel to give each bus a range of 220-240 miles before fueling. The buses also take advantage of a regenerative braking system. This system captures energy usually lost as heat during braking. The energy is stored onboard to assist the fuel cell system, which helps solve acceleration problems that have plagued previous iterations of the technology.

Most of the hydrogen used by AC Transit comes from a process called steam-methane reformation, a non-renewable source. When hydrogen becomes available in a renewable form, the third-generation buses will be able to be run on that as well.

Of particular importance to AC Transit was that its buses were tested in real-world conditions, not just on routes intended to maximize their performance. Rather, routes were selected to maximize the analysis of the performance by putting them in areas where they would be used most. This includes a focus on areas with high ridership and frequency of service on graded streets and an attempt to maximize, rather than minimize, load factors. The buses were operated under heavy demand in the cities of Oakland, Albany, and Berkeley.



Hydrogen fuel cell bus as is travels through the city. Photo courtesy of AC Transit.

Infrastructure

AC Transit has built two hydrogen fuel stations in conjunction with area fuel providers, though only one has been in operation at any given time. A second functioning fuel station will be constructed at the site of the previously decommissioned station in 2012, providing two operational hydrogen fuel stations within the AC Transit service area.

Approximately two-thirds of the hydrogen fuel used by AC Transit comes from a process called steam-methane reformation. This process involves reacting steam at a high temperature with methane to create hydrogen. This process does result in a release of greenhouse gases; however there is a 43% reduction in the release of greenhouse gases when compared to buses powered by diesel. Because this process utilizes fossil fuels, it is a non-renewable method for creating hydrogen fuel.

View of the hydrogen fueling station. Photos courtesy of AC Transit.

The other one-third comes from a 100% renewable process called solar electrolysis. Solar electrolysis uses solar energy to generate electricity to trigger a process to derive hydrogen from water, splitting the water molecules into the separate components of hydrogen and oxygen. The hydrogen is then collected and used as hydrogen fuel. This process does not yet produce sufficient fuel to service all of AC Transit's needs, but the process is renewable; it uses solar energy and water to develop hydrogen fuel.

Costs

As stated previously, there remains a significant cost gap between hydrogen fuel cell buses and standard diesel, buses. AC Transit estimates that the cost of a diesel bus is $1.5 million compared to a hydrogen bus at $3 million.

Some of the cost will be offset by a reduction in maintenance costs. As the fuel cost for hydrogen decreases, the savings in fuel economy will be realized as cost savings as well. The hydrogen buses used by AC Transit have doubled the fuel economy of the company's diesel buses.

Maintenance and Satisfaction

Overall satisfaction with the hydrogen fuel cell buses is high with AC Transit, its drivers, maintenance workers, and customers.

Initially AC Transit drivers noted that there was some "sluggishness" to the hydrogen buses when accelerating from 15-30 mph with the three vehicles purchased in 2006. This problem was solved with the purchase of the third-generation buses, which integrated regenerative braking systems. This added energy provided an extra boost of power and eliminated the sluggishness. Drivers rave about the performance of the vehicle. Driver quality of life has also improved as they are no longer inhaling diesel fumes when they drive the clean-burning hydrogen vehicles.

Fleet mechanics enjoy working with the new technology as well. Because hydrogen fuel and hydrogen fuel cell are clean burning, there is not the debris accumulation maintenance workers see in diesel engines. The fuel cells themselves have been extremely durable as well; with more than 11,000 hours of continuous operation, there is still no degradation in the cell's ability to produce electricity.

The customer base has been extremely satisfied with the hydrogen fuel cell buses, whether they are active bus riders or not. Riders appreciate that there are no fumes associated with the fuel cell buses, the bus runs more quietly, and that there is not a trade-off with performance. A recent survey randomly polled 500 bus riders and found overall satisfaction with the hydrogen buses to be in the high 80th percentile, while diesel buses are typically surveyed in the low 50th percentile.

Community members who live along bus routes but don't ride the bus also have expressed satisfaction with the hydrogen vehicles. Because they are clean-burning, the community is not exposed to the noxious fumes that are expelled by diesel buses. Community members also have cited the silence of the buses as a positive, though AC Transit has acknowledged that being completely silent can pose a public safety risk and have installed noise making devices including bells and wind chimes to alert pedestrians that there is an oncoming bus.

AC Transit has been very satisfied with the performance and customer satisfaction associated with the hydrogen fuel cell buses. The company's officials conducted a great deal of research before committing to the technology and it appears that the commitment has already been fruitful in the form of increased goodwill with the community.

Summary

Jaimie Levin believes that hydrogen fuel cell technology "has a lot of robustness to it. We see it in the long term as our future." It is this belief that led to AC Transit's willingness to pay a premium to adopt this technology as a way to demonstrate its viability to other agencies. The technology has met every one of AC Transit's goals; high-performance, zero emission, customer satisfaction, and environmentally friendly.

AC Transit views its purchase of hydrogen fuel cell buses and the construction of hydrogen fuel dispensing stations as a research and development project with the ultimate goal being nothing less than global fuel reduction.