

An environmental and economic comparison between hybrid electric vehicles and pure internal combustion vehicles

**A Group Project Proposal to the Donald Bren School
of Environmental Science and Management,
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Introduction

Hybrid electric vehicles (HEV) arrived on the North American markets at the end of the last millennium. In 1999 Honda introduced the Insight, and in 2000 Toyota followed suit with the Prius. Since then Toyota has upgraded the Prius, and Honda has added a hybrid version of the Civic to its portfolio. Ford, GM and Chevrolet have all plans to offer hybrid gasoline-electric vehicles to retail customers. At this year's Detroit Motor Show the Prius was elected North American car of the year, and Honda announced that its Accord would become available as a hybrid this fall. At the same time, Robert Lutz, Chairman of GM North America and Vice Chairman of Product Development, stated that it makes no environmental and economic sense to have hybrid engines in cars other than SUVs and pickup trucks.

The proposed research will focus on HEVs based on internal combustion engines (ICEs). ICE-based HEVs combine a conventional ICE with an electric propulsion motor, which are used in parallel. In parallel hybrid systems, the vehicle can be driven by the internal combustion engine, the electric motor, or both. The electric motor is used partly as a generator to capture energy usually lost to the brakes, and it assists with acceleration, allowing for improvements in performance or downsizing of the ICE for additional efficiency benefits. Air pollution was, until recently, the primary concern associated with the combustion of fuel. Global warming and energy security are now becoming as or more important of an issue. Therefore, there is increasing pressure on government regulators and the auto industry to improve the fuel efficiency of motor vehicles and also to reduce the contribution from the transport sector to greenhouse gases such as CO₂.

HEVs based on ICEs are mainly marketed to customers looking for cars with high environmental performance. Most car buyers are sensitive to the environmental issues that surround the production and use of cars but are reluctant to pay price premiums in order to buy products that have above average environmental performance. While public surveys show customer willingness to consider buying a hybrid electric vehicle, even "green" customers appear to be lacking in knowledge of the true environmental benefits of acquiring a hybrid vehicle and even less certain about the optimal timing for doing so.

Project Objective

The project has the following four objectives:

- To compare the total environmental impacts of production, use and end-of-life management of an ICE-based HEV with a pure ICE vehicle.
- To compare the overall economics of purchase, use and maintenance of an ICE-based HEV with a pure ICE vehicle; especially the trade-off between price premium and fuel savings of hybrid technology.
- To assess the environmental and economic incentives for car owners to change from a conventional car to an ICE-based HEV.
- To investigate the most effective tools to communicate the findings from above and assist the decision making of car owners and buyers.

Project Significance

The rates at which the US fleet of road vehicles consumes fossil fuel and generates harmful emissions have massive adverse environmental consequences both locally and globally. This also means that improving the environmental performance of a significant part of the vehicle

fleet could dramatically lower the environmental impacts and costs of road transportation. The question is how best to achieve this. HEVs are believed by some to be a substantial part of the answer, but their true environmental potential is uncertain as is the technology. This makes it difficult for car owners and buyers to make informed decisions. Car owners and buyers are aware of the environmental problems caused by road transport but also very price sensitive. The economics of HEVs is therefore just as important as their environmental performance. By investigating both in a scientifically rigorous and quantitative manner the proposed project intends to create knowledge that will be of use to car owners and buyers, managers in the car industry and environmental and transportation policy makers.

Background

Hybrid technology, the advent of alternative motor vehicle fuels and vehicles such as dedicated natural gas vehicles, significant improvements in diesel engines for light duty vehicles, and the growing interest in fuel cells have all risen to the forefront in the regulatory and product planning arenas in the auto industry. The customer is a key to the success of any of these technologies. Yet, it is uncertain if the mass market is ready for these technologies, not only because of cost considerations and other issues such as refueling infrastructure, but also because of the shortfall of customer awareness regarding the merits of the technologies. The authors of this proposal strongly feel that this issue could benefit from a rigorous and independent scientific investigation in the form of a Bren Group Project. Honda has expressed interest in supporting this to supplement its own research.

Stakeholders

Honda has kindly agreed to be the client of the proposed project and will thus be its main stakeholder. However, because of the timely nature and large public interest of the issue potential stakeholders are all car owners and buyers, auto manufacturers, and environmental and transportation policy makers.

Scientific Approach and Data Availability

Due to the interdisciplinary nature of the research a range of methodologies will have to be employed from environmental sciences, industrial ecology, management science and economics. The scope of the environmental assessment requires a life cycle perspective. Data availability and the nature of the most prominent environmental impacts will guide the choice of life cycle methodology. The approaches necessary for an adequate economic assessment will be in agreement with the standards of microeconomics and management science. Risk and uncertainty, whether real or perceived, surround every market introduction of a new technology and will therefore also play a role in the proposed analysis. Much of the data necessary to conduct the proposed comparative quantitative assessments should be in the public domain, e.g. via published life cycle inventories, and relatively easy to access. Honda will serve as an additional and very valuable source of information.

References

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