How much fuel do you save with a hybrid SUV?

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2006 Toyota Highlander Hybrid. ©Toyota

Hybrids are getting heavier, but they seem to bear their weight better than conventional vehicles when it comes to fuel efficiency, according to a recent study. In the study, the scientists found that the trend toward higher-performing hybrid-electric vehicles (HEVs) in the North American market is eroding the fuel consumption benefit of hybrid technology.

However, the gain in vehicle weight and power is not necessarily surprising or discouraging, as researchers Conor Reynolds and Milind Kandlikar explain. HEVs are new in the market and, as such, are diversifying from the compact cars that first appeared in 1999, such as

the relatively light, low-power Honda Insight.

“In our analysis, we found that changes in weight and power affect HEVs differently than ICEVs [conventional internal combustion engine vehicles],” Reynolds explained to *PhysOrg.com*. “For example, we found that added weight doesn’t matter as much for hybrids as for conventional vehicles, a comparison that reinforces the fuel benefits of hybrid technology.”

The study by the University of British Columbia scientists is the first to account for all nine light-duty HEV models on the North American market in 2007 (a number expected to double in the next two to three years). While HEVs made up about 1.6% of the total vehicle sales in the U.S. in 2006, nearly 30% of these HEVs were SUVs. Further, HEV cars in the second generation hybrid wave (2004 and later model years) exhibit higher performance levels across the board: an overall 30% weight increase and 60% power increase.

To understand how fuel consumption changes for HEVs compared with ICEVs, the scientists compared HEVs and ICEVs using three different models: a one-on-one vehicle-to-vehicle comparison; a comparison of each HEV to all ICEVs; and group comparison of cars to cars and SUVs to SUVs.

Depending on the comparison model, HEVs showed a fuel consumption benefit that ranged from 2.7 to 3.25 liters/100 km. Compared with the average U.S. fuel consumption of around 20 mpg (11.3 liters/100Km), this benefit means that the mileage would improve to around 27-29 mpg.

“Consider an average driver who drives 20,000 km (12,400 miles) a year, who changes from an ICEV to an equivalent hybrid,” Reynolds explained. “Using a conversion factor of approximately 3 liters/100 km saved, and 2.5 kg of CO_2 emitted per liter of fuel burnt, the fuel saved is

600 liters (160 gallons), and the CO_2 saved is 1.5 tons (or about 0.4 tons of carbon)."

The scientists' results showed that HEV fuel consumption is significantly affected by both weight and power: a 100 kg weight increase results in a 0.4 liter/100 km fuel increase, and a 10 kW power increase results in a 0.14 liter/100 km fuel increase. ICEVs, however, are greatly affected by weight, where a 100 kg weight increase results in a 0.72 liter/100 km fuel increase, but the power impact is insignificant.

"This difference means that a weight increase is much less important in an HEV than if the same weight is added to an ICEV, which is good news for fuel use and carbon dioxide emissions if the trend towards heavier HEVs continues," said Reynolds.

The cause of these differences is the different engine systems and the way they use fuel to move a vehicle.

"Initially, we were somewhat surprised to find that increased weight in hybrids is not as bad for fuel consumption as it is for ICEVs," Reynolds said. "When we looked into this, however, we found that it can be quite easily explained by the regenerative braking (and other features) that HEVs have. Hybrids are able to recapture inertial energy that would otherwise be 'wasted' in a conventional vehicle. It's an important finding because the general trend has been toward heavier vehicles for all technology types, and HEVs do better than ICEVs."

Even though weight has less of an impact on the fuel consumption of HEVs than ICEVs, the scientists' second model of comparison reveals that, on average, 2007 HEVs are 136 kg heavier than equivalent ICEVs—resulting in a fuel penalty of 0.75 liters/100 km for HEVs. And 2007 HEVs also have an average of 10 kW more power than equivalent ICEVs, resulting in another fuel penalty of 0.1 liters/100 km. Overall,

these weight and power penalties reduce the potential fuel benefits of HEVs by at least 27%.

Compared with some of the larger HEVs, conventional vehicles could still have the upper hand in fuel savings. For instance, a small or regular-sized conventional car (e.g. Toyota Yaris) would give you much better mileage than a hybrid SUV (e.g. Toyota Highlander hybrid) or luxury car (e.g. Honda Accord hybrid).

Comparisons like this one will hopefully help policy makers design better initiatives aimed at reducing fuel consumption and carbon emissions worldwide. While currently all hybrids receive a tax break, the study shows that hybrids have a wide range of environmental and fuel benefits—and the variety will likely only increase.

“This is an important issue for policy makers and consumers because it clarifies and quantifies what we can expect from this relatively new technology,” Reynolds said. “As an example of how policy makers might take our findings into account, it might be decided that tax breaks should be given to any vehicle that has demonstrated environmental benefits, and not necessarily to hybrid SUVs or hybrid luxury cars.

“In general, this is a reminder that although HEVs have real benefits, they are not a miracle cure for our dependence on oil for transportation, nor a fix for the problem of GHG emissions,” he added. “The point is that each time an HEV is used instead of an ICEV there is a small but important contribution to GHG reduction, and it will add up as hybrids become more numerous.”

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