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Introduction to Hybrid Vehicles

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NOTE: Due to the oil embargo of 1973 and increased demand for alternative energy sources, Congress enacted Public Law 94–413, the *Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976,* which was designed to promote new technologies.

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FIGURE 26.1 View of the components of the General Motors electric vehicle (EV1). Many of the features of this vehicle, such as regenerative braking, currently used on hybrid vehicles were first put into production on this vehicle.

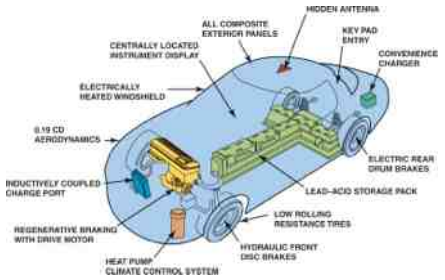

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FIGURE 26.2 General Motors EV1 without a body.

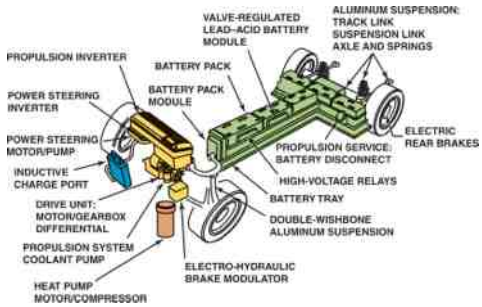

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FIGURE 26.3 A drawing of the power flow in a typical series-hybrid vehicle.

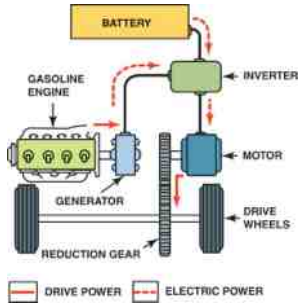

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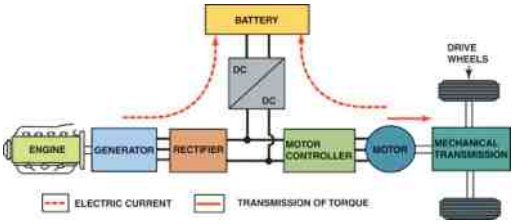
FIGURE 26.4 This diagram shows the components included in a typical series-hybrid design. The solid-line arrow indicates the transmission of torque to the drive wheels. The dotted-line arrows indicate the flow of electrical current.



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FREQUENTLY ASKED QUESTION

How Fast Does the Motor-Generator Turn the Engine When Starting?

The typical starter motor used on a conventional gasoline or diesel engine rotates the engine from 100 to 300 revolutions per minute (RPM). Because the typical engine idles at about 600 to 700 RPM, the starter motor is rotating the engine at a speed slower than it operates. This makes it very noticeable when starting because the sound is different when cranking compared to when the engine actually starts and runs.

However, when the motor-generator of a hybrid electric vehicle rotates the engine to start it, the engine is rotated about 1,000 RPM, which is about the same speed as when it is running. As a result, engine cranking is just barely heard or felt. The engine is either running or not running, which is a truly unique sensation to those not familiar with the operation of hybrid electric vehicles (HEVs).

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FREQUENTLY ASKED QUESTION

Is a Diesel-Hybrid Electric Vehicle Possible?

Yes, using a diesel engine instead of a gasoline engine in a hybrid electric vehicle is possible. While the increased efficiency of a diesel engine would increase fuel economy, the extra cost of the diesel engine is the major reason this combination is not currently in production.

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FIGURE 26.5 The power flow in a typical parallel-hybrid vehicle.

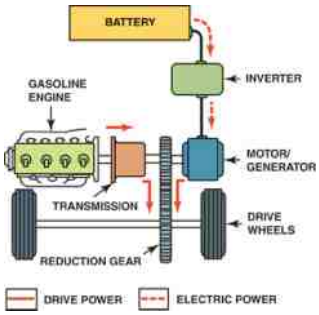

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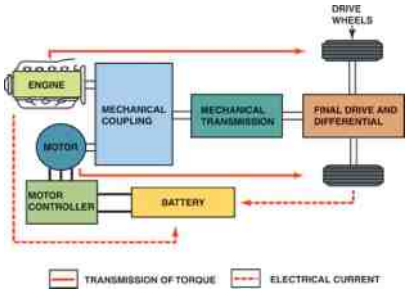
FIGURE 26.6 Diagram showing the components involved in a typical parallel-hybrid vehicle. The solid-line arrows indicate the transmission of torque to the drive wheels, and the dotted-line arrows indicate the flow of electrical current.



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NOTE: A parallel-hybrid design could include additional batteries to allow for plug-in capability, which could extend the distance the vehicle can travel using battery power alone.

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NOTE: The internal combustion engine may or may not start when the driver starts the vehicle depending on the temperature of the engine and other conditions. This can be confusing to some who are driving a hybrid electric vehicle for the first time and sense that the engine did not start when they tried to start the engine.

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FIGURE 26.7 A series-parallel hybrid design allows the vehicle to operate in electric motor mode only or in combination with the internal combustion engine.

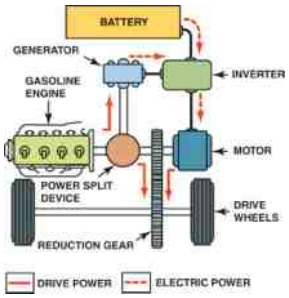

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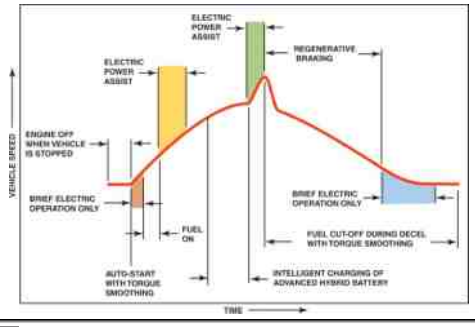
FIGURE 26.8 This chart shows what is occurring during various driving conditions in a BAS-type hybrid.



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NOTE: A BAS system uses a conventional starter motor for starting the ICE the first time, and only uses the high-voltage motor-generator to start the ICE when leaving idle stop mode.

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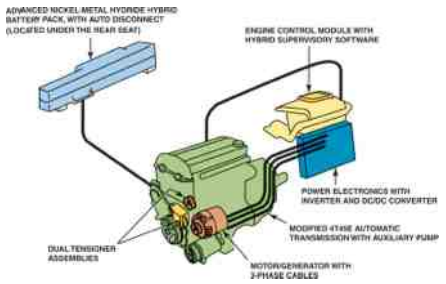
FIGURE 26.9 The components of a typical belt alternator-starter (BAS) system.



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FREQUENTLY ASKED QUESTION

Can Hybrids Use the HOV Lane?

In most locations the answer is yes, but it depends on the type of hybrid vehicle. The **high-occupancy vehicle (HOV) lane** in many cities is reserved for use by vehicles that are carrying more than one occupant as a way to encourage carpooling and the use of public transportation. In California, only those hybrids classified as being high-fuel-economy models and those meeting certain emission ratings qualify. Those that do qualify, such as the Toyota Prius, are issued stickers that show that they are entitled to be in the HOV lane even if there is just the driver in the vehicle. High-performance hybrids, such as the Honda Accord hybrid, do not meet the specified fuel economy rating to allow the owners to be issued HOV stickers, which are also limited as to how many in the entire state can be issued.

SEE FIGURE 26–10.

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FIGURE 26.10 This sticker on a hybrid vehicle allows the driver to use the high-occupancy vehicle (HOV) lanes even if there is only one person in the vehicle as a way to increase demand for hybrid vehicles in California.

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FIGURE 26.11 A combination starter/alternator is used to provide idle stop function to conventional vehicles. This very limited and low cost system is called a micro-hybrid drive.

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Watch Out for Motoring Mode

When a hybrid electric vehicle is operating at low speeds, it is often being propelled by the electric motor alone, sometimes called motoring mode. As a result, the vehicle is very quiet and it said to be operating in **quiet mode**.

During this time, the driver should be aware that the vehicle is not making any sound and should be careful when driving in congested areas. Service technicians should also be extremely careful when moving a hybrid electric vehicle around the shop due to the silence of the vehicle.

Hybrid Features by Make/Model

Make/Model	Idle Stop	Regenerative Braking	Motor Assist	Engine-Off Drive—EV Mode
2004–2007 Chevrolet Silverado 1500/2500 Sierra Hybrid	✓	✓		
Ford Escape and Mercury Mariner Hybrid	✓	✓	✓	✓
Honda Accord Civic Hybrid	✓	✓	✓	
Honda Insight	✓	✓	✓	
Toyota Prius	✓	✓	✓	✓
Saturn Vue	✓	✓	✓	
Toyota Highlander: Lexus RX hybrids	✓	✓	✓	✓

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FREQUENTLY ASKED QUESTION

What Is an Assist Hybrid?

An assist hybrid-electric vehicle is a term used to describe a vehicle where the electric motor is not able to start moving the vehicle on electric power alone. This type of hybrid would include all mild hybrids (36 to 42 volts), as well as the medium hybrids that use 144- to 158-volt systems.

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