

Maximize



Your Mileage

by Guy Marsden

Squeeze more mileage from your hybrid car with this expert advice.

If you own a hybrid-electric vehicle (HEV or “hybrid”) or are considering buying one, you’ve probably wondered whether these cars really get the gas mileage their manufacturers claim. Well, that all depends on how you drive it. Hybrids are quite different from standard gasoline-fueled cars, and there’s a learning curve involved in optimizing their fuel economy.

My wife Rebekah and I have been driving HEVs for more than a decade. She purchased the original two-seater Honda Insight hybrid in 2001, and we immediately made a competition out of who could get the best mileage per trip. We developed several strategies for that vehicle, some of which did not translate to the 2006 Ford Escape hybrid that I purchased later. The two-seater Insight (made from 2000 to 2006) is considered a “mild hybrid”—one that never operates entirely in electric mode. For that reason, many of the strategies discussed here do not apply to that vehicle.

Most of the HEVs on the road are considered “full” hybrids—they can drive for several miles in electric vehicle (EV) mode alone. One of the keys to understanding how to optimize HEV performance is to learn how to make the best use of the battery that powers the electric motor.

Regenerative Braking

All HEVs have both an internal combustion engine (ICE) and an electric motor, which gets energy from a battery pack. In many HEVs, such as the Toyota Prius, the ICE is an Atkinson engine which, while efficient at its optimal rpm, does not develop much torque at low rpm—so it’s rather inefficient during acceleration. The electric motor augments the ICE during acceleration—the faster you accelerate, the more battery power is used. Of course, most hybrids can also operate entirely in electric mode for periods and this uses a lot more battery energy.

The electric motor is used as a generator anytime you take your foot off the accelerator or apply the brakes. Additionally, once the car is up to speed and cruising along, the generator tops off the battery if it is low. This is known as a “cruising charge.” Regenerative braking switches the electric drive motor to generator mode, slowing the vehicle, recovering kinetic energy to convert it to electric energy, and storing it in the battery bank.

All DC motors can become generators if you turn the motor by force. The faster you turn it, the more electric

power you can generate. In a hybrid, when you press your foot down on the brake pedal, the brakes are applied—but the motor is also used as a generator, which also slows down the vehicle. Some of the braking force is converted to electric energy rather than heating the brake pads and rotors. Besides helping recharge the battery, this also extends the life of the brake pads and rotors. The amount of regenerative brake energy depends on the battery pack's state of charge. If the battery is low, the engine computer will configure regenerative braking to recover as much energy as it can. Many HEVs have two gauges—one that shows energy going into or out of the battery (charging or discharging the battery bank); another shows the state of charge. Along with the real-time mpg gauge, these are the two most important gauges to pay attention to for optimizing performance.

Driving a HEV like a normal car will yield fairly good gas mileage, but mastering regenerative braking means more energy stored in the battery and therefore less gasoline used. Driving more consciously is the key to wresting more mpg performance from regenerative braking. This is not always easy when you have passengers in the vehicle—especially children—but it becomes easier with practice. Most good driving guides stress paying attention to the road and planning as far ahead as possible, while also being aware of the vehicles behind you—and this certainly applies to driving a hybrid effectively.

To optimize the benefits of regenerative braking, plan all of your stops in advance and ride the brake gently for as long as possible until you come to a stop. Braking puts a lot more energy back into the battery than coasting with your foot off the accelerator. This is not always practical in traffic and doing this to extremes will certainly annoy the other drivers on the road. But used appropriately, it is an excellent HEV fuel-saving strategy.

Addressing Your Acceleration

To prevent wasteful idling, HEVs will usually shut down their ICEs at a stop, so plan your acceleration strategy according to how fast you expect to go when you take off.

Stress Sucks Fuel

Responsible, think-ahead driving makes you a better driver—but it also helps to be relaxed. The Discovery Channel's *MythBusters* team tested the hypothesis that a car gets better gas mileage when you are driving relaxed. They had the same drivers drive the same course once when they were very relaxed, and once when they were extremely agitated. They showed that driving while relaxed improved gas mileage significantly. No big surprise, since the relaxed drivers weren't taking out their aggression on the accelerator.

Hypermiling

"Hypermilers" go to considerable extremes to get high gas mileage—many can more than double the rated mpg of their vehicles in ideal conditions. While these strategies are not always considered safe or prudent, they can be used judiciously on open roads with light traffic. One technique that works well with the Prius is known as "pulse and glide." The practice is to accelerate up to 39 mph using the ICE. Then, you remove your foot from the accelerator so the ICE shuts off, and coast down to 33 mph. This repeated process can help increase your mpg on long, straight, fairly level roads. Some hybrids require riding the brake very gently for a few seconds to shut off the ICE. While the car is gliding, be sure you are neither using regenerative braking nor engaging the ICE. Maintaining a coasting glide on level ground takes some accelerator finesse, so don't be discouraged if you don't get results at first. A Web search for "hypermiling" will yield a wealth of information for your specific vehicle.

If you accelerate gently, the vehicle will remain in EV mode longer before it switches on the ICE. If you are stopped at the top of a hill, you can use gravity to assist your acceleration, reducing your need to depress the accelerator.

In city driving, accelerating very gently will keep you in EV mode longer if you remain below about 25 mph—any sudden pressure on the accelerator is likely to kick on the ICE. One way of looking at accelerating in a hybrid is to see how lightly you can hold your foot on the accelerator and still maintain the speed that you need. Most drivers tend to press on the accelerator much harder than is actually needed to maintain speed. Watching the real-time mpg display on the dashboard will help you get a feel for this (see "Scan Gauge" sidebar).

Let's say you're planning a round trip from your rural home to do some town shopping and your route in town consists mostly of low-speed driving (below 25 mph). If you can plan your driving so that you enter town with a fully charged battery bank, this will give your car the maximum EV range. For instance, if you have a long downhill run on the way into town, you can either drop the vehicle into low gear on that hill if it is quite steep or feather the brake pedal all the way down, or both. Using low gear turns the engine generator faster, extracting more energy from regenerative braking while also limiting the speed of the vehicle. Riding the brake gently without necessarily slowing the vehicle, especially at speeds above 45 miles an hour, will put a lot more charge in the battery than simply keeping your foot off the accelerator (coasting).

Going the Extra Mile: Tips for Wiser Driving

Lose the Lead Foot

If there is a single rule that says almost everything, it is this: Aggressive, impatient driving (quick starts and stops) produces the worst mileage. At highway speeds, this behavior packs a wallop, shaving off more than one-third from your car's fuel economy.

- In stop-and-go traffic, try to find the speed that you can hold as constant as possible.
- Never tailgate.
- Accelerate moderately, and avoid unnecessary acceleration, such as over a short distance before a turn or stop.
- Keep a steady foot on the gas pedal—accelerating and decelerating can significantly decrease your mileage.
- Delay acceleration for short distances if doing so allows you to use a downward slope to take advantage of gravity.

Cruise & Coast

In all vehicles, it pays to plan ahead for braking.

- Instead of keeping your foot on the throttle up to the instant you switch to the brake, learn to use the third state of driving—coasting. If you see the light turning red ahead of you or traffic bogging down, lift off the throttle and coast.
- When possible, slow down gradually. Try to avoid heavy braking unless it's absolutely necessary.

Don't be a Drag

At higher speeds, wind resistance steals most of a car's power. This varies from car to car, and depends on a lot more than the vehicle's aerodynamics. For pickup trucks, a tonneau cover over the bed can make a real difference.

- At low speeds, use "natural air-conditioning" (open the windows); at high speeds, turn on the mechanical air-conditioning.
- Keep the body in good shape. Dents are not aerodynamic.
- When it rains, slow down for good mileage, regardless of the type of car you have. Pushing air around is one thing—but pushing water around is even more difficult, especially at high speeds.

The Cold, Hard Truth

One of the jobs of a cold engine is to warm up, and it takes fuel to do this. And any car, regardless of type, gets worse mileage when its engine is cold.

- Try to eliminate short trips, especially those followed by long intervals, when the engine can cool.
- Limit or eliminate unnecessary trips in cold weather—or any weather, for that matter. Plan ahead to do multiple errands on a single trip instead of making multiple trips.

Go on a Diet

Not you, but your car. Every extra 100 pounds you carry around cuts 1% to 2% from your fuel economy.

- Clean out all of the extraneous clutter in the car, including in the trunk and under the seats, and only keep the items that you really need.
- Lighten your load. Replace a full-size spare tire with a space- and weight-saving "limited-use" spare. This will also encourage you to fix or replace a flat tire promptly. If you have back seats you rarely use, take them out and store them at home.

Keep it in Shape

Several simple things can make a big difference in fuel economy for any kind of car.

- Get your car serviced promptly when it is due. Tuning up a car can improve mileage an average of 4%.
- Replace the air filter regularly. A clogged, dirty filter can suck up to 10% from your mileage.
- Keeping your tires properly inflated can improve your car's fuel economy up to 3%.
- Stick with the fuel your manufacturer recommends, and change the oil early and often. This can improve your mileage by 1% to 2%.

—Adapted from "Wise Driving: Outsmart the 7 Worst Gas Guzzlers," in *HP111*

Pushing the Boundaries

There are two thresholds to be aware of in most HEVs. One is the speed at which the ICE will always kick in from EV mode, even if you are going downhill or coasting. This usually occurs at about 40 mph. Similarly, you can drop your car into EV-only mode while coasting or slowing to below about 40 mph. The other threshold is the upper limit for acceleration in EV mode, which is about 25 mph. Being conscious of these thresholds will help you to maintain EV mode longer.

Here in rural Maine, most of our driving is on rolling, two-lane blacktop roads where the average speed is about 50 mph. My strategy is to allow the vehicle to slow on the uphill run, using the ICE minimally. At the hill's peak, I feather the brake slightly, which causes the ICE to shut off and allows the vehicle to accelerate downhill using gravity. If the hills are gentle enough, by staying below 40 mph, I can stay in EV mode rather than having the ICE kick in for every uphill run.

Real-Time MPG: Not Just for Hybrids

Getting good gas mileage in any vehicle requires conscious effort and attention to detail, and having a real-time display of fuel economy can provide a clear picture of your driving efficiency. You don't have to buy a hybrid to do this—if you have a vehicle that was made after 1996, you're good to go. Several manufacturers, such as PLX Devices (KIWI) and Linear Logic (Scan Gauge), offer real-time mpg gauges, which will help you achieve your hypermiling goals.

The Scan Gauge II meter displays real-time data on a small screen that you stick to your dashboard. The meter plugs into the on-board diagnostics computer port that's standard on any vehicle made since 1996, the year that OBD-II specification was made mandatory for all cars sold in the United States. You'll recognize this as a rectangular connector found somewhere under the dash. The Scan Gauge can be configured to show four parameters, including real-time mpg that updates every 2 seconds. Other useful features monitor engine temperature, oil pressure, and even the temperature of the air entering the engine. But simply watching the real-time mpg is an education in any vehicle, since you can use this data to immediately adjust your driving strategy to the road conditions.

It is eye-opening to see a vehicle's fuel economy plummet from 30 mpg to 8 mpg on acceleration, and then bump up to more than 100 mpg when you take your foot off the gas going downhill. My Ford Escape hybrid did not come with the fancy computer console, so I installed this gauge to monitor real-time mpg and battery state of charge as a percentage. By pressing a few buttons when I return home, I also can review my mpg per trip, day or tank. The simpler KIWI shows only fuel economy info (see Access).



Courtesy Guy Marsden

With no other vehicles in sight, I can allow the vehicle to slow below 25 mph at the peak of each hill, and then gain speed by the bottom of each hill, usually up to 45 mph. On steeper downslopes, I ride the brakes, staying below 40 mph and charging the battery. My Escape is nominally rated at 30 mpg on the highway and I have achieved up to 40 mpg using this technique. Of course, I pay attention to the road and resume a more normal driving strategy with vehicles behind me, or I pull over to let them pass.

Access

Guy Marsden develops electronic prototypes of electronic products for individual inventors and small companies. He also manufactures differential controllers for PV-powered solar thermal systems. His website (www.arttec.net) showcases his sustainable efforts in considerable detail.

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