The Advantages of Hydrogen Fuel Cell Technology

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Hydrogen fuel cells can be used in a wide range of environments such as use in homes, ships, cranes and vehicles. Still, current funding is directed mostly to the transportation sector to be reduce pollution. In this article, we will focus on one of the most exciting uses for fuel cells: a Zero Emission Vehicle (ZEV). A ZEV is a common term used today for any application that is typically propelled by an internal combustion engine (ICE) but is now propelled by an alternative emission-free source. An ICE uses conventional fuel, such as diesel or gasoline, which creates harmful emissions. Unlike an ICE, a ZEV uses another method or fuel, such as hydrogen in a fuel cell, which creates an emission of only water. A hydrogen fuel cell has certain advantages over its alternative, a pure battery vehicle. A battery carries only so much charge and as such has a limited range.

It is important to clear up any confusion with terms related to energy efficient vehicles. Intoday's "green initiative" world, the term hybrid is thrown around quite a bit. A hybrid vehicle uses two or more power sources for operation. In most cases this means the use of an ICE and energy storage, such as a battery pack or ultra-capacitor. These come in two flavors commonly referred to as series and parallel. The difference depends on how the propulsion system drives the axle. Building on this we have Hybrid Electric Vehicles (HEV) or Plug in Hybrid Electric Vehicles (PHEV) which depend on the combination of battery and engine. In this article we will focus on the zero emission arena where common terms may be Pure Electric Vehicle (PEV) or the previously mentioned ZEV (which can also be considered hybrid since it normally consists of a hydrogen fuel cell and a battery/ultra-capacitor).

When thinking about hybrids, California often comes to mind with its many hybrid cars and strict environmental regulations. As a result of its large populations, spread out cities and climate patterns that trap pollution, California has been at the forefront of air pollution reduction measures. Not surprisingly, much green technology is developed in California. In the United States, the majority of the

Siemens hybrid technology (ELFA) is integrated and used today in California. This drive to reduce pollution is not simply confined to cars, trucks and buses. For example, the Port of Los Angeles is one of the nation's busiest ports. Currently, there are many applications being developed to make this a "zero emission zone." In order to make this a reality, all ships, trucks, cranes, etc need to be converted to pure electric power. Because of the long duty cycle, such as a semi driving from the port to a distribution center 24 hours a day, a battery version would need to be charged or changed out frequently to keep the vehicle running. This results from a limited amount of energy that a battery can hold before it needs to be charged again. In a car, the small battery that runs all the accessories and starts your car is charged by the alternator, if it is operating correctly of course. Because of this limitation, the hydrogen fuel cell is a better solution. This fuel cell simply runs on hydrogen and oxygen but emits only water.

While this sounds ideal, there are challenges that must be addressed. Hydrogen fuel cells are a new technology with current small production volumes that can lead to high costs. More investment needs to be made into the infrastructure to support fuel cell manufacturing and development.

The graph in Figure 1 has every possible combination for an electric vehicle, but we will concentrate on the yellow section for the fuel cell. As you move from the right of the graph which shows 100 percent fuel cell usage to the left which is 100 percent energy storage, there is a mix of fuel cell and energy storage power. Finding the right mix is what drives the development of all hybrid manufacturers. The key is to make optimal use of the advantages in both parts of the system: energy storage and the long range of a fuel cell.

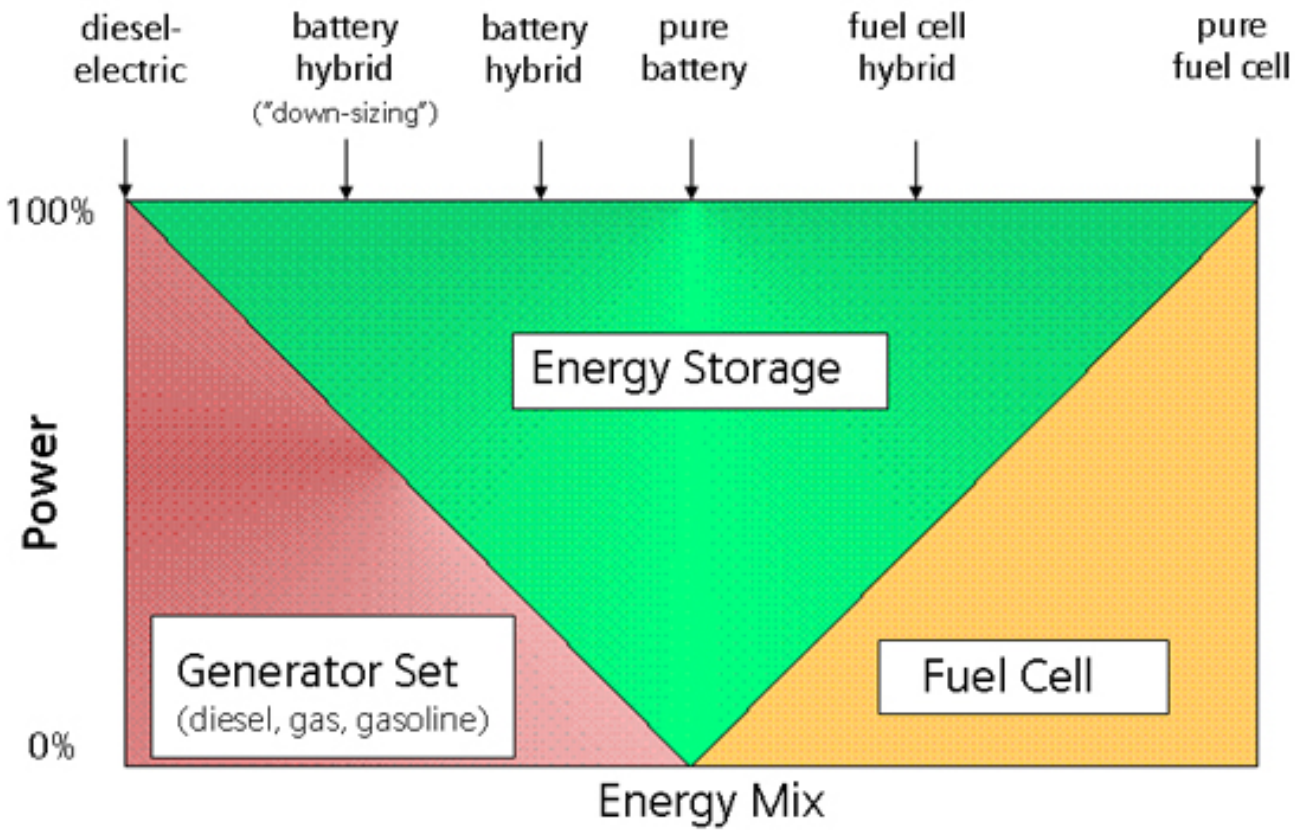

Figure 1. The entire range of vehicle operation.

For a quick technical rundown refer to Figure 2. Starting on the left, the negative electrode makes the hydrogen carry a positive charge (H+). This process creates the negative electron (E-) that powers the bus. The membrane only allows the H+ to pass through which is combined with oxygen (O) and the electrons that are flowing back from the bus. The fuel cell then expels the only emission, H2O or water. The power from the fuel cell combined with the battery power determines the power available to propel the bus. This is great for forward motion, but what about slowing down? In a car, brake pads and discs slow the vehicle down, but in our case we take this opportunity to regenerate electricity. This regeneration is done with an electric motor that takes the momentum and transfers it to electricity. This is a great advantage since the battery is charging and the brake pads are being saved, thus reducing maintenance.

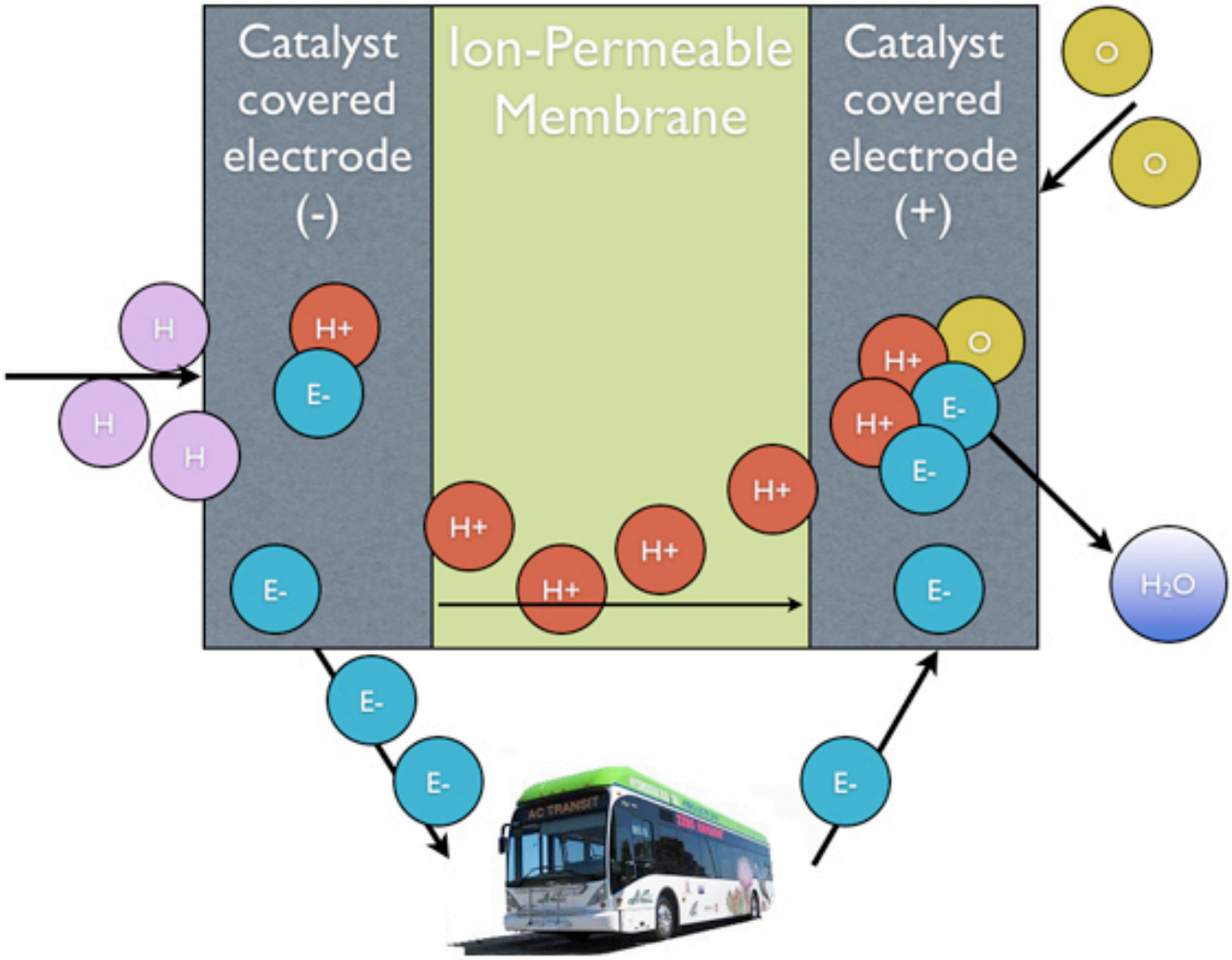

Figure 2. Typical hydrogen fuel cell operation.

Reducing emissions and reusing energy that would otherwise be wasted and emitted as heat is a great combination in the overall goal of reducing carbon emissions and increasing fuel efficiency. Siemens Large Drives-Traction group builds drives for light and heavy rail vehicles as well as buses and other large vehicles. For many of these vehicles it integrates hybrid technology with ELFA technology, which consists of the electric drive portion of the vehicle. Although the Large Drives Hybrid division works mostly with buses, the technology will work for any large application. The ELFA inverters take the electricity from the energy storage and the fuel cell then invert it to a usable energy for the ELFA motors. This is the most basic layout of the entire system, which is all controlled with Siemens software. The software interacts with the vehicle data -- fuel cell and battery management, operator controls, etc. -- to make the bus operate as closely to the conventional style as possible.

Figure 3. The new fuel cell bus for AC Transit.

Conclusion

There is no doubt that the electric vehicle is the wave of the future. With zero emissions, and lower maintenance costs there is no comparison to conventionally powered vehicles. Initially, battery-powered vehicles offered the most viability. Even better is to make possible large vehicles, like buses and trucks, that run continuously for hours on a fuel cell that does not require frequent recharging. To get there, greater funding for fuel cells and associated technologies is essential.

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