Hybrid Vehicles
Prius vs Civic

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DEE Departamento de Engenharia Electrotécnica

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History

- **1665 – 1825**

Between 1665 and 1680, Flemish Jesuit priest and astronomer Ferdinand Verbiest created plans for a miniature four-wheel unmanned steam "car" for Chinese Emperor Khang Hsi. In 1769, Frenchman Nicholas Cugnot built a steam-powered motor carriage capable of six miles per hour. In 1825, British inventor Goldsworthy Gurney built a steam car that successfully completed an 85 mile round-trip journey in ten hours time. (Steamers dominated the automotive landscape until the late 19th century.)

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History

- **1839**

Robert Anderson of Aberdeen, Scotland built the first electric vehicle.

- **1870**

Sir David Salomon developed a car with a light electric motor and very heavy storage batteries. Driving speed and range were poor.

- **1886**

Historical records indicate that an electric-powered taxicab, using a battery with 28 cells and a small electric motor, was introduced in England.

History

- **1888**

Immisch & Company built a four-passenger carriage, powered by a one-horsepower motor and 24-cell battery, for the Sultan of the Ottoman Empire. In the same year, Magnus Volk in Brighton, England made a three-wheeled electric car.

- **1890 – 1910**

Period of significant improvements in battery technology, specifically with development of the modern lead-acid battery by H. Tudor and nickel-iron battery by Edison and Junger.

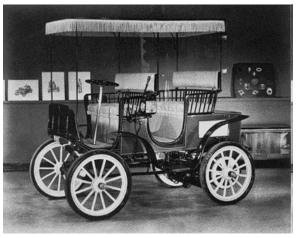
History

- **1897**

The London Electric Cab Company began regular service using cars designed by Walter Bersey. The Bersey Cab, which used a 40-cell battery and 3 horsepower electric motor, could be driven 50 miles between charges.

- **1897**

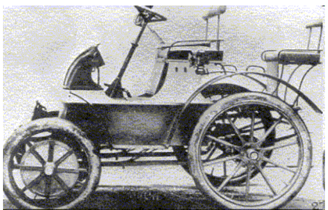
The Pope Manufacturing Company of Hartford, Connecticut, built around 500 electric cars over a two-year period.



History

- **1898**

The German Dr. Ferdinand Porsche, at age 23, built his first car, the Lohner Electric Chaise. It was the world's first front-wheel-drive. Porsche's second car was a hybrid, using an internal combustion engine to spin a generator that provided power to electric motors located in the wheel hubs. On battery alone, the car could travel nearly 40 miles.



The early 1900's Lohner-Porsche, originally electric-powered, then with an internal combustion engine powering hub-mounted electric motors.

The Electric Carriage and Wagon Company, of New York City, had a fleet of twelve sturdy and stylish electric cabs.

History

- **1899**

The Pope Manufacturing Company merged with two smaller electric car companies to form the Electric Vehicle Company, the first large-scale operation in the American automobile industry. The company had assets of $200 millions.

Two hybrids appeared at the Paris Salon.

- **1900**

American car companies made 1,681 steam, 1,575 electric and 936 gasoline cars. In a poll conducted at the first National Automobile Show in New York City, patrons favored electric as their first choice, followed closely by steam.

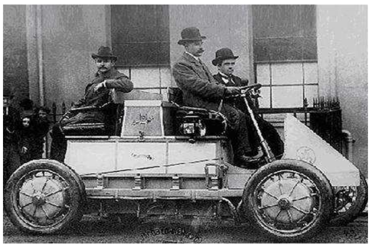
History

- In the first few years of the twentieth century, thousands of electric and hybrid cars were produced. This car, made in 1903 by the Krieger company, used a gasoline engine to supplement a battery pack. Henry Ford's assembly line and the advent of the self-starting gas engine signaled a rapid decline in hybrid cars by 1920.

History

- **1900**

A Belgian carmaker, Pieper, introduced a 3-1/2 horsepower "voiturette" in which the small gasoline engine was mated to an electric motor under the seat. When the car was "cruising," its electric motor was in effect a generator, recharging the batteries. But when the car was climbing a grade, the electric motor, mounted coaxially with the gas engine, gave it a boost. The Pieper patents were used by a Belgium firm, Auto-Mixte, to build commercial vehicles from 1906 to 1912.



History

- **1902**

A series-hybrid runabout competed against steam and gas-powered cars in a New York to Boston reliability test.

- **1904**

The Electric Vehicle Company built 2000 taxicabs, trucks, and buses, and set up subsidiary cab and car rental companies from New York to Chicago. Smaller companies, representing approximately 57 auto plants, turned out about 4000 cars.

History

- **1904**

Henry Ford overcame the challenges posed by gasoline-powered cars — noise, vibration, and odor — and began assembly-line production of low-priced, lightweight, gas-powered vehicles. Within a few years, the Electric Vehicle Company failed.

- **1905**

An American engineer named H. Piper filed a patent for a petrol-electric hybrid vehicle. His idea was to use an electric motor to assist an internal-combustion engine, enabling it to achieve 25 mph.

History

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- **1905**

The Woods Interurban, an electric car that allowed long-distance drivers to swap the electric power unit for a two-cylinder gas engine (supposedly a fifteen-minute job), failed to get more than a handful of customers.

- **1910**

Commercial built a hybrid truck which used a four-cylinder gas engine to power a generator, eliminating the need for both transmission and battery pack. This hybrid was built in Philadelphia until 1918.

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History

- **1913**
With the advent of the self-starter (making it easy for all drivers to start gas engines), steamers and electrics were almost completely wiped out. In this year, sales of electric cars dropped to 6,000 vehicles, while the Ford Model T sold 182,809 gasoline cars.

- This 1921 Owen Magnetic Model 60 Touring uses a gasoline engine to run a generator that supplies electric power to motors mounted in each of the rear wheels.

History

- **1916**
Two prominent electric-vehicle makers — Baker of Cleveland and Woods of Chicago — offered hybrid cars. Woods claimed that their hybrid reached a top speed of 35 mph and achieved fuel efficiency of 48 mpg. The Woods Dual Power was more expensive and less powerful than its gasoline competition, and therefore sold poorly.

- **1920 – 1965**
Dormant period for mass-produced electric and hybrid cars. So-called alternative cars became the province of backyard tinkerers and small-time entrepreneurs.

History

- **1969**

The GM 512, a very lightweight experimental hybrid car, ran entirely on electric power up to 10 miles per hour. From 10 to 13 miles per hour, it ran on a combination of batteries and its two-cylinder gas engine. Above thirteen miles per hour, the GM 512 ran on gasoline. It could only reach 40 miles per hour.

This gasoline-electric hybrid is one of three experimental 512 series of special-purpose cars developed by General Motors Engineering Staff in the late 60's. Its power system consists of a 12-cubic-inch gasoline engine coupled with a series DC electric motor through an electro-magnetic clutch. It runs either in electric or hybrid mode.

Photo courtesy of General Motors

History

- **1970s**

With the Arab oil embargo of 1973, the price of gasoline soared, creating new interest in electric vehicles. The U.S. Department of Energy ran tests on many electric and hybrid vehicles produced by various manufacturers, including a hybrid known as the “VW Taxi” produced by Volkswagen in Wolfsburg, West Germany. The Taxi, which used a parallel hybrid configuration allowing flexible switching between the gasoline engine and electric motor, logged over 8,000 miles on the road, and was shown at auto shows throughout Europe and the United States.

History

- **1974**

As part of the Federal Clean Car Incentive Program, engineers Victor Wouk and Charlie Rosen created a prototype hybrid gas-electric vehicle using a Buick Skylark body. The U.S. Environmental Protection Agency tested the vehicle, certified that it met the strict guidelines for an EPA clean-air auto program — and rejected it out of hand.

- **1975**

AM General, a division of American Motors, began delivery of 352 electric vans to the U.S. Postal Service for testing. The U.S. Energy Research and Development Administration began a government program to advance electric and hybrid technology.

History

- **1976**

U.S. Congress enacted Public Law 94-413, the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976. Among the law’s objectives were to work with industry to improve batteries, motors, controllers, and other hybrid-electric components.

General Electric was chosen to construct a parallel-hybrid sedan, and Toyota built its first hybrid — a small sports car with a gas-turbine generator supplying current to an electric motor.

History

- **1980**

Briggs and Stratton, the company known for manufacturing lawn mower engines, developed a hybrid car powered by a twin cyclinder four-stroke 16hp gasoline engine and an electric motor—for total of 26 horsepower. The hybrid drivetrain provided power for a custom-designed two-door vehicle with six wheels—two in front and four in the back.

- **1989**

Audi unveiled the first generation of the Audi Duo experimental vehicle, based on the Audi 100 Avant Quattro. The car had a 12.6 horsepower electric engine, which drove the rear wheels instead of a propeller shaft. A nickel-cadmium battery supplied the energy. The front-wheel drive was powered by a 2.3-litre five-cylinder engine with an output of 136 horsepower. Two years later, Audi unveiled the second generation Duo, also based on the Audi 100 Avant quattro.

History

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- **1991**

The United States Advanced Battery Consortium (USABC), a Department of Energy program, launched a major program to produce a “super” battery to get viable electric vehicles on the road as soon as possible. The USABC would go on to invest more than $90 million in the nickel hydride (NiMH) battery. The NiMH battery can accept three times as many charge cycles as lead-acid, and can work better in cold weather.

- **1992**

Toyota Motor Corporation announced the "Earth Charter," a document outlining goals to develop and market vehicles with the lowest emissions possible.

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History

- **1993**

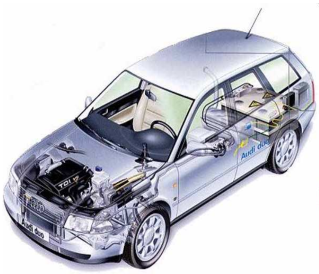
The Clinton Administration announced a government initiative called the Partnership for a New Generation of Vehicles (PNGV). In the program, the government worked with the American auto industry to develop a clean car that could operate at up to 80 miles per gallon. Several years and a billion dollars later, the PNGV emerged with three prototypes for their 80 mpg car. Every prototype was a hybrid.

Toyota's exclusion from PNGV prompted Chairman Eiji Toyoda to create a secret project called G21, Global Car for the 21st Century. The following year, Toyota doubled its original goal of improving fuel efficiency by 50 percent.

History

- **1997**

The Toyota Prius was introduced to the Japanese market, two years before its original launch date, and prior to the Kyoto global warming conference held in December. First-year sales were nearly 18,000.



- **1997**

Audi became the first manufacturer in Europe to take a hybrid vehicle into volume production: the Audi duo based on the A4 Avant. The vehicle was powered by a 90 horsepower 1.9-litre TDI in conjunction with a 29 horsepower electric motor. Both power sources drove the front wheels. A lead-gel battery at the rear stored the electrical energy. The Duo was not a commercial success and therefore discontinued, prompting European carmakers to focus their R&D investment on diesels.

History

- **1997 – 1999**
  A small selection of all-electric cars from the big automakers — including Honda's EV Plus, GM's EV1 and S-10 electric pickup, a Ford Ranger pickup, and Toyota's RAV4 EV — were introduced in California. Despite the enthusiasm of early adopters, the electrics failed to reach beyond a few hundred drivers for each model. Within a few years, the all-electric programs were dropped.

History

In the early 1990s California passed a law requiring car makers to sell zero emission vehicles if they wanted to sell any gas powered cars there. They required 2% of sales to be ZEVs by 1998 and 10% by 2003. The car manufacturers complied. For instance, between 1997 and 1999 GM produced 1100 electric cars called the EV1. They leased them all and had a waiting list.
However, the manufacturers also fought back. They sued the State of California, and in 2003 California lifted the ZEV requirement. GM promptly canceled the EV1 program, rounded up all the EV1s, and crushed them.

History

- **1999**

Honda released the two-door Insight, the first hybrid car to hit the mass market in the United States. The Insight won numerous awards and received EPA mileage ratings of 61 mpg city and 70 mpg highway.

History

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- **2000**

Toyota released the Toyota Prius first hybrid four-door sedan available in the United States.

- **2002**

Honda introduced the Honda Civic Hybrid, its second commercially available hybrid gasoline-electric car. The appearance and drivability of the Civic Hybrid was (and still is) identical to the conventional Civic.

- **2004**

The Toyota Prius II won 2004 Car of the Year Awards from Motor Trend Magazine and the North American Auto Show. Toyota was surprised by the demand and pumped up its production from 36,000 to 47,000 for the U.S. market. Interested buyers waited up to six months to purchase the 2004 Prius. Toyota Motor Sales U.S.A. President Jim Press called it "the hottest car we've ever had."

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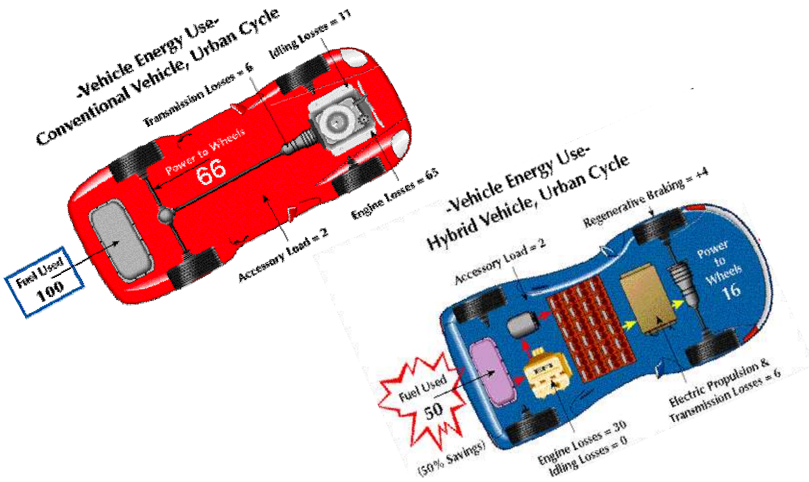
Why hybrids?



Why hybrids?

As shown by the chart below, a hybrid electric vehicle will travel twice the distance of a conventional vehicle on the same amount of energy. An internal combustion engine is inefficient not only because of the amount of energy loss incurred in the transfer of energy from the liquid state to the drive-train, but it also becomes more inefficient when the vehicle is not moving but the engine is still consuming energy.

Why hybrids?

Energy Source/Sink	Hybrid Electric Vehicle	Internal Combustion Engine
Fuel	100	100
Transmission Losses	-6	-6
Idling Losses	0	-11
Accessory Loads	-2	-2
Engine Losses	-30	-65
Regenerative Braking	+4	0
Total Energy Remaining	66	16

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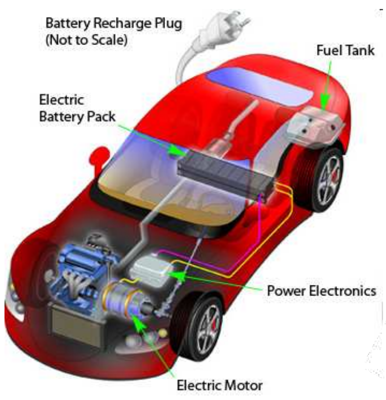
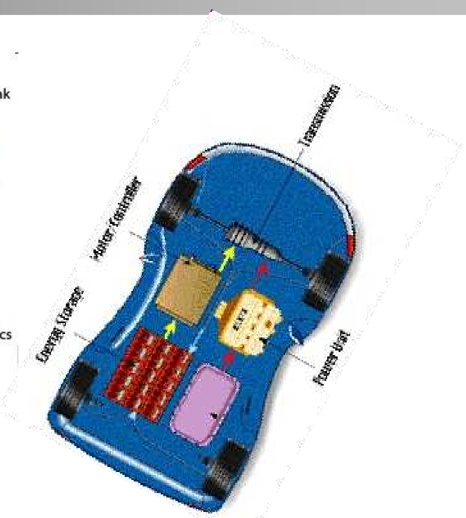
What is a hybrid vehicle?





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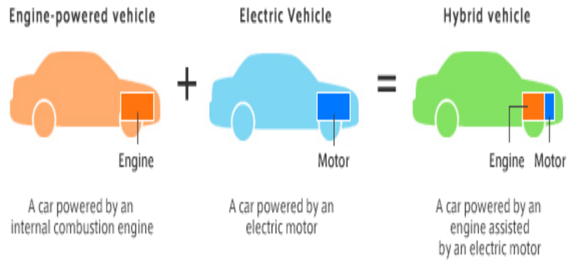
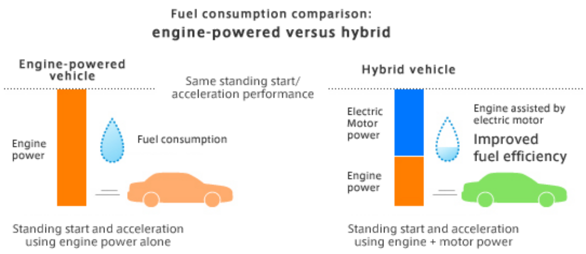
What is a hybrid vehicle?

- A hybrid vehicle is an automobile powered by an engine assisted by an electric motor.



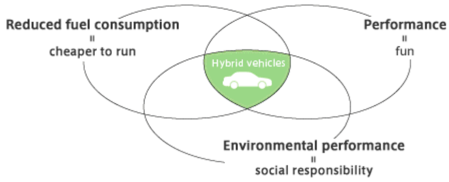
What is a hybrid vehicle?

- In a Hybrid vehicle, the electric motor assists the engine to help reduce fuel consumption in standing starts and accelerations. This means that compared to a regular car of the same size, a hybrid is cheaper to run.



What is a hybrid vehicle?

- Furthermore, electric motors deliver maximum torque from zero rpm for powerful, exhilarating standing starts and added power for acceleration.
- Combining fuel efficiency, and driving performance with environmental performance through reduced fuel consumption and reduced CO_2 emissions: that is what hybrid vehicles are all about.



Characteristics of a hybrid

- Hybrid systems possess the following four characteristics:

  1) **Energy-loss reduction**
  The system automatically stops the idling of the engine (idling stop), thus reducing the energy that would normally be wasted.

  2) **Energy recovery and reuse**
  The energy that would normally be wasted as heat during deceleration and braking is recovered as electrical energy, which is then used to power the starter and the electric motor.

  3) **Motor assist**
  The electric motor assists the engine during acceleration.

  4) **High-efficiency operation control**
  The system maximizes the vehicle's overall efficiency by using the electric motor to run the vehicle under operating conditions in which the engine's efficiency is low and by generating electricity under operating conditions in which the engine's efficiency is high.

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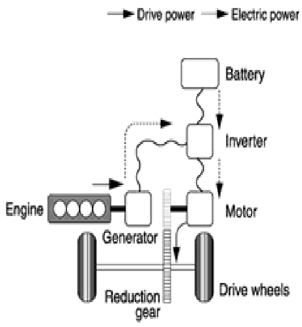
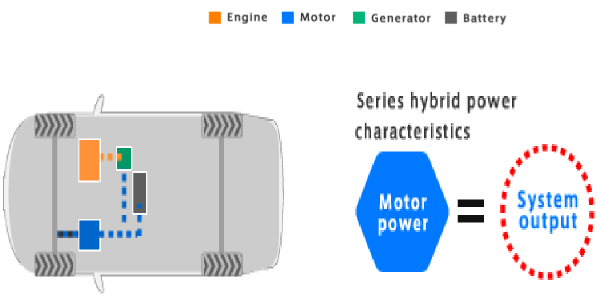
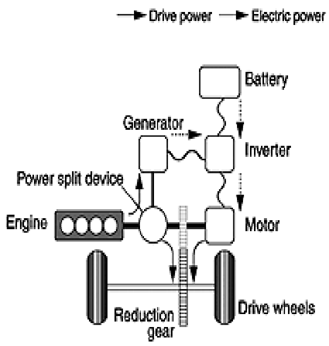
1) Series hybrid system
The engine drives a generator, and an electric motor uses this generated electricity to drive the wheels. This is called a series hybrid system because the power flows to the wheels in series, i.e., the engine power and the motor power are in series. A series hybrid system can run a small-output engine in the efficient operating region relatively steadily, generate and supply electricity to the electric motor and efficiently charge the battery. It has two motors-a generator (which has the same structure as an electric motor) and an electric motor. This system is being used in the Coaster Hybrid.



Types of hybrid vehicles

Series hybrids

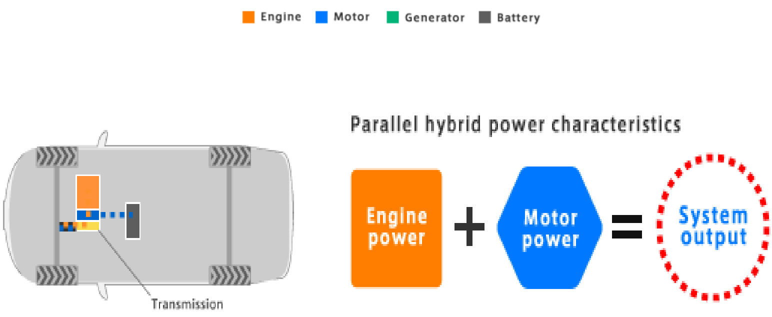


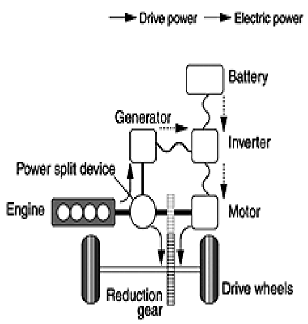


2) Parallel hybrid system
In a parallel hybrid system, both the engine and the electric motor drive the wheels, and the drive power from these two sources can be utilized according to the prevailing conditions. This is called a parallel hybrid system because the power flows to the wheels in parallel. In this system, the battery is charged by switching the electric motor to act as a generator, and the electricity from the battery is used to drive the wheels. Although it has a simple structure, the parallel hybrid system cannot drive the wheels from the electric motor while simultaneously charging the battery since the system has only one motor.

Types of hybrid vehicles

Parallel hybrids

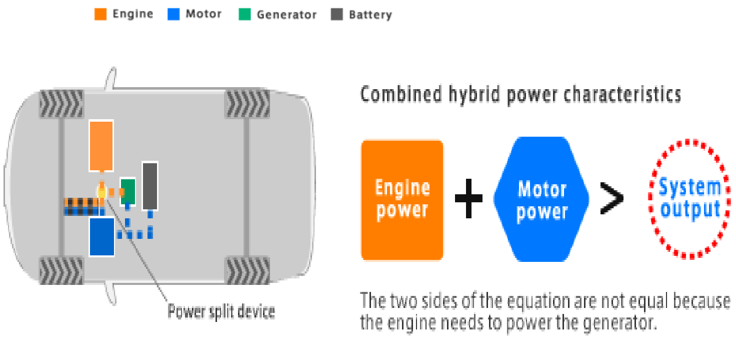




3) Series/parallel hybrid system
This system combines the series hybrid system with the parallel hybrid system in order to maximize the benefits of both systems. It has two motors, and depending on the driving conditions, uses only the electric motor or the driving power from both the electric motor and the engine, in order to achieve the highest efficiency level. Furthermore, when necessary, the system drives the wheels while simultaneously generating electricity using a generator. This is the system used in the Prius and the Estima Hybrid.

Types of hybrid vehicles

Combined hybrids



Types of hybrid vehicles

- **Engine and Motor Operation in each system**
- The chart below shows how the ratio of use between engine and motor differs depending on the hybrid system.

  Since a series hybrid uses its engine to generate electricity for the motor to drive the wheels, the engine and motor do about the same amount of work.

  A parallel hybrid uses the engine as the main power source, with the motor used only to provide assistance during acceleration. Therefore, the engine is used much more than the motor.

  In a series/parallel hybrid (THS in the Prius), a power split device divides the power from the engine, so the ratio of power going directly to the wheels and to the generator is continuously variable. Since the motor can run on this electric power as it is generated, the motor is used more than in a parallel system.

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Types of hybrid vehicles

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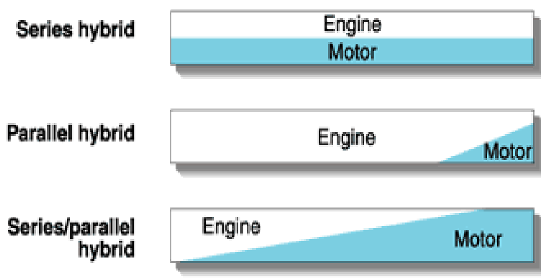
Ratio of engine and motor operation in hybrid systems (conceptual diagram)



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Types of hybrid vehicles

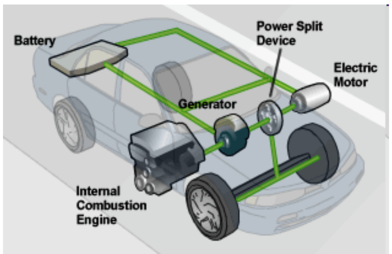
Hybrid system comparison

	Fuel economy improvement				Driving performance	
	Idling stop	Energy recovery	High-efficiency operation control	Total efficiency	Acceleration	Continuous high output
Series	Superior	Excellent	Superior	Superior	Somewhat unfavorable	Somewhat unfavorable
Parallel	Superior	Superior	Somewhat unfavorable	Superior	Superior	Somewhat unfavorable
Series/parallel	Excellent	Excellent	Excellent	Excellent	Superior	Superior

● Excellent ● Superior ○ Somewhat unfavorable

Types of hybrid vehicles

- Hybrid-electric vehicles (HEVs) combine the benefits of gasoline engines and electric motors and can be configured to obtain different objectives, such as improved fuel economy, increased power, or additional auxiliary power for electronic devices and power tools.



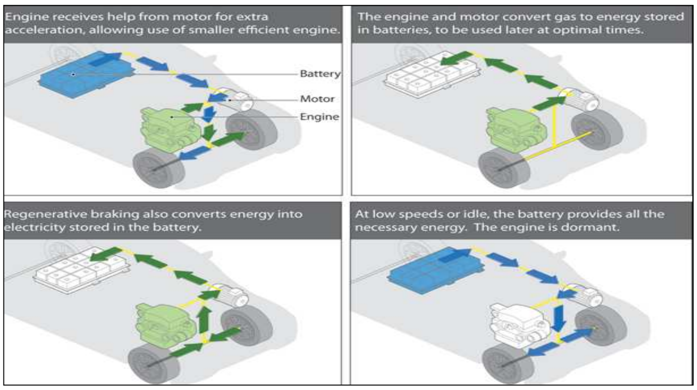
http://www.fueleconomy.gov/feg/hybridAnimation/fullhybrid/fullhybridstarting.html

How Hybrids Work

- Some of the advanced technologies typically used by hybrids include
- **Regenerative Braking.** The electric motor applies resistance to the drivetrain causing the wheels to slow down. In return, the energy from the wheels turns the motor, which functions as a generator, converting energy normally wasted during coasting and braking into electricity, which is stored in a battery until needed by the electric motor.
- **Electric Motor Drive/Assist.** The electric motor provides additional power to assist the engine in accelerating, passing, or hill climbing. This allows a smaller, more efficient engine to be used. In some vehicles, the motor alone provides power for low-speed driving conditions where internal combustion engines are least efficient.

How Hybrids Work

- **Automatic Start/Shutoff.** Automatically shuts off the engine when the vehicle comes to a stop and restarts it when the accelerator is pressed. This prevents wasted energy from idling.



Prius

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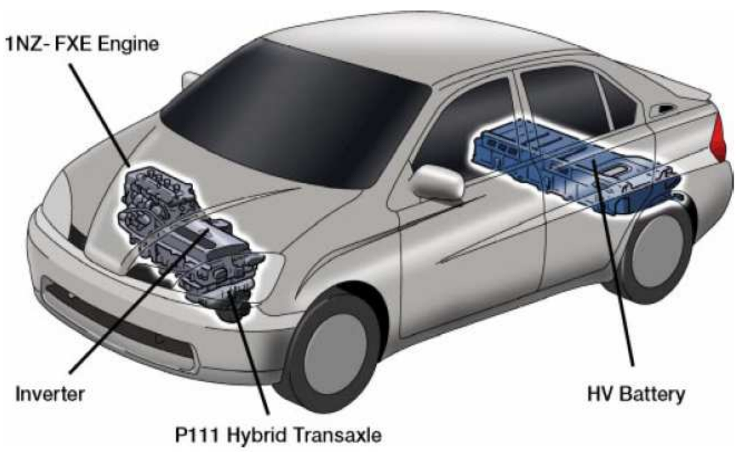
Prius



Prius

The main components of the hybrid system are:

- IC Engine
- Motor Generator 1 (MG1)
- Motor Generator 2 (MG2)
- Planetary Gear Set
- Inverter
- HV Battery
- HV ECU

Prius

IC Engine The 1NZ-FXE 1.5-liter gasoline engine employs VVT-i variable valve timing and ETCS-i electronic throttle control.

Prius

Motor Generator 1 (MG1) operates as the control element for the power splitting planetary gear set. It recharges the HV battery and also supplies electrical power to drive Motor Generator 2 (MG2). MG1 effectively controls the continuously variable transmission function of the transaxle and operates as the engine starter.

Motor Generator 1 (MG1)

MG1 generates electrical power and starts the engine.

Prius

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MG2 is used for motive force at low speeds and supplemental force at high speeds. It provides power assist to the engine output as needed and helps the vehicle achieve excellent dynamic performance. It also functions as a generator during regenerative braking.

Motor Generator 2 (MG2)

MG2 drives the vehicle.

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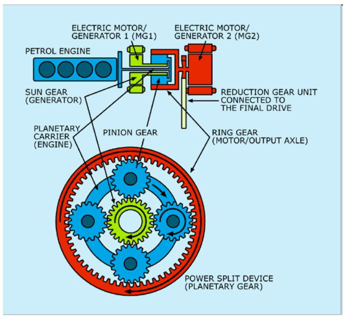
Prius

The planetary gear unit is a power splitting device. MG1 is connected to the sun gear, MG2 is connected to the ring gear and the engine output shaft is connected to the planetary carrier. These components are used to combine power delivery from the engine and MG2, and to recover energy to the HV battery.

Planetary Gear Unit

A single Planetary Gear Unit splits the torque between MG1, MG2, and the engine.



Prius

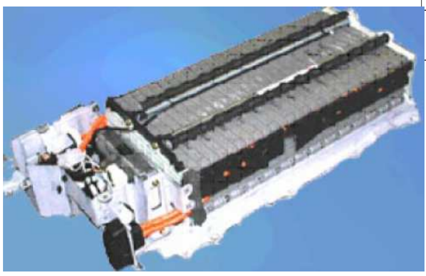
Inverter Assembly

A device that converts the high-voltage DC (HV battery) into AC (MG1 and MG2) and vice versa.

Prius

HV Battery The battery stores power recovered by MG2 during regenerative braking and power generated by MG1. The battery supplies power to the electric motor when starting off or when additional power is required.

THS (2001-2003 Prius)	THS-II (2004 and later Prius)
38 Nickel-Metal Hydride modules	28 Nickel-Metal Hydride modules
Total voltage: 273.6V	Total voltage: 201.6V



Prius

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Hybrid System Control Modes

When starting off and traveling at low speeds, MG2 provides the primary motive force. The engine may start immediately if the HV battery State of Charge (SOC) is low. As speed increases above 15 to 20 mph the engine will start.

When driving under normal conditions, the engine's energy is divided into two paths; a portion drives the wheels and a portion drives MG1 to produce electricity. The HV ECU controls the energy distribution ratio for maximum efficiency.

During full acceleration, power generated by the engine and MG1 is supplemented by power from the HV battery. Engine torque combined with MG2 torque delivers the power required to accelerate the vehicle.

During deceleration or braking, the wheels drive MG2. MG2 acts as a generator for regenerative power recovery. The recovered energy from braking is stored in the HV battery pack.

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Prius

Hybrid Control Modes The hybrid system uses various modes to achieve the most efficient operation in response to the driving conditions. The following graphics review each of these modes.

Prius

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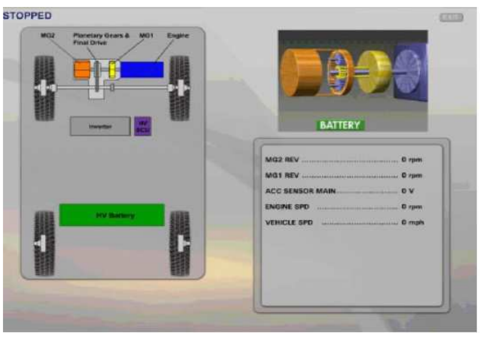
Stopped If the vehicle is fully charged and it not moving, the engine may stop. The engine will start up automatically if the HV battery needs charging. Also, if MAX A/C is selected on a 2001 – 2003 Prius, the engine will run continuously due to the engine driven compressor. The 2004 & later Prius use an electric compressor.



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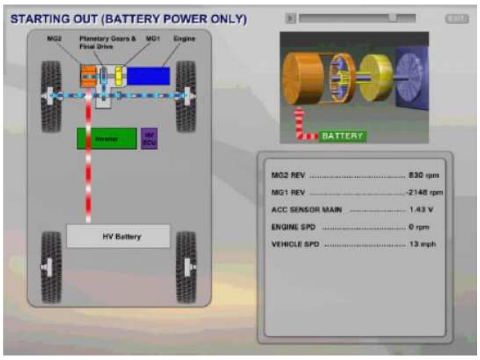
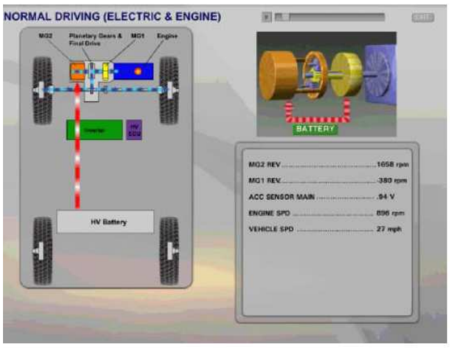
Prius

Starting Out When starting out under light load and light throttle, only MG2 turns to provide power. The engine does not run and the vehicle runs on electric power only. MG1 rotates backwards and just idles; it does not generate electricity.



Prius

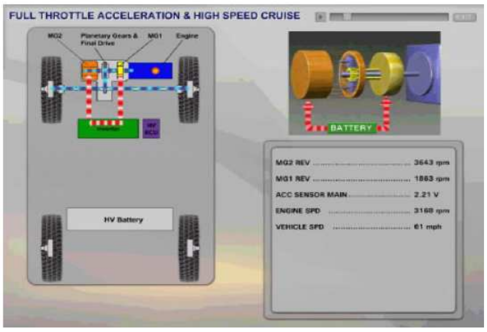
Normal Driving During normal low-speed driving (15 – 40mph), the engine runs and provides power. MG2 turns and runs as a motor and provides an electric assist. MG1 is turned in the same direction by the engine as a generator and provides electricity for MG2.



Prius

Full Throttle Acceleration and High Speed Cruise

For maximum acceleration or speed (over 100mph), electric drive power from MG2 supplements engine power. The HV battery provides electricity to MG2. MG1 also receives electrical power from the HV battery and turns in the reverse direction to create an overdrive ratio for maximum speed.

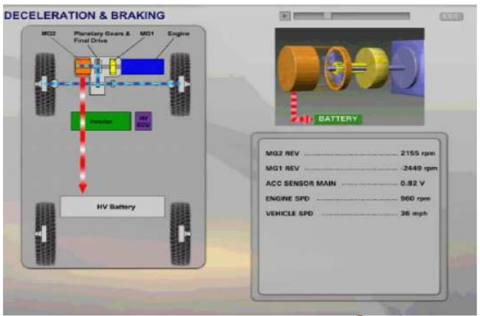


Prius

Deceleration and Braking

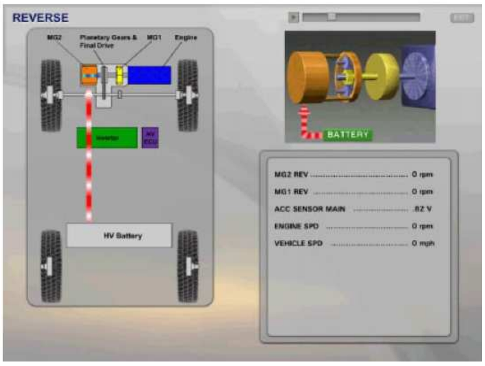
As soon as the driver releases the accelerator pedal, MG2 becomes a generator. MG2 is turned by the drive wheels and generates electricity to recharge the HV battery. This process is called Regenerative Braking. As the vehicle decelerates, the engine stops running and MG1 turns backwards to maintain the gear ratio.

When the brake pedal is depressed, most initial braking force comes from Regenerative Braking and the force required to turn MG2 as a generator. The hydraulic brakes provide more stopping power as the vehicle slows.



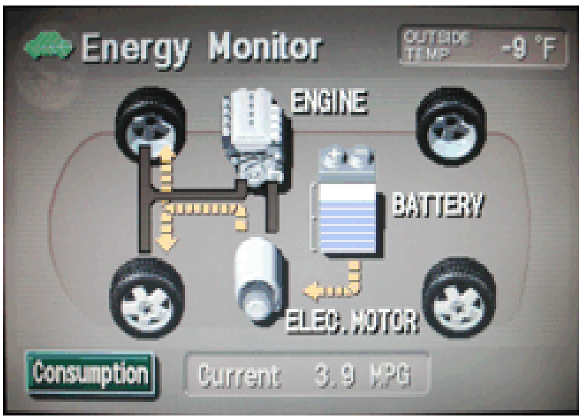
Prius

Reverse When the vehicle moves in reverse, MG2 turns in reverse as an electric motor. The engine does not run. MG1 turns in the forward direction and just idles; it does not generate electricity.



Prius

Simulation of Energy Monitor



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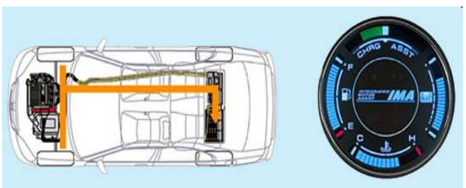
Honda



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Honda

- **Honda believes that the engine plays an all-important role, even in hybrid powerplants.**

  A variety of hybrid systems are in use in automobiles today. Honda's lightweight and simple design features a parallel system in which the motor assists the engine as required.

  Since in a parallel system the engine serves as the main power source, Honda has further refined the engine, developing a new i-VTEC engine around the core of its original valve-control technology. In addition to achieving both powerful torque and high fuel economy, the new engine optimizes efficiency with such innovations as deactivating all cylinders during deceleration for improved regenerative braking. This results in outstanding environmental performance combined with impressive acceleration.

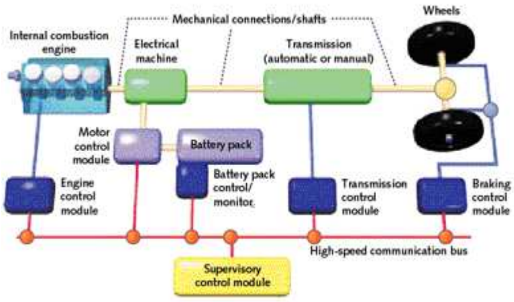
Honda

- **Motor-alone and cylinder-Idle modes provide improved fuel efficiency and increased driving pleasure.**

  The electric motor provides ample power to allow low-speed cruising under motor power alone. Moreover, the i-VTEC engine controls valve operation to permit deactivating of all four cylinders, for improved regenerative braking efficiency during deceleration.

Honda

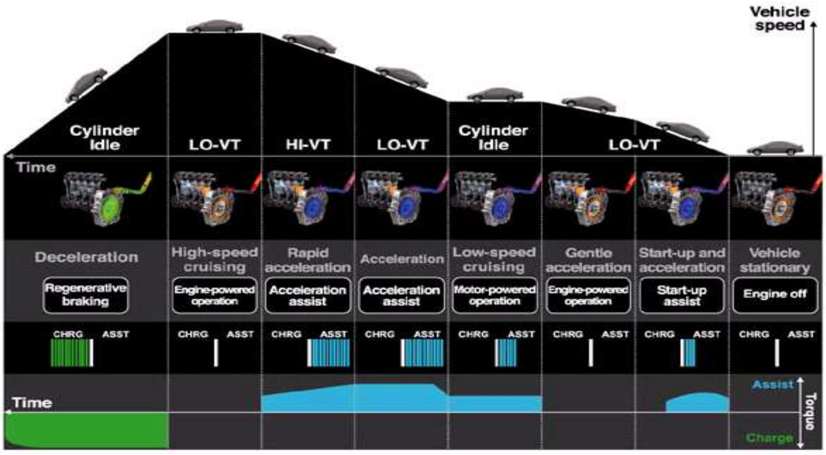
In Figure which shows essentially the layout of the Honda Civic Hybrid available today, the purpose of the electric motor is to assist the internal combustion engine during acceleration (enabling use of a smaller, more efficient engine), recovering energy during deceleration and braking, and starting the engine.



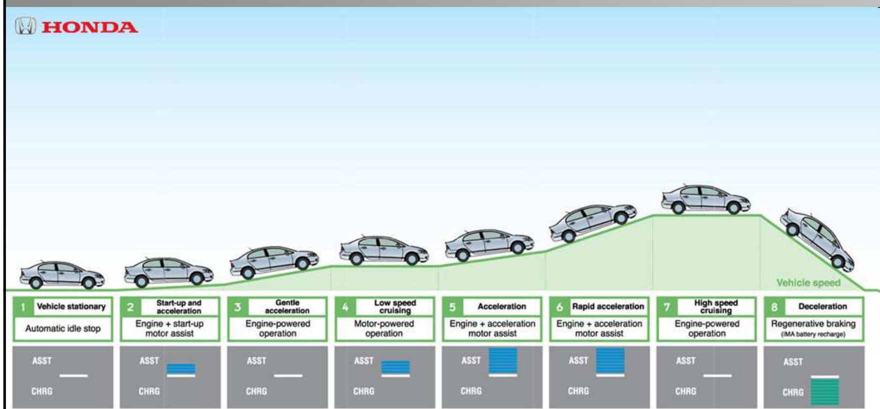
Honda

The Civic Hybrid attains decreased emissions and fuel consumption in three ways. First, energy normally lost during vehicle deceleration and braking is used to recharge the batteries. Second, fuel is saved by turning the internal combustion engine off when the vehicle is idling. The electric motor is large enough to both restart the engine and begin propelling the vehicle simultaneously. Finally, a smaller displacement engine is employed in this car than the standard Civic, since the electric motor is able to assist during high-demand periods (such as rapid acceleration).

Honda



Honda

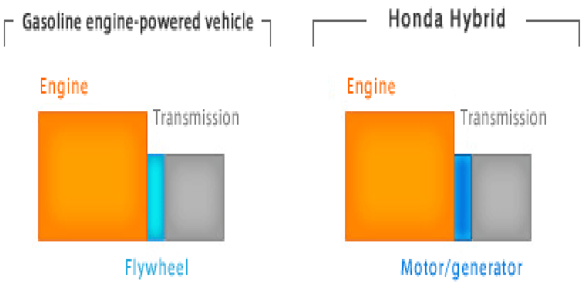


1. **Vehicle stationary (automatic idle stop*1 mode):** Engine automatically stopped. Zero fuel consumption and zero exhaust emissions. Automatic Idle Stop warning lamp on. Engine automatically re-starts as driver releases brakes.
   *1 Under certain circumstances, the engine might not stop.
2. **Start-up and acceleration (engine + motor assist):** Engine running in low rpm mode. Motor assist provides necessary additional power to accelerate.
3. **Gentle acceleration (engine only):** Engine running in low rpm mode.
4. **Low speed cruise (motor assist only):** When cruising at around 40 km/h, all 4 cylinders are de-activated and fuel supply is stopped. The vehicle runs on power from the motor alone.
5. **Acceleration (engine + motor assist):** Engine running in low rpm mode. Motor assist provides necessary additional power to accelerate.
6. **Rapid acceleration (engine + motor assist):** As speed rises, engine switches to high rpm mode for higher power output. Motor assist provides additional power for strong, powerful acceleration.
7. **High speed cruise (engine only):** Engine running in low rpm mode.
8. **Deceleration (IMA battery recharge mode):** All 4 cylinders are de-activated and fuel supply is stopped. The motor switches to regenerative braking mode and energy recovery is maximized to recharge the IMA batteries.

- **Slim and compact, the motor of the Honda Hybrid System is no larger than the flywheel of a conventional engine.**

- In a conventional car there is a flywheel between the engine and the transmission, serving to smooth out fluctuations in engine torque for smooth engine operation. The electric motor in the Honda Hybrid System is slim and compact enough to fit into the space usually taken up by the flywheel. And the rotor in the electric motor serves as the flywheel. This is why the Honda Hybrid System fits in to existing vehicles as is. Honda is hard at work on further hybrid technology development to make hybrid cars even more a part of our lives.

Honda



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Honda

- Honda's fourth-generation hybrid, the Civic Hybrid, combines a petrol-powered engine with an electric motor to boost power and cut fuel consumption and exhaust emissions. A Nickel-Metal Hydride (NiMH) battery pack is used to capture and store electricity for the electric motor.
- The improved Integrated Motor Assist (IMA) system now allows the Civic Hybrid to drive on electric power alone, provided the vehicle is travelling at less than 40 km/h. The Civic Hybrid has a combined petrol/electric output of 85kW and develops 170Nm. Quoted fuel consumption is 4.6 litres per 100km. The Civic Hybrid is equipped with a Continuously Variable Transmission (CVT).

Honda

- During acceleration, the engine, or the engine working in tandem with the electric motor, propel the vehicle. During cruising, the petrol engine and/or the electric motor can propel the vehicle, depending on conditions. During braking, the petrol engine deactivates and the electric motor acts as a generator to replenish the battery pack. At a stop, the engine can enter an idle-stop mode to save fuel and reduce emissions, with the engine turned off until the brake pedal is released.

Honda

- **Engine Block Construction, Pistons and Connecting Rods**

- The 1.3 litre aluminium engine block and its internal components create a lightweight package with extremely low friction qualities. To save weight, the block incorporates a thin sleeve construction. Friction-reducing measures include plateau honing, low friction pistons, low tensile force piston rings and an offset cylinder bore.

Honda

- Thin sleeve cylinder wall construction results in a reduction of the total amount of aluminium used in the engine. Plateau honing lowers the friction level between the pistons and the cylinders by creating an ultra smooth surface. Plateau honing is a two stage machining process that uses two grinding processes instead of the more conventional single honing process. This also enhances the long-term wear characteristics of the engine.

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Honda

- Low friction pistons made of aluminium alloy are lightweight and have "micro-dimples" on the cylinder walls for improved lubrication. Offset cylinder bores help minimise friction by positioning the crankshaft axis in a more efficient alignment to the cylinder bore axis. This reduces friction caused by the side thrust of the pistons against the cylinder walls, just after top-dead-centre, as each piston begins its descent on the firing stroke.

- Connecting rods are high strength forged steel units that have been treated with a special carbon process that hardens the surface and allows engineers to use a design that weighs less than a traditional connecting rod.

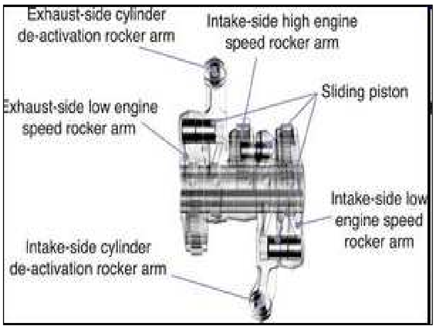
Honda

- **3-Stage i-VTEC with Variable Cylinder Management (VCM)**

- The Civic Hybrid uses a 3-Stage i-VTEC valve control system that provides normal valve timing, high output valve timing and cylinder idling functions. The previous generation system in the 2005 Civic Hybrid uses 2-stage VTEC that provides normal valve timing and 3-cylinder idling. The 3-stage system adds high output valve timing and 4-cylinder idling. Over the previous model, the high output valve timing contributes to the engine's output increase of 9 percent, while the added cylinder deactivation reduces pumping losses by 66 percent to help improve electrical regeneration capability by 1.7 times.

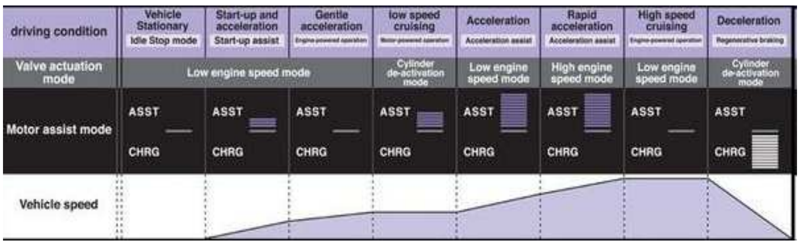
Honda

The Civic Hybrid's single overhead camshaft (SOHC) cylinder head uses a compact chain drive and a compact, low friction VTEC system. It uses a common rocker shaft for both the intake and exhaust rocker arms. Placing all the rocker arms on one shaft eliminates the need for a second rocker-arm shaft, so the valve mechanism can be lighter and more compact. To reduce friction, the rocker arms have built-in rollers.



Honda

- The compact valvetrain allows for a narrow angle (30 degrees) between the intake and exhaust valves, which helps supply a more powerful direct charge into the cylinder chamber. The narrow angle valvetrain also allows for a more compact combustion chamber. The intake ports create a swirl effect in the cylinder chamber that promote a well balanced and even air fuel mixture as it enters the engine. This optimises the air fuel mixture for a cleaner, more efficient combustion.



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Honda

- The new VCM (Variable Cylinder Management) system is an advanced form of the three-cylinder Cylinder Idling System used on the previous generation. VCM allows the regenerative braking system to reclaim as much energy as possible during deceleration, while also allowing the electric motor to propel the vehicle in certain steady cruising situations.

- Since the electric motor, which also acts as an electric generator, is attached directly to the crankshaft of the engine, the engine needs to provide as little resistance as possible during deceleration to allow the generator to produce high levels of electricity and charge the batteries. In a traditional engine, the pumping action of the cylinders will actually provide a moderate amount of resistance, or "engine braking," during deceleration. VCM virtually eliminates that effect.

- From a mechanical standpoint, the three stage VTEC switching capabilities are made possible by a rocker arm design with three hydraulic circuits that accommodates (a) low rpm VTEC switching on each cylinder's intake and exhaust valve and (b) high speed switching on the intake valve. Three oil passages inside the rocker shaft receive oil from an external spool valve (controlled by the ECU based mostly on throttle and rpm). The oil pressure from one of the three passages activates a combination of push pins inside the rocker arms for each of the intake and exhaust valves. By moving the pins, the intake valve rocker arms can follow one of two lobes on the camshaft (normal or high profile). Or, to deactivate the valves and leave them closed, the pins are pushed in a direction that allow part of the intake and exhaust rocker arms to move with the camshaft and not move the closed valves.

Honda

- **Dual & Sequential Ignition with Twin Plug Sequential Ignition Control**
- The twin plug sequential ignition control is part of the i-VTEC system and helps facilitate an intense and rapid combustion process in the engine. The ignition control has eight ignition coils that are independently controlled according to a dynamic engine map program. The benefits are more power, less fuel consumption and reduced emissions. Honda's patented twin plug sequential control system is programmed to respond to engine rpm and load conditions. Since the system has eight individual ignition coils, it can manipulate the ignition timing of each iridium-tipped spark plug.

Honda

- When the air/fuel mixture enters the combustion chamber, the first plug located near the intake port ignites. Shortly thereafter, the second plug located near the exhaust port ignites, accelerating the combustion process by forcing the flame to more rapidly propagate. The spark plugs can also ignite simultaneously under certain circumstances. This process results in a more complete combustion compared to a single plug system.

Honda

- **Electronic Throttle Control**
- An electronic drive-by-wire system enhances the driving character of the Civic Hybrid. With smart electronics connecting the throttle pedal to the throttle butterfly valve in the intake manifold, the engine response and IMA operation can be optimised to suit the driving conditions and to better match the driver's expectations. By eliminating the direct throttle cable connection to the engine, the ratio between pedal movement and throttle butterfly movement can be continuously optimised. This adjustable "gain" between throttle and engine is a significant step forward in driveability, which also allows for VCM to cut all cylinders and drive with the electric motor only during some cruising situations. A DC motor moves the throttle butterfly position in the intake manifold to change actual throttle position. To establish the current driving conditions, the system monitors pedal position, throttle position, vehicle speed, engine speed, calculated road slope and engine vacuum. This information is then used to define the throttle control sensitivity.

Honda

- **Programmed Fuel Injection (PGM-FI)**
- The Civic Hybrid is equipped with a Programmed Fuel Injection (PGM-FI) system. The system monitors throttle position, engine temperature, intake-manifold pressure, atmospheric pressure, exhaust-gas oxygen content, and intake-air temperature. It controls fuel delivery by multi-holed injectors mounted in the plastic intake manifold. The ECU also tracks the operation of the engine with position sensors on the crankshaft and camshaft.

Honda

- **Lightweight Composite Resin Intake Manifold Chamber**
- Upstream from the aluminium intake manifold, the engine’s intake manifold chamber is constructed of a composite resin instead of aluminium alloy in order to save weight. The individual pieces that make up the manifold chamber are permanently connected with a vibration welding technique.

Honda

- **Dual Scroll Air Conditioning Compressor**
- A dual scroll hybrid air conditioning system reduces the load on the petrol engine by using a combination of engine power and an internal electric motor to drive two air conditioning compressors. These compressors can act independently or together as dictated by the cooling needs of the Civic Hybrid’s automatic climate control system.

Honda

- **Engine Mounts**
- A new torque rod damper system added to the subframe helps reduce rocking and isolate powertrain NVH from the passenger compartment. The engine mounts, one of which is hydraulic, and reinforcements in the engine compartment help further reduce engine noise and vibrations.

Honda

- **IMA System**

- The 4th generation IMA system is the most powerful and most efficient to come out of Honda's hybrid development program. (1st generation: Insight; 2nd generation: Civic Hybrid; 3rd generation: Accord Hybrid.) As with previous versions, the IMA system consists of an ultra-thin DC brushless electric motor mounted between the petrol engine and the continuously variable transmission, and an Intelligent Power Unit (IPU) that stores electric power in a battery and controls the flow of electricity to and from the electric motor.

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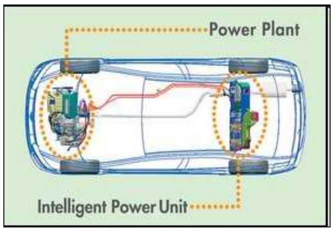
Honda

- **IMA Electric Motor**

- Providing a supplemental power boost to the 1.3-litre 4-cylinder engine and giving the Civic Hybrid the capability to cruise on its electric motor in certain situations, the IMA's electric motor is designed to provide up to 15 kW and 89Nm of additional torque to the Civic Hybrid's engine. Mounted between the engine and the CVT transmission, the IMA motor is a 70 mm thick DC brushless design and provides a substantial amount of low-end torque to aid acceleration, while also assisting in steady-state cruising and hill climbing.



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- In addition to providing supplemental motive power, the IMA motor acts as a generator during deceleration and braking to recapture kinetic energy and recharge the IMA's battery pack during regenerative braking.

- For this fourth generation of IMA motor, a new internal permanent magnet was designed to increase output density and make the motor more efficient than previously. It also uses flat wire construction to increase wire density. The electric motor has increased output power by 46 percent and maximum torque by 14 percent compared with the 2005 Civic Hybrid IMA motor. The electric motor is also more efficient, now converting 96 percent (versus 94.6 percent efficiency of the 2005 Civic Hybrid IMA motor) of the available electricity into motive energy in assist mode.

Honda

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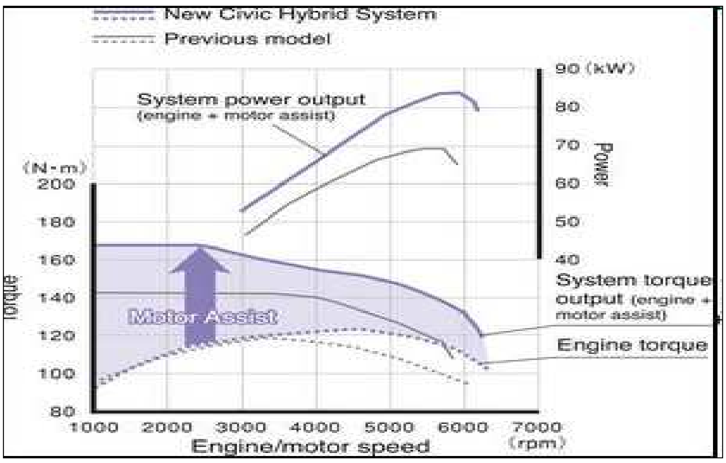
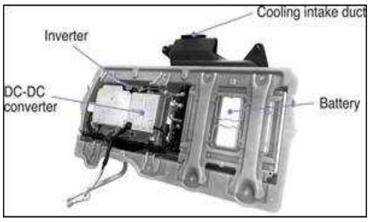


Honda

- **IMA Intelligent Power Unit (IPU)**

- Power for the IMA system is controlled through the Civic Hybrid's Intelligent Power Unit. Located directly behind the rear seat, the IPU consists of the Power Control Unit (PCU) - the IMA's command centre, a rechargeable Nickel Metal-Hydride battery module, and an integrated cooling unit.



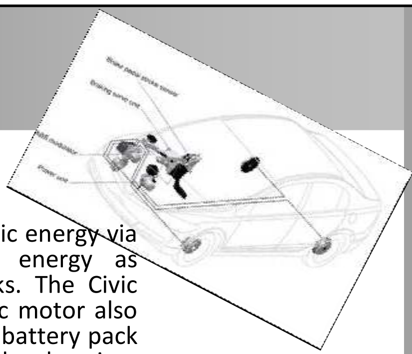
Honda

- The Power Control Unit (PCU) electronically controls the flow of energy to and from the IMA's electric motor. Using the latest computer chip technology, the PCU's response time is quicker than the previous versions, and a new inverter and DC/DC Converter help contribute to the IMA's overall increase in power.

- The battery pack stores electricity in a bank of Nickel Metal-Hydride cells. This bank of 132 1.2-volt units stores up to 158 volts of electrical energy for the IMA motor compared to 144 in previous versions. A new Panasonic dual module casing reduces weight from previous hybrid battery packs and also allows it to increase efficiency of the electrical flow. The 12 percent smaller battery pack provides more cargo space.

- The Integrated Cooling Unit offsets the heat generated by the constant flow of electricity to and from the battery pack with an integrated cooling system mounted directly on the battery pack's outer box. Interior cabin air is continually flowed over the battery pack and re-circulated via a small vent placed on the rear seat shelf.

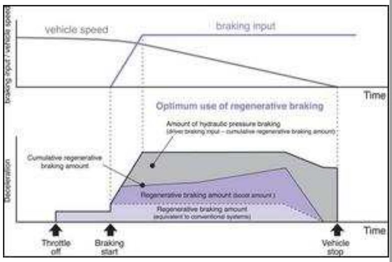
Honda



- **Cooperative Regenerative Brake System**
- Hybrid-powered vehicles recapture kinetic energy via regenerative braking and store this energy as electricity in rechargeable battery packs. The Civic Hybrid is no different, as its IMA electric motor also acts as a generator that can recharge its battery pack during braking, steady cruising, gentle deceleration, or coasting. New for 2006, a cooperative regenerative braking system debuts on the Civic Hybrid with the added capability to intelligently proportion braking power between the hydraulic brakes and the electric motor to extract even more electricity from the vehicle's kinetic energy. Less reliance on the traditional braking system and reduced engine pumping losses translate into greater electrical regeneration (170 percent more than the 2005 Civic Hybrid) and ultimately improved fuel economy.

Honda

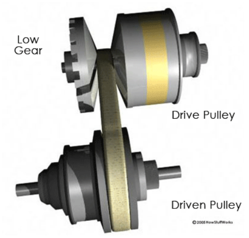
- When braking, a brake pedal sensor sends a signal to the vehicle's IMA computer (IPU). The computer activates a servo unit in the brake system's master cylinder that proportions braking power between the traditional hydraulic brakes and the electric motor to maximised regeneration. Previous versions of Honda's IMA systems proportioned braking power at a pre-set rate below the maximum regeneration threshold and with no variable proportioning.

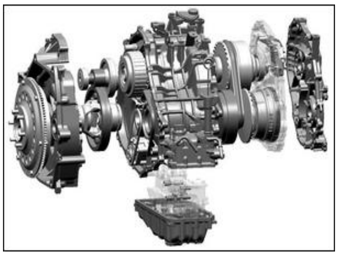


Honda

- **Continuously Variable Transmission**

- Honda's Continuously Variable Transmission (CVT) is standard equipment on the Civic Hybrid and provides a 9 percent wider range between the maximum and minimum gear ratios to enhance acceleration and minimise engine rpm at high speeds.





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- Unlike a conventional transmission with four of five gears that change the final drive ratio in steps, a CVT uses a steel belt and a variable pulley to infinitely change the final drive ratio between a minimum and maximum setting. The variable pulley with its angled internal sides moves in and out by hydraulic pressure to expand or reduce the radius travelled by the steel belt.
- Improvements to the new CVT include:
- 9 percent wider ratio range of 2.52 - 0.421:1 (previously 2.36 - 0.407:1)
- Final drive ratio of 4.94:1 (previously 5.58:1)
- Expanded pulley axial distance from 143 mm to 156 mm
- Expanded pulley ratio range to 6.0 mm from 5.8 mm
- Double hydraulic piston used on variable pulley increases pressure by 170 percent
- Improved low friction construction for overall efficiency increase
- Torque handling capacity increases by 18 percent

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Honda

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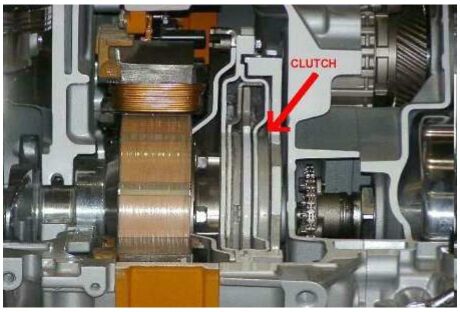
- Overall, a CVT provides a greater fuel economy benefit than a conventional automatic transmission with gears. It helps the engine stay in its most efficient operating range for both performance and economy, and the need to shift gears is eliminated.



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- **2006 Civic Hybrid Specifications**
- Wheelbase (mm) - 2700
- Length (mm) - 4550
- Width (mm) - 1750
- Height (mm) - 1430
- Engine - 1.3-litre i-VTEC SOHC
- Power @ rpm (combined) - 85 @ 6000
- Torque (Nm) @ rpm (combined) - 170 @ 2500
- Transmission - CVT
- Tyre Size - 195/65 R15
- Fuel consumption (litres per 100km) - 4.6
- Weight - 1265

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Honda vs Prius

Honda vs Prius

- The Portuguese medium car segment only features two eco-friendly green machines; there's the widely known Toyota Prius and the somewhat less known Honda Civic Hybrid. Both vehicles have their advantages and disadvantages and one is a clear winner in terms of its frugal fuel use. But the overall competition is much closer than expected.
- Anyway, enough of the pillow-talk, let the battle begin!

Honda vs Prius

- When it comes to interiors, Honda has dared to be different with very futuristic styling. Although the Civic Hybrid's interior is the same shape as other Civic models, Honda has opted for a beige treatment that makes the interior look and feel roomier.
- In the other corner, the Toyota Prius is very simple in comparison. All the gauges and controls are either confined to the steering wheel or to the touch-screen LCD monitor. In a change from the norm, the steering wheel allows the driver to not only control the audio, telephone and cruise control, but also the climate and demister controls. It's the first vehicle I have driven that allows the driver to control these aspects via the steering wheel, and I must say that it's fantastic in terms of its functionality and ease of use. The driver never has to reach over and fiddle with knobs, it should be a feature built into all new vehicles.

Honda vs Prius

When it comes to gizmos and gadgets, the Prius i-Tech takes the cake. It's a given though, the Prius i-Tech costs thousands of dollars more than the Civic Hybrid (almost $16,000 more to be exact). Nevertheless, your cash gets you a very impressive centre console LCD that controls the DVD satellite navigation, along with reverse camera and vehicle statistics. A screen with live power sampling can be selected, whereby the driver can see where power is being obtained at any given time (engine or electric, or both).

Honda vs Prius

Honda vs Prius

- The Prius i-Tech also includes a Lexus-esque keyless entry and keyless start system. The driver simply approaches the vehicle with the key fob in their pocket, then simply grabs the handle and the doors unlock. From there it's simply a case of hitting the starter button when the key is anywhere within the vehicle.

- Interior room on the other hand proves that both vehicles are certainly not short of space. It's amazing just how much room is on offer in the Prius and Civic Hybrid. Four people can quite comfortably fit inside either vehicle. Boot space in both vehicles is somewhat compromised due to the battery packs fitted to both vehicles, but is still very reasonable. The Prius has a flat battery pack that sits beneath the floor of the boot, whereas the Civic Hybrid has a battery pack that sits parallel to the rear seat and boot divider. The Prius carries a 456L boot capacity, whilst the Civic Hybrid can hold 376L worth of cargo.

Honda vs Prius

Honda vs Prius

- In terms of exterior viewing pleasure, the Honda Civic Hybrid can't help but look the best. The Hybrid Civic features very eco-friendly looking alloy wheels, along with chrome highlights and Hybrid badges. Unlike the Prius, the Civic Hybrid uses carryover styling from the rest of the Civic range, whereas the Prius uses a totally unique style (which in my opinion is far less appealing).
- The Civic also uses Peugeot style inverted windscreen wipers, which could have been a little bit better in terms of their ability and functionality. You can also expect to see indicator lights built into wing mirrors on the Civic Hybrid, adding to the 'luxurious' touch conveyed by the new Civic.

Honda vs Prius

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- Prius has an entirely unique design that makes its presence more known, there isn't a need to check twice to see if it's the Hybrid model or not. In a way, this is good but in ours opinion the styling could have been more adventurous and less Hybrid stereotypical.

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Honda vs Prius

- Both vehicles feature alloy wheels, but when parked next to each other, it's quite clear that the Honda looks easier on the eye in comparison to the Toyota.

Honda vs Prius

- When it came to driving these Hybrids, I wasn't expecting any revolutionary handling characteristics or supercar-like acceleration.

- The Honda Civic Hybrid is generally ahead when it comes to turning corners and general enthusiastic handling. As it's based on the new Civic chassis, there is more room for further development of the chassis and handling dynamics. The Civic sits more flat through bends and feels more composed and features little body roll. The steering in the Civic is very sharp and responsive, allowing more confident cornering and general driving.

Honda vs Prius

Honda vs Prius

- Toyota's Prius on the other hand is more of a laid back vehicle in terms of its handling. There are abysmal amounts of body roll and the chassis simply feels like it can't handle taking corners at any great pace. The steering also felt far too power assisted and generally less in touch with the road. It's obvious that the Prius is at home in metropolitan areas, opposed to the twisty roads.

Honda vs Prius

- Both vehicles feature a CVT (Continually Variable Transmission). Without going into too much detail, a CVT is kind of like an infinite-speed gearbox – generally speaking. A CVT uses a pulley system to variably adjust the gear ratio in order to suit the driving style. For example, if the driver plants the right foot, the CVT adjusts the ratios continuously, allowing the revs to stay at the maximum power zone, thus allowing constant and variable power. There are no 'gear changes' as such, it's quite eerie.

Honda vs Prius

Honda vs Prius

- The Toyota Prius is most at home in stop-start city driving. At speeds of below 32km/h, the Prius can drive entirely on battery power. At a complete stop, the engine is switched off to save petrol. When you take off, the vehicle seamlessly changes between battery and engine power, or both when full power is required. The driver can also elect to operate entirely on battery power (providing enough battery charge is present) by pushing a button on the dashboard.

Honda vs Prius

- The best part about the Prius's low-speed driving style is that it's so incredibly seamless. You really need to concentrate to feel when the engine switches on and off. Surely you would think there are no downsides to a battery-only running mode? Funnily enough, there is one. Before leaving Toyota's Port Melbourne complex, the head of the Press Fleet joked around and told me to be careful of pedestrians. I lost count at the amount of times I came close to running over stupid pedestrians. One particular lady with a pram decided to cross the road at a car park without looking both ways. She received the fright of her life when your's truly slammed on the brakes and jumped on the horn. The Prius literally makes no noise when running on battery mode, allowing pedestrian idiocy to glow without hesitation. Moral of the story: Look left and right before crossing the road, it will limit the chance of you being run over by an environmentally friendly Prius!

Honda vs Prius

Honda vs Prius

- Such problems are not encountered with the Hybrid Civic. The Civic only switches off its engine when the vehicle comes to a complete stop and the driver has their foot on the brake pedal. The second the brake pedal is released, the engine comes back to life and powers the vehicle. In fact, there were only rare occasions that I witnessed the battery level decrease in the Civic. Not because the battery had a massive capacity, more so because the battery only ever came into use when the driver had a heavy right foot. The battery didn’t seem to power the vehicle unless the driver required a bucket load of power in a hurry.

Honda vs Prius

- Highway driving on the other hand seemed to favour the Civic. The battery assisted the vehicle far more during highway driving and seemed to assist fuel use. I recorded an average fuel use of 5.4L/100KM on the highway, opposed to a combined highway and city cycle value of 6.2L/100KM. The Prius shone in both scenarios. I managed to travel around 900KM on a single 45L tank of fuel. The fuel use average was 4.9L/100KM, with a 40/60 split of city/highway driving. In both instances, the fuel use I recorded was higher than the manufacturer's claims. Toyota claimed a fuel use average of 4.4L/100KM, whilst Honda claims a miraculous figure of 4.6L/100KM, I'd love to know how they achieved such a fuel economy figure.

Honda vs Prius

- I was caught out on a few occasions where I needed that instant jolt of power to move me off the line. If you caught the car in a situation where the engine was off, it took a moment to switch the engine on and divert the power as required. Although both vehicles experienced this trait, it was more evident in the Civic over the Prius. But, interestingly enough, even though the Prius is only 3kW short of the Civic, the Civic was able to complete the dash from 0-100km/h in just over 12-seconds, whereas the Prius took just over 13-seconds. Obviously the 100KG weight difference between the vehicles made a very noticeable 1-second difference.

Honda vs Prius

- Both vehicles use regenerative braking. This system generates power through the energy that would generally be dissipated through regular braking. Power is also generated whilst the vehicle is coasting. Both methods were very efficient and even through an exhaustive mountain climb; both vehicles had ample battery power left for regular operation. My knowledge with regards to the technical aspects of this technology is limited, for further information, check out Google or HowStuffWorks.

Honda vs Prius

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- It was quite evident that the Prius was the 'true' fuel economy warrior of the two Hybrids. It was able to produce very impressive fuel economy figures without fail. Although the Civic Hybrid's fuel economy was still impressive, it wasn't anything ground breaking.

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Honda vs Prius

Honda vs Prius

- These Hybrid vehicles are different to your run of the mill type vehicle. Under the bonnet you will find two motors. You will find a regular petrol motor (in these small Hybrids, it's usually a small capacity motor) and an electric motor.

- The Toyota Prius produces 57kW at 5000RPM and 115Nm of torque at 4000RPM from its petrol engine. The electric motor produces 50kW at 1200RPM and 400Nm of torque from 0RPM. When both engines are put to use, they produce a combined power figure of 82kW.

Honda vs Prius

Honda vs Prius

- The Honda Civic Hybrid on the other hand produces 85kW at 6000RPM (combined) from its 1.3-litre, inline 4-cylinder engine. This equates to a combined torque rating of 170Nm at 2500RPM.
- Both engines are far from spectacular, but if you give them a flat foot worth of input, they give you a pretty decent push in the back, which is impressive from such a small package.

Honda vs Prius

Honda vs Prius

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- **Price, safety and features –**
- The Honda Civic Hybrid is currently the cheapest way to get into the greenie club. The Civic only comes in one variant and is priced at $31,990 (same price as the automatic Honda Civic Sport).
- Standard features you can expect to see with the Civic Hybrid include: Climate controlled air-conditioning; cruise control; central locking; electric windows; leather bound steering wheel; driver and passenger front SRS airbags; driver and passenger side SRS airbags; front and rear curtain airbags; alloy wheels; ABS brakes; immobiliser and 6-stack CD player with MP3 compatibility.
- The Toyota Prius on the other hand comes in two variants, the Prius and the Prius i-Tech (vehicle being tested); they are priced at $37,000 and $46,500 respectively.

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Honda vs Prius

- Standard features on the base model Prius include: Push button start; power windows; electric power steering (EPS); climate controlled air-conditioning; ABS brakes with brake assist (BA) and electronic brake distribution (EBD); dual front SRS airbags; motor traction control; 6-speaker CD system; cruise control; front fog lights; alloy wheels; immobiliser; central locking; reverse warning and drive by wire.
- In comparison to the Honda Civic Hybrid, the base model Toyota Prius is roughly on par in terms of features, making the Honda Civic better value in terms of pricing.
- If you opt for the i-Tech model Toyota Prius, you can expect to see all the standard features of the base model Prius, plus: Rear view camera; smart entry and keyless start; premium MP3 compatible JBL audio system; Bluetooth capability; DVD satellite navigation system; dual side curtain shield airbags; dual front seat mounted side airbags; vehicle stability/swerve control (VSC); leather interior and mini audio jack in floor console compartment.

Honda vs Prius

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