

## We Have the Power: Alternative Fuels for Alternative Vehicles

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The amount of energy consumed by automobiles increases every year as our appetite for convenient food delivery, one-day shipping, and personal travel grows. The majority of these vehicles are powered by **fossil fuels** like gasoline or diesel, which are derived from the remains of living organisms from millions of years ago. We have a limited supply of fossil fuels on earth, and when they are burned, fossil fuels release **greenhouse gases** like carbon dioxide (CO<sub>2</sub>) that are known to cause global warming. In this article, we discuss potential alternative fuels that could be the key to our society's future transportation needs.

### How do “normal” cars run?

Regular cars have an internal combustion engine that burns a fuel, most commonly gasoline, to convert chemical energy to heat. The hot gases expand and push on a rotor within the engine, converting the heat to mechanical energy and spinning the car's wheels. Modern engines are more efficient than their predecessors when burning fuel, but we need renewable and clean fuel sources to meet the ever-growing transportation demands of our society without contributing to further climate change.

### What about electric vehicles?

Electric cars, like the Tesla Roadster, operate differently than cars that rely on an internal combustion engine. Instead, these types of vehicles run on large batteries that power an electric motor to spin their wheels. The main feature of these electric vehicles are their **rechargeable** batteries, which are usually lithium-ion based—the same type of battery used in a cellphone or laptop. While traditional cars produce CO<sub>2</sub> in their exhaust fumes, battery-powered cars produce no CO<sub>2</sub> emissions.

Hybrid electric vehicles like the Toyota Prius are a combination of a traditional car and an electric car: they use both fuel and electricity at the same time, making them more efficient than a traditional car, but still producing some CO<sub>2</sub>.

One area of research for electric vehicles involves improving battery technology for quicker charging and higher energy capacity. This would allow electric vehicles to be “refueled” as fast as a gasoline pump, and drive long distances comparable to traditional cars. A tank of gas provides an average of 400 miles of driving distance, while today's electric vehicles have a driving range of 100-300 miles per charge.

It's also important to make sure the electricity used to charge electric vehicle batteries comes from a renewable source. More and more local power grids are using solar panels, hydroelectric dams, or wind turbines to generate power, but many locations still burn coal or natural gas, releasing CO<sub>2</sub> at large power plants.

### What about biofuels?

Other forms of fuel, called **biofuels**, are made commercially from organic matter (aka **biomass**).

One common type of biofuel is ethanol, an alcohol made from sugars found in corn and other grains. Ethanol produces much less greenhouse gas than fossil fuels when it is burned, so it may be a suitable alternative to fossil fuels. Ethanol can be mixed with gasoline or diesel to increase its eco-friendliness, or used by itself. However, burning ethanol only yields about two-thirds as much energy as burning the same amount of gasoline. Likewise, scientists have produced conflicting studies on the **ethanol fuel energy balance** — if producing enough ethanol to replace fossil fuel uses more fossil fuel than just burning it directly. The most recent studies do indicate a net energy gain, depending on the ethanol production method.

Another type of biofuel is known as biodiesel. Considered to be renewable, it can be easily made from various vegetable oils (e.g., soybean, corn, canola oil), recycled cooking oil/grease, or animal fats.

Despite their promise as a renewable source of energy, all biofuels are produced from plants. Some argue that biofuels may help reduce the amount of CO<sub>2</sub> in the atmosphere, since plants consume CO<sub>2</sub> and convert it into biomass as they grow. However, this reduction is only temporary, as the CO<sub>2</sub> is released once the biofuel is burned. Also, growing crops to produce biofuels requires farmland that is being used to grow food, potentially increasing deforestation.

### **What is a hydrogen fuel cell? How is it different from a battery?**

Another alternative is the hydrogen fuel cell. These power sources work by converting hydrogen and oxygen gases into water, releasing electrons to produce electricity. Besides water, the only other byproduct is heat!

However, despite the clean nature of hydrogen fuel cells, there are some concerns: How safe is it to ride in a car with a tank of pressurized gas? What if the hydrogen and oxygen, which are both highly combustible, are released during a car accident? Can we produce the hydrogen and oxygen using clean electricity?

While a handful of fuel cell-powered cars, trucks, and buses are already on the road, there is not enough **infrastructure** to support this technology. In order to compete with gas stations, hydrogen tanks must be able to be filled quickly and easily, but as of 2018, there were only 337 hydrogen fueling stations worldwide. Engineers, scientists, politicians, and even the general public must work together to create better infrastructure before society can adopt cars powered by hydrogen fuel cells.

Photo credit Department of Energy EERE

[http://www1.eere.energy.gov/hydrogenandfuelcells/presidents\\_initiative.html](http://www1.eere.energy.gov/hydrogenandfuelcells/presidents_initiative.html)



### **A bright future for solar cars?**

Another option for renewable transportation is a solar car. Unlike electric vehicles that plug into the grid like an appliance, solar cars use solar panels to generate electricity that directly powers a motor or charges a battery. The Clean Energy Institute at the University of Washington incorporates a solar car activity as part of its science outreach efforts, where small solar panels are used to power toy-sized car models. But will it be possible to power a full-sized car with solar panels? That depends on whether enough solar energy can be captured to power it. The larger the solar panel, the more sunlight can be harvested — but with current technology, powering a whole car requires a pretty big panel.

Recently, the RAHS Green Energy Team from Raisbeck Aviation High School in Tukwila, WA won first place at the 2019 Solar Car Challenge (Advanced Division) by completing almost 1000 miles with an average speed of 32

mph—the longest distance for any team in the competition. Their winning vehicle had a solar panel measuring 16 ft long by 6 ft wide and had 604 cells—giving it a surface area of over 90 square feet. Weighing in at 550 lbs, its battery pack consisted of 476 lithium ion cells. Solar cars employ a variety of engineering principles such as aerodynamic design, use of lightweight materials, and very compact sizes. All these serve to increase its energy-use efficiency to maximize driving range.

Powering a car with solar panel raises some questions: how will people drive at night if their vehicle relies on solar power? How about when driving on cloudy days? Would transporting more people require a vehicle with a much larger solar panel? Can solar cars achieve the same level of performance (top speed, acceleration, etc.) as other types of vehicles?



Photo credit: [www.rahsgreenenergy.com](http://www.rahsgreenenergy.com)

### Final thoughts

There are a variety of options available to help reduce society's reliance on fossil fuels for transportation. However, before committing to a specific strategy, we must carefully ponder their pros and cons before applying them. Of the current technologies available, electric vehicles are the most well-developed, although biofuels have progressed consistently over the years. Likewise, much research and investment has been made into solar energy, including building the infrastructure and modernizing power grids. Perhaps, rather than pursuing only one type of alternate energy, we should use a combination that takes advantage of the best qualities of each. But this will take time, dedication and effort. Nevertheless, you have the power to help achieve this goal.

### Let's discuss!

- 1) How do existing electric vehicles compare to current gas-based cars?
- 2) How are fuel cells better for the environment? In what ways could they be harmful?
- 3) How does biofuel help solve the problem with fossil fuels? In what ways will it not help?
- 4) What are the main limitations of using solar cars?

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