Hybrid Cars
Versus
Conventional Cars

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Hybrids, Hybrids Everywhere…

As Americans become increasingly more concerned about global warming, many are making choices about the vehicles they drive based on fuel economy and tail pipe emissions. Hybrid sales have increased 313% from 84,199 cars in 2004, to 347,102 in 2007.

Driving a hybrid might make people feel better for helping the environment, but is it really better for our planet? The answer it seems, is, "it depends." It depends on who is doing the evaluating and what the criteria are. When I started this analysis, I expected to find overwhelming evidence in favor of one category or another. Instead what I found was a lot of confusing information. The confusion arose because different groups focused on different aspects. Most analysis focused either on economics, (i.e. how much money the owner would save over time) or consumption, (i.e. how many gallons of fuel the car would consume over its useful life), but in nearly all cases, the analysis was confined to the period of time during which the car would be driven. What went into making the car and what happens to it after it's been abandoned by its owners was largely ignored, and I suspect it's ignored because it's so hard to evaluate.

I found this to be a very consistent theme in the rating systems of all products I've researched. Even Energy Star, which ranks household appliances, focuses on energy consumption during use, but the energy to produce, estimated useful life and eventual disposal, is largely ignored. This leads to an incomplete and sometimes inconsistent perspective to consumers.

One organization that focuses on the full life cycle analysis of automobiles is CNW Marketing in Bandon, Oregon. Founded in 1984, CNW is a for profit market research company that specializes in the automotive industry. In 2001, they pioneered a life cycle analysis of the auto industry in an annual report they called, "Dust to Dust".

In this report, CNW collected data on the energy consumed to plan, build, sell, drive and eventually dispose of a vehicle. They followed it from initial concept to the junk yard. They even took into consideration small details such as the distance from manufacturing plant to dealership, the average distances between employees' homes and the factory where the cars were built. They also considered the method of transportation employees take to get to work, (i.e if mass transit was available and utilized).

Worth noting is that CNW excluded economics from their analysis. The economic cost to build a car and run and maintain it was completely ignored. Also ignored were the environmental impacts of materials. If one car required less energy to produce but incorporated hazardous substances, it scored better than a car that required more energy but used benign materials. CNW focused strictly on energy consumption.

For 2007, 284 cars were evaluated. The average energy rating for all cars was 2.54 per mile. The car with the highest energy cost was the Mercedes Maybach, with an energy factor of 15.97. The car with the lowest energy cost was the Mercedes Smart Car, with a score of 0.58. Worth noting was the average for all hybrids was 3.41, which was significantly worse than the average. The best in the hybrid group was the Toyota Prius which scored 2.19. According to their analysis, hybrid vehicles cost more in terms of overall energy consumed than conventional cars. One of the reasons hybrids score so poorly is because of their complexity to manufacture, repair, replace, and dispose of batteries and electric motors, (which exists in *addition* to a conventional engine). Hybrids are also more difficult to recycle.

For example, the Honda Accord hybrid scored 4.23, but the regular non hybrid Accord with a conventional gasoline engine scored a 1.96. Over the course of its lifetime, the Accord hybrid is expected to consume more than twice the energy of it non-hybrid sibling. The non hybrid has a 2.4 liter, four cylinder motor rated at 166 horsepower. The hybrid has a 3.0 liter, six cylinder engine rated at 255 horsepower. The hybrid also has an additional electric motor and batteries. The hybrid achieves 29 miles per gallon in the city and 37 miles per

gallon highway as compared to 25 in the city and 35 on the highway for the non hybrid. The hybrid version cost almost $10,000 more than the non-hybrid. Again, economics were not considered in the study, but the price alone should give some indication of the cars increased complexity. In 2008, Honda abandoned manufacture of the Accord Hybrid.

The Backlash…..

CNW's automotive research was sold largely to the auto industry executives and companies that supply the auto industry. It wasn't until 2005, when word got out that CNW's annual "Dust to Dust" report listed the Hummer H3 as reportedly "better for the environment" than the Toyota Prius, that the company gained widespread attention. Environmentalists were outraged. They demanded that the details of the analysis be made public for further scrutiny.

CNW is a for-profit organization that charges a fee for their analysis. They believed that publishing their calculations would open them up to competition they would rather avoid. They did disclose some information to the general public and their critics. CNW also pointed out that they never said the Hummer was better for the environment, only that it would consume less energy from a cradle to grave perspective.

In fairness to CNW's critics, the life cycle energy rating is largely dependent on the products useful life. The Hummer was assumed to have a useful life of 200,000 miles, whereas the Prius was assumed to have a useful life of only 109,000 miles. The environmentalists believed that these "projected life cycle miles" were unsubstantiated and pointed out that a small change in miles can have a huge effect on the overall energy rating. CNW countered that their mileage were real world estimates based on actual driving conditions and interviews with owners. After interviewing many Prius owners, CNW determined that the average miles driven were only 6,700 per year. This equated to a useful life of just over 16 years, which CNW pointed out exceeded Toyota's life expectancy for the Prius' batteries, which is between 10 and 15 years.

The same criticism was noted for the Honda Accord as well. The hybrid Accord was assumed to have a useful life of 117,000 miles, whereas the non hybrid Accord had a useful life of 209,000 miles. Change the miles and the ratings can change quite dramatically.

CNW continues to point out that if what is important to consumers is fuel economy and tail pipe emissions, then hybrids do make sense during their useful life, but taking into consideration the "bigger picture", hybrids don't measure up where most consumers think they should. Many consumers perceive sport utility vehicles as "bad" because of their lower fuel economy and perceived inefficiency as a method of transportation, but many of these vehicles are easy to produce, have a long useful life and are easy to dissemble / recycle. So, their impact on the environment is not as bad as originally thought. CNW also points out that like many other things, the simplest design is often the best design and the cars that score best on CNW's list are simple, low technology cars, that have long useful lives.

Keep in mind that CNW ignored economics and the environmental impact of materials used. Had CNW incorporated an auto manufacturer's monetary investment of profits into green technology versus another's deliberate use of hazardous materials, it would have made the analysis incredibly complicated. If anything, the controversy surrounding CNW's report illustrates out how difficult it is to assess the overall green nature of any product.

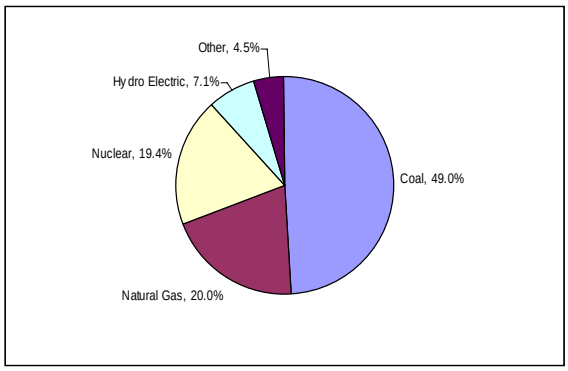
Energy Life Cycle Assessment – CNW's 10 Most Efficient versus Hybrids

Top 10 Most Efficient Cars	
2007 Models	**Dust to Dust Per Mile**
Mercedes SMART	0.583
Saturn Ion	0.621
Ford Focus	0.621
Chevy Cavalier	0.655
Jeep Wrangler	0.656
Scion xB	0.683
Chevy Aveo	0.693
Scion xA	0.713
Pontiac Sunfire	0.732
Toyota Corolla	0.748
Industry Average - All Models	**2.538**

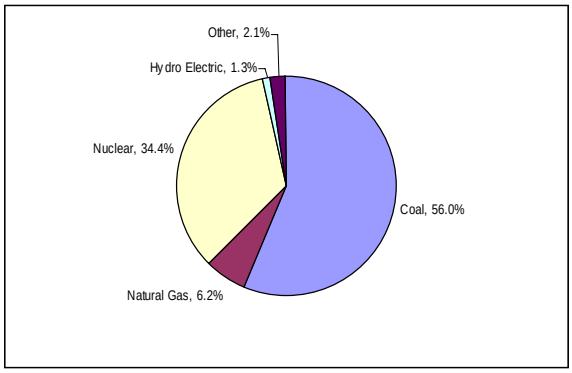
All Hybrids	
2007 Models	**Dust to Dust Per Mile**
Toyota Prius	2.191
Ford Escape Hybrid	2.747
Honda Civic Hybrid	2.943
Toyota Camry Hybrid	3.042
Toyota Highlander Hybrid	3.078
Ford Mercury Mariner Hybrid	3.412
Honda Accord Hybrid	4.228
Lexus GS450h	4.365
Lexus RX400h	4.661
Hybrid Average	**3.407**

The Electric Movement….

In 2010, Chevrolet is expected to introduce the Volt, a car that can be recharged like a cell phone and travel 40 miles on electricity before using any fuel. GM hopes that those with short commutes can use the car solely on battery power. Again, what's not taken into consideration is the "bigger picture" of where the electricity comes from. Just because it appears clean when it's recharging, doesn't mean that things aren't getting dirty somewhere else. A study in 2003 by the Institute for Lifecycle of Assessment determined that if an electric vehicle is recharged via a power plant that uses coal as its primary fuel source, than the impact to the environment would be no better than a conventional gasoline engine. According to the US Department of Energy, in 2006, the US derived 49% of its total electrical power from coal. The state of Pennsylvania derived 56% of its electrical power from coal. Again, these are both averages for both the US and the state of Pennsylvania. Energy source may differ by location within a state. I live in Vineland, New Jersey. Vineland has its own power utility. It is 100% coal fired.



U.S. Energy by Source

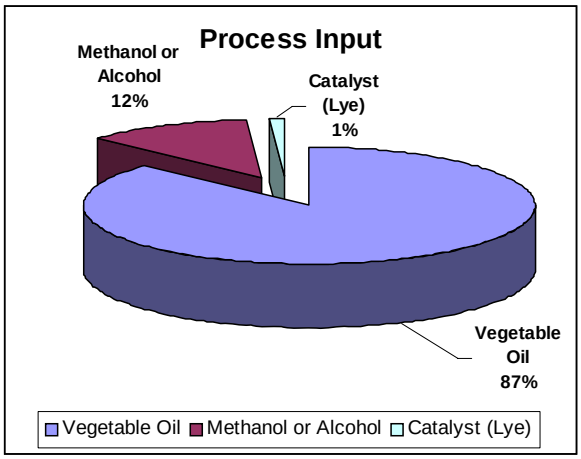


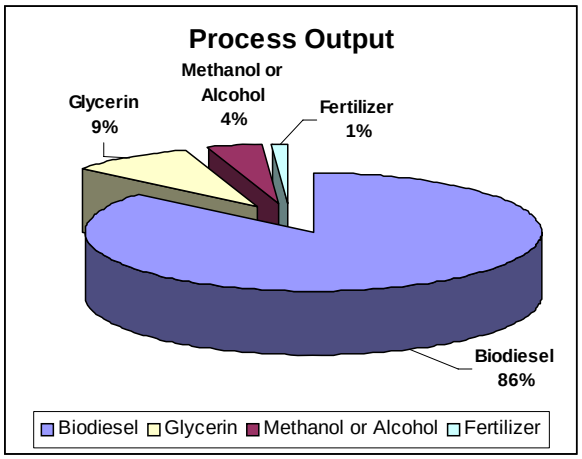
Pennsylvania Energy by Source

Choices, Choices Everywhere…

Gas? Electric? Ethanol? Alcohol? Diesel? Hybrid? With all the choices and incomplete information available to consumers, which choice is best, (and practical), for consumers who are interested in a sustainable energy source that minimizes harm to the planet?

In my personal opinion, the best energy choice for transportation that is currently available is biodiesel. Biodiesel is a renewable fuel manufactured from vegetable oils, animal fats and recycled cooking oils.





It can be burned in any current vehicle with a diesel engine as a replacement to conventional petroleum based diesel fuel. To make biodiesel, (see above), a catalyst, (Sodium Hydroxide), is used to mix methanol and vegetable oil to separate the glycerin. The end result is mainly a mixture of biodiesel and glycerin, with a small amount of methanol and fertilizer. The fertilizer is used in agricultural production. The methanol is returned back to the process input. The glycerin is a byproduct used in the manufacture of soaps and cosmetics.

Making biodiesel may seem complicated, but it is not, and can be done by anyone with limited knowledge of chemistry. Vegetable oils can be new or used and purchased from a grocery store or taken for free as waste oil from most restaurants. Methanol is made from methane, a naturally occurring chemical in the atmosphere that is caused when bacteria break down organic compounds. Methanol is also a commonly used racing fuel and can be purchased in bulk from fuel suppliers. The catalyst, Sodium Hydroxide, is the technical name for lye. Lye is also a natural product that is used in the manufacture of soap. It can be purchased as a drain cleaner available in most hardware stores. Those three ingredients and a little bit of heat are all that is needed to make biodiesel.

Biodiesel is significantly better for the environment than conventional diesel because it is made from renewable resources and has lower emissions than petroleum diesel. It is less toxic than household table salt and biodegrades as fast as sugar. Since it can be made in the U.S. from renewable resources such as soybeans, it decreases dependence on foreign oil and helps support local farmers.

When the diesel engine was invented in 1890, its inventor, Rudolf Diesel, designed it to run on peanut oil. However, in the early 1900's petroleum based fuels were considered easier and cheaper to manufacture and the diesel engine was converted to run on a petroleum based fuel, (that later became his namesake). Diesel engines utilize high compression and are inherently more energy efficient than gasoline engines.

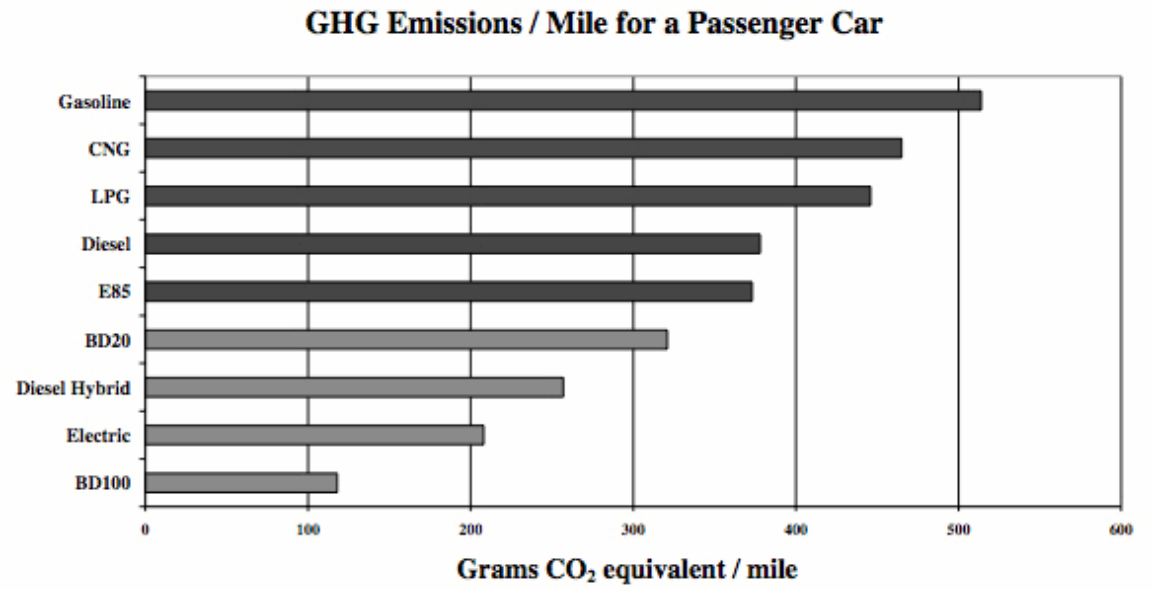
A recent analysis by RAND Corporation, a not for profit institution that studies challenges facing society, found that of the most common alternative fuels available, that a conventionally powered diesel car provides the greatest benefit to consumers and to society. They found that advanced diesel engines provide a slight edge over gas-electric hybrids and both diesels and hybrids were significantly better than ethanol, mainly due to the high cost and resource-intensive means of producing and transporting ethanol.

Green Car.com recently gave the 2009 Green Car of the Year award to the Volkswagen Jetta Diesel, beating both hybrids and ethanol powered cars. Earlier this year, the Jetta TDI set a new Guinness World Record for lowest fuel consumption. It averaged 58.8 miles per gallon as it traveled through 48 contiguous states. Imagine the environmental impact if the Jetta were powered by biodiesel instead of conventional diesel. The EPA estimates that if advanced diesels such as the one that powers the Jetta were used in one third of all light duty vehicles in the US, it would save almost 60 million gallons of oil per day.

The Advantages of Biodiesel….

The benefits of bio based fuels are numerous. Most notably, they are significantly less pollutive than petroleum diesel. In a study conducted by the Environmental Protection Agency in 2002, they found biodiesel to have 67% less unburned hydrocarbons, 48% less carbon monoxide, 47% less particulate matter, 100% less sulfates and 50% less ozone smog than conventional petroleum based diesel. They did however; find a 10% increase in NoX, (Nitrous Oxide), emissions.

A life cycle study on Green House Gas emissions per mile by Harvard University in 2001 found that cars powered by biodiesel, (BD100), produced the lowest emissions.



Another advantage to biodiesel is that it is a renewable and sustainable fuel made from plants and animal fats. So long as there is the ability to grow plants and animals, there is the opportunity to make biodiesel. Studies have also found that biodiesel has better lubricating capabilities than conventional diesel fuel, which contributes to increased engine life. Use of biodiesel reduces our reliance on foreign countries and places greater reliance on American farmers. Lastly, from a practical perspective, there is no expensive infrastructure rollout necessary to make biodiesel work. It will function in any conventional diesel

engine that currently uses petroleum based diesel fuel with no problems and can even be blended with petroleum diesel without harm.

The Disadvantages of Biodiesel…

Unfortunately, biodiesel retains some of the physical characteristics of its source material, most problematic being its narrow temperature range. Most plant oils and animal fats gel or coagulate at around 50 degrees Fahrenheit. Even after processing out the glycerin, biodiesel will gel at around 32 degrees Fahrenheit, which means it can only be used in warm climates, can only be used in the summer, or if it is to be used year round, it must be blended with kerosene or diesel fuel to retain some of the latter's cold weather capabilities.

Another disadvantage to biodiesel is that it can only be used in a diesel engine. Currently, less than 2% of the cars in the U.S. have diesel engines. The majority of cars and light trucks in the U.S. are powered by gasoline. Until the diesel engine makes a comeback in the U.S passenger car market, its use is limited to large trucks and heavy equipment. Worth noting too, is that biodiesel, though significantly cleaner than petroleum diesel, is still not environmentally perfect. Until a cleaner fuel source, like hydrogen, whose emissions are water and oxygen, become commercially and practically available, this is the best that is currently available.

As stated earlier, biodiesel is made from plant oils and animal fats. If farm crops are diverted from human consumption in favor of fuel production, then biodiesel can raise the prices of soy and rapseed in much the same way that ethanol increased the price of corn. However, unlike ethanol, biodiesel can be made from waste oil after it has made its way through the food supply. In this way, (and unlike ethanol), biodiesel can convert a waste product instead of decreasing a food supply.

Another weakness to biodiesel is its perception as a commodity. Commodities compete solely on the basis of price. As the price of petroleum based diesel drops, biodiesel makes little to no economic sense.

Biodiesel is not free. Even in instances where it is made from food waste or byproducts, there is still a conversion cost and that cost often exceeds the price of petroleum diesel. At best, on a commercial scale, biodiesel is a "break even" business, which is of little interest to the investment community. Biodiesel production centers exist largely though financial assistance from the government. For this reason, almost all large scale biodiesel production centers are not-for-profit oriented, or exist solely to service municipal vehicles.

Making it Personal…

The most successful application of biodiesel appears to come from "home brewers" – people like me who have crafted processors in their garages and basements and make biodiesel from waste vegetable oil collected from the dumpsters behind restaurants and schools. For this group, biodiesel is largely a hobby, supported by a grass roots community who are frugal, environmentally conscious, interested in renewable energy, and making a political statement. They make biodiesel in much the same way that people home brew wine or beer for personal consumption.

Ironically, the only obstacle to this group seems to be the U.S. government. Uncle Sam has "green" ideas of his own. In the US, Federal and State fuel taxes combined can make up as much as 15% to 20% of the total fuel price paid at the pump. When a home brewer makes biodiesel, no road taxes are paid. There have been numerous instances of "biodieselers" being threatened by the government with fines and imprisonment. Legislation surrounding biodiesel production for home consumption is still unclear.

In Conclusion…

Biodiesel production has increased dramatically in the past 5 years, with annual production rising from 5 million gallons in 2001 to an estimated 500 million gallons in 2007. However, this is not even a drop in the bucket when compared to the 840 million gallons of oil the U.S. consumes PER DAY! There are simply not enough plant oils and animal fats on earth to sustain the U.S.'s

current level of demand. A long term solution must include some way to decrease consumption.

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