

## **Hybrid Electric Vehicles: Consumer Misperceptions**

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**Abstract** Many efforts have been made to reduce emissions into the atmosphere in the past 25 years, however the number of cars on the road and the average number of miles driven has been steadily increasing. Vehicle exhaust accounts for almost half of the ozone forming emissions produced in California. A mass switch-over to HEVs would reduce emissions into the atmosphere and reduce US dependence on foreign oil. Hybrid electric technology is expensive, and despite government subsidies and tax breaks, the cost of HEVs to consumers remains \$3000 - \$10000 higher than comparable vehicles. Many public outreach programs have been created to overcome public misconceptions in order to undermine the high cost of HEVs. This study showed that the public still has many misconceptions regarding HEVs, primarily regarding how HEVs compare to gas powered vehicles and how HEVs are maintained. Information pertaining to public awareness was gathered at Honda and Toyota (the two manufacturers that offer HEVs) dealerships via questionnaire survey. The data showed that about a fifth of the participants had never even heard of HEVs. Most of the participants who knew of HEVs, however, indicated that HEVs are worse than conventional vehicles with respects to performance and maintenance and thought that HEVs need to be plugged in overnight for recharging. Overcoming misconceptions such as these could help increase sales of HEVs. Public outreach programs have been successful, but a mass advertising and education campaign could prove to be even more beneficial.

## **Introduction**

Air quality in California has improved dramatically over the past 25 years, largely due to continued progress in controlling pollution from vehicles. Despite this progress, the number of vehicles driven continues to grow and people are driving an increasing number of miles (Wouk, 1995). Well over half of the ozone-forming emissions produced in California come from the tail pipes of vehicles (Hushcroft, 1993). Vehicle use accounts for 44 percent of the nation's average oil consumption of 19.8 million barrels per day. A 50 percent increase in the average miles per gallon of cars and SUVs would lead to a 5 percent decrease (one million barrels less per day) on oil imports (Reuyl, 1996). The Partnership for a New Generation of Vehicles was created as a government and industry effort aimed at making more fuel efficient automobiles (Reuyl, 1996). They first focused on creating a zero emissions electric vehicle, but couldn't develop batteries that would last for more than 80 miles of travel before needing recharging (Shimizu, 1993). Hybrid electric technology proved to be a more practical alternative to gas engines in terms of capabilities and fuel efficiency compared to electric vehicles. Hybrid electric technology increases gas mileage and reduces emissions using an electric motor that works in conjunction with the internal combustion engine. Hybrid electric vehicles (HEVs) feature cutting-edge technology that is costly to manufacture, so even after government subsidies and tax credit for buyers they are not competitively priced. The high cost, along with misconceptions of HEVs due to exposure to old outdated technologies and misleading stories in the media (Urban, 1997) offer obstacles for HEV market success. The high production and consumer costs for HEVs will decrease as the demand for the new technology increases, as is the case with most technologies introduced to the market (Wienberger, 1991). The high costs are a fixed obstacle for the time being, but something can be done to increase public awareness and invalidate misconceptions. Effective marketing strategies are essential in order to increase the demand for HEVs. Although many efforts have been made by state agencies such as the Air Resources Board and the Department of General Services to increase awareness about HEVs (Urban, 1997), this study attempts to show that the public still has many misconceptions which in turn hinder market success.

HEVs aren't necessarily identical in their operation. But in simplistic terms, their systems are similar. An internal combustion engine provides the basic propulsion for the hybrid vehicles but is aided by an onboard electric motor. How and when the electric motor assists can differ,

however (Wouk, 1995). For example, in the three different models of HEVs available to the public currently, the electric motor provides torque for the front wheels right at the start of acceleration from a standstill. As the car picks up speed, the internal combustion engine kicks in, and at top highway speeds the gas engine alone provides the power ([www.energy.gov](http://www.energy.gov)). In another type of HEV an internal combustion engine is the sole power source for the rear wheels, while an electric motor provides added power to the front wheels when needed. To date, only three HEV models are currently available in the US – the Toyota Prius, the Honda Insight, and most recently a hybrid version of the popular Honda Civic. These models are comparable to conventional vehicles (CVs) in terms of performance and handling ([www.energy.gov](http://www.energy.gov)). They have better initial acceleration due to the torque from the electric motor which doesn't rely on a certain rpm level to be reached before high torque is achieved as with gas engines (Wouk, 1995). Tests comparing the performance of HEVs to CVs showed that HEVs are comparable to popular vehicles such as the Toyota Corolla and Honda Accord in terms of acceleration. These models are comparable to conventional vehicles (CVs) in terms of performance and handling ([www.energy.gov](http://www.energy.gov)). HEVs produce some emissions unlike electric vehicles, but they are greatly reduced in comparison to conventional vehicles. HEVs are certified better than the SULEV (super ultra low emissions vehicle) level – they are certified at the 'green' level (Wouk, 1995). The hybrids available today cut emissions of global warming pollutants by a third to a half, and later models may cut emissions by even more ([www.energy.gov](http://www.energy.gov)). In addition, the Toyota Prius, Honda Insight, and Honda Civic can turn off their engines when the vehicles are at rest – for example, when they're waiting at a stoplight. This not only saves on fuel but cuts emissions. Also, HEVs never need to be manually recharged; the batteries are continuously recharged while the vehicle is being driven (Wouk, 1995).

Much market research has been conducted in order to study vehicle purchasing factors and patterns of consumers. Most published advertising studies range from content analysis and qualitative investigations of consumer perceptions to statistically sophisticated econometric modeling (Shimitzu, 1993). Virtually all of this research tends to fall into two broad categories: a) assessments of the influence of various types of advertising appeals or messages on consumer attitudes and b) studies of specific market segments. As an example of the first category, a study by Urban (1997) tested automobile advertisements using statistics against advertising without statistics. He concluded that consumers considered the advertisements containing

statistics to be more effective. In the second category of studies, researchers have focused on differences between types of consumers as defined by various segmentation variables. HEVs feature cutting edge technology – for some customers, this is a positive benefit. The manufacturer marketing strategies used in early demonstration programs focused on “early adopters” and “techno champs” for that reason (Thione, 1993). For other customers, however, the introduction of new technology is cause for hesitation. Such customers will need additional information and consultation. They will also be very sensitive to any perception that the HEV market has no future (Sukhdail, 1995). A survey study conducted by the Office of Transportation Technologies (OTT), a branch of the Department of Energy, showed that the customer’s willingness to pay a premium for fuel economy and emissions improvements is limited. By combining the results of several surveys, they further found that fuel economy has not been an important consideration since the mid-1980s ([www.energy.gov](http://www.energy.gov)). The Electric Power Research Institute (EPRI) conducted a study on people’s propensity to purchase HEVs before and after obtaining a better understanding of the various options and the attributes HEVs could offer. Their results showed that the focus group in their study were more interested in purchasing an HEV once they were made aware of the advantages (Reuyl, 1996). These studies show that information about the impacts of driving on the environment and awareness of the benefits of HEVs are key to the market success of HEVs.

In order to develop a sustainable market for HEVs, sales need to be increased by advancing awareness about the new technology and the benefits it offers. Many people are unaware of the capabilities of the new production HEVs on the road today. Most people have misconceptions about HEVs. These misconceptions are partly due to exposure to old outdated technologies or misleading stories in the media (Urban, 1997). The perception of electric vehicles being slow, unable to travel long distances, and in constant need of recharging has been extended to HEVs (Thione, 1993), and this association needs to be dispelled. HEV stakeholders have taken significant steps to get the word out about HEVs. To date, the Air Resources Board (ARB) and Department of General Services have been very proactive in conducting public outreach to schools, community events, and community groups. The Sacramento Municipal Utility District (SMUD) has produced excellent outreach materials providing information on HEVs. SMUD also showcases HEVs at local schools and community events in order to increase awareness. The US Department of Energy has formed a group called the Green Vehicle Marketing Alliance

to address and promote green vehicle marketing. This group is made up of representatives of the auto industry, federal, state and local government agencies, environmental and consumer organizations. These stakeholders come together to form an improved mutual understanding of the challenges of and opportunities for marketing environmentally friendly vehicles (Fukuyama, 1992). These efforts have advanced awareness of HEVs, but many people remain in the dark about the advantages and benefits of HEVs. This study will attempt to a) show that public knowledge regarding HEVs is low despite the public awareness advancing efforts and b) emphasize the importance of a mass advertising campaign to advance sales of HEVs.

## **Methods**

HEVs offer important benefits over CVs – reduced emissions and increased fuel efficiency while maintaining the performance and capabilities of gas powered cars. Their high cost is a fixed barrier for market success until demand for HEVs increases. The public's misconceptions also serve as a barrier; however, misconceptions can feasibly be overcome in a short period of time. A survey was designed for this study to ascertain the public's perceptions on HEVs. The survey gathered information regarding if and where the participants heard about HEVs; what style of car interests them the most; what factors are most important to their car buying decision; and how much more, if any, they are willing to pay for an HEV. It asked participants to compare HEVs to conventional vehicles in terms of performance, maintenance, environmental impacts, and purchase price. It also tested the participants' knowledge of how HEVs are maintained, how they work, and where they are available. At the end of the survey, participants were asked for a rough estimate of their household income and age.

The survey was administered by the author outside of two different car dealerships from March 24 to April 6 during peak hours (11 am – 4 pm as suggested by the managers at the dealerships). The survey was handed out to people passing by and entering the dealerships located in Berkeley: Doten Honda and Toyota of Berkeley, both found on Shattuck Avenue in Berkeley. A sample size of 100 was chosen due to time constraints - 98 surveys were completed.

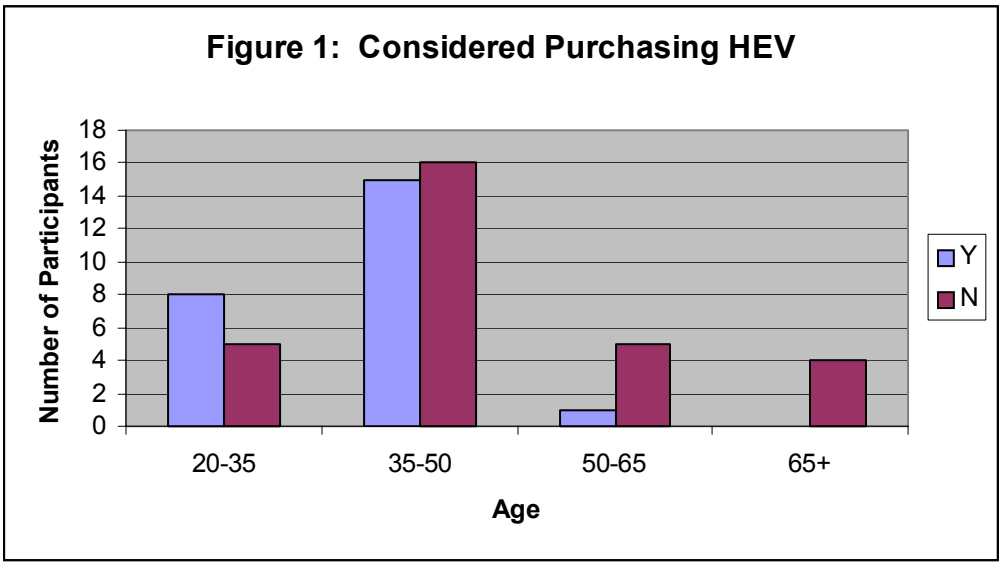
The data was first divided into two categories: those who had heard of HEVs and those who had not. The surveys completed by those who had never heard of HEVs were of no more use

other than to show how many participants are completely clueless about HEVs. The remainder and majority of the surveys were analyzed statistically using the chi-squared test. Age and income were treated as the independent variables and the misconceptions and interests were treated as dependant variables. The chi test was used to determine associations between age and income and each of the common misconceptions (questions 8-15). Also, the chi test was used to determine associations between age and income and the participants who have considered HEVs as a possibility for their next vehicle purchase (question 4). Percentages were calculated for: where most participants got their information regarding HEVs (question 2); the type of vehicle most participants want to purchase (question 3); the most important car purchasing factors (question 5); how many participants chose lower initial purchase price over increased savings on fuel and maintenance over time (question 6); the number of participants who would pay more, and how much more, for HEVs (question 7); and the most common misconceptions (questions 8-15).

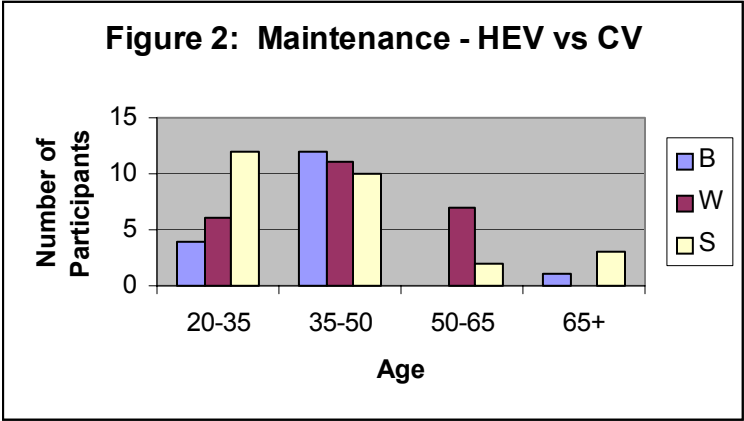
## **Results**

Of the 98 participants, 20% had never heard of HEVs. The statistical tests were conducted on the 80% who had heard of HEVs.

A chi-squared test revealed an association with a p-value of .07 between participant age and whether the participant had ever considered purchasing an HEV. Figure 1 shows that little over half (56%) of the participants aged 20-50 had considered it and about 80% of the participants aged 50 and up had never considered purchasing an HEV.



An association between participant age and their perception of HEVs versus conventional vehicles with regards to maintenance was shown using a chi-squared test resulting in a p-value of .02. Figure 2 shows that about half of the participants aged 20-35 indicated that maintenance costs for HEVs are the same as those for conventional vehicles. Participants aged 35-50 were split fairly evenly among 'better', 'worse', or 'same' responses for maintenance costs. 77% of the participants aged 50 and up indicated that maintenance costs are worse for HEVs.



An association between age and participant perception of how HEVs are powered was also found using a chi-squared test. Figure 3 shows 82% of the participants aged 20-50 and 50% aged 50 and up correctly indicated that HEVs are powered by an internal combustion engine with a p-value of .05.

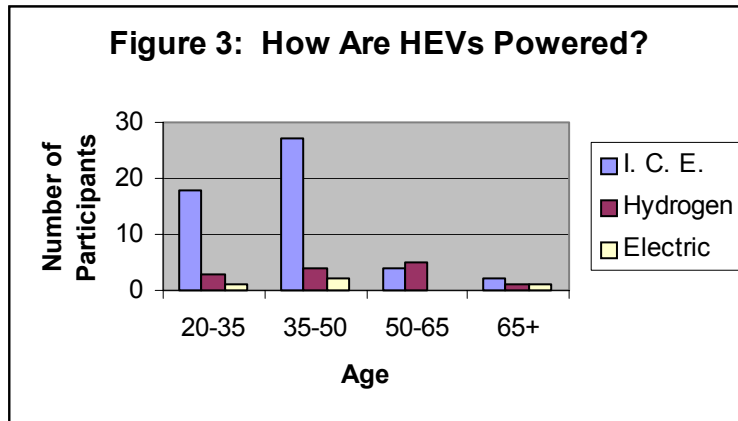
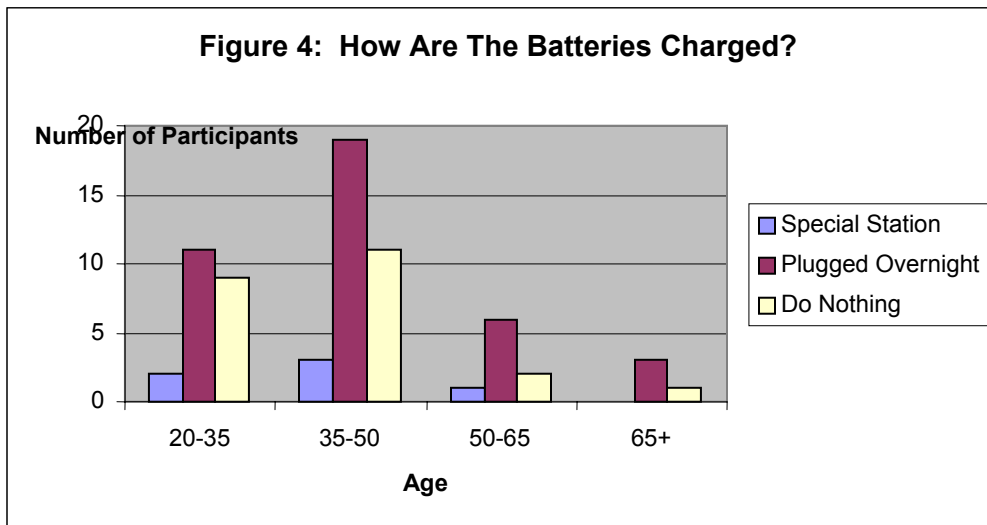


Figure 4 shows 57% indicated that HEVs need to be plugged in overnight for recharging and 34% indicated that nothing extra (compared to CVs) needs to be done to recharge the batteries for the electric motor.



Most of the participants knew where HEVs are available (83%) and that they cost more compared to CVs (73%).

Most of the participants had gotten their information about HEVs (participants were asked to indicate all sources they used) from magazines (64%) and the internet (57%). When asked to



indicate which type of car they're interested in (they were asked to check all that apply), 25% checked SUVs, trucks, minivans, and sports cars; 51% chose sedans.

The majority of participants (60%) preferred a lower initial purchase price to increased savings on fuel and maintenance over time. About 60% also indicated that HEVs perform (in terms of acceleration, handling, braking distance) worse than CVs.

All participants (with the exception of three) indicated that HEVs have better fuel efficiency and are better for the environment compared to conventional vehicles. Most of the participants ranked either reliability or performance as their most important consideration when deciding upon a vehicle.

The different misconceptions showed no association with income.

## **Discussion**

The results show that the majority of participants had misconceptions regarding HEVs. What most of the participants knew was where HEVs are available and that they cost more compared to CVs. They also indicated correctly that HEVs have better fuel efficiency and less environmental impacts. Apart from that, most of the participants had misconceptions about the maintenance and performance of HEVs. These are very important misconceptions because they are major factors that consumers consider when purchasing a vehicle (Thione, 1993).

The majority of the participants indicated that they would be willing to pay \$1000 - \$5000 more for an HEV version of a car that could meet all their requirements. This shows that people are interested in the environmental impacts of driving. The limited variability in models of HEVs is an obstacle for their market success; however, most of the participants indicated that they are interested in purchasing sedans, which is currently the only style of vehicle using hybrid electric technology. Also, for consumers who are discouraged by the HEV's unique or awkward appearance, the new hybrids will look no different from the styles of CVs they are accustomed to – for example, the new hybrid Honda Civic is simply a hybrid version of a popular vehicle. A very common misconception was that HEVs need to be plugged in overnight for recharging. The majority of the participants also indicated that they don't think HEVs perform as well as CVs, and performance was chosen as the highest ranking factor influencing their car buying decision. Overcoming these misconceptions regarding the maintenance and performance of

HEVs could lead to an increase in sales. Accurate information aimed at the public about the benefits and conveniences of HEVs is vital for their market success (Barber, 1993).

The survey for this study unfortunately did not contain very structured questions. The questions dealt only with basic interests and did not span a very wide range of misconceptions. Questions aimed at how the price and accessories of a vehicle influence people with varying incomes is just an example of how the survey could have been modified to produce more specific data which could then have shown some associations between income and the public's perceptions or interests. The public has many different perceptions of HEVs, and although the survey didn't show many associations between age and misperceptions, shortening the age gap in each of the age groups (i.e. grouping participants into ages 20-25, 25-30, etc. instead of 20-35, 35-50) could reveal more associations. The sample size for this study was small. A larger sample size could reveal more trends. The results of this study showed that the public probably still has some misconceptions about HEVs. Many agencies and organizations have tried to promote awareness of HEVs, but the information they provide it seems is not reached by everyone.

One way to overcome these lingering misconceptions would be to create and advertise for a web site that contains all the information the public could want regarding HEVs. The internet is used by people everywhere, and most of the HEV sites on the web currently provide varying information about HEVs. It might be confusing to consumers, for example, to see different values for how many miles per gallon HEVs travel from different sources. Creating a site with information from well known and respected sources for the public would be an easy way to overcome some misconceptions. Also, the information on the web site could be placed onto CD-ROMs and distributed at dealerships, community events, and schools. I feel this would be a very cost effective and efficient method of dealing with misconceptions.

Future studies could focus in on the politics behind the advancement of HEVs. In January of 2002, President Bush announced that he will no longer provide financial support to help the Partnership for a New Generation of Vehicles advance HEV technology. Instead he chose to support fuel cells which would be zero emissions vehicles, but they aren't expected to be widely available to the public for another decade or so (ENN, 1/10/02). Also in March of 2002, the Senate rejected a proposal to increase the average miles per gallon by 50% (ENN, 3/14/02). Consumer misperceptions and the high cost of HEVs can be overcome with time and effort, but

government support is also a vital part of the equation. Despite the withdrawal of government support, HEV manufacturers are still planning on coming out with new models of HEVs for the next couple of years. Future studies could try to show the importance of government support in the advancement of HEVs.

## References

Barber, K. F. 1993. An overview of the electric and hybrid vehicles R&D program at the US Department of Energy. Paper presented at the 10<sup>th</sup> International Electric Vehicle Symposium. December 3-5. Hong Kong.

[www.energy.gov](http://www.energy.gov) Department of Energy/Office of Transportation Technologies

[www.enn.com](http://www.enn.com) Bush abandons high mileage car program for fuel cell approach (1/10/02), Senate rejects hike in vehicle fuel standards (3/14/02). Environmental News.

Fukuyama, T. 1992. Fast Recharge Batteries and the Future Outlook for Electric Vehicles. Nissan Motor Company, Ltd. Transportation Research Laboratory, Japan.

Harbauer, W. 1992. Modern Drive Systems for Electric Vehicles – Criteria for Selection and Practical Application. Pp. 23-78 *In* EVS Vol 11, No. 3. Florence.

Hushcroft, Susan V. June 15, 1993. Electric Vehicles: A Key Element of California's Air Quality Strategy. Report for California Air Resources Board. IATSS Research..

Iguchi, Masakazu. 1993. Electric Vehicle Expectations and Popularization Policies. National Institute for Environmental Studies. IATSS Research, Vol 17, No 2: 45-54.

Renner, Roy A. 1986. The Hybrid Car Revisited. Proceedings of the 8<sup>th</sup> International Electric Vehicle Symposium, Washington, D. C., US Department of Energy.

Reuhl, J. S. April 22, 1996. Policy Implications of Hybrid Electric Vehicles. Final Report to NREL, Subcontract No. ACB-5-15337-01. Nevcor, Inc., Stanford, Ca.

Shimizu, Hiroshi. 1993. The New Possibility of Electric Vehicles. National Institute for Environmental Studies. IATSS Research. Vol 17, No. 5: 2-10.

Sukhdial, Ajay S. 1995. Measuring Values Can Sharpen Segmentation in the Luxury Auto Market. *In* Journal of Advertising Research.

Thione, L. 1993. Electric Vehicle Technology Prospects: Customer Needs and Industry Responses. Centro Elettotecnico Sperimentale Italiano, Italy.

Urban, David J. 1997. The Super Automotive Category Killer: What now? What future?  
Journal of Consumer Marketing, Vol 14: 14-33.

Wakefield, Earnest H. 1994. History of the Electric Automobile: Battery Only Powered Cars.  
Society of Automotive Engineers, Warrendale, Pa.

Weinberger, Marc. 1991. Negative Product Safety News: Coverage, Responses, and Effect.  
Business Horizons, Vol 34: 33-40.

Wouk, Victor. July 1995. EVS Unplugged: Hybrid Vehicles Boost Range But Not Pollution.  
IEEE Spectrum, Vol 32, No 7: 34-56, 104.