Hyundai Sonata Hybrid 2011-2012



The Sonata Hybrid has a new front grille and bumper

The 2011 Hyundai Sonata is a roomy, four-door family car that has garnered favorable reviews since it was revealed in February of 2010. Hyundai also introduced a hybrid version of that Sonata a few months later that delivers excellent mileage and can be driven in zeroemissions, full-electric mode at speeds up to 62 mph (if you are lucky).

The Sonata Hybrid incorporates Hyundai's latest Hybrid Blue Drive system. The car uses a lithiumpolymer battery technology, a first for any car. NiMH or Lithium-ion is the preferred chemistry these days. Hyundai engineers designed this system by themselves and with the new aerodynamic tuning this hybrids will get an EPA of 40 mpg on the highway and 35 mpg city. Not bad for a car this size.

The new hybrid system combines the lithium-polymer battery with an electronically controlled clutch arrangement to create a strong hybrid that can use an existing six-speed automatic transmission. It's a simpler design, potentially cheaper, and it yields a big improvement in efficiency compared to mid-size hybrids that use nickel-metal-hydride batteries.



This layout is unique. Hyundai has found a new way of using two high voltage motors

The Battery Pack

In the world of hybrids, the "breakthrough" battery has always been just over the horizon. In the Sonata Hybrid, Hyundai claims to have built its system around a battery that leapfrogs existing battery packs. We wouldn't call it a breakthrough as the Nissan Leaf and Chevy Volt use lithium-ion batteries too that use a different chemistry than the Hyundai, but the Sonata's hybrid's batteries are a significant step compared to what's used on existing hybrids.





LG makes the Lithium Polymer cells for Hyundai

Compared to nickel-metal-hydride (NiMH) batteries of the same output, such as those used in the hybrid versions of the Toyota Camry and the Ford Fusion, the lithium-polymer batteries are 35 percent lighter and 40 percent smaller. Therefore, they can more easily be packaged without adding weight and taking up cargo space. They also have a lower self-discharge rate, which improves on the tendency to lose electricity when the vehicle is parked.

Compared to lithium-ion batteries, such as those used in electronic appliances, lithium-polymer batteries offer a similar energy density but with lower heat generation, which improves cycle life.

Mercedes-Benz was first to introduce similar lithiumion batteries in its S-400 Hybrid luxury sedan using a small battery pack to assist a 20-hp motor in a "mild" hybrid that was not designed to operate on electric power alone. In the case of the Sonata, a 34-kilowatt, 40-hp electric motor is powered by a battery weighing 96 pounds, with a capacity of 5.3 amp-hours, operating at 270 volts.

The difference between lithium-ion and lithiumpolymer is in the chemistry and packaging. Engineers seeking to take advantage of lithium-ion's superior power density have battled its tendency to overheat and degrade as charge cycles accumulate.

The lithium-polymer batteries in the Sonata use a manganese spinel chemistry that balances energy density with thermal stability. Structurally, the cells are flat, rectangular sheets surrounded by polymer gel electrolyte. Unlike lithium-ion cells, which may flex and crack during recharge/discharge cycles, they are



Can't open the trunk with a dead 12 volt? Look under the trim for a key slot.

mechanically stable because the cells are separated by a ceramic-coated polyolefin material that does not shrink at higher temperatures. This greater thermal stability extends battery life.

Hyundai engineers say that the lithium-polymer batteries can tolerate tens of thousands of charge cycles, without having to use a liquid-cooling system. According to W. C Yang, president of the Hyundai R&D Center, the Sonata Hybrid batteries should supply "300,000 miles with less than 10 percent reduction in performance... that's purely from an engineering point of view, not a warranty point of view." Hyundai currently offers a 100,000 mile/10 year powertrain warranty in the USA market.

Hyundai's Blue Drive Hybrid components consists of, Hybrid Battery Pack Assembly, Hybrid Starter Generator, Hybrid Power Control Unit and the Automatic Transmission including Traction Motor. These are the parts that have the 10 year, 100,000 mile warranty. As of this writing Hyundai is considering a "lifetime" (whatever that is) warranty on the battery pack.

Another claimed advantage is safety. Even if the cell casing is pierced the electrolyte remains contained and the cell resists thermal runaway. The flat packaging also improves the airflow paths and exposes more surface area for cooling. To cool the batteries, a duct draws air in from the passenger compartment through the rear package shelf and exhausts it out the rear of the car.

It all adds up to a battery pack that is smaller, easier to cool and less likely to overheat, which translates into a





Electric Motor that drives the car



This Electric Motor is a lot like the eAssist that came from the BAS designed by GM

car that operates on electric power more often, and for longer periods of time. The batteries cost about the same to produce as lithium-ion batteries, but are perhaps 10 to 15 percent more costly than nickelmetal-hydride batteries.

Two HV Electric Motors

The Sonata has two high voltage brushless ac motors. One mounted between the ICE and a six speed transmission with a clutch on the ICE side and another where you would normally find a 12 volt alternator.



Under the hood you will see a water cooled belt driven HV motor.

This is a well thought out design. If you understand how the VW/Porsche hybrid system works the advantage that this design has over the VW is using a second motor to restart the ICE when it is driving in EV mode. The starter/generator (S/G) is a water cooled belt drive unit not unlike the Buick eAssist. Once you are driving away on electricity only and need the power of an ICE, the S/G (using a belt drive to the front crankshaft pulley) restarts the ICE. The mid- mounted drive motor (3 phase brushless ac) is spinning at this time as the car accelerates and when the ICE rpm matches the electric drive motor rpm, the clutch closes. No slip, no wear and the driver does not notice. Good engineering and smart thinking.

Why this Hybrid is Good

The Sonata Hybrid is unusual in that the car gets better highway mileage than city mileage. The improved highway ratings come from the ability of the system to operate efficiently at higher speeds, the relatively light battery pack, and from the aerodynamic bodywork.

The Sonata Hybrid shares the same fluid body panels with all other 2011 Sonatas but has lighter, more aerodynamic pieces at the front and rear. These changes have reduced the drag coefficient to 0.25, compared to 0.28 for the standard model. At the rear, a unique compound taillight saves electrical power and offers a distinctive "floating triangle" nighttime visual icon.



Also enhancing highway mileage is a LIVC (Atkinsoncycle type) version of the 2.4 Theta II engine, based on the standard 2.4-liter engine in the Sonata, but recalibrated to run on the Atkinson cycle, a common way of improving the efficiency of engines used in hybrids. A fair amount of low-end torque is sacrificed in the Atkinson conversion, but that is made up by the addition of torque from the electric motor. Combined, the engine and electric motor generate 209 hp and 195 lb-ft of torque, compared to 198 hp/184 lb-ft from the 2.4-liter version standard in the Sonata.

While the battery design clearly represents a step forward, Hyundai engineers suggest that the bigger advancement is its use of a clutch to couple and decouple the engine from the transmission. According to Yang, it's an idea that was discarded in the early years of hybrid development, because of difficulties of engaging and disengaging the clutch fast enough to smoothly blend engine and motor outputs.

"The most difficult thing to overcome was the clutch engagement system, to engage without any delay or any shocks. Ten or 15 years ago, the technology was not good enough to accurately control the engine and motor with a clutch. At that time it was not possible. That's why Toyota got away from that idea. By using new advanced electronic systems, we made it possible to engage and disengage very quickly at very high engine speeds. We revisited the old idea with new technology to make it possible." The electronics helping to reduce clutch engagement shock take into account fuel flow, spark advance and throttle position, among other things.

The multi-disc clutch pack sits within the motor and is used to decouple the 2.4-liter engine for idle/stop and electric-drive modes. By allowing higher EV-only speeds, the clutch plays a big part in the Sonata's highway fuel efficiency. With a 17.2-gallon fuel tank, the Sonata Hybrid has a theoretical range of 766 miles.

Technical Information

I write a column for Auto, Inc. 4 times a year about ease of service of newer cars. One song of praise I have for Hyundai/Kia is free technical information. If you have a USA E-mail address go to www.nastf.org and log onto the web site for Hyundai. All the technical information on this car is there.

The Summary

Hyundai has been, all along, a brand built on value much like Honda. There are a lot of things to like about the Sonata Hybrid, and some very promising engineering to boot. But in the end, the appeal of the car will depend on how much one will spend. At \$26,000 Hyundai sold about 27,000 so far. Not bad for a market that is down. Quality, character and operating costs seem to be on par with the competition.

Voltage	Max. 270V
Hybrid System Performance Combined	
Horsepower (estimated)	209.2 hp @ 6,000 rpm
Torque (estimated)	195.41b-ft
Battery	
Power output	34kW
Туре	Lithium polymer battery
Voltage	270V
Weight	95.91bs
Capacity	5.3 Ah
Electric-vehicle operation	Limit of 62 mph
TRANSMISSION	
Six-speed electronic automatic without lock-up torque converter	

The Specifications

