FACT SHEET

ZERO EMISSION BUS TECHNOLOGIES

There are several types of zero emission buses that are currently being manufactured. These types differ in fueling types and technologies utilized, which subsequently affect which routes and usages these buses best service.

A hydraulic system for hybrid vehicles to capture braking energy to convert to electricity

Battery Electric Vehicle (BEV) Buses

Battery electric vehicles (BEV) have a battery pack and an electric motor instead of a fuel tank and an engine. This battery is the vehicle's sole source of power and must be recharged, often from the electric grid.

Medium- and heavy-duty BEVs have been predominantly used on urban or suburban routes, characterized by frequent stops and starts, high idle times, lower average speeds, and a daily range of 100 miles or less. These BEVs have included, but are not limited to, urban transit buses and intracity delivery vehicles.

BEV maintenance costs can be as low as 20%[1] that of conventional vehicles. Furthermore, the electricity used to power the vehicle can cost less than diesel fuel, further lowering operational costs. Electric powertrains are more efficient than internal combustion powertrains[2] and are able to perform the same amount of work as other vehicles while using less fuel.

As battery technology continues advancing with increased use of electric vehicles, overall costs of BEVs and their batteries are projected to decrease over time.

Contact Us

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RACE to Zero emissions

The American Fuel Cell bus.

An all-electric bus operated by the San Joaquin Regional Transit District.

Hybrid Electric Vehicle Buses

Hybrid electric vehicles (HEV) have both an electric motor and an internal combustion engine, utilizing both electricity and gasoline. While the vehicle can use gasoline for part of its mileage, it can also run emission-free once switching to electric mode.

There are two primary categories of HEVs: **parallel** hybrids use both the electric motor and the engine to move the vehicle, while **series** hybrids' engines can generate electricity for the motor as well to move the vehicle. Series hybrids are also known as **extended range vehicles,** as the engine can be used to operate the vehicle in the event that the battery is completely depleted.

There are several types of hybrid vehicles.

Conventional Hybrids

Conventional hybrid vehicles recharge their electric batteries from the energy created from braking. Because it also has a battery, hybrids have an increased fuel economy compared to conventional vehicles when it combines both its gasoline and electric mileage. Increased fuel economy reduces fuel costs and can save fleets money.

Plug-in Hybrids

Like BEVs, **Plug-in hybrid electric vehicles (PHEV)** can be charged by being plugged into an outlet. While these hybrids have gasoline capabilities, its ability to be charged reduces the need for gasoline present in conventional hybrids. Users can opt to operate entirely on electricity, with gasoline for emergencies.

Fuel Cell Electric Vehicle (FCEV) Buses

Fuel cell electric vehicles (FCEV) contain a fuel cell system powered by hydrogen that generates electricity to operate the vehicle. This electricity used to power the vehicle, along with heat and water vapor, are the only byproducts of fuel cells. Electricity is stored in a battery system.

FCEVs have performed a variety of tasks but have mostly been used as transit buses since 1991. Recent demonstrations show the technology's growth to become competitive to conventional transit buses in terms of availability, performance, and durability. Other forms of FCEV have included step vans, walk-in delivery vans, shuttle buses, and semi-tractors for drayage services.

While fuel cell vehicles have demonstrated comparable performance with conventional vehicles, their capital costs are still high due to low production volumes. However, manufacturers are projecting that increasing the amount of buses built and used will decrease individual bus costs[3] due to a better positioning for purchasing components and transition toward assembly line production. Larger volumes makes on-site hydrogen fueling feasible, which can make it equivalent or cheaper than diesel fuel.

[1] *http://www.arb.ca.gov/msprog/tech/techreport/bev_tech_report.pdf*
[2] *Ibid = http://www.arb.ca.gov/msprog/tech/techreport/bev_tech_report.pdf*
[3] *http://www.afdc.energy.gov/uploads/publication/fc_buses_2014_status.pdf*