

Toyota Prius (2005) Pluses:

- Mid-size sedan with the outside dimensions of a Toyota Corolla and the inside dimensions of a Toyota Camry.
- 1.497 liters, 16-valve 4 cylinder engine: Power: 57 kW (76 hp) @ 5000 rpm; Torque: 111 N-m (82 lb-ft) @ 4200 rpm. Provides motive power and recharges the battery. (See bottom for more details.)
- Ni-MH (Nickel Metal Hydride) 201.6-Volts battery: 38 kW (51 hp). There is a normal 12-Volts battery, also. Hybrid System net power: 82 kW (110 hp). It weighs only 86 lb and has a life expectancy of 10-12 years or 150,000 to 200,000 miles (10,000 recharging cycles.)
- 500-Volts permanent-magnet electric motor/generator: Power: 50 KW (67 hp) @ 1200-1540 rpm; Torque: 400 N-m (295 lb/ft) @ 0-1200 rpm. Provides motive power from the battery and recharges the battery using vehicle kinetic power when braking or coasting. (See bottom for more details.)
- There is a second less-powerful (500-Volts, 25 kW/34 hp) permanent-magnet electric motor/generator that starts the engine when the engine is needed, provides some motive power from the battery and recharges the battery using engine power. (See bottom for more details.) It starts the engine at 1000 rpm, instead of the usual 100 rpm. (Fuel is not injected until proper oil-pressure is established, reducing wear.)
- Has regenerative braking. When the brakes are engaged, the car's kinetic energy is retrieved to charge the batteries by turning the large motor/generator into a generator. Braking is very smooth. Shifting the gear selector to 'B' activates engine braking. (No fuel is consumed by engine braking, but it does not convert kinetic energy into electrical energy as does foot-pedal braking.) In emergency stops regular ABS brakes are used. Brake linings last longer than for most cars.
- The Hybrid Synergy Drive feeds power to an Electronic Continuously Variable Transmission (ECVT; not to be confused with the Audi CVT with a chain belt and variable pulleys used in some hybrids such as the Honda Insight), which keeps the engine operating at peak torque. The gear selector has only four positions: R (reverse), N (neutral), D (drive) and B (engine braking). There is a separate parking (P) button and a foot-operated parking brake. A small (about adult palm size) planetary/epicycle gear system (power-split device) feeds power from a 1st motor/generator and engine to the front wheels, from the front wheels to the 1st motor/generator to charge the battery during braking and coasting and from the engine to the less-powerful 2nd motor/generator to charge the batteries; all controlled by computers. (See more details at the bottom.)
- Only the electric motor is used for reverse, slow starts, and level low-speed cruising when the battery is highly charged. At high-speed cruising the engine powers the car and charges the battery.
- The gasoline engine shuts off when not needed and usually runs at peak-efficiency rpm (about 4000). Therefore, the car runs very quietly except when accelerating. Both engine and motor are used during high acceleration.
- Has a thermos container to store three liters of coolant at close to boiling temperature for up to three days. When the Power button is pressed, hot coolant is injected into the engine coolant system. This avoids a cold start, which reduces emissions at startup, as well as wear and tear on the engine. It also allows interior heating near start time.
- Lowest coefficient of drag (0.26) accomplished by futuristic design (sloping hood and hatchback and a straight rear end). This greatly increases fuel use efficiency and reduces interior wind noise.
- Has hydrocarbon absorber and catalytic converter to reduce exhaust emissions. Advanced Technology Partial Zero Emission Vehicle (AT-PZEV). Produces almost 90% fewer emissions than a vehicle powered by a standard internal combustion engine.
- 11.9 gallon gasoline tank has plastic bladder to reduce gasoline vapors. Will run car for about 500 miles at about 44 mpg on highways and 48 mpg in city driving.
- Uses standard low-friction all-season radial tires. Electric-assisted steering with 17-foot

- turning radius. Ground clearance 4.9 inches.
- Does 0 to 60 mph in 10.1 seconds. Reasonably high acceleration is more efficient than low acceleration.
 - Comfortable seats. Much well-designed storage space. Seats fold down in the front and in the back for carrying items up to 8 feet in length. Large trunk opening with removeable cargo cover.
 - Very safe car with crumple zones all around it. Can get 6 second-generation air bags, including side curtain air bags; 2 are standard.
 - Two well-designed displays of engine/motor operating characteristics, fuel consumption and energy regeneration.
 - Excellent climate-control system.
 - Keyless entry and start is well designed; an option.
 - Premium sound system. Easy to operate 6-CD changer is an option.
 - Accurate navigation system that is easy to operate is an option.
 - Warranty: Basic: 36 months/36,000 miles; Hybrid components: 8 years/100,000 miles; Power train: 60 months/60,000 miles; Rust-through: 60 months/unlimited miles; Accessories purchased with car: 36 months/36,000 miles. Road side assistance and hazard insurance: 36 months/36,000 miles. I bought an extended warranty for 96 months/75,000 miles for slightly over \$1000.

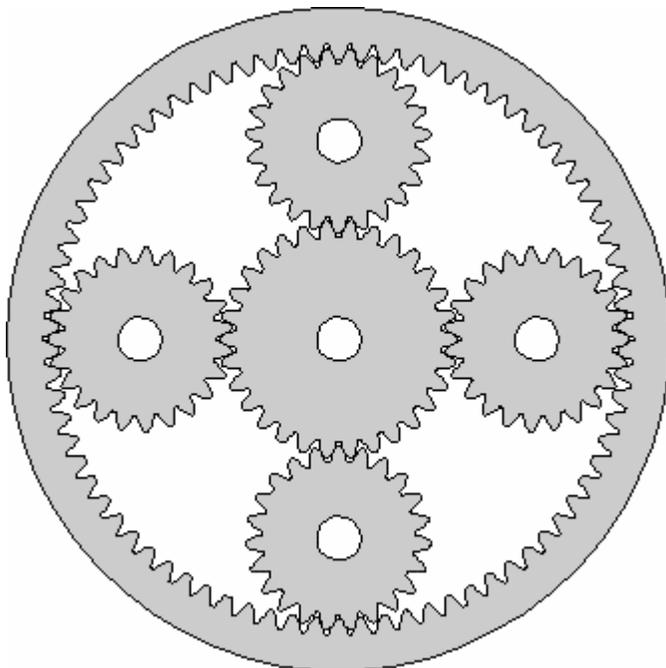
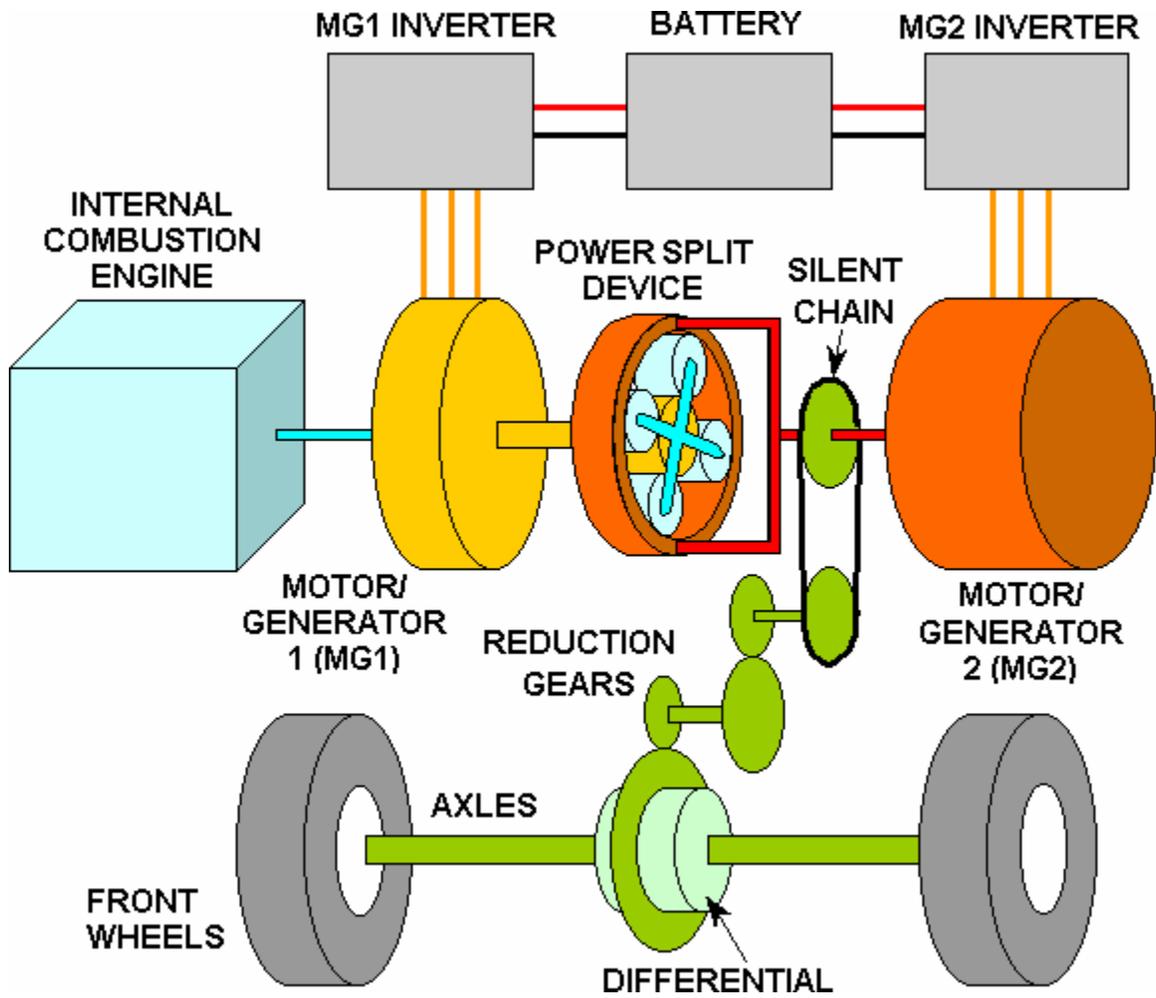
The following is taken from <http://home.earthlink.net/~graham1/MyToyotaPrius/Understanding/Contents.htm>, with some additional comments by L. David Roper.

MG1 - Motor/Generator 1 (25 kW), drives the sun gear of the power split device. To fully understand the use of this motor/generator, you need to understand the operation of the power split device. Simplistically, MG1 starts the ICE when needed and draws off some power to pass electrically to MG2 or to recharge the batteries. To simulate the lowest gear MG1 acts maximally as a generator; to simulate higher gears it reduces its generator function, eventually turning into a motor; to simulate the highest gear it acts maximally as a motor.

MG2 - Motor/Generator 2 (50 kW), coupled to the ring gear of the power split device and hence the wheels via the final drive. This is the high-torque motor that drives the car, either along with or instead of the ICE, getting power from the battery and frequently also from MG1. Used as a generator, MG2 can also recover the kinetic energy of the car during braking and coasting to recharge the battery. To simulate the lowest gear MG1 acts maximally as a motor; to simulate higher gears it reduces its motor function, eventually turning into a generator; to simulate the highest gear it acts maximally as a generator.

Electronic Continuously Variable Transmission:

Low-gear driving is simulated by MG1 being a generator, sending its power to MG2, and MG2 being a motor getting its power from MG1 and the battery. This causes the ICE to spin faster. High-gear driving is simulated by MG1 being a motor and MG2 being a generator, sending its power to MG1 and the battery. This causes the ICE to spin slower. An infinity of gears in between low and high are simulated by varying MG1 and MG2 between being pure motors and pure generators. This is all done electronically. The "Battery" in the diagram below should be "Electronic Control Unit/Battery". Some of the electric power generated by one of the generators can be passed directly to the opposite motor without passing through the battery.



The planetary gear layout.