Challenges of Energy Saving Crisis as a Panacea to Hybrid Electric Vehicle (HEV)

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Abstract *Modern HEVs make use of efficiency-improving technologies energy such as regenerative braking, which converts the vehicle's kinetic energy into battery-replenishing electric energy, rather than wasting it as heat energy as conventional brakes do. Some varieties of HEVs use their internal combustion engine to generate electricity by spinning an electrical generator (this combination is known as a motor-generator), to either recharge their batteries or to directly power the electric drive motors. Many HEVs reduce idle emissions by shutting down the ICE at idle and restarting it when needed; this is known as a start-stop system. A hybrid-electric produces less emissions from its ICE than a comparably-sized gasoline car, since an HEV's gasoline engine is usually smaller than a comparably-sized pure gasoline-burning vehicle (natural gas and propane fuels produce lower emissions) and if not used to directly drive the car, can be geared to run at maximum efficiency, further improving fuel economy.*

Introduction

A hybrid electric vehicle (HEV) is a type of hybrid vehicle and electric vehicle which combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. The presence of the electric power train is intended to achieve either better fuel economy than a conventional vehicle, or better performance. A variety of types of HEV exist, and the degree to which they function as EVs varies as well. The most common form of HEV is the hybrid electric car, although hybrid electric trucks (pickups and tractors) and buses also exist. A gasoline car meets these requirements but produces a relatively large amount of pollution and generally gets poor gas mileage. An electric car, however, produces almost no pollution, but it can only go 50 to 100 miles (80 to 161 km) between charges. And the problem has been that the electric car is very slow and inconvenient to recharge. A gasoline-electric car combines these two setups into one system that leverages both gas power and electric power.

Classification of hybrid vehicle: Hybrid electric vehicles can be classified according to the way in which power is supplied to the drive train:

Parallel hybrids: the ICE and the electric motor are both connected to the mechanical transmission and can simultaneously transmit power to drive the wheels, usually through a conventional transmission. Honda's Integrated Motor Assist (IMA) system as found in the Insight, Civic, Accord, as well as the GM Belted Alternator/Starter (BAS Hybrid) system found in the Chevrolet Malibu hybrids are examples of production parallel hybrids. Current, commercialized parallel hybrids use a single, small (<20 kW) electric motor and small battery pack as the electric motor is not designed to be the sole source of motive power from launch. Parallel hybrids are also capable of regenerative braking and the internal combustion engine can also act a generator for supplemental recharging. Parallel hybrids are more efficient than comparable non-hybrid vehicles especially during urban stop-and-go conditions and at times during highway operation where the electric motor is permitted to contribute.

Series hybrids, only the electric motor drives the drive train, and the ICE works as a generator to power the electric motor or to recharge the batteries. The battery pack can be recharged through regenerative braking or by the ICE. Series hybrids usually have a smaller combustion engine but a larger battery pack as compared to parallel hybrids, which makes them more expensive than parallels. This configuration makes series hybrids more efficient in city driving. The Chevrolet Volt is a series plug-in hybrid, although GM prefers to describe the Volt as an electric vehicle equipped with a "range extending" gasoline powered ICE as a generator and therefore dubbed an "Extended Range Electric Vehicle" or E-REV.

Power-split hybrid:s have the benefits of a combination of series and parallel characteristics. As a result, they are more efficient overall, because series hybrids tend to be more efficient at lower speeds and parallel tend to be more efficient at high speeds; however, the power-split hybrid is higher than a pure parallel. Examples of power-split (referred to by some as "series-parallel") hybrid power trains include current models of Ford, General Motors, Lexus, Nissan, and Toyota.

Full hybrid: sometimes also called a strong hybrid, is a vehicle that can run on just the engine, just the batteries, or a combination of both.[17] Ford's hybrid system, Toyota's Hybrid Synergy Drive and General Motors/Chrysler's Two-Mode Hybrid technologies are full hybrid systems.[18] The Toyota Prius, Ford Escape Hybrid, and Ford Fusion Hybrid are examples of full hybrids, as these cars can be moved forward on battery power alone. A large, high-capacity battery pack is needed for battery-only operation. These vehicles have a split power path allowing greater flexibility in the drive train by interconnecting mechanical and electrical power, at some cost in complexity.

Mild hybrid: is a vehicle that can not be driven solely on its electric motor, because the electric motor does not have enough power to propel the vehicle on its own. Mild hybrids only include some of the features found in hybrid technology, and usually achieve limited fuel consumption savings, up to 15 percent in urban driving and 8 to 10 percent overall cycle. A mild hybrid is essentially a conventional vehicle with oversize starter motor, allowing the engine to be turned off whenever the car is coasting, braking, or stopped, yet restart quickly and cleanly. The motor is often mounted between the engine and transmission, taking the place of the torque converter, and is used to supply additional propulsion energy when accelerating. Accessories can continue to run on electrical power while the gasoline engine is off, and as in other hybrid designs, the motor is used for regenerative braking to recapture energy. As compared to full hybrids, mild hybrids have smaller batteries and a smaller, weaker motor/generator, which allows manufacturers to reduce cost and weight.

Honda's early hybrids including the first generation Insight used this design, leveraging their reputation for design of small, efficient gasoline engines; their system is dubbed Integrated Motor Assist (IMA). Starting with the 2006 Civic Hybrid, the IMA system now can propel the vehicle solely on electric power during medium speed cruising. Another example is the 2005-2007 Chevrolet Silverado Hybrid, a full-size pickup truck.[18] Chevrolet was able to get a 10% improvement on the Silverado's fuel efficiency by shutting down and restarting the engine on demand and using regenerative braking. General Motors has also used its mild BAS Hybrid technology in other models such as the Saturn Vue Green Line, the Saturn Aura Greenline and the Mailbu Hybrid.

A plug-in hybrid electric vehicle (PHEV): also known as a plug-in hybrid, is a hybrid electric vehicle with rechargeable batteries that can be restored to full charge by connecting a plug to an external electric powersource. A PHEV shares the characteristics of both a conventional hybrid electric vehicle, having an electric motor and an internal combustion engine; and of an all-electric vehicle, also having a plug to connect to the electrical grid. PHEVs have a much larger all-electric range as compared to conventional gasoline-electric hybrids, and also eliminate the "range anxiety" associated to all-electric vehicles, because the combustion engine works as a backup when the batteries are depleted.

Chinese battery manufacturer and automaker BYD Auto released the F3DM PHEV-62 (PHEV-100 km) hatchback to the Chinese fleet market on December 15, 2008, for 149,800 yuan (US $22,000).General Motors launched the 2011 Chevrolet Volt series plug-in in December 2010. The Volt displaced the Toyota Prius as the most fuel-efficient car sold in the United States.

The regenerative braking system: the core design concept of most production HEVs, was developed by electrical engineer David Arthurs around 1978, using off-the shelf components and an Opel GT. However the voltage controller to link the batteries, motor (a jet-engine starter motor), and DC generator was Arthurs'. The vehicle exhibited 75 miles per US gallon (3.1 L/100 km; 90 mpg-imp) fuel efficiency, and plans for it (as well as somewhat updated versions) are still available through the Mother Earth News web site. The Mother Earth News' own 1980 version claimed nearly 84 miles per US gallon (2.8 L/100 km; 101 mpg-imp).

In 1989, Audi produced its first iteration of the Audi Duo (the Audi C3 100 Avant Duo) experimental vehicle, a plug-in parallel hybrid based on the Audi 100 Avant quattro. This car had a 9.4 kilowatts (12.8 PS; 12.6 bhp) Siemens electric motor which drove the rear roadwheels. A trunk-mounted nickel-cadmium battery supplied energy to the motor that drove the rear wheels. The vehicle's front roadwheels were powered by a 2.3 litre five-cylinder petrol engine with an output of 100 kilowatts (136 PS; 134 bhp). The intent was to produce a vehicle which could operate on the engine in the country, and electric mode in the city. Mode of operation could be selected by the driver. Just ten vehicles are believed to have been made; one drawback was that due to the extra weight of the electric drive, the vehicles were less efficient when running on their engines alone than standard Audi 100s with the same engine.

In 1992,Volvo ECC was developed by Volvo. The Volvo ECC was built on the Volvo 850 platform. In contrast to most production hybrids, which use a gasoline piston engine to provide additional acceleration and to recharge the battery storage, the Volvo ECC used a gas turbine engine to drive the generator for recharging.

Automotive hybrid technology: became widespread beginning in the late 1990s. The first mass-produced hybrid vehicle was the Toyota Prius, launched in Japan in 1997, and followed by the Honda Insight, launched in 1999 in the United States and Japan. The Prius was launched in Europe, North America and the rest of the world in 2000. The first generation Prius sedan has an estimated fuel economy of 52 miles per US gallon (4.5 L/100 km; 62 mpg-imp) in the city and 45 miles per US gallon (5.2 L/100 km; 54 mpg-imp) in highway driving. The two-door first generation Insight was estimated at 61 miles per US gallon (3.9 L/100 km; 73 mpg-imp) miles per gallon in city driving and 68 miles per US gallon (3.5 L/100 km; 82 mpg-imp) on the highway.

The Ford Escape Hybrid: the first hybrid electric sport utility vehicle (SUV) was released in 2005. Toyota announced calendar year 2005 hybrid electric versions of the Toyota Highlander Hybrid and Lexus RX 400h with 4WD, which uses a rear electric motor to power the rear wheels negating the need for a transfer case.

In 2006, General Motors Saturn Division began to market a mild parallel hybrids in the form of the 2007 Saturn Vue Green Line which utilized GM's Belted Alternator/Starter (BAS Hybrid) System combined with a 2.4 litre L4 engine and a FWD automatic transmission. The same hybrid powertrain was also used to power the 2008 Saturn Aura Greenline and Mailbu Hybrid models. As of December 2009, only the BAS equipped Malibu is still in (limited) production.

In 2007, Lexus released a hybrid electric version of their GS sport sedan, the GS 450h, with a power output of 335 bhp. The 2007 Camry Hybrid became available in Summer 2006 in the United States and Canada. Nissan launched the Altima Hybrid with technology licensed by Toyota in 2007.

Volkswagen announced at the 2010 Geneva Motor Show the launch of the 2012 Touareg Hybrid, scheduled for 2011. VW also announced plans to introduce diesel-electric hybrid versions of its most popular models in 2012, beginning with the new Jetta, followed by the Golf Hybrid in 2013 together with hybrid versions of the Passat.The Peugeot 3008 HYbrid4 will be launched in the European market in early 2011 and is expected to become the world's first production diesel-electric hybrid. According to Peugeot the new hybrid delivers a fuel economy of up to 62 miles per US gallon (3.8 L/100 km; 74 mpg-imp) and CO2 emissions of 99g/km on the European test cycle Other gasoline-electric hybrids already scheduled for commercial sales in 2011 are the Lexus CT 200h,[55] the Infiniti M35 Hybrid, the Hyundai Sonata Hybrid and its siblling the Kia Optima Hybrid

The varieties of hybrid electric designs can be differentiated by the structure of the hybrid vehicle drivetrain, the fuel type, and the mode of operation.

In 2007, several automobile manufacturers announced that future vehicles will use aspects of hybrid electric technology to reduce fuel consumption without the use of the hybrid drivetrain. Regenerative braking can be used to recapture energy and stored to power electrical accessories, such as air conditioning. Shutting down the engine at idle can also be used to reduce fuel consumption and reduce emissions without the addition of a hybrid drivetrain. In both cases, some of the advantages of hybrid electric technology are gained while additional cost and weight may be limited to the addition of larger batteries and starter motors. There is no standard terminology for such vehicles, although they may be termed mild hybrids.Free-piston engines could be used to generate electricity as efficiently as, and less expensively than, fuel cells.

Gasoline

Gasoline engines: are used in most hybrid electric designs, and will likely remain dominant for the foreseeable future. While petroleum-derived gasoline is the primary fuel, it is possible to mix in varying levels of ethanol created from renewable energy sources. Like most modern ICE powered vehicles, HEVs can typically use up to about 15% bioethanol. Manufacturers may move to flexible fuel engines, which would increase allowable ratios, but no plans are in place at present.

Diesel

Diesel-electric HEVs: use a diesel engine for power generation. Diesels have advantages when delivering constant power for long periods of time, suffering less wear while operating at higher efficiency. The diesel engine's high torque, combined with hybrid technology, may offer substantially improved mileage. Most diesel vehicles can use 100% pure biofuels (biodiesel), so they can use but do not need petroleum at all for fuel (although mixes of biofuel and petroleum are more common, and petroleum may be needed for lubrication). If diesel-electric HEVs were in use, this benefit would likely also apply. Diesel-electric hybrid drivetrains have begun to appear in commercial vehicles (particularly buses); as of 2007, no light duty diesel-electric hybrid passenger cars are currently available, although prototypes exist. Peugeot is expected to produce a diesel-electric hybrid version of its 308 in late 2008 for the European market.

PSA Peugeot Citroën has unveiled two demonstrator vehicles featuring a diesel-electric hybrid drivetrain: the Peugeot 307, Citroën C4 Hybride HDi and Citroën C-Cactus. Volkswagen made a prototype diesel-electric hybrid car that achieved 2 L/100 km (140 mpg-imp; 120 mpg-US) fuel economyFedEx, along with Eaton Corp. in the USA and Iveco in Europe, has begun deploying a small fleet of Hybrid diesel electric delivery trucksAs of October 2007 Fedex now operates more than 100 diesel electric hybrids in North America, Asia and Europe.

Liquefied petroleum gas

Hydrogen can be used in cars in two ways: a source of combustible heat, or a source of electrons for an electric motor. The burning of hydrogen is not being developed in practical terms; it is the hydrogen fuel-cell electric vehicle (HFEV) which is garnering all the attention. Hydrogen fuel cells create electricity fed into an electric motor to drives the wheels. Hydrogen is not burned, but it is consumed. This means molecular hydrogen, H2, is combined with oxygen to form water. 2H2 (4e-) + O2 --> 2H2O (4e-). The molecular hydrogen and oxygen's mutual affinity drives the fuel cell to separate the electrons from the hydrogen, to use them to power the electric motor, and to return them to the ionized water molecules that were formed when the electron-depleted hydrogen combined with the oxygen in the fuel cell. Recalling that a hydrogen atom is nothing more than a proton and an electron; in essence, the motor is driven by the proton's atomic attraction to the oxygen nucleus, and the electron's attraction to the ionized water molecule.

An HFEV is an all-electric car featuring an open-source battery in the form of a hydrogen tank and the atmosphere. HFEVs may also comprise closed-cell batteries for the purpose of power storage from regenerative braking, but this does not change the source of the motivation. It implies the HFEV is an electric car with two types of batteries. Since HFEVs are purely electric, and do not contain any type of heat engine, they are not hybrids.

Hybrid vehicles might use an internal combustion engine running on biofuels, such as a flexible-fuel engine running on ethanol or engines running on biodiesel. In 2007 Ford produced 20 demonstration Escape Hybrid E85s for real-world testing in fleets in the U.S. Also as a demonstration project, Ford delivered in 2008 the first flexible-fuel plug-in hybrid SUV to the U.S. Department of Energy (DOE), a Ford Escape Plug-in Hybrid, capable of running on gasoline or E85

The Chevrolet Volt plug-in hybrid electric vehicle would be the first commercially available flex-fuel plug-in hybrid capable of adapting the propulsion to the biofuels used in several world markets such as the ethanol blend E85 in the U.S., or E100 in Brazil, or biodiesel in Sweden.[The Volt will be E85 flex-fuel capable about a year after its introduction.

In split path vehicles (Toyota, Ford, GM, Chrysler) there are two electrical machines, one of which functions as a motor primarily, and the other functions as a generator primarily. One of the primary requirements of these machines is that they are very efficient, as the electrical portion of the energy must be converted from the engine to the generator, through two inverters, through the motor again and then to the wheels.

Most of the electric machines used in hybrid vehicles are brushless DC motors (BLDC). Specifically, they are of a type called an interior permanent magnet (IPM) machine (or motor). These machines are wound similarly to the induction motors found in a typical home, but (for high efficiency) use very strong rare earth magnets in the rotor. These magnets contain neodymium, iron and boron, and are therefore called Neodymium magnets. The magnet material is expensive, and its cost is one of the limiting factors in the use of these machines.

In some cases, manufacturers are producing HEVs that use the added energy provided by the hybrid systems to give vehicles a power boost, rather than significantly improved fuel efficiency compared to their traditional counterparts. The trade-off between added performance and improved fuel efficiency is partly controlled by the software within the hybrid system and partly the result of the engine, battery and motor size. In the future, manufacturers may provide HEV owners with the ability to partially control this balance (fuel efficiency vs. added performance) as they wish, through a user-controlled setting.[117] Toyota announced in January, 2006 that it was considering a "high-efficiency" button.[citation needed]

One can buy a stock hybrid or convert a stock petroleum car to a hybrid electric vehicle using an aftermarket hybrid kit.

Fuel Efficiency

Current HEVs reduce petroleum consumption under certain circumstances, compared to otherwise similar conventional vehicles, primarily by using three mechanisms:Reducing wasted energy during idle/low output, generally by turning the ICE off Recapturing waste energy (i.e. regenerative braking)

Reducing the size and power of the ICE, and hence inefficiencies from under-utilization, by using the added power from the electric motor to compensate for the loss in peak power output from the smaller ICE.

Any combination of these three primary hybrid advantages may be used in different vehicles to realize different fuel usage, power, emissions, weight and cost profiles. The ICE in an HEV can be smaller, lighter, and more efficient than the one in a conventional vehicle, because the combustion engine can be sized for slightly above average power demand rather than peak power demand. The drive system in a vehicle is required to operate over a range of speed and power, but an ICE's highest efficiency is in a narrow range of operation, making conventional vehicles inefficient. On the contrary, in most HEV designs, the ICE operates closer to its range of highest efficiency more frequently. The power curve of electric motors is better suited to variable speeds and can provide substantially greater torque at low speeds compared with internal-combustion engines. The greater fuel economy of HEVs has implication for reduced petroleum consumption and vehicle air pollution emissions worldwide

Reduced noise emissions resulting from substantial use of the electric motor at idling and low speeds, leading to roadway noise reduction, in comparison to conventional gasoline or diesel powered engine vehicles, resulting in beneficial noise health effects (although road noise from tires and wind, the loudest noises at highway speeds from the interior of most vehicles, are not affected by the hybrid design alone).

Reduced noise may not be beneficial for all road users, as blind people or the visually impaired consider the noise of combustion engines a helpful aid while crossing streets and feel quiet hybrids could pose an unexpected hazard. The U.S. Congress and the European Commission are exploring legislation to establish a minimum level of sound for plug-in electric and hybrid electric vehicles when operating in electric mode, so that blind people and other pedestrians and cyclists can hear them coming and detect from which direction they are approaching. Tests have shown that vehicles operating in electric mode can be particularly hard to hear below 20 mph (32 km/h). In January 2010 the Japanese Ministry of Land, Infrastructure, Transport and Tourism issued guidelines for hybrid and other near-silent vehicles.

A 2009 study conducted by the U.S. National Highway Traffic Safety Administration found that crashes involving pedestrian and bicyclist have higher incidence rates for hybrids than internal combustion engine vehicles in certain vehicle maneuvers. These accidents commonly occurred on in zones with low speed limits, during daytime and in clear weather.

Even though no specific national regulation has been enacted in most countries as of mid 2010, some carmakers announced they have decided to address this safety issue shared by regular hybrids and all types of plug-in electric vehicles, and as a result, the upcoming Nissan Leaf and Chevrolet Volt, both due in late 2010, and the new Nissan Fuga hybrid and the Fisker Karma plug-in hybrid, both due in 2011, will include synthesized sounds to alert pedestrians, the blind and others to their presence.

There is also after market technology available in California to make hybrids sound more like conventional combustion engine cars when the vehicle goes into the silent electric mode (EV mode). On August 2010 Toyota began sales in Japan of an onboard device designed to automatically emit a synthesized sound of an electric motor when the Prius is operating as an electric vehicle at speeds up to approximately 25 kilometres per hour (16 mph). Toyota plans to use other versions of the device for use in gasoline-electric hybrids, plug-in hybrids, electric vehicles as well as fuel-cell hybrid vehicles planned for mass production.

Battery toxicity is a concern, although today's hybrids use NiMH batteries, not the environmentally problematic rechargeable nickel cadmium. "Nickel metal hydride batteries are benign. They can be fully recycled," says Ron Cogan, editor of the Green Car Journal. Toyota and Honda say that they will recycle dead batteries and that disposal will pose no toxic hazards. Toyota puts a phone number on each battery, and they pay a $200 "bounty" for each battery to help ensure that it will be properly recycled.

Economic and environmental performance comparison among several popular hybrid models available in the U.S.] Vehicle Year model EPA

Peugeot HYmotion3 compressor, a hybrid scooter is a three-wheeler that uses two separate power sources to power the front and back wheels. The back wheel is powered by a single cylinder 125 cc, 20 bhp (15 kW) single cylinder motor while the front wheels are each driven by their own electric motor. When the bike is moving up to 10 km/h only the electric motors are used on a stop-start basis reducing the amount of carbon emissions

SEMA has announced that Yamaha is going to launch one in 2010, with Honda following a year later, fueling a competition to reign in new customers and set new standards for mobility. Each company hopes to provide the capability to reach 60 miles (97 km) per charge by adopting advanced lithium-ion batteries to accomplish their claims. These proposed hybrid motorcycles could incorporate components from the upcoming Honda Insight car and its hybrid powertrain. The ability to mass-produce these items helps to overcome the investment hurdles faced by start-up brands and bring new engineering concepts into mainstream markets

Toyota Camry Hybrid-Electric Taxi and Hybrid Bus.

Hybrid technology for buses has seen increased attention since recent battery developments decreased battery weight significantly. Drivetrains consist of conventional diesel engines and gas turbines. Some designs concentrate on using car engines, recent designs have focused on using conventional diesel engines already used in bus designs, to save on engineering and training costs. Several manufacturers are currently working on new hybrid designs, or hybrid drivetrains that fit into existing chassis offerings without major re-design. A challenge to hybrid buses may still come from cheaper lightweight imports from the former Eastern block countries or China, where national operators are looking at fuel consumption issues surrounding the weight of the bus, which has increased with recent bus technology innovations such as glazing, air conditioning and electrical systems. A hybrid bus can also deliver fuel economy though through the hybrid drivetrain. Hybrid technology is also being promoted by environmentally concerned transit authorities.

Hybrid electric truck technology and powertrain maker: Friedrichshafen.
The United States Army's manned ground vehicles of the Future Combat System all use a hybrid electric drive consisting of a diesel engine to generate electrical power for mobility and all other vehicle subsystems. In May 2003, JR East started test runs with the so called NE (new energy) train and validated the system's functionality (series hybrid with lithium ion battery) in cold regions. In 2004, Rail power Technologies had been running pilots in the US with the so called Green Goats,[which led to orders by the Union Pacific[149] and Canadian Pacific Railways starting in early 2005.

Rail power offers hybrid electric road switchers, as does Diesel-electric locomotives may not always be considered HEVs, not having energy storage on board, unless they are fed with electricity via a collector for short distances (for example, in tunnels with emission limits), in which case they are better classified as dual-mode vehicles.

HEVs can be initially more expensive (the so-called "hybrid premium") than pure fossil-fuel-based ICE vehicles (ICEVs), due to extra batteries, more electronics and in some cases other design considerations (although battery renting can be used to reach the cost parity). The trade-off between higher initial cost (also called showroom costs) and lower fuel costs (difference often referred to as the payback period) is dependent on usage - miles traveled, or hours of operation, fuel costs, and in some cases, government subsidies. Traditional economy vehicles may result in a lower direct cost for many users (before consideration of any externality).

Consumer Reports ran an article in April 2006 stating that HEVs would not pay for themselves over 5 years of ownership. However, this included an error with charging the "hybrid premium" twice.When corrected, the Honda Civic Hybrid and Toyota Prius did have a payback period of slightly less than 5 years. This includes conservative estimates with depreciation (seen as more depreciation than a conventional vehicle, although that is not the current norm) and with progressively-higher gas prices. In particular, the Consumer Reports article assumed $2/U.S. gallon for 3 years, $3/U.S. gallon for one year and $4/U.S. gallon the last year. As recent events have shown, this is a volatile market and hard to predict. For 2006, gas prices ranged from low $2 to low $3, averaging about $2.60/U.S. gallon.

A January 2007 analysis by Intellichoice.com shows that all 22 currently available HEVs will save their owners money over a five year period. The most savings is for the Toyota Prius, which has a five year cost of ownership 40.3% lower than the cost of comparable non-hybrid vehicles

A report in the Greeley Tribune says that over the five years it would typically take for a new car owner to pay off the vehicle cost differential, a hybrid Camry driver could save up to $6,700 in gasoline at current gasoline prices, with hybrid tax incentives as an additional saving.

In countries with incentives to fight against global warming and contamination and promote vehicle fuel efficiency, the pay-back period can be immediate and all-combustion engine vehicles (ACEVs) can cost more than hybrids because they generate more pollution.

Toyota and Honda have already said they've halved the incremental cost of electric hybrids and see cost parity in the future (even without incentives)

The rare earth element dysprosium is required to fabricate many of the advanced electric motors and battery systems in hybrid propulsion systems

However, nearly all the rare earth elements in the world come from China, and one analyst believes that an overall increase in Chinese electronics manufacturing may consume this entire supply by 2012

In order to encourage the purchase of HEVs, several countries have introduced legislation for incentives and ecotaxes. In Haifa, hybrid vehicles are entitled to a free parking in city's parking lots for domestic citizens

In 2009 the Japanese government implemented a set of policies and incentives that included a scrappage program, tax breaks on hybrid vehicles and other low emission cars and trucks, and a higher levy on gasoline that raised prices in the order of USD 4.50 per gallon. New hybrid car sales for 2009 were almost triple those for 2008

The purchase of hybrid electric cars qualifies for a federal income tax credit up to $3,400 on the purchaser's Federal income taxes. The tax credit is to be phased out two calendar quarters after the manufacturer reaches 60,000 new cars sold in the following manner: it will be reduced to 50% if delivered in either the third or fourth quarter after the threshold is reached, to 25% in the fifth and sixth quarters, and 0% thereafter Certain states (e.g., New York, California, Virginia, and Florida) allow singly occupied HEVs to enter the HOV lanes on the highway.

Summary

Drivers of HEVs in the United Kingdom benefit from the lowest band of vehicle excise duty (car tax), which is based on carbon dioxide emissions. In central London, these vehicles are also exempt from the £8 daily London congestion charge. Due to their low levels of regulated emissions, the greenest cars are eligible for 100% discount under the current system. To be eligible the car must be on the current Power Shift Register. At present, these include the cleanest LPG and natural gas cars and most hybrid-, battery- and fuel cell-electric vehicles.

Conclusion

The gasoline-electric hybrid car is just what it sounds like -- a cross between a gasoline-powered car and an electric car. A gas-powered car has a fuel tank, which supplies gasoline to the engine. The engine then turns a transmission, which turns the wheels.Gasoline-powered car ,An electric car, on the other hand, has a set of batteries that provides electricity to an electric motor. The motor turns a transmission, and the transmission turns the wheels. The hybrid is a compromise. It attempts to significantly increase the mileage and reduce the emissions of a gas-powered car while overcoming the shortcomings of an electric car.

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