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European carmakers rev up the electro-diesel concept

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Reporting from Frankfurt, Germany

If you think all hybrid cars are like the Toyota Prius -- mirthless, ugly hair shirts of green conscience -- BMW would like you to meet its Vision: a stealth submarine of a car, lower than a boxing foul, all folded geometry and LED tracer lights. The signature BMW grille glows blue like a reactor cooling pond. The transparent doors open like dragonfly wings.

The all-wheel-drive Vision sport coupe is the Usain Bolt of hybrid cars: zero to 60 mph in under 4.8 seconds, top speed of 155 mph, 356 horsepower, and handling and braking comparable to the company's brain-melting M3 coupe.

Fuel economy: 75 miles per gallon. And you can plug it in.

Santa Monica might never be the same.

The Vision is one of several so-called electro-diesels at the Frankfurt Motor Show that put a typically European spin on Japan's signature eco-tech of hybrids. By combining electric motors and batteries with the huge torque and efficiency of direct-injection turbo-diesels, the European automakers are breeding a species of car that delivers V-8 performance with the fuel economy of mopeds.

Behind the menacing grille of the Vision, there's a small, 1.5-liter, 163-horsepower three-cylinder turbo-diesel engine and a big electric traction motor; arrayed like a capital "I" running down the spine of the car are rows of lithium-polymer batteries. At the rear axle is another electric motor, which gives the car essentially all-wheel drive. Together these components produce a whopping 590 pound-feet of torque, considerably more than your average Lamborghini.

The Vision, which uses batteries developed for Apache attack helicopters, is only an experimental vehicle for now. But "all the components are very realistic," said Philip Koehn, BMW's director of concept vehicle development. The batteries, the diesel components and electric motors are "off the shelf," he said.

Too flashy for you? At the other end of the performance spectrum is Volkswagen's L1 concept, a



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hyperlight, tandem-seat oil-burner, like a bobsled for the road. Getting its world premiere in Frankfurt, the L1 is powered by a small, two-cylinder turbocharged direct-injection (TDI) diesel engine and a small electric motor.

The L1's marquee number: 170 mpg, or about four times that of a Honda Insight hybrid. If it comes to market as planned in 2013, the VW L1 could claim the title of most fuel efficient passenger car on the road.

It would also be one of the cleanest. On a carbon-gram-per-mile basis -- that's the emissions metric that Europeans are most concerned with -- electro-diesels can outperform the thriftiest gas hybrids on the planet.

In the case of the Vision, BMW says the car produces 99 grams of carbon per kilometer on its own; plug it in and that number drops to 50 g/km.

To compare, a Toyota Prius has carbon emissions of 89 g/km in the European emission test cycle.

Depending on what you call a hybrid, electro-diesels have already arrived. Audi sells two diesel cars that are equipped with small starter/generators and battery packs to give them stop/start capability (the engine shuts down when the car is put in neutral).

However, Americans think of hybrids as cars with powerful electric motors that can move at low speed on battery power alone. The first such diesel car to come to market will be the Peugeot 3008 HYbrid4. Arriving in spring 2011, this mid-size sport-utility vehicle is expected to get about 62 mpg and produce 99 g/km of carbon.

A HYbrid4 version of the company's RCZ sports coupe is all but certain.

For years European automakers, who are the acknowledged masters of turbo-diesel technology, have quietly stewed as Asian companies reaped the green-image benefits of hybrid technology.

On a cost and emissions basis, German automakers argued, turbo-diesel engines are more efficient. One reason is that diesel fuel itself has a higher energy content than gasoline.

Still, hybrids offer some advantages. They recover kinetic energy as they brake or coast and use it to charge the batteries. They also save fuel by shutting down the internal-combustion engine when the vehicle comes to a stop. And they can move on electric power alone at low speeds, where internal combustion engines are less efficient.

So why not combine the best of both technologies?

Cost, mostly.

"Normal turbo-diesels are already so powerful and efficient [on the order of 30% more efficient than gasoline engines] that it was a challenge to improve on that and very expensive," said Volker Mornhinweg, the head of Mercedes-Benz's high-performance AMG division.

Then there's the inherent incompatibility of diesels and electric power sources. Both produce torque at low revolutions per minute. Gasoline engines, in contrast, produce most of their torque at higher speeds. So in a gasoline hybrid, the engine torque ramps up just as the electric motor torque is falling off. That creates a seamless yin and yang, a complementary blending of mechanical forces that's

missing in the diesel-electric union.

But thanks to some advances in the field, including software necessary to smoothly integrate diesel and electric power, the hybrid diesel equation has become more promising. It's still difficult. And expensive. But the eye-popping gas mileage of this marriage is what keeps the Europeans pushing.

"It's better in terms of total fuel efficiency to make a diesel hybrid," said Christophe Chateau, technology spokesman for French automaking giant Peugeot.

It can also be better marketing. Chateau pointed out that because Peugeot's hybrid system situates electric motors on the rear axle (like some Lexus gas hybrids) the cars are in effect all-wheel drive. Buyers who might not pay the extra price for an electro-diesel might be willing to pay a premium for AWD.

"We will get much more sales for this big amount," Chateau said.

Peugeot and other manufacturers see battery-electric powertrains as the most likely technology for small urban cars of the future. Because of the cost factor, electro-turbo-diesel will probably remain an up-market option. "We will not find this combination in too low-cost cars," BMW's Koehn said.

But there's an unknown out there: the increasing cost to rein in diesel emissions. In Europe, diesel cars command about 60% of the market; however, Europe has less-strict rules regarding diesel emissions of particulates and nitrous oxides.

"If the [European Union] moves to the emissions standards of the U.S.," said Koehn, "diesel will become more expensive and the relative cost-benefit of hybrid and diesels will change."

As Europe and the U.S. get closer in emissions regulations, the cost to homologate (legally certify) cars for both markets will drop. So one day, the hybrid that blows your doors off might itself have transparent doors.

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