Something for Nothing

Hybrids use energy captured during deceleration to improve fuel economy. In conventional cars, this energy is dissipated as heat by the brakes. But in a hybrid, a light touch on the brakes spins a generator that charges a battery pack. (Harder braking also engages the vehicle's normal brake system.) Currently there are two principal hybrid architectures on the road—Toyota's and everybody else's. Toyota uses a torque splitter, while Honda and the others use a simpler system coupled to a conventional transmission. Both systems provide most fuel-economy improvement during stop-and-go driving.

Starting off

Some hybrids, such as the Toyota Prius, drive away from a stop—and sometimes go for short distances—with only electric power. Others, like Hondas and GMs, use the electric motor only to boost the engine, and always run the engine while in motion.

Short trips

Even with a fully charged battery pack, conventional hybrids can run only a mile or two on battery power. They rely on the gasoline engine for longer distances and expressway speeds.

Idle shutdown

All hybrids save fuel by shutting down the gasoline engine during stop-and-go idling. The motor/generator can restart the engine faster than you can move your foot from the brake to the accelerator.

All-wheel drive

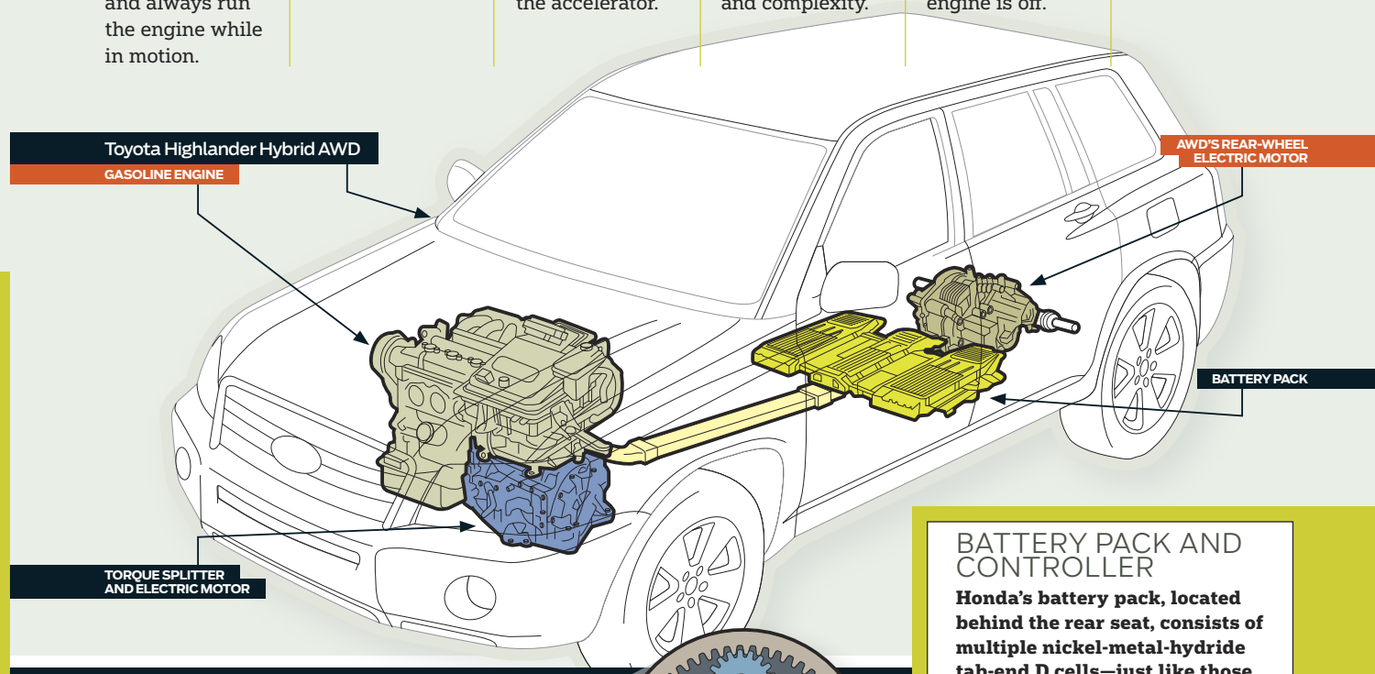
The Highlander's optional 4wd system uses an electric motor to drive the rear wheels. It replaces the transfer case and rear driveshaft, provides power to rear wheels only on demand, and reduces weight and complexity.

Reducing parasitic losses

With plenty of battery power on board, hybrids can run the power steering and a/c electrically, on demand, reducing friction losses from belts and pumps. Batteries also mean the a/c can run when the engine is off.

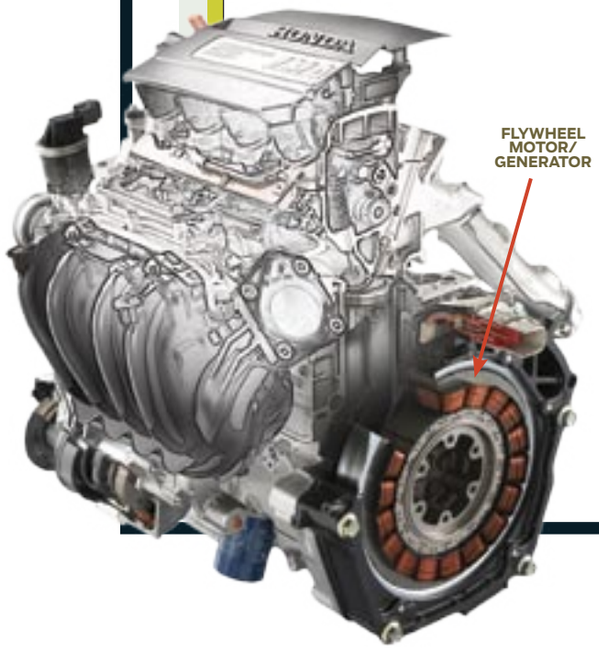
Battery management

If the battery pack is undercharged—for example, after going up a long hill—the controller will partially charge the battery pack with energy from the engine. Upon deceleration, the brakes recharge it further.

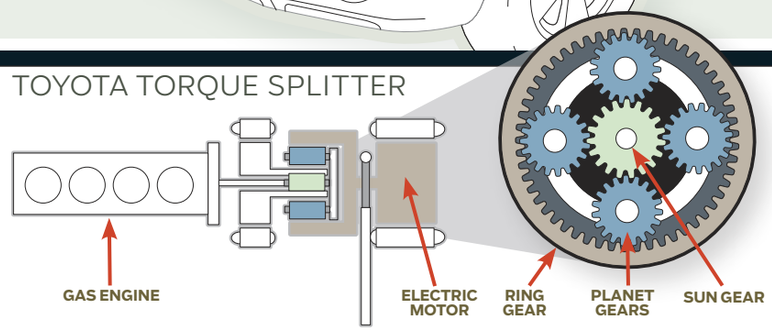


HONDA ENGINE AND FLYWHEEL

The engine in the Honda Civic, like the GM and other systems, uses a flywheel-type motor/generator. This device is also the engine's primary starter motor, permitting near-instant starts. Battery power aids in acceleration, and is recaptured as the vehicle slows.



TOYOTA TORQUE SPLITTER



Toyota Prius's planetary-gear torque splitter proportions power between the electric motor, engine and front wheels. This allows the engine or motor, or both, to drive wheels, while the engine or wheels can power a generator to charge batteries. This device also acts as a constantly variable transmission.

BATTERY PACK AND CONTROLLER

Honda's battery pack, located behind the rear seat, consists of multiple nickel-metal-hydride tab-end D cells—just like those in your flashlight. These are stacked to produce 158 volts DC. The controller changes this to three-phase AC to run the electric motor.

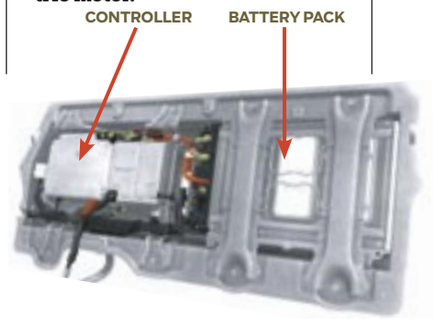


ILLUSTRATION BY **FLYING-CHILLI.COM**