

2008 Hybrid Vehicle Comparison Tests



The Automobile Club of Southern California's Hybrid Shootout 2008

These days there are many questions that might be posed that will lead you to consider a hybrid as your next vehicle purchase:

- With gas prices setting new records each day, will the price increases ever stop?
- And if the prices do stop going up, how high will it be?
- Are the experts correct when they say we will run out of oil soon?
- Will I ever be able to breathe clean air?
- What can I do to curtail global warming?

A popular answer to mitigating all of these problems is to buy and drive a hybrid. They have a reputation for excellent fuel economy, reduced Carbon Dioxide (CO₂) emissions (CO₂ is the most widely discussed global warming gas), and low smog causing emissions (carbon monoxide "CO", as well as hydrocarbons "HC" and oxides of nitrogen "NO_x". HC and NO_x react in the atmosphere in the presence of sunlight to form "Smog"). Are these high mpg and low emissions claims true? And if so, are the vehicles glorified prototypes, or are they useful in the ways we Americans usually use our vehicles (for that ski/boating/camping/you-name-it vacation, for slogging around on the 405 in bumper-to-bumper traffic, to drive 2 blocks to the store, for the daily commute to work, for hauling the soccer team to practice, for use as a mobile office, or even as a home away from home).

The Automobile Club of Southern California's engineers and specialists at the Automotive Research Center (ARC) decided to find out. A few selected popular hybrids were put through their paces using objective, scientific, and repeatable test procedures.

Items evaluated include emissions, fuel economy, crashworthiness, braking, acceleration, handling, cargo carrying capacity, ride quality, interior noise, ease of entry and exit, maneuverability, and roominess. Tests were performed at the Club's Automotive Research Center in Diamond Bar, California, the newly-renamed Auto Club Speedway in Fontana, California, and on the road. Testing procedures were based on those developed by the Society of Automotive Engineers (SAE), the US Environmental Protection Agency (EPA), and the ARC. Test vehicles were obtained from the public relations departments of the automobile manufacturers.

The test vehicles (4) selected for this evaluation were:

- **Toyota Prius:** The Prius is the only purpose built (not adapted from a gas only car) hybrid on the market today. It is the leader in sales and provides the best fuel economy. The aero-look modern styling of the Prius has made it “cool”, and the “in” vehicle to drive.
- **Honda Civic Hybrid:** The Civic Hybrid is the second best selling hybrid on the market and gets the second best fuel economy available. In direct contrast to the Prius, the Civic looks almost exactly like the gas-engined Civic sedan, allowing it to blend into the crowd.
- **Ford Escape Hybrid:** The Escape Hybrid was the first domestic hybrid on the market and it achieves the best fuel economy of any SUV.
- **Lexus RX 400h:** The RX 400h is the first luxury/hybrid SUV on the market. Its design seeks (and achieves) a different blend of attributes than the others in this evaluation. The words “luxury” and “utility” receive significant attention. This vehicle offers excellent performance (0-60 mph around 7.9 seconds), is roomy enough for five, and can tow a 3500 pound trailer. All of this comes with about 40% better mpg than the gas-engined competition.

What is a Hybrid?

A hybrid is technically a vehicle that employs more than one powertrain. There are many potential technologies that can be combined in a hybrid, but those currently in production are all gasoline/electric hybrids. They combine a conventional gasoline engine with an electric motor/generator, a battery pack, and a controller. Hybrids take advantage of the efficiencies of the two powertrains to increase the fuel efficiency of the vehicle. For gas/electric hybrids, the electric motors are very efficient in stop and go city driving and the gasoline engine is more efficient at higher speeds. Hybrids are also equipped with regenerative braking. Under braking or coasting conditions, the electric motor is switched to function as a generator and converts the kinetic energy of the vehicle into electricity to charge the batteries (by slowing the vehicle). Regenerative braking also serves to extend the life of brake pads.

There are many different strategies in use for blending the gas and electric powerplants. Some are designed to operate in “electric-only” mode (often at low speeds/light loads) for a short time, while others only turn the

gasoline engine off when stationary (the Honda Civic). The Civic also is the lone entrant in this evaluation that operates as a gas-engined car first, and uses the electric motor as a “boost” for better performance. The remaining vehicles evaluated do the opposite. They operate as an electric vehicle and bring on the gas engine to boost performance.

Some of the hybrids are designed to maximize fuel economy with only adequate performance, while others retain good or even excellent performance (the Lexus RX 400h) with fuel economy that is easily the best in its class, but is not maximized. It should be noted that none of the hybrids tested in this report need to be “plugged in”, although some manufacturers have plans to produce “plug-in hybrids” in the future.

Scoring:

The ARC has an extensive database of previously tested “Green Vehicles” (22 vehicles with high mpg and/or low emissions including other hybrids, as well as cars meeting the following emission certification standards: PZEV, SULEV, as well as a few ULEV light trucks). The test results for the four vehicles evaluated for this program were combined with this database to show how these specific vehicles compare to the competition on the market. Then, the scores on each test were ranked on a 0 to 10 point basis with the best scoring vehicle in the database receiving 10 points and the lowest receiving 0 points. The scores from all of the tests were then added to determine the overall score. The total points are divided by the “price as tested” to determine the “cost per point”.

Fuel economy/emissions testing and ratings:

We used ratings published by the EPA to obtain the fuel economy score in this evaluation. Miles per gallon accounts for 8 of the 10 possible points. If a vehicle uses regular fuel, it receives 2 more points (1 for mid-grade). We also list the high, low, and average on-the-road fuel economy obtained during our evaluation of the test vehicle (which includes a day of testing at the Auto Club Speedway).

All of the vehicles were tested in the ARC’s state-of-the-art dynamometer test cell for emissions and fuel economy. Three tests used by the EPA for certifying new vehicles for sale were performed:

- Federal Test Procedure (FTP). This is a test used to certify the emissions and was also used to establish the “city mpg” for all passenger vehicles up to model year 2007.
- Highway Fuel Economy Test (HFET). This is a test used to certify the emissions and was also used to establish the “highway mpg” for all passenger vehicles up to model year 2007.
- Supplemental FTP (US06). This is a newer test designed to do a better job of simulating modern high speed and congested driving for emissions certification. It also provides the majority of the data used to generate the new (model year 2008 and beyond) mileage estimates.

All of the vehicles lived up to their EPA mileage estimates on all three tests, and as such emit lower CO₂ emissions per mile than their competition. It should be noted for carbon based fuels (gasoline, diesel, ethanol, methanol, natural gas, and propane) that CO₂ emissions are directly proportional to miles per gallon.

Previous tests on conventional gasoline-fueled vehicles have shown the large influence driving style can have on fuel economy. Fuel economy can be improved by 25% to as much as 100% (depending on how aggressive your “normal” driving style is) by following fuel-efficient driving tips including:

- Slow down: higher speeds increase the aerodynamic and frictional losses on the vehicle and use extra fuel.
- Accelerate gently: acceleration uses the most fuel of any driving mode. Driving like you have a raw egg between your foot and the accelerator pedal (and you don’t want to break it) can save fuel.
- Anticipate traffic and stop lights: you can save fuel by looking down-the-road and anticipating slow/stopped traffic and red lights and coasting up to them.

Since hybrid vehicles have two powerplants to work with, it is likely that even better improvements might be obtainable for those who keep an eye on the energy consumption display and learn to maximize the use of the electric motor and the vehicle’s regenerative braking capability.

They also all passed the emission standards for all three of the above mentioned tests easily. Their emissions were barely distinguishable from zero. The Prius, Civic, and Escape are all certified to PZEV standards, while the RX 400h is certified as a SULEV.

- **PZEV** = “Partial Zero Emission Vehicle”. These vehicles produce only very miniscule amounts of harmful pollutants from the tailpipe and are certified to produce no emissions from fuel evaporation. The tailpipe standards have been set by the California Air Resources Board (CARB) to be equivalent to the emissions into the atmosphere in California caused by electrical generation to charge a battery-electric car. This level is based on the relatively clean mix of electrical generation (natural gas, hydro, nuclear, and renewable sources) in California. For other regions, where electricity is not as clean because it is generated by burning coal or oil, operating a PZEV will actually be cleaner than a battery-electric vehicle. In addition, PZEVs have a 15 year/150,000 mile warranty.
- **SULEV** = “Super Ultra-Low Emission Vehicle”. This is a vehicle with the same tailpipe standards as a PZEV, but with some evaporative emission allowed.

Exterior noise testing:

Although not included in the scoring, the ARC used this opportunity to assess an important issue that has come to light recently. Since many hybrids operate in electric-only mode at low speeds, they might be too quiet for some pedestrians to hear. This can especially be a problem in intersections, parking lots, and for the blind. In order to measure this, the ARC used an exterior noise level procedure developed by the International Standards Organization (ISO) that the ARC had used in previous vehicle evaluations.

Each of the test vehicles was driven at a constant 10 mph between two microphones and the highest sound level in decibels (db) was recorded. Unfortunately, the day of the test was somewhat windy and the db levels when the hybrids went through the test were barely discernable above the background readings. So while no definitive sound levels were successfully measured, it can be concluded that the sound levels are very low and that the problem of pedestrians not being able to hear hybrids operating at low speeds is a valid one and requires further evaluation.

Conclusions:

Many studies have been conducted about whether you can save money buying a more expensive hybrid as opposed to a conventional vehicle because of the improved fuel economy. These studies have conflicting conclusions. However, it is almost never cost-effective to purchase a new car if you already have a relatively new vehicle that is in good operating condition. This is because the largest share of ownership costs comes from depreciation, and generally, new cars take the biggest hit from depreciation in the first couple of years of ownership. However, if you are really in need of a new car, then the vehicles in this evaluation and similar hybrids can make sense. Even if you can't quite save enough money by using less fuel to make up for the extra initial cost, the more fuel prices go up, the closer you get to recouping that extra cost. And you don't really expect fuel prices to stop going up, do you?

None of the vehicles evaluated for this report are "glorified prototypes". Rather they are well-developed, useful vehicles that provide excellent fuel economy and low emissions. Each is focused on a slightly different segment of the new-car market, but each one appears to hit their targets dead-on.

- Ford Escape Hybrid: this vehicle works well for hauling the kids and their soccer/baseball/football/every sport under the sun gear all over town. The four wheel drive version also makes a great ski shuttle.
- Honda Civic Hybrid: This vehicle works best as a comfortable and efficient commuter car for getting back and forth to work and might be especially suited as a first new car for your kids due to the low operating costs.
- Lexus RX 400h: This vehicle is a top-of-the-line luxury sport utility. It can tow your boat and pamper you in comfort at the same time. The fact that it is a hybrid and gets better mpg than its competition is a big bonus!
- Toyota Prius: this is the state-of-the-art hybrid. Like the Civic, this is an excellent commuter car, but the hatchback design allows it to haul more bulky items.

Ford Escape Hybrid FWD

GREEN CAR SCORES

Score For This Vehicle	83.30
Highest Scoring Green Car	83.97
Lowest Scoring Green Car	72.91

VEHICLE PRICE

Base Price	\$25,075
Price as Tested:	\$29,825
Cost per Point for this Vehicle	\$358
Highest Green Car Cost/Point	\$640
Lowest Green Car Cost/Point	\$280

FUEL ECONOMY

Fuel Type	Unleaded Regular
Fuel Capacity (gal):	15.0
EPA Urban MPG:	34
EPA Highway MPG:	30
Auto Club Highest MPG:	29.5
Auto Club Average MPG:	28.2
Auto Club Lowest MPG:	20.9

MODEL YEAR TESTED - 2008



DESCRIPTION/COMMENTS

4-door SUV

STRONG POINTS

- Extremely low emissions (AT-PZEV)
- Excellent fuel economy with good performance
- Headroom
- Room for cargo

WEAK POINTS

- High door sill makes entry difficult
- Mushy feeling brake pedal
- Rear window does not open fully
- Engine and road noise

OVERALL OBSERVATIONS

The Ford Escape Hybrid is the most fuel efficient SUV available. Its combination of a 133 horsepower 2.3 liter engine and a 94 horsepower electric motor provide acceleration similar to its V6 powered sibling, with extremely low emissions. The Escape Hybrid scores 5 stars on all NHTSA crash tests except for 4 stars for the driver's side frontal test. It maintains virtually all of the utility (except for a limited 1000 pound trailer towing capacity) that have made SUVs so popular. It even has the option of a 110 volt AC power outlet in the cabin. If you want a compact SUV, but value being "green", the Escape Hybrid (& the similar "sister cars" the Mercury Mariner & Mazda Tribute Hybrids) can meet your needs.

VEHICLE SPECIFICATIONS

Number of Passengers (F/R):	2/3
Curb Weight (lbs):	3880
Exterior Length (in):	174.7
Exterior Width (in):	81.3
Exterior Height (in):	67.7
Wheelbase (in):	103.1
Anti-lock Braking System:	4 Wheel ABS
Restraint Type:	8 Air Bags
Warranty (Months/Miles):	36/36,000
Tire Manufacturer:	Continental
Tire Size:	P235/70R16
Towing Capacity (lbs)	
With/Without Brakes:	1000/1000
Transmission Type:	CVT
Drivetrain Type:	Front Wheel
Engine Size	
Liter CID Configuration:	2.3L I4 Atkinson Cycle
Horsepower @ RPM:	133 @ 6000
Electric Motor Horsepower:	94 @ 5000

TEST DATA

Test Vehicle Scores (1 to 10 Points)

EPA Emissions Score:	10.00
Braking:	5.33
Crashworthiness:	7.36
Visibility:	7.90
Slalom Handling:	6.61
Ride Quality:	7.50
Fuel Economy:	6.31
Interior Noise:	4.76
Acceleration:	6.06
Ease of Entry and Exit:	7.04
Interior Size:	4.92
Turning Circle:	6.60
Luggage Capacity:	2.89

Honda Civic Hybrid

GREEN CAR SCORES

Score For This Vehicle	72.91
Highest Scoring Green Car	83.97
Lowest Scoring Green Car	72.91

VEHICLE PRICE

Base Price	\$24,350
Price as Tested:	\$24,985
Cost per Point for this Vehicle	\$343
Highest Green Car Cost/Point	\$640
Lowest Green Car Cost/Point	\$280

FUEL ECONOMY

Fuel Type	Unleaded Regular
Fuel Capacity (gal):	12.3
EPA Urban MPG:	40
EPA Highway MPG:	45
Auto Club Highest MPG:	42.9
Auto Club Average MPG:	39.1
Auto Club Lowest MPG:	26.4

MODEL YEAR TESTED - 2008



DESCRIPTION/COMMENTS

Compact 4-door sedan

STRONG POINTS

- Excellent fuel economy
- Extremely low emissions (AT-PZEV)
- Has lots of easy to see of warning lights
- Sound system features XM satellite radio

WEAK POINTS

- Underpowered
- Small sun visors
- Noisy at wide open throttle
- Lacks rear center armrest & rear cupholders

OVERALL OBSERVATIONS

The Honda Civic Hybrid combines a 1.3-liter gasoline engine with an electric motor to take advantage of the strengths of both to provide excellent fuel economy (second best gasoline fuel economy available) and low emissions. However, even with both powerplants going full tilt, acceleration is minimal, making passing a white knuckle (and noisy) ride. Front, side, and side curtain airbags are standard and the Civic scores 4 or 5 stars on all NHTSA crash tests. The Civic Hybrid is visually almost identical to other Civic sedans, and shares most of the advantages that make the Civic a top-selling compact car.

VEHICLE SPECIFICATIONS

Number of Passengers (F/R):	2/3
Curb Weight (lbs):	3100
Exterior Length (in):	176.7
Exterior Width (in):	69.0
Exterior Height (in):	56.3
Wheelbase (in):	106.3
Anti-lock Braking System:	4 Wheel ABS
Restraint Type:	6 Air Bags
Warranty (Months/Miles):	36/36,000
Tire Manufacturer:	Bridgestone
Tire Size:	P195/65R15
Towing Capacity (lbs)	
With/Without Brakes:	Not Recommended
Transmission Type:	CVT
Drivetrain Type:	Front Wheel
Engine Size	
Liter CID Configuration:	1.3L I4 SOHC 8V
Horsepower @ RPM:	93 @ 6000
Electric Motor Horsepower:	20 @ 2000

TEST DATA

Test Vehicle Scores (1 to 10 Points)

EPA Emissions Score:	10.00
Braking:	6.78
Crashworthiness:	5.19
Visibility:	7.00
Slalom Handling:	7.11
Ride Quality:	7.71
Fuel Economy:	8.86
Interior Noise:	1.61
Acceleration:	0.00
Ease of Entry and Exit:	7.10
Interior Size:	3.44
Turning Circle:	7.90
Luggage Capacity:	0.22

Lexus RX 400h

GREEN CAR SCORES

Score For This Vehicle	80.11
Highest Scoring Green Car	83.97
Lowest Scoring Green Car	72.91

VEHICLE PRICE

Base Price	\$41,180
Price as Tested:	\$51,272
Cost per Point for this Vehicle	\$640
Highest Green Car Cost/Point	\$640
Lowest Green Car Cost/Point	\$280

FUEL ECONOMY

Fuel Type	Unleaded Premium
Fuel Capacity (gal):	17.2
EPA Urban MPG:	27
EPA Highway MPG:	24
Auto Club Highest MPG:	27.9
Auto Club Average MPG:	24.9
Auto Club Lowest MPG:	21.0

MODEL YEAR TESTED - 2008



DESCRIPTION/COMMENTS

4-door SUV

STRONG POINTS

- Good fuel economy for an SUV of this size
- Powerful, good acceleration
- Roomy and comfortable interior
- Auto dimming mirrors, adaptive HID headlights & vehicle height = good visibility
- Fit and finish

WEAK POINTS

- Torque steer
- Requires premium fuel
- Expensive purchase price
- C posts limit rear visibility
- Tire and wind noise

OVERALL OBSERVATIONS

The Lexus RX 400h was the first luxury SUV on the market. It offers excellent V8-like performance, but still provides fuel economy about 40% better than similar non-hybrid SUVs and meets SULEV tailpipe emission standards to boot. It is loaded with the safety and convenience features you would expect from a modern luxury vehicle including Bluetooth, adaptive HID headlights, DVD rear entertainment system, and front, side, side curtain and driver's knee airbags. The "utility" of an SUV is maintained and the RX 400h can even tow a 3500 pound trailer. The RX 400h scores 5 stars on all NHTSA crash tests. If you want to be "Green" with utility, performance, and luxury, then the RX 400h is for you!

VEHICLE SPECIFICATIONS

Number of Passengers (F/R):	2/3
Curb Weight (lbs):	4580
Exterior Length (in):	187.2
Exterior Width (in):	72.6
Exterior Height (in):	67.7
Wheelbase (in):	106.9
Anti-lock Braking System:	4 Wheel ABS
Restraint Type:	9 Air Bags
Warranty (Months/Miles):	48/50,000
Tire Manufacturer:	Michelin
Tire Size:	225/65R17
Towing Capacity (lbs)	
With/Without Brakes:	3500
Transmission Type:	CVT
Drivetrain Type:	Front Wheel
Engine Size	
Liter CID Configuration:	3.3L V6 DOHC 24V
Horsepower @ RPM:	208 @ 5600
Electric Motor Horsepower:	167 @ 4500

TEST DATA

Test Vehicle Scores (1 to 10 Points)

EPA Emissions Score:	9.00
Braking:	3.90
Crashworthiness:	8.92
Visibility:	8.00
Slalom Handling:	2.24
Ride Quality:	7.50
Fuel Economy:	2.66
Interior Noise:	5.53
Acceleration:	9.92
Ease of Entry and Exit:	7.66
Interior Size:	3.72
Turning Circle:	6.56
Luggage Capacity:	4.51

Toyota Prius

GREEN CAR SCORES

Score For This Vehicle	83.97
Highest Scoring Green Car	83.97
Lowest Scoring Green Car	72.91

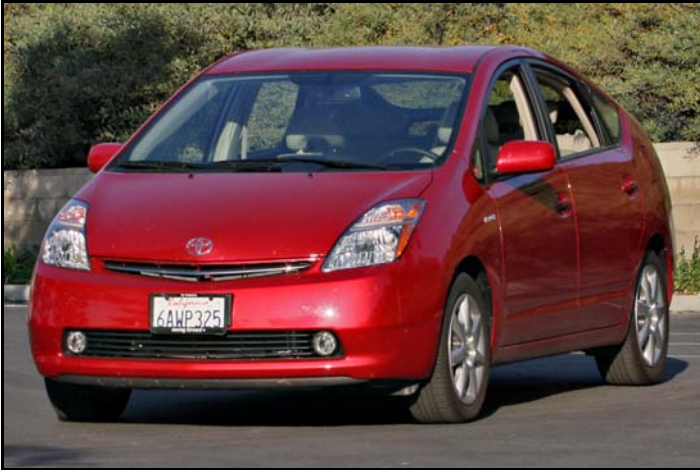
VEHICLE PRICE

Base Price	\$22,325
Price as Tested:	\$23,543
Cost per Point for this Vehicle	\$280
Highest Green Car Cost/Point	\$640
Lowest Green Car Cost/Point	\$280

FUEL ECONOMY

Fuel Type	Unleaded Regular
Fuel Capacity (gal):	11.9
EPA Urban MPG:	48
EPA Highway MPG:	45
Auto Club Highest MPG:	42.2
Auto Club Average MPG:	40.7
Auto Club Lowest MPG:	40.0

MODEL YEAR TESTED - 2008



DESCRIPTION/COMMENTS

Mid-size 4-door sedan

STRONG POINTS

- Excellent fuel economy
- Extremely low emissions (AT-PZEV)
- High tech styling and layout
- Good handling and maneuverability
- The "in" car to have these days

WEAK POINTS

- Lacks power (especially for passing)
- Small sun visors
- Unusual controls can take some getting used to
- Rear visibility

OVERALL OBSERVATIONS

The Toyota Prius is seen by many as the state of the art vehicle of today. It has a sophisticated hybrid powertrain that mates a 1.5 liter 4-cylinder engine with a 67 hp electric motor and meshes the operation of both to extract the maximum efficiency each is capable of. It achieves fuel economy that is second to none in the US. The Prius scores 4 or 5 stars in all NHTSA crash tests and is equipped with 8 air bags and many other advanced safety technologies. The futuristic styling has become "en vogue" and owners who purchased the car to save fuel and drive a clean car are now driving a modern status symbol!

VEHICLE SPECIFICATIONS

Number of Passengers (F/R):	2/3
Curb Weight (lbs):	3200
Exterior Length (in):	175.0
Exterior Width (in):	67.9
Exterior Height (in):	58.7
Wheelbase (in):	106.3
Anti-lock Braking System:	4 Wheel ABS
Restraint Type:	8 Air Bags
Warranty (Months/Miles):	36/36,000
Tire Manufacturer:	Bridgestone
Tire Size:	P195/55R16
Towing Capacity (lbs)	
With/Without Brakes:	Not Recommended
Transmission Type:	CVT
Drivetrain Type:	Front Wheel
Engine Size	
Liter CID Configuration:	1.5L I4 DOHC 16V
Horsepower @ RPM:	76 @ 5000
Electric Motor Horsepower:	67 @ 1200-1540

TEST DATA

Test Vehicle Scores (1 to 10 Points)

EPA Emissions Score:	10.00
Braking:	5.09
Crashworthiness:	6.34
Visibility:	7.20
Slalom Handling:	9.65
Ride Quality:	7.00
Fuel Economy:	10.00
Interior Noise:	3.86
Acceleration:	4.72
Ease of Entry and Exit:	7.15
Interior Size:	3.42
Turning Circle:	8.71
Luggage Capacity:	0.83