

Hybrid Electric Vehicles



When I returned to the United States a couple of years ago after living in Singapore, I had no particular brand loyalty to limit my choice

of which new car to buy. But as an electrical engineer, I naturally wanted to evaluate a hybrid electric vehicle. As you will know from my previous writings in this column, the drive motor in this vehicle represents a major application for the use of neodymium-iron-boron magnets, one that is significantly pushing the demand for rare earths. So it is important to the magnetics industry to challenge projections such as Toyota's forecast of 2 million hybrid vehicles a year by 2010. And on a personal level, I decided to challenge the benefit to me of owning a hybrid.

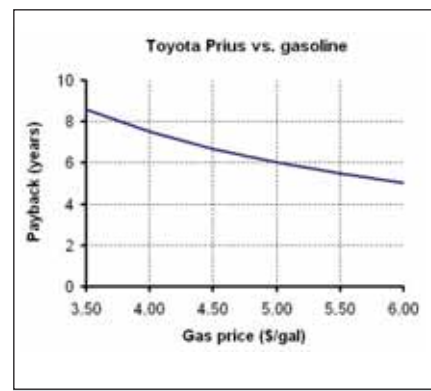
There is certainly a segment of car buyers with strong altruistic motives who will consider the environmental benefits regardless of the price premium, whether this is directly via a reduction in oil consumption, or indirectly by averting the need to produce ethanol with its unfortunate tendency to promote food shortages. A price premium in the range of \$6,000 to \$7,000 is inevitable for almost any type of electric, hybrid or fuel cell vehicle, due to all of the additional components that are required for any alternative drive to the simple gasoline engine. For those without a purely altruistic motive, the two most important attributes in considering a new car purchase today are the vehicle's price and its fuel economy. So if the sales of hybrid electric vehicles are to grow as aggressively as forecast

over the next few years, the price premium must have a payback over a reasonable period of time.

Most of the hybrid electric vehicles on the market today have equivalent gasoline versions, so direct comparisons on the basis of fuel economy are easy to make. But to be realistic, it is better to consider hybrids which are well-established in the market and whose price premium has had time to stabilize. I would also suggest that the comparison should be made on the basis of fuel economy in city driving rather than highway driving, for the simple reason that there is virtually no difference in fuel economy between hybrid and gasoline counterparts under highway driving conditions. Payback of a hybrid's price premium should be based almost entirely on its performance in city driving, which is commonly assumed to be 12,000 miles per year. This is ironic because, if the vehicle's use were for city driving alone, then it is likely that a wholly electric vehicle would suffice, but the gasoline engine is needed for those occasional extended journeys.

Toyota is the most established manufacturer of a wide range of hybrid electric vehicles, and I have chosen to use its popular Prius model as my example here. Its estimated fuel economy of 48 miles per gallon in city driving is far superior to that of a comparable small gasoline car, which gets about 27 mpg. With gasoline selling at \$4/gal, payback of the premium paid for the hybrid Prius is achieved in seven to eight years, but if gasoline rises to \$6/gal, this drops to about five years. And if it should rise further to \$9/gal, about that being paid for gasoline in Europe now, the premium is paid back

in only three years. There are several much more conventional vehicles of which Toyota's models include a hybrid version, and it is interesting to note that very similar paybacks are obtained both by a full-size car (such as the Camry) and by an SUV (such as the Highlander).



These relatively short payback periods indicate that many hybrids on the market today are already competitively priced against their gasoline counterparts, so aggressive growth projections such as that forecast by Toyota seem quite realistic, as does the significant demand for neodymium-iron-boron magnets for their electric drives. Furthermore, because the payback periods seems so easily in reach now that gasoline prices have risen steadily, it doesn't appear that the current high price of rare earths will be much of an impediment to their continued demand in this application.

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